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October 18, 2011

TO: Central Valley Flood Protection Board

FROM: Paul Brunner, TRLIA Executive Director PAB 10-18-2011
Ric Reinhardt, TRLIA Project Engineer
Scott Shapiro, TRLIA General Counsel

SUBJECT: Background Information for Briefing on TRLIA Interim Findings of Flood Risk Analysis of the Yuba Goldfields at CVFPB October 28, 2011 meeting

Background:

The Yuba Goldfields (Goldfields) is located on the south side of the Yuba River in Yuba County, California, just northeast of Marysville; see Figure 1 of the attached Technical Memorandum. The Goldfields encompass approximately 10,000 acres and were formed by dredging of the hydraulic mining debris from the Yuba River floodplain.The remnant mounds of sands, gravels, and cobbleswere deposited along the active river bank and interior floodplain creating the irregular hills and ponds seen today. Active gold recovery from floating dredges continues today. In addition, asgold recovery mining operations declined, aggregate mining operations were initiated.

The Goldfields currently has irregularly shaped gravel/cobble mounds, ravines, streams, and ponds. Water moves through the Goldfields by a combination of surface flow, subsurface flow, and seepage through the gravel/cobble mounds. This makes for a very complex hydraulic flow pattern through the Goldfields. In addition, ongoing gold dredging and aggregate mining operations continually change the topography.

Training walls along both sides (north and south) of the active YubaRiver main channel were originally constructed in the early 1900s to control the location of the YubaRiver. This work was performed under the direction of the California Debris Commission. The Debris Commission was dissolved in 1986 and their remaining responsibilities in the Goldfields were transferred to the United States Army Corps of Engineers (USACE). The Training walls were considered to be an experiment when they were constructed and it was understood at that time that they would need to be monitored and maintained. USACE does not consider the training walls to be flood protection facilities and does not actively monitor or maintain these structures. These training walls consist of dredge tailings deposited to significant heights (estimated 10-20 feet of freeboard above the 100-year flood elevation) and top widths that vary, but can be up to 500 feet. The south training wall prevents YubaRiver flood waters from directly entering the Goldfields.

The flood risk to South Yuba County as a result of flooding from the Goldfields is of interest to the Three Rivers Levee Improvement Authority (TRLIA), as they strive to implement a program to provide 200-year flood protection to this urban area. Since 2004, TRLIA has implemented significant levee repair projects with a goal of providing 200-year flood protection to the communities of Linda, Arboga, Olivehurst and Plumas Lake. TRLIA is currently constructing the final phase of levee repairs on the south levee of the Yuba River, from Simpson Lane to the Goldfields. This last reach of levee protection ties into the Goldfields with the assumption that the Goldfields serve as high ground.

In March 2010, the USACE gave a presentation to the CVFPB which included a summary of the results from their hydraulic analysis of the Goldfields area. The USACE analysis led itto conclude that the Goldfields did not present a flood risk for the Yuba Basin for a 100-year storm event,but did present a flood riskat the 200-year storm event. The USACE analysis was a coarse level 2-dimensional analysis to ascertaina conservative estimate of flood damages and costs for their Yuba BasinGeneral Reevaluation Report. The USACE presentation also concluded that there was not a Federal interest in an engineered solution to extend existing flood protection, specifically constructing a new levee south of the Goldfields area.

Discussion:

TRLIA's goal is to provide 200-year protection to the RD 784 levee protected area. In an effort to better define residual flood risk associated with the Goldfields, TRLIA has refined and expanded the hydraulic analysis of the Upper Yuba River to include the most recent topographic information available for the Goldfields and to develop a comprehensive 2-dimensional hydraulic model to simulate surface flow through the complex Goldfields area and into the RD 784 protected area should a breach occur in the South Training Wall of the Yuba River. In addition to the hydraulic modeling, TRLIA has evaluated the South Training Wall to examine how this feature has performed during past flood events and determine the reliability of the training wall to safely pass a 100 -year flood event. Preliminary results from the TRLIA analysis were completed in August 2011. This staff report presents the initial results to the CVFPB.A more detailed memorandum of the technical analysis done for the Goldfields is attached to this summary report. The figures referred to in this summary report are located in the attached Technical Memorandum.

Analysis:

TRLIA obtained recent topographic information from DWR to use in identifying potential flow paths through the Goldfields in the event of a breach of the South Training Wall. This analysis was difficult in that there are many potential pathways. However through careful analysis of the topography, discussion with the mining operators and others familiar with the Goldfields about how water flowed in the goldfields during past flood events, and comparisons to past large flow events, TRLIA was able to identify the most likely pathways for flows through the Goldfields and the most probable exit points from the Goldfields into the RD 784 protected area. Historic aerial photography of the Goldfields was analyzed to see how mining and dredging operations are changing these flow paths and to evaluate how past

flood events did not break out of the Goldfields and why those same size flood events might flow through the Goldfields today.

A profile of the 100-year flood event in the Yuba River was plotted along with profiles of the top elevation and width of the South Training Wall,see Figure 6. It was also noted where the current location of the YubaRiverdirectly attacks the South Training Wall. This helped to identify sites of greatest risk of a breach in the South Training Wall. These potential breach sites were categorized as either Tier 1 or Tier 2 with Tier 1 sitesbeing most probable to breach in the near future, see Figure 7. Two (Sites B and F) of the Tier 1 sites were evaluated by looking at historic photographs and plotting the erosion of the training wall at these locations. Erosion ranged from 150 to 175 feet over the last 45 years, see Figures 16 and 38.This analysis demonstrates that the YubaRiver is meandering south and is actively eroding the South Training Wall. This meandering has the potential to cause a breach in the South Training Wall during the next flood event, see Figures 18 and 40.When a breach develops at either Site B or F, flows can enter channels in the Goldfields, flow through the Goldfields and exit into the RD 784 urban area, see Figures 18 and 40. Additional historic photographic analysis has identified landform changes within the Goldfields created through mining and dredging operations which have made it easier for flood waters to flow through the Goldfields and exit into the RD 784 area, see Figure 28. This analysis shows that contrary to early reconnaissance findings by USACE, there is a newly identified risk of flooding from the Goldfields for floods more frequent than the 100-year flood as a result of landform changes made by aggregate miners and a gold dredger and also from a more detailed understanding of the historic rate of erosion of the Yuba River training wall.

