C V F P P

AUGUST 2017

Central Valley Flood Protection Plan Investment Strategy Highlights

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Historical Perspective

The original purpose of the Central Valley flood management system was to reduce seasonal flooding on rural-agricultural lands while maintaining navigable channels for commerce. Local landowners built levees with dredged material to support this agricultural development. There was no coordination or agreement between landowners for levee size or downstream capacity, so levees usually failed 2 out of 5 years (Kelley, 2008).

In 1910, the California Debris Commission produced the Jackson Report, which proposed a State-federal plan of coordinated channels, bypasses, and miles of unsophisticated levees to mostly reduce agricultural flooding and protect some small cities. Additional plans for San Joaquin improvements followed. Since that time, the flood management system has evolved to serve multiple needs of modern society, but without many modern engineering and other needed upgrades, including:

- Engineering standards and knowledge
- Operations and maintenance regulation manuals
- Frequency and funding for routine operations and maintenance

Prolonged over many years, insufficient funding has led to deferred routine maintenance and repair and further degraded the design life and performance of facilities.

*Battling the Inland Sea, Robert Kelley, 2008

Contents

Cover: Crews shore up the south levee of the Tisdale Bypass in 1997. DWR photo.

Changing Conditions Demand Action

Challenges are increasing for an aging system

The State's past investments in flood management have begun to improve the flood system. For example, considerable investments in the past decade prevented the impacts of the 2017 storm events from being much worse. Critical repairs, forecast-coordinated operations of dams, improved and new infrastructure, and informed floodplain management helped prevent flooding in many regions in California. Areas of recent investment performed well. But much more remains to be done.

All elements of the flood system are aging and vulnerable, and we must look ahead: $17 to $21 billion of investment is needed over 30 years in the Central Valley.

The State Plan of Flood Control, the series of levees and other facilities for which the State has responsibility, provides flood protection for people and property in the Central Valley. However, past approaches to flood management and investment are not keeping pace with the demands of today and projected future conditions.

- Despite recent advances in flood management, over a million people and billions of dollars in assets are exposed to significant flood risk in the Central Valley.
- The system for managing flood waters was not originally designed to meet the expansive demands and benefits it is now expected to provide.
- Investment has been largely reactionary and sporadic, not sustained and proactive.
- Operations and maintenance is chronically underfunded, but is critical for system performance and public safety.
- Climate change will significantly affect flood risk and needed improvements.

A clamshell dredge uses river-bottom material to form unengineered levees in the Central Valley, circa 1910–1930.

100 YEARS OF EVOLVING FLOOD MANAGEMENT

1917 — **LOCAL LEADERSHIP ERA**

PARTNERSHIPS AND SUSTAINABLE FUNDING — **2017**

1917		2017
$110 million authorized for Sacramento River Flood Control Project	**INVESTMENT**	$17 to $21 billion Investment needed systemwide for both river basins
Safely convey large flows	**NEED**	Safely convey large flows, plus water supply, ecosystem, recreation
Predominantly rural agriculture	**LAND USE**	Widely varied: urban centers, industry, small communities, rural agriculture, public space
3+ Agencies	**AGENCIES AND REGULATION**	500+ Districts and agencies (Local, State, and Federal)
Local materials and practices, urban and rural not differentiated	**DESIGN AND CONSTRUCTION STANDARDS**	Engineered structures with design life, advanced geotechnical practices and materials
No reservoirs, scouring flows, minimal historical data	**STORAGE AND FLOWS**	Many reservoirs, coordinated operations, regulated flows for multiple objectives, robust data
Generally not considered	**ECOSYSTEM**	Habitat and species decline are critical concerns
Simple and adequately funded	**MAINTENANCE**	Conflicting regulations and inconsistent funding result in deferred maintenance

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Note: All values in 2016 dollars.

Learning from the Past, Preparing for the Future

Dramatic storm events and flooding are a natural phenomenon in the Central Valley. Today, more than 150 years of experience and hydrologic data provide us with a robust understanding of the Central Valley's hydrology and how to better prepare for and manage flood risks. This knowledge enables us to not only learn from the past, but also better forecast likely future scenarios.

NOTE: Damage values provided in 2017 dollars

1862 Downtown Sacramento

BATTLING AN INLAND SEA—FOREVER

- Agricultural levees defeated
- Over 1,000 fatalities
- Approximately $240 million in statewide damages