Whenthe breach develops at Site B, floodwaters would enter the RD 784 area and create a floodplain as depicted in Figure 19. A breach at Site F would create a floodplain as shown in Figure 41. The third Tier 1 location, Site D, is a location of low ground where high flows in the Yuba River can enter the Goldfields and flow through the Goldfields in the same manner as flows from a breach at Site F would, see Figure 29. The floodplain in the RD 784 area would be similar to the Site F breach floodplain, Figure 41.

Solution:

With the Goldfields flood threat verified by more recent information and a more stringent analysis; and the mechanism of flooding identified in detail, TRLIA has developed a four phase plan for reducing this flood threat and providing sustainable 200-year flood protection for RD 784.TRLIA has identified available funding and, as detailed below, completion of the work is dependent upon TRLIA's ability to secure this funding.

Work Plan

Phase 1 consists of immediately modifying locations within the mining areas that have been identified in the TRLIA analysis as flow paths and completing agreements with mining operators to establish maintenance responsibilities for these features. TRLIA has identified solutions that consist of re-establishing high ground mounds at key locations to prevent flow from entering RD 784, see Figures 52,53,54,55 and 56. TRLIA has negotiated and signed contracts with the mining companies in the Goldfields to construct these high ground mounds using the mining companies' authorities to mine in the Goldfields area. TRLIA will oversee this construction and will negotiate maintenance agreements with the mining companies to ensure that these high ground features remain in place. This work is currently underway and

will be completed this fall with the help of the mining companies. Additional analysis in Phase 2 will verify what additional work, if any, is necessary to meet 100-year requirements.

Phase 2 will entail modifications of any additional mining areas that are subsequently identified as necessary to certify that the RD 784 area meets FEMA's criteria for the 100 year flood event. TRLIA will perform additional hydraulic modeling, as needed and will have geotechnical evaluations performed to verify that high ground mounds within the Goldfields that must retain 100-year flows are adequate to do so. If additional high ground solutions are needed to retain the 100-year flow, TRLIA will develop a plan to construct these improvements. TRLIA will oversee any new construction and will negotiate maintenance agreements to ensure that these high ground features remain in place. TRLIA may be able to complete Phase 2 in 2012 depending upon the severity of the costs and the willingness of the State to cost sharein this effort.

Phase 3 is devoted to development of a sustainable 200-year plan involving all stakeholders (Federal, State, Local, and Private) that:

- Ensures future mining operations do not increase flood risk
- Provides 200-year flood protection for the RD 784 area
- Repairs the South Training Wall and other land features identified that are needed for 200-year flood protection
- Maintains the South Training Wall and other land features identified that are needed for 200-year flood protection

This phase is proposed to be completed by September 30, 2013.The accomplishment of this task will take cooperation from all involved parties: Mining Companies, USACE, CVFPB, DWR, SMGB (Mining and Geology Board), Yuba County, YCWA, and TRLIA.

Phase 4 will be the implementation of the 200-year plan developed in Phase 3. Physical modifications to the Goldfields as identified in the sustainable 200-year plan will be accomplished. This phase will also require the implementation of a long-term mechanism for governance and oversight of Goldfield mining operations to ensure and sustain 200-year protection. This effort would need to be funded from both State and local funding. This phase is proposed to be completed by 2025 or earlier to meet the Senate Bill 5 date.

Funding

TRLIA has identified available funding for this work through a combination of local funds, which are currently in hand, and State funding, currently available within the State cost share limit of DWR Funding Agreement (#4600008654) for TRLIA's Upper Yuba Levee Improvement Project (UYLIP).

On September 5, 2011, TRLIA requested that DWR modify the Overall Work Plan associated with the UYRLIP funding agreement to include a new project Element #8 – Re-Establishment of the Yuba River High Ground Project (a four phased plan). This request was essentially a funding request by TRLIA that the State continue to cost share in work associated with TRLIA's efforts to provide 200-Year flood protection to TRLIA's Project Area 1 as identified in TRLIA's Area Plans. DWR notified TRLIA via e-mail on October 7 that before a final decision could be made with respect to the State's commitment to cost share in the work located in the Goldfields, that additional information was needed. An

ultimate decision and commitment by DWR to cost share in this work will take time and that decision will not be forthcoming in the near term.

In order to ensure the safety of the people and property located within the area impacted by high flows through the Goldfields, TRLIA has determined that it is necessary to move forward with Phases 1 and 2 of its plan. As a result, TRLIA will incur costs associated with this work (including both design and construction expenses) in advance of a new or modified funding agreement covering the State cost share of this work.

Section V.B of the DWR's January 2011 EIP Guidelines speaks to credit and indicates that the State will consider, on a case by case basis, the approval of credit requested for non-construction work and that prior written approval is needed for construction work. TRLIA has requested credit for all work related to the Goldfields since November 7, 2006 and this would include both non-construction and construction work. In order for TRLIA to complete its plan for the Goldfields, TRLIA will ultimately need a funding agreement securing a cost share with the State.

Conclusion:

TRLIA has developed a detailed hydraulic model that allowsStakeholders to evaluate the hydraulic risks of the Goldfields and todevelop solutions to reduce the flood risk. The problems in the Goldfields area have been identified in a timely manner to develop and apply corrective actions. Local funding has been identified and is availableto fund near term corrective measures in this plan. DWR is in the process of considering State funding of this effort. Initial discussions with the Mining Community have found them cooperative and supportive of corrective measures. A phased plan has been developed to move forward to achieve long term active flood protection measures in the Goldfields area. Success in reducing the flood risk will require that all stakeholders work together in the final implementation of the plan.

Attachment:

MBK Technical Memorandum: Preliminary Analysis of the Yuba River South Training Wall; dated October 18, 2011

Technical Memorandum

Preliminary Analysis of the Yuba River South Training Wall

Prepared for

THREE RIVERS
LEVEE IMPROVEMENT AUTHORITY

Prepared By

MBK ENGINEERS

October 18, 2011

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BACKGROUND

The Yuba River Goldfields is located on the south side of the Yuba River in Yuba County, California, just northeast of the city of Marysville. Figure 1 shows the location of the Goldfields. The Goldfields encompasses approximately 10,000 acres and was formed in the late 1800s by dredging of the hydraulic mining debris from the Yuba River. The Goldfields is filled with oddly shaped cobble mountains, ravines, streams, and ponds. Water moves through the Goldfields by surface flow, subsurface flow, and seepage through the cobble piles, which greatly complicates hydraulic modeling of the area. In addition, ongoing mining operations continually change the area's topography.

Training walls along both sides (north and south) of the Yuba River were originally constructed in the early 1900s, under the direction of the California Debris Commission, to control the location of the Yuba River. Figure 2 shows the South Training Wall within the Yuba Goldfields. The training walls were designed to prevent dredge tailing debris from returning to the Yuba River as debris. The training walls have provided an additional benefit of blocking high flows in the Yuba River from entering the Goldfields and flowing into the communities of Linda and Olivehurst. The only historic flooding from the Goldfields occurred in 1950 when mining operators blocked the low flow channel approximately four miles above DaGuerre Point Dam and removed a section of the South Training Wall as part of mining operations. In November of that year, flood waters flowed through the manmade breach in the south side of the Yuba River channel in the Goldfields and flooded portions of South Yuba County. The configuration of the training walls and low flow channel in the upper reaches of the Goldfields has significantly changed since 1950 and that same risk of failure does not exist today.

The flood risk to South Yuba County as a result of a breach of the south training wall that could lead to flood flows exiting the Goldfields is of interest to the Three Rivers Levee Improvement Authority (TRLIA), as they strive to implement a program to provide 200-year protection to this urban area. Since 2004, TRLIA has implemented significant levee repair projects with a goal of providing 200-year flood protection to the communities of Linda, Arboga, Olivehurst and Plumas Lake.

In March 2010, the USACE gave a presentation to the CVFPB which included a summary of the results from their hydraulic analysis of the Goldfields area. The USACE analysis led it to conclude that the Goldfields did not present a flood risk for the Yuba Basin for a 100-year storm event, but did present a flood risk at the 200-year storm event. The USACE analysis was a coarse level two-dimensional analysis to ascertain a conservative estimate of flood damages and costs for the General Reevaluation Report. The USACE presentation also concluded that there was not a Federal interest in an engineered solution to extend existing flood protection, specifically constructing a new levee south of the Goldfields area.

PURPOSE

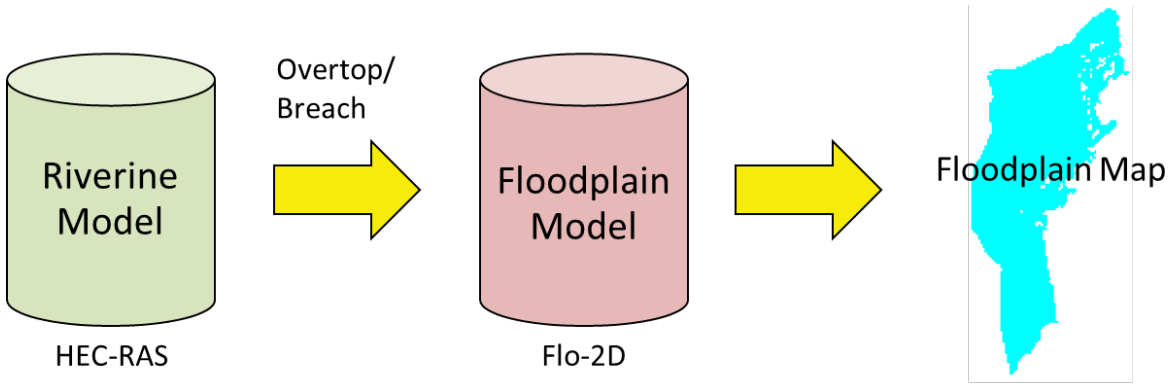
In an effort to better define residual flood risk associated with the Goldfields, TRLIA expanded and refined the Corps' hydraulic analysis to include the most recent topographic information and a

comprehensive 2-dimensional hydraulic model to simulate the complex movement of flood flows through the Goldfields area. In addition to the hydraulic modeling, TRLIA began an evaluation of the historic rate of erosion of the South Training Wall to examine how this feature has performed during past flood events.

This Technical Memorandum presents the preliminary evaluation of the South Training Wall, including the identification of several problem sites and the associated hydraulic analysis that has been made to evaluate the effects of training wall breaches at the those sites.

HYDRAULIC MODELING TOOLS

Two hydraulic models were utilized for this analysis, a HEC-RAS one-dimensional unsteady flow model and a FLO-2D two-dimensional finite difference unsteady flow model. The HEC-RAS model simulates flows in the river and levee failures. The FLO-2D model simulates surface flows in the Goldfields and overland flow in the South Yuba County area. Breach flow hydrographs from the HEC-RAS model are routed in the FLO-2D model to determine flows through the Goldfields and potential resultant floodplain in South Yuba County.