1955 Yuba City

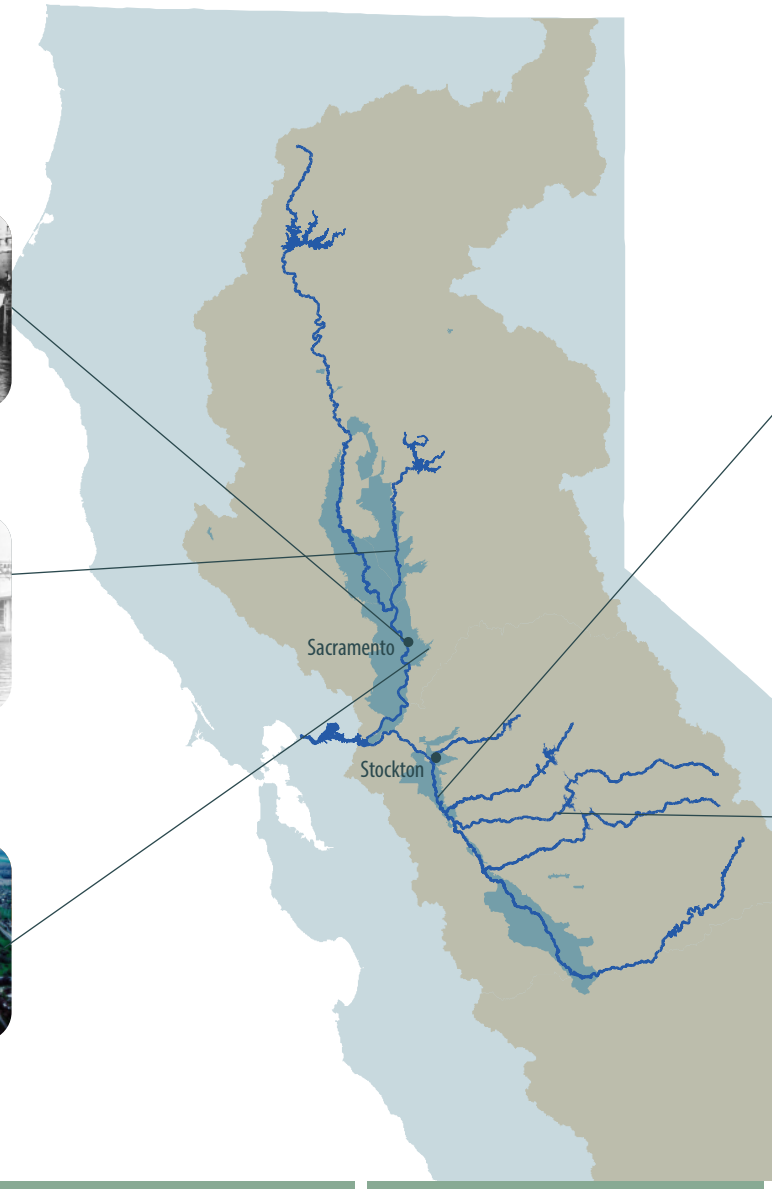
CATASTROPHIC CHRISTMAS SURPRISE

- Triggered Lake Oroville Dam construction
- Two levee failures at night result in 38 fatalities
- Approximately $1,300 million in statewide damages

1986 American River

LARGEST URBAN THREAT IN 100 YEARS

- Record flows on Sacramento and American rivers overtop levees and inundate hundreds of homes
- 13 fatalities statewide
- $332 million in Sacramento Basin damages



Event	1862	1955	1983
Preceding Conditions	Heavy snow Nov–Dec '61, then 4 large warm storms	Wet Dec '55 to Jan '56, intense period at Christmas.	Previous wettest season and large snow pack
Storm Pattern			
Rainfall Detail	>25 in. over 19 days	8–16 in. over 4 days	Double average annual rainfall

San Joaquin River 1983

RECORD YEAR FOR BASIN

- 77.4 inches of rain – the standing San Joaquin record
- High water content in large snow pack creates approximately 4 times the average runoff
- $681 million in San Joaquin Basin damages

Central Valley–Wide 1997

DEVASTATING SYSTEMWIDE FLOODING

- More than 40 levee failures
- New Don Pedro and Millerton Lake exceed design capacity
- $757 million in Central Valley damages

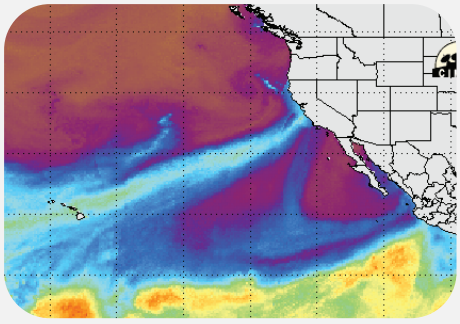
Tuolumne River 2017

SYSTEM INTEGRITY CHALLENGED

- New Don Pedro Emergency Spillway operated
- 71.5 inches of rain in San Joaquin basin (as of June 30)
- Record snowpack continues melting
- $1 billion in statewide damages and counting...

Possible Future Scenario

Central Valley flooding is a chronic problem. Almost every 10 years, a major event strikes. These flooding challenges will not go away, and climate change brings greater uncertainty of the size and frequency of future storm events and related flood risk.



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What are we preparing for?

A series of large, warm atmospheric rivers striking when Sierra snowpack is high and the flood management system is already at capacity.

How do we make the system more resilient?

Invest in bypass expansions, robust levees, reservoir enlargement and forecast-informed operations, easements, and emergency response.

Why should Californians pay for this?

Preventing the consequences of a disaster is a more cost-effective and responsible strategy than recovering from a disaster.

1986	1997	2017	Next Problematic Event
Dry Dec '85 to Jan '86, then 4 Feb storms	Wet Dec '96, largest flood event at New Year	Historic drought, then wettest season in Central Valley	Average season fills reservoirs, then major atmospheric river event followed by steady smaller events
12–50 in. rainfall over 10 days	30 in. rainfall over 3 days (75–100 yr event)	Steady series of moderate storms	Not a new wettest season, but punctuated by large storms

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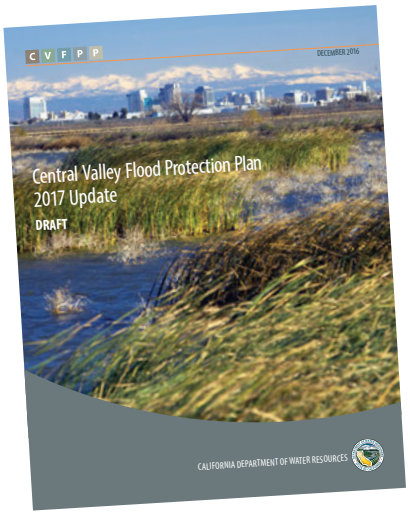
Risk is Increasing

Even with substantial flood management progress in the last decade, there are still unacceptably high levels of flood risk for many people and property in California's Central Valley.