HEC-RAS

The HEC-RAS model was developed to determine the water surface elevations in the Yuba River for this analysis. These model-derived water surface elevations were used to analyze South Training Wall freeboard and thickness at the 100-year riverine water surface elevation. Additionally, the HEC-RAS model was used to model training wall breaches at problem sites and determine the flow hydrograph through those breaches.

Model Extent

The HEC-RAS model represents the Feather River and its tributaries from below Oroville reservoir within the basin to its confluence with the Sacramento River. Figure 3 shows the geographic extent of the model and the waterways contained in the model in the area of the Goldfields

Model Development

The HEC-RAS modeling system is capable of simulating one-dimensional unsteady flow through a full network of open channels. A special feature of the unsteady flow routine is levee breach and overtopping analysis. The software was developed by the USACE, and this analysis was performed with HEC-RAS version 4.1.

The model used for this analysis was a derivative of the Upper Feather River HEC-RAS Model developed by the U.S. Army Corps of Engineers. MBK Engineers made improvements and updates (e.g., Bear and Feather River TRLIA levee setbacks) to this model so that it provides an accurate representation of the flood system hydraulics for current conditions. The model has been calibrated to the January 1997 flood event.

FLO-2D

FLO-2D is a two-dimensional flood routing model based on a finite difference algorithm to solve the equations of continuity and momentum. For overland flow, the model distributes volume between square grid elements in eight directions. Each grid element is assigned a representative elevation and flow roughness (Manning's n value). Discharge is computed between two grid elements by using the full dynamic wave approximation to the momentum equation. A grid system is considered to be a system of tiles and each tile shares volume with all its neighbors in the four compass directions and the four diagonal directions. FLO-2D simulates unconfined overland flow. The model simulations can further be enhanced by adding components such as rainfall, infiltration, bridges, culverts, levees, and flow obstructions.

Model Extent

The model extent was defined such that it included the Goldfields proper and the portions of the South Yuba County floodplain bounded by:

- Yuba River
- Feather River
- Bear River
- Western Pacific Interceptor Canal (WPIC)

This delineation is shown in Figure 4 (entire study area) and Figure 5 (Goldfields area only). The model domain was extended such that it went beyond the levees of these waterways on the opposite side of the waterways. The model uses a regular grid with 250-ft spacing between two-dimensional nodes.

Model Development

The model was developed such that it could route water emanating from the surrounding riverine system (e.g., Yuba River) and appropriately distribute that water within the area on the land side of the flood protection system (levees, Training Wall). The following model components were enlisted to allow water entering the model domain to be appropriately routed:

- Land use-based roughness assignment
- Levees and embankments (railroads, highways)
- Hydraulic structures (culverts, embankment openings)
- Area-reduction and width reduction factors (obstructions, e.g., buildings)

In order to be able to route water within the Yuba Goldfields, the following were developed:

- One-dimensional channels (internal waterways)
- Hydraulic Structures (channel crossings)
- Berms (mine tailing piles)

ANALYSIS

METHODOLOGY

The goal of the South Training Wall analysis was to determine locations where the training walls have eroded to the point that they may be susceptible to failure during a flood event from either overtopping or erosion. Failure of the training wall due to other geotechnical causes (e.g., through seepage, stability, or under seepage) was not examined as part of this preliminary analysis.

The evaluation of the South Training Wall consisted of analyzing topography to find locations susceptible to failure or overtopping during a flood event on the Yuba River. Additionally, an analysis of the historical rate of erosion of the training wall was conducted using aerial photography.

DATA

As part of the overall effort of the Central Valley Floodplain Evaluation and Delineation (CVFED) program, an effort has been undertaken to improve the quality and accuracy of flood hazard data and mapping for the Sacramento and San Joaquin Basins in the Central Valley. Beginning in 2008, an extensive task was undertaken to acquire high-resolution topographic and imagery data. The topographic and imagery data were collected using airborne remote sensing and photogrammetry devices. LiDAR (Light Detection and Ranging) data provides detailed topography data to a vertical accuracy of 0.5 feet and organized in tiles covering a 5000’ x 5000’ area. This high resolution data was used to depict the Yuba River South Training Wall and adjacent areas in this analysis.

CRITERIA

The following criteria were used to determine South Training Wall locations susceptible to failure or overtopping:

- Freeboard (Training Wall height above reference 100-year water surface elevation)
- Thickness (Training Wall width at reference 100-year water surface elevation)
- Position (Assessment of location's vulnerability to a wall breach, including analyzing mining pile redundancy at location and potential flow paths through the Yuba Goldfields if breach was to occur at the site)

SUMMARY OF FINDINGS

Profiles were developed along the South Training Wall to aide in assessing these criteria. These profiles, shown in Figure 6, display the following information:

- Yuba River 100-year flood event water surface elevations along training wall
- Training wall crest elevations
- Training wall freeboard for 100-year flood event
- Training wall width at 100-year flood event elevation

Using this data and the site selection criteria, ten sites on the South Training Wall were identified as problem sites. These sites were divided in two classes, Tier 1 and Tier 2, based on an assessment of the flood risk for each site. Figure 7 shows the location of these sites. Tier 1 sites were where the South Training Wall was determined to be the most vulnerable to failure, and that failure could lead to flood flows exiting the Goldfields. Three such sites were identified. Tier 2 sites showed a lower vulnerability to failure as described below. Seven such sites (Tier 2) were identified.

Individual Sites

<u>Site A</u>

Site A has been classified as a Tier 2 site. Figure 8 shows a close-up view of this site, and Figure 9 displays photos of the site. This site is a low-elevation waterway crossing that is overtopped during the 100-year flood event. Its position along the Yuba River is relatively sheltered, so it's not particularly vulnerable to erosive forces of the River. Review of historic aerial photographs show this location to be relatively stable. The channel which contains this crossing is relatively narrow (approx. 100 ft.) and surrounded by ground that's high enough such that Yuba River breach at this site would likely be limited to this effective width.

<u>Site B</u>

Site B has been classified as a Tier 1 site. Figure 10 shows a close-up view of this site, and Figure 11 displays a photo of the site. This site is on an outer bend of the Yuba River and is subject to higher erosive forces. If this site were to breach, a several hundred foot pathway could develop based on

orientation of surrounding cobble piles. A breach at this location could flow to an exit point from the Goldfields and into the floodplain.

An analysis of the historical position and topography of the training wall at this site was performed. Figure 12 shows the annual peak flow for the Yuba River near Marysville (USGS 11421000) from 1946-2011, along with the years for which aerial photography of the Yuba Goldfields was available (years labeled years at top). In order to assess the training wall position at this site through time, several aerial photographs were compared, the training wall crest was digitized from those photos, and the incremental changes in wall position between photos were calculated.

This analysis showed indicated the following at this location:

- The training wall has shown incremental recession over the past several decades (see Figures 13-16).
- The training wall has lost freeboard over the last decade (see Figure 17).

In order to assess the consequences of a training wall failure at this location, hydraulic model simulations depicting a failure of the training wall were developed. These simulations used the 100-year flood event for the Yuba River. For those simulations, the following training wall failure parameters were assumed:

- 300-foot breach opening (based on orientation of surrounding cobble piles and training wall width)
- Breach developed over 24 hour period of time
- Breach opening lowered to existing ground elevation

Figure 18 depicts the flow path resulting from this training wall breach and Figure 19 shows the floodplain results from these simulations. A significant portion of the water flowing through the breach exits the Goldfields along two points on the Goldfields western boundary into the Yuba River floodway. Some water exits along the eastern boundary of the lower Goldfields and then flows south and west, developing a floodplain to the south of the Upper Yuba River (Patrol Rd.) levee, as shown in Figure 19.

<u>Site C</u>

Site C has been classified as a Tier 2 site. Figure 20 shows a close-up view of this site, and Figure 21 displays photos of the site. This site is on an outer bend of the Yuba River and is subject to higher erosive forces. Analyzing the surrounding topography within the Goldfields indicates there is sufficient mining debris behind the training wall at this location and no immediate pathway for water to exit the Goldfields and enter the floodplain.

An analysis of the historical position and topography of the training wall at this site indicated the training wall has shown incremental recession and thinning due to erosion over the past several decades (see Figures 22-25).

Site D

Site D has been classified as a Tier 1 site. Figure 26 shows a close-up view of this site, and Figure 27 displays a photo of the site. This site is a waterway crossing that has eroded during high river flows in 2011. The waterway at this site functions to facilitate the drainage of water from the Goldfields. The 100-year flood event is able to enter the Goldfields from the Yuba River at this location through this waterway.

The area behind this crossing within the Goldfields has recently undergone topographic changes due to the mining operations in the Goldfields. Figure 28 shows the progression of these changes via aerial photography. These changes have increased the vulnerability of this site to a flood event which could cause water to pass through the Goldfields and enter the floodplain. Water originating from the Yuba River is now likely to escape the Goldfields from 100-year flood event via overtopping of the crossings. This flooding would be worse if the internal crossings put in place behind the dredge path were to fail, which is likely given evidence of erosion from overtopping that occurred in 2011.

In order to assess the consequences of overtopping at this location, hydraulic model simulations depicting overtopping were developed. For those simulations, the following were assumed:

- Site D crossing removed (not rebuilt to pre-2011 intact condition)
- Crossings put into place behind dredge path removed (assumed failed)

Figure 29 depicts the flow path resulting from this training wall breach and Figure 30 shows the floodplain results from these simulations. In these simulations, water flows through and exits the Goldfields southern boundary after flowing through the pathways and ponds created by mining operations. A floodplain developed to the south of the Upper Yuba River (Patrol Rd.) levee in this scenario, as shown in Figure 30.

Site E

Site E has been classified as a Tier 2 site. Figure 31 shows a close-up view of this site, and Figure 32 displays photos of the site. This site is a waterway crossing. This waterway no longer drains the Goldfields under normal conditions as the waterway is higher in elevation than surrounding waterways. The waterway draining to Site D currently drains flows from the Goldfields. The 100-year flood event is able to overtop this crossing (Site E) and enter the Goldfields at this location, but the crossing is at an elevation high enough such that the amount of water able to cross this boundary is relatively limited relative to other sites (e.g., Site D).

Site F

Site F has been classified as a Tier 1 site. Figure 33 shows a close-up view of this site, and Figure 34 displays a photo of the site. This site is on an outer bend of the Yuba River and is subject to higher erosive forces. If this site was to breach, it's possible that a 1000 ft breach width could develop to due orientation of surrounding cobble piles. A breach at this location would also have a pathway with access to an exit point to the floodplain.

An analysis of the historical position and topography of the training wall at this site indicated the following:

- The training wall has shown incremental recession and thinning due to erosion over the past several decades (see Figures 35-38).
- The training wall has lost width over the last decade (see Figure 39).

Additionally, like Site D, recent mining changes within the Goldfields near this site have left a vulnerable pathway for water to potentially exit the Goldfields.

In order to assess the consequences of a training wall failure at this location, hydraulic model simulations depicting a failure of the Training Wall were developed. These simulations used the 100-year flood event for the Yuba River. For those simulations, the following wall failure parameters were assumed:

- 1,000-foot breach opening (based on orientation of surrounding cobble piles and training wall width)
- Breach developed over 24 hour period of time
- Breach opening lowered to existing ground elevation
- Crossings put into place behind dredge path removed (assumed failed)

Figure 40 depicts the flow path resulting from this training wall breach and Figure 41 shows the floodplain results from these simulations. A significant portion of the water flowing through the breach exits the Goldfields southern boundary after flowing through the ponds created by existing mining operations. A significant floodplain was developed to the south of the Upper Yuba River (Patrol Rd.) levee in this scenario, as shown in Figure 41.