- More than 1.3 million people are exposed to risk of flooding.
- Approximately $80 billion of infrastructure and other physical assets are exposed to risk of flooding.
- More than 500 species of native plants and wildlife rely on habitat found in the Central Valley. Habitat degradation in many areas has stressed ecological processes and sensitive species.

Furthermore, with population within the State Plan of Flood Control Planning Area projected to increase by 70% over the next 50 years; exposure to people, property and ecosystems will continue to increase.



Strategic Investments Promote Sustainability

Diverse systemwide investments phased over time are needed

The flood management system is aging. Many elements of the system are over 100 years old and are at the end of their life cycle. Substantial improvements of the system are needed to upgrade to modern engineering standards, serve multi-purpose uses, and meet the needs of modern society. A modern society that calls for reasonable public health and safety, sustainable ecosystems, a stable economy, and opportunities for other enriching experiences.

The Central Valley Flood Protection Plan has guided the State's participation in managing flood risk in areas protected by the State Plan of Flood Control since the plan's adoption pursuant to the Central Valley Flood Protection Act of 2008 (Act) in 2012. A strategic, long-range plan, the Central Valley Flood Protection Plan describes a programmatic vision for flood system improvements over time in accordance with the requirements of the Act.

The Central Valley Flood Protection Plan was prepared by the Department of Water Resources (DWR) and adopted by Central Valley Flood Protection Board (CVFPB) through Resolution 2012–25. Pursuant to the requirements of Senate Bill 5, the Central Valley Flood Protection Plan's first update is in 2017.

- Long-range plan updated on a 5-year cycle.
- Programmatic vision for flood system improvements over time.
- Descriptive document, not a decisional document; it is not a funding or permitting decision for specific projects.
- Guide to recommended investments and policies to support comprehensive flood risk management actions locally, regionally, and systemwide.
- Informs important statewide planning:
  - 2017 Statewide Flood Investment Strategy
  - 2018 California Water Plan Update
  - California's Five Year Infrastructure Plan (updated annually)

> A strategic, long-range plan, the Central Valley Flood Protection Plan describes a programmatic vision for flood system improvements and investment over time.

Preparing the Investment Strategy

Once the 2012 Central Valley Flood Protection Plan was developed, it was clear that a robust analysis was needed to focus on effective implementation. The 2017 Central Valley Flood Protection Plan Update provides implementation recommendations at a programmatic level, as well as an investment strategy that describes the funding options necessary to make the recommendations a reality.

The Central Valley Flood Protection Plan investment strategy considers the uncertainties of future funding as "prescribed constraints." Prescribing investment constraints allows flood managers to project future variabilities, understand different funding scenarios, and better prepare to navigate the future. The following "prescribed constraints" were considered:

- Outcomes and priorities of a variety of flood management actions
- Cost estimates provided by several supporting studies and efforts completed since 2012, including six Regional Flood Management Plans
- Phasing of flood management actions
- Availability and applicability of existing and potential new funding mechanisms
- Nexus of funding mechanisms and cost-sharing partners
- Other external Influential factors such as ability and willingness to pay

The financial model varied these constraints to analyze several possible funding scenarios. The investment strategy recommends an optimal funding scenario that fully funds the portfolio presented in the 2017 Central Valley Flood Protection Plan Update. The funding plan is one component of the investment strategy.

Regional Flood Management Plans

The six Regional Flood Management Plans, led by local agencies and funded by the Department of Water Resources, were critical to developing the 2017 Central Valley Flood Protection Plan Investment Strategy. These regional plans included financing or funding plans that provided important regional perspective on investment priorities, ability and willingness to pay and cost sharing capabilities.

2017 CVFPP Update — States why flood investments are needed and proposes a portfolio of actions.

Investment Strategy — Recommends a strategy to fully fund the refined portfolio of actions described in the 2017 Central Valley Flood Protection Plan.

Recommended Funding Plan — Describes the cash needs necessary for the prioritized investments, and identifies potential revenue sources to pay for prioritized investments.

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Investment Portfolio

The 2017 Central Valley Flood Protection Plan Update presents a portfolio of management actions that provide a reasonable and balanced vision of improvements for the State Plan of Flood Control. These improvements are intended to be implemented at a systemwide scale alongside improvements for urban, rural and small communities over a 30-year period after further project-level analysis is complete. A total investment of approximately $17 to $21 billion over 30 years is split between ongoing investments and capital investments.

Residual risk can be reduced by ongoing investments such as better emergency response and routine maintenance.