Site G

Site G has been classified as a Tier 2 site. Figure 42 shows a close-up view of this site. This site shows relatively low freeboard and minimal wall thickness for the 100-year flood event. Its position along the Yuba River is relatively sheltered, so it is not particularly vulnerable to erosive forces of the Yuba River. If the training wall were to breach at this site, the analysis of the surrounding topography within the Goldfields indicates there is likely sufficient mining material behind the training wall at this location and no immediate pathway for breach water to exit the Goldfields and enter the floodplain.

Site H

Site H has been classified as a Tier 2 site. Figure 43 shows a close-up view of this site, and Figure 44 displays photos of the site. This site shows relatively high freeboard and several hundred feet of training wall thickness for the 100-year flood event. This site is on an outer bend of the Yuba River and is subject to higher erosive forces. If the training wall were to breach at this site, the analysis of the surrounding topography within the Goldfields indicates there is likely sufficient mining material behind the Training Wall at this location and no immediate pathway for breach water to exit the Goldfields and enter the floodplain.

Site I

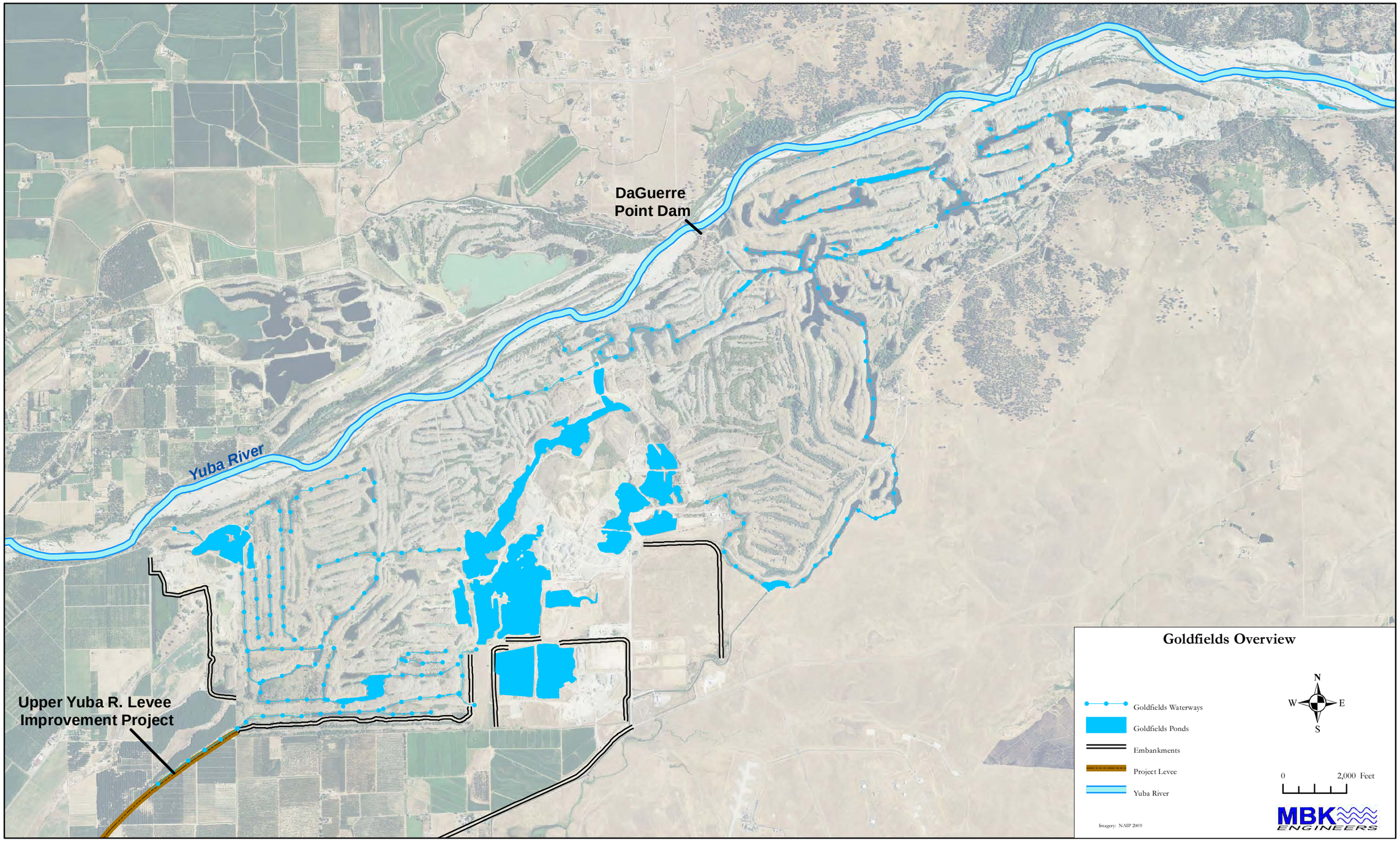
Site I has been classified as a Tier 2 site. Figure 45 shows a close-up view of this site. This site shows relatively low freeboard compared with the surrounding training wall portions. Additionally, this site is near an outside bend of the Yuba River and displays irregular geometry which may make it somewhat susceptible to erosive forces.