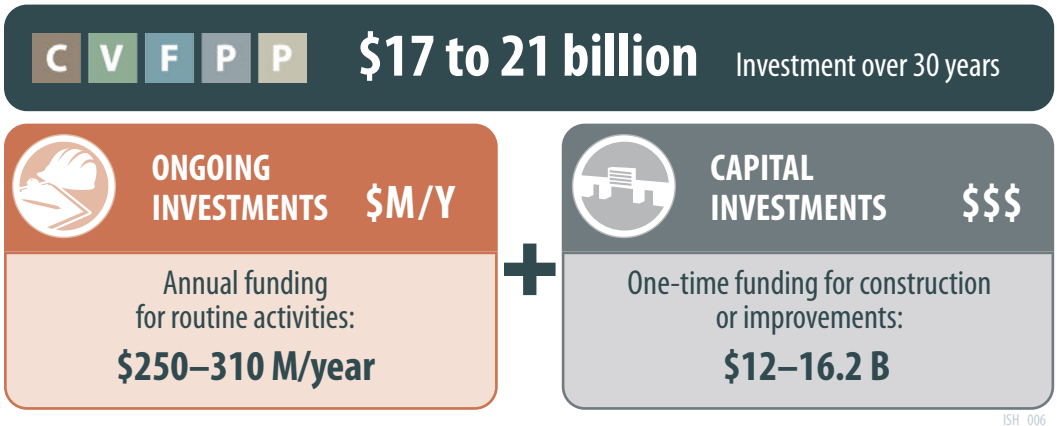
- **Ongoing investments**, such as better emergency response and comprehensive maintenance, most effectively reduce residual risk within the flood system. Residual risk is the risk remaining after all flood management actions have performed as intended.

Resilience can be improved across the system by capital investments such as expanded bypasses and levee setbacks.

- **Capital investments**, such as expanded bypass capacity and levee setbacks, provide the most resiliency across the flood system. Resiliency is the ability of a system or community to recover from a shock, such as an extreme flood, or to successfully adapt to adversity or changing conditions, such as climate change, in a timely manner.

Acknowledging and separating capital investments and ongoing investments in the 2017 Central Valley Flood Protection Plan Update is a major refinement of the 2012 Central Valley Flood Protection Plan. This separation of funding types is beneficial because it helps identify funding shortfalls, appropriate funding mechanisms, and areas for priority funding.

Ongoing investments provide the annual baseline funding needed for routine activities, whereas capital investments are one time investments that generally involve construction or expansion of infrastructure. Each type of investment is discussed and calculated separately.



Funding Mechanisms and Cost-Sharing

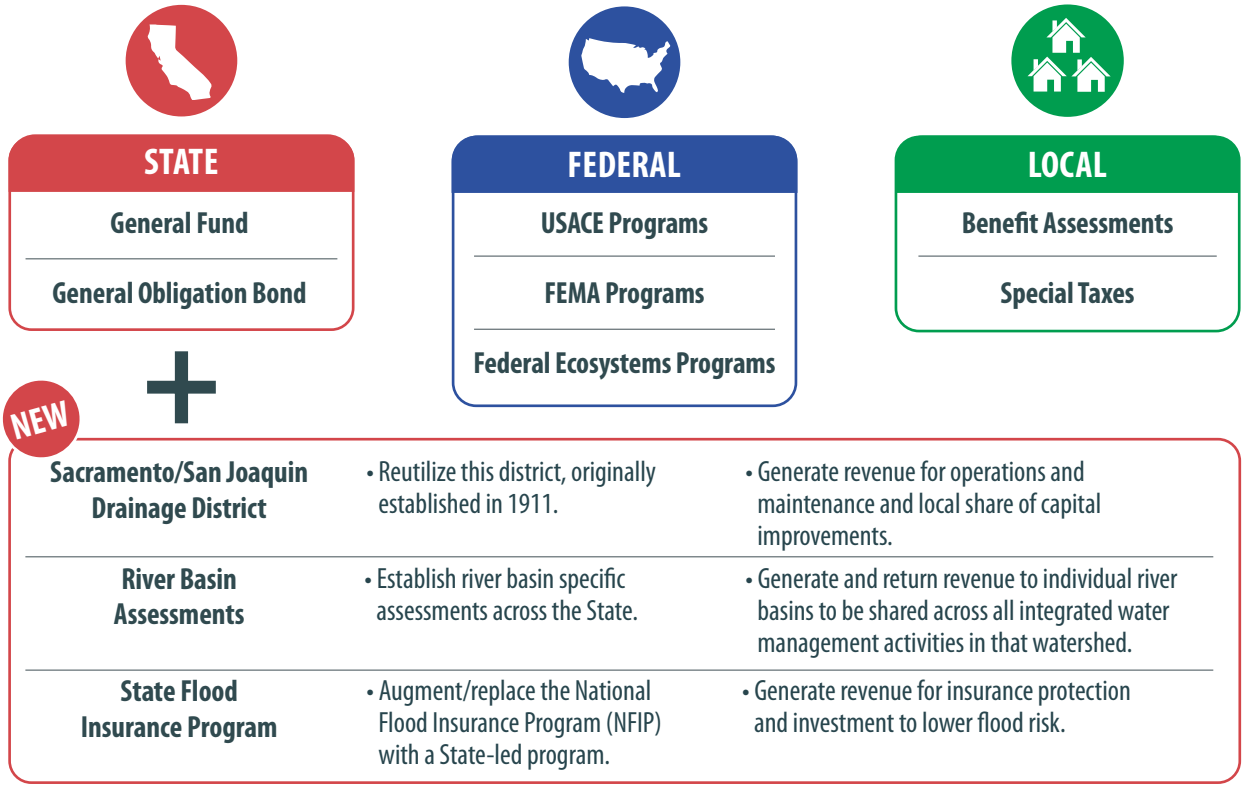
Three levels of government—State, federal and local—are needed to fund implementation of the Central Valley Flood Protection Plan using existing and potentially new funding mechanisms. Understanding each cost-share partner's priorities is the best way to identify the strength of their nexus to potential funding. All cost-sharing partners have a common interest in the following values:

- Provide for public health and safety
- Sustain vital ecosystems
- Support a stable economy
- Provide opportunities for enriching experiences (other benefits)

All cost-sharing partners will be asked to contribute significantly more than they have in the past, because historical revenue amounts (before Propositions 1E and 84) would only be able to fund approximately 20 percent of needed investment. Furthermore, funding from these propositions is anticipated to be exhausted by fiscal year 2019–2020.

A host of existing and potential new funding mechanisms were considered for funding the 2017 Central Valley Flood Protection Plan Update and applied in the financial model. New funding mechanisms play a critical role in securing consistent and ongoing funding when other sources are unavailable.

Tremendous shared responsibility and effort across all levels of government is required.



ONGOING INVESTMENTS $M/Y

Annual funding
for routine activities:
$250–310 M/year

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Focusing on Ongoing Investments

Ongoing investments are continuous annual investments that are critical to the long-term sustainability and performance of the flood management system. The 2017 Central Valley Flood Protection Plan Update recommends dramatic increases to ongoing investments from the amount currently spent. A ramping scheme was applied to all ongoing investments to provide the State and its partner agencies with enough time to establish the necessary staff, resources, and mechanisms needed to accommodate the influx of annual funding if obtained, while still maintaining their routine activities.

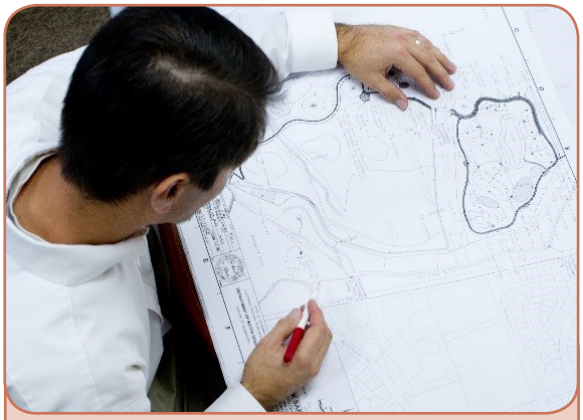
Ongoing investments include routine operation and maintenance activities (approximately half of the total ongoing investment, $130M/year). However, annual emergency management, routine reservoir operations coordination, and annual State flood planning and analysis make up a considerable portion of this investment. It is important that these other activities also have secure and sufficient annual funds.

Ongoing investments are critical to system performance and sustainability.

Routine operation and maintenance
coupled with reduction of environmental stressors

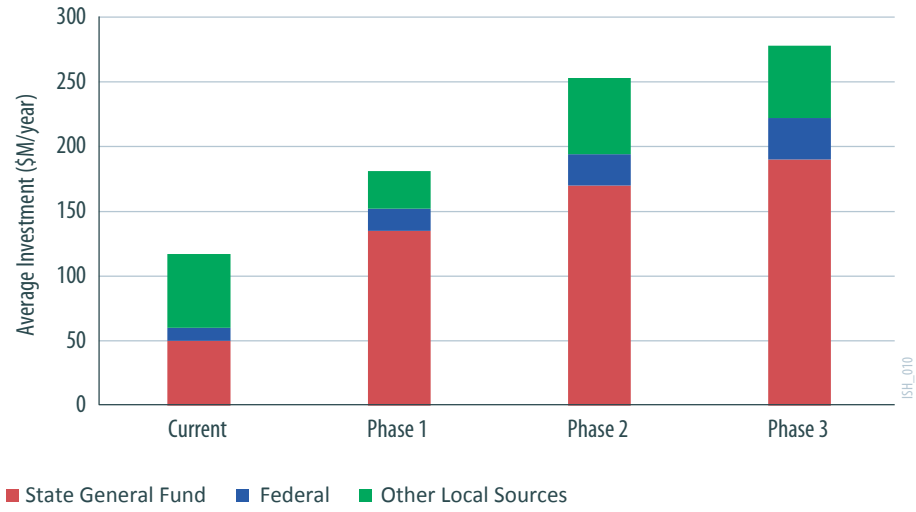
Annual emergency management
coupled with preparedness drills
and flood risk awareness outreach

Routine reservoir operations coordination
along with forecast-informed operations

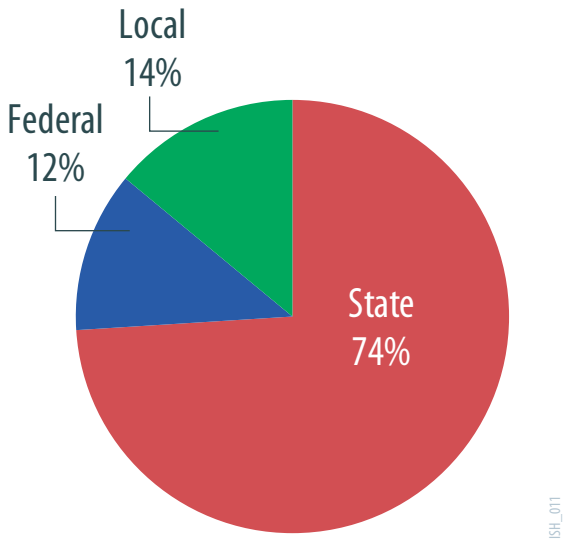


Annual State flood planning and analysis
along with local agency coordination and assistance