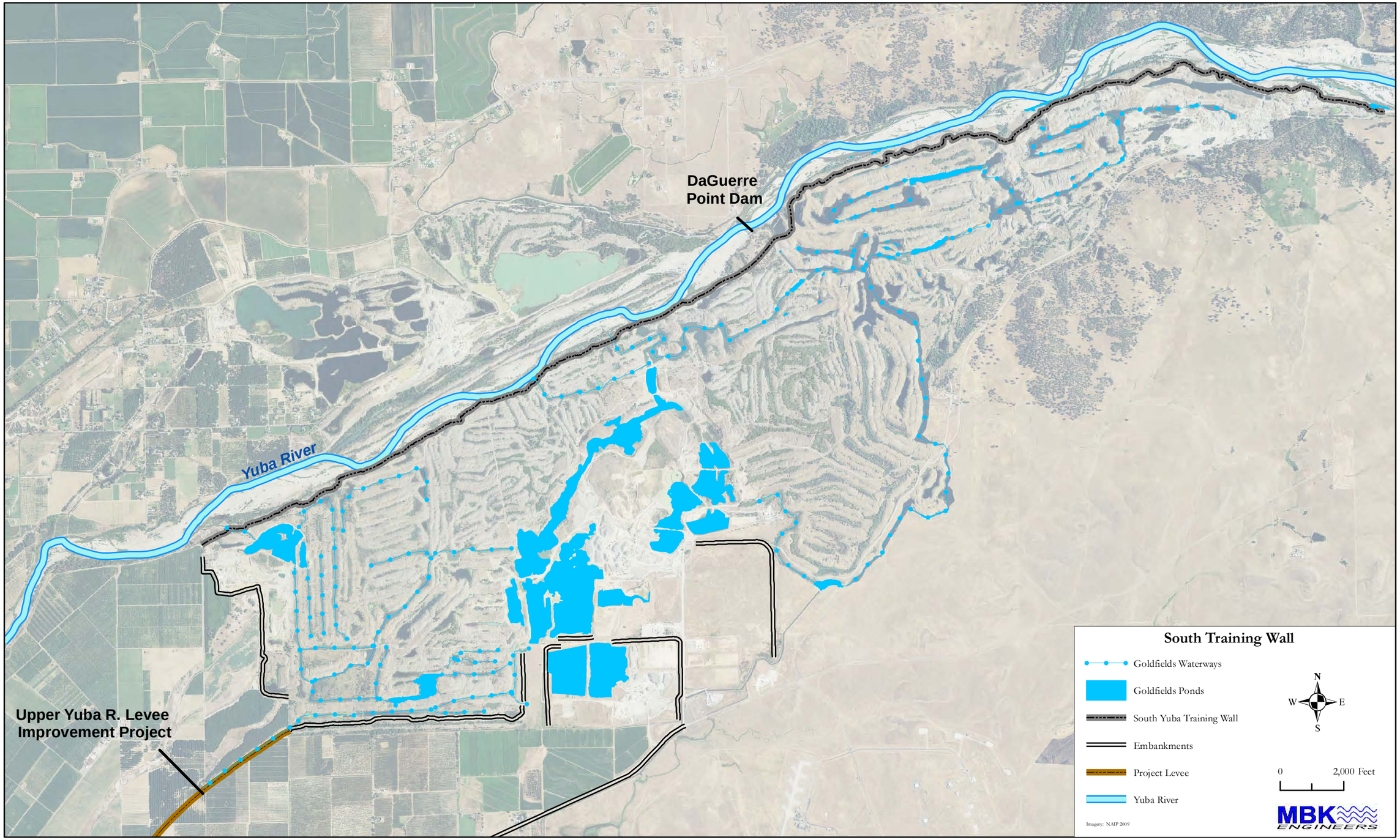
Site J

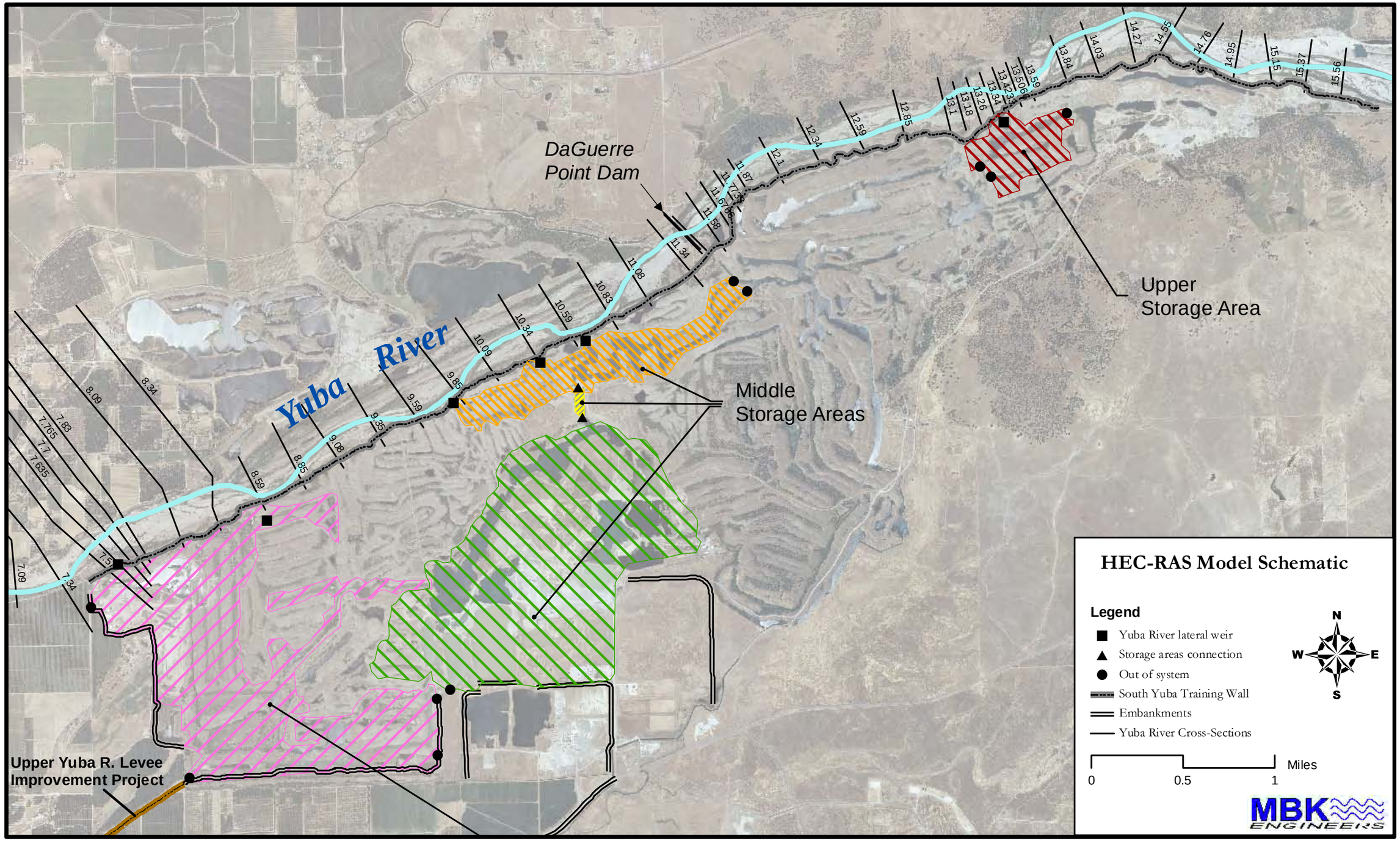
Site J has been classified as a Tier 2 site. Figure 46 shows a close-up view of this site, and Figure 47 displays photos of the site. This site is on an outer bend of the Yuba River and is subject to higher erosive forces. An analysis of the historical position and topography of the Training Wall at this site indicated the Training Wall has shown incremental recession and thinning due to erosion over the past several decades (see Figures 48-51).