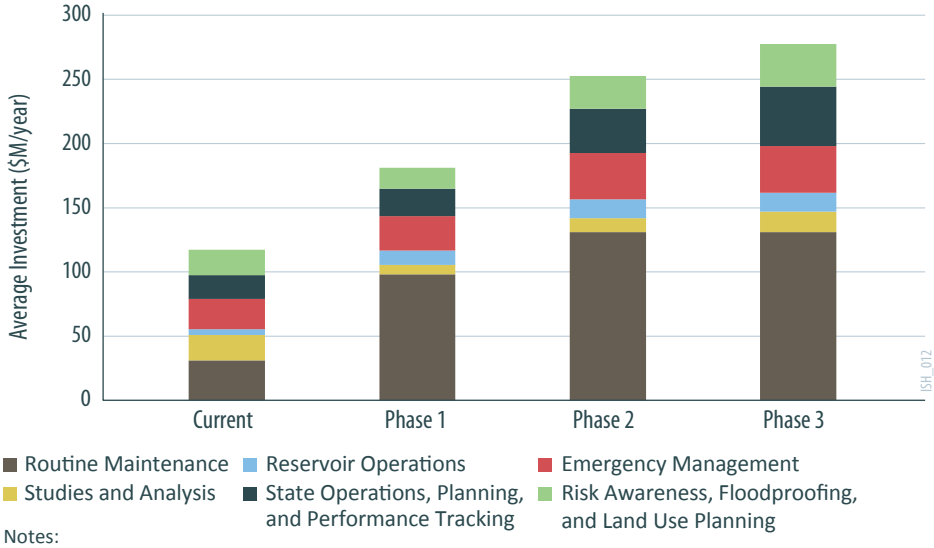
- ✓ Funding plan recommends greater contributions from the State General Fund for ongoing activities.
- ✓ Consistent and stable new mechanisms are needed to supplement the State General Fund contributions.



- ✓ Heavier reliance on State funding sources is needed because of limited federal resources.
- ✓ Larger than historical contributions are required from local sources for ongoing activities.



- ✓ Ramping of ongoing investments over three 10-year phases allows time to build necessary resources and capacity.
- ✓ Immediate funding increases in critical routine maintenance are prioritized before any other actions.



Notes:
1. All estimated dollar values are in 2016 dollars and indicate average annual investments made over 30 years. They have not been discounted to present value nor escalated for inflation.
2. Ramping of investments shown represent capacity building of staff and resources, it is not intended to account for escalating costs from inflation.

CAPITAL INVESTMENTS $$$

One-time funding for construction or improvements:

$12–16.2 B

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Focusing on Capital Investments

Capital investments are one-time investments that make up a large portion of the 2017 Central Valley Flood Protection Plan Update and improve flood management across the Central Valley. These investments range in scale, cost, and benefit.

Capital investments include new construction, expansion of existing or replacement of flood infrastructure features such bypasses, weirs, levees, and setback levees. Also included are new construction or expansion of enhanced habitat restoration and reconnection features, and floodplain storage features with necessary land acquisitions and easements.

Diverse capital investments increase system resilience.

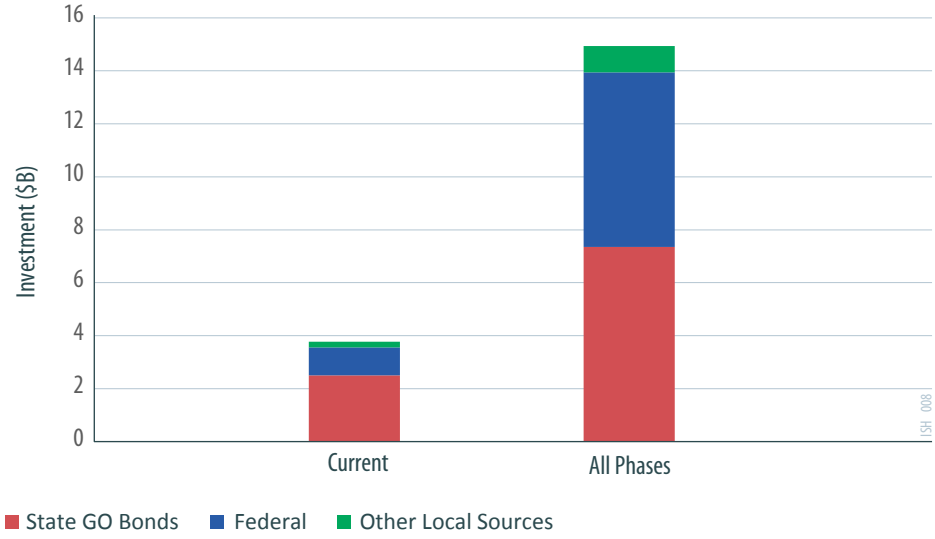
Bypass expansions
coupled with ecosystem enhancement and multi-benefit improvements

Levee upgrades for urban areas
coupled with critical levee repairs for rural areas

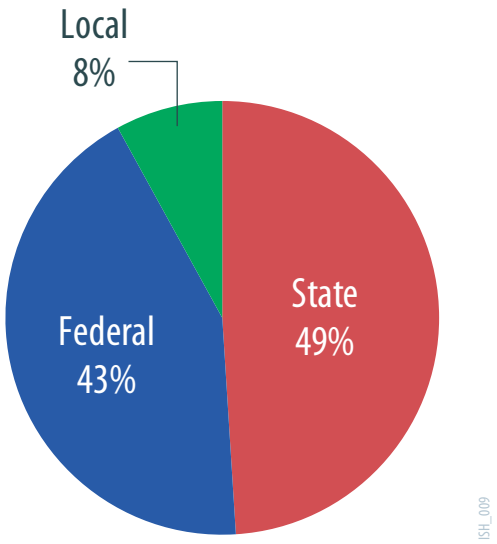
Storage capacity increases
and alternative floodplain storage options

Levee setbacks and floodplain storage
and habitat restoration/reconnection options

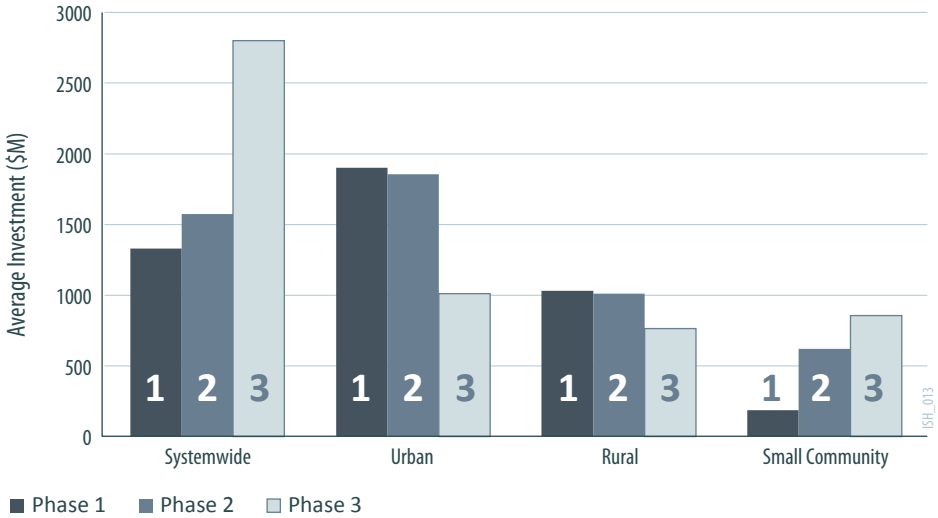
- ✓ Funding plan recommends greater contributions from USACE for capital investments.
- ✓ New general obligation bonds must provide financing for capital investments.



- ✓ Heavier reliance on State and federal cost-sharing partners is needed because of limited local ability to pay.
- ✓ Increased local assessments are needed to meet cost-share requirements of new State and federal funds.



- ✓ Three 10-year phases differentiate near- and long-term needs.
- ✓ Reducing the highest levels of risk to lives and assets are prioritized in Phase 1.



Note: All estimated dollar values are in 2016 dollars and indicate an investment over 30 years.

Recent Events Highlight Risk

Diminished funding, increased risk, and heightened public awareness demand action now.

"Recent storms have pounded the state of California, resulting in dam spillway eroding, roads crumbling and levees failing. Our aging infrastructure is maxed out. We can take some immediate actions – and we will – but going forward we'll need billions more in investment."

Governor Edmund G. Brown, Jr.
February 2017

Over the past 5 years, the Central Valley experienced a severe multi-year drought that largely diverted the attention of water managers and emergency responders. California's climate of extremes then swung from drought to flood, and a statewide flood emergency was declared. Now, 2017 has become one of the wettest years on record in the Central Valley.

Flood events in the past year renewed public focus on the need for adequate flood risk management. This public focus offers an opportunity to advance long-term flood protection goals and prepare for future flood events by shifting from reactive to proactive investment.

Learning from the Last Decade

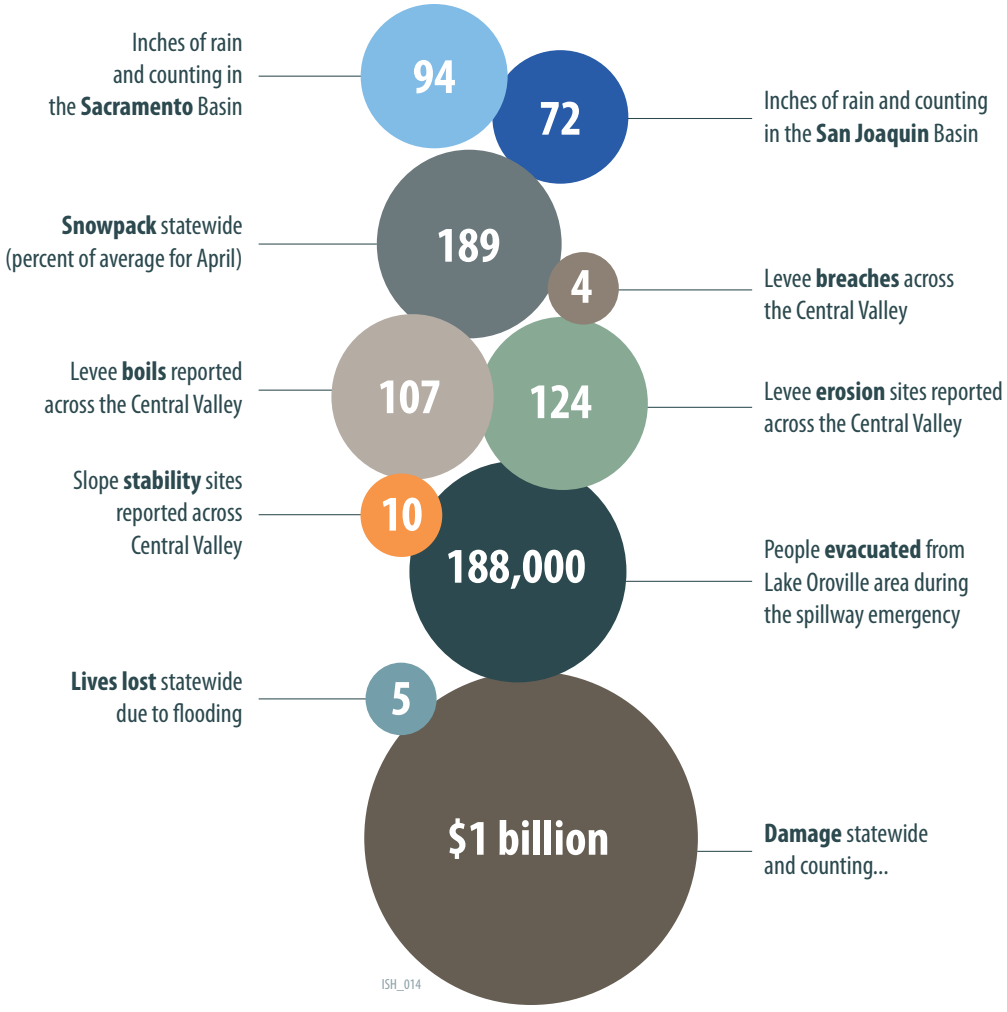
- **Progress is steady, but more work remains.** General obligation bond funding has supported progress of repair, rehabilitation, and improvement of about 220 miles of urban State Plan of Flood Control levees (out of 300 miles) and about 100 miles of non-urban State Plan of Flood Control levees (out of 1,300 miles) since 2007. *Significant investment contributions are required from all cost-sharing partners.*
- **Flood management receives a small portion of State dollars.** Although a historic flood investment, the authorized 2007 general obligation bonds provided only 6% of the statewide total for flood management. *New and sustained funding mechanisms are critical to ensuring sustainable ongoing investments such as operation and maintenance.*

- **Flooding is a chronic problem in the Central Valley and will be intensified by climate change.** Nearly every 10 years, a major event occurs: 1986, 1997, 2006, and 2017. Flooding challenges will not disappear, and neither the Sacramento Basin nor the San Joaquin Basin are prepared for the inevitable future. *Political actions are needed to elevate flood management issues to the forefront of public discussion.*
- **Reactionary investment is powerful but not sustaining.** Hurricane Katrina's devastating floods prompted action in California to pass Propositions 1E and 84 in 2007 for $5 billion in general obligation bonds. *Additional new general obligation bonds are vital to implementation of significant capital improvements.*
- **Partnership is key.** All partners and stakeholders have built momentum and consensus around pivotal issues. *Stronger partnerships between State, federal, and local agencies are essential over the next 30 years.*

Flooding by the Numbers: Water Year 2017

The 2017 water year serves as a reminder of the work left to be done. With the Oroville Dam Spillway under repair, communities throughout the State recovering from flooding, and the snow pack still melting—we are reminded that the consequences of flooding can be devastating. The following statistics provide a tally of consequences as of June 30, 2017.

- **All elements of the flood system are aging and vulnerable.** The Oroville Dam and Spillway was completed more recently (1968) than many capital infrastructure projects in the downstream flood system. With the incident that occurred in February, we are reminded that catastrophic failure and vulnerability applies to all flood system elements despite their age.
- **Identified areas of concern must be fixed.** Many areas in the State Plan of Flood Control need critical repairs and reinvestment.
- **Emergency response and coordination is substantially better.** Over the past several years, the State has worked with local emergency agencies to ensure flood emergency response plans are updated, coordination has increased, roles and responsibilities have been clarified, and response techniques have been practiced with preparedness drills and training classes.
- **Areas of recent investment performed well.** Levees and infrastructure that have seen renewed investment in the last 10 years for improvements and upgrades, performed substantially better than in past major flooding events, particularly in urban areas. Areas with known deficiencies that are awaiting improvements suffered from expected chronic problems, including levee erosion, seepage, and slope stability.



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Today's Reality

Although past investments in flood management have delivered results, much more needs to be done.

Aging infrastructure, deferred maintenance, and climate change have intensified the risk to people and property. It is only a matter of time before the Central Valley's next significant flood event.

Call to Action

All Californians are responsible for the Central Valley flood management system and benefit from it in some way (such as flood protection, water supply, and recreation). Preventing the consequences of disasters is a more cost-effective and responsible strategy than recovering from disasters. Therefore, all Californians and levels of government must commit to providing sufficient, stable, and long-term investment in Central Valley flood management.

- Significant investment contributions are required from all cost-sharing partners
- New and sustained funding mechanisms are critical to ensuring sustainable ongoing investments such as operation and maintenance
- Political actions are needed to elevate flood management issues to the forefront of public discussion
- Additional new general obligation bonds are vital to implementation of significant capital improvements
- Stronger partnerships between State, federal, and local agencies are essential over the next 30 years

EDMUND G. BROWN JR.
GOVERNOR
STATE OF CALIFORNIA

JOHN LAIRD
SECRETARY
THE CALIFORNIA NATURAL RESOURCES AGENCY

GRANT DAVIS
DIRECTOR
DEPARTMENT OF WATER RESOURCES

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