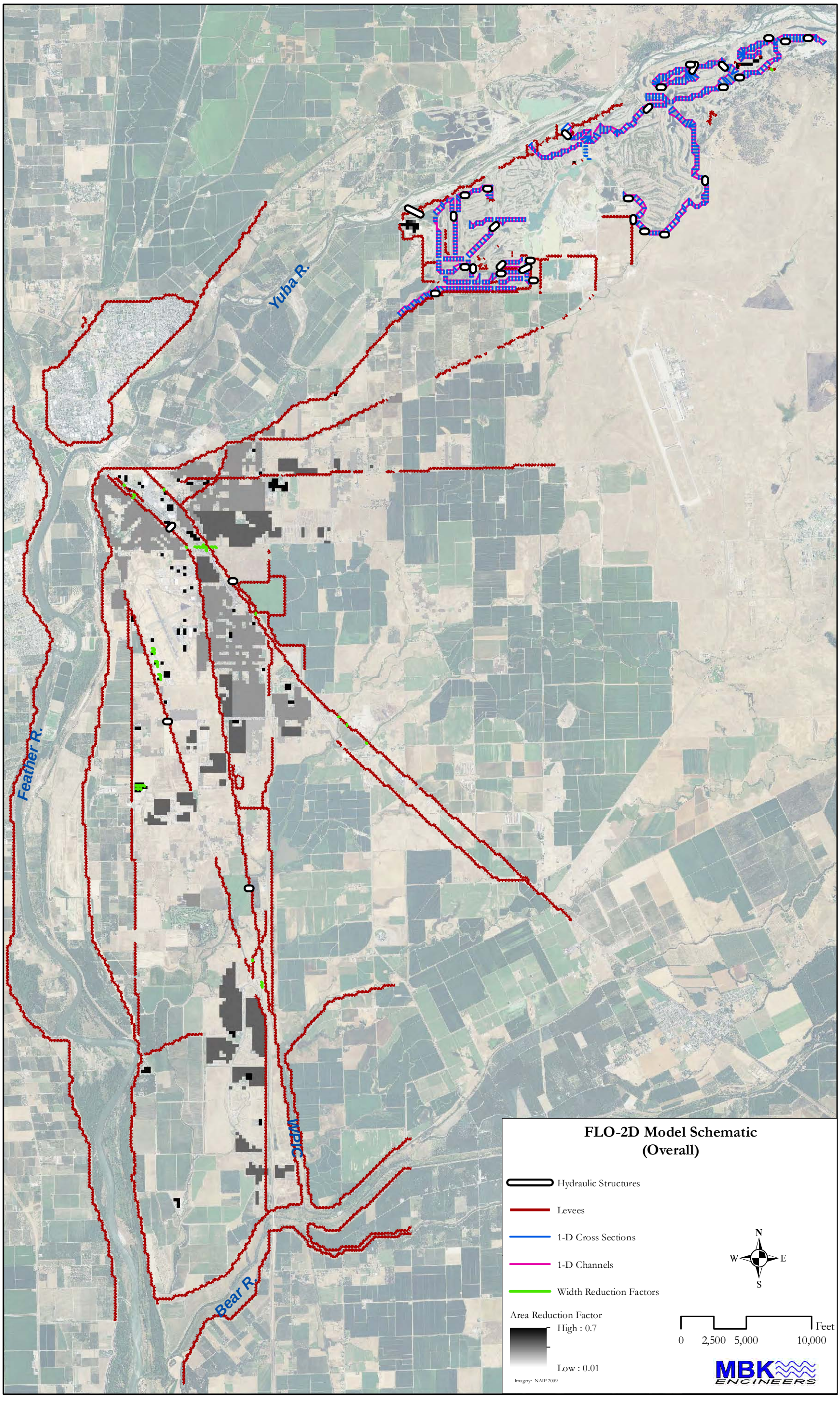
Analyzing the surrounding topography within the Goldfields indicates there is sufficient mining material behind the training wall at this location and no immediate pathway for breach water to exit the Goldfields and enter the floodplain.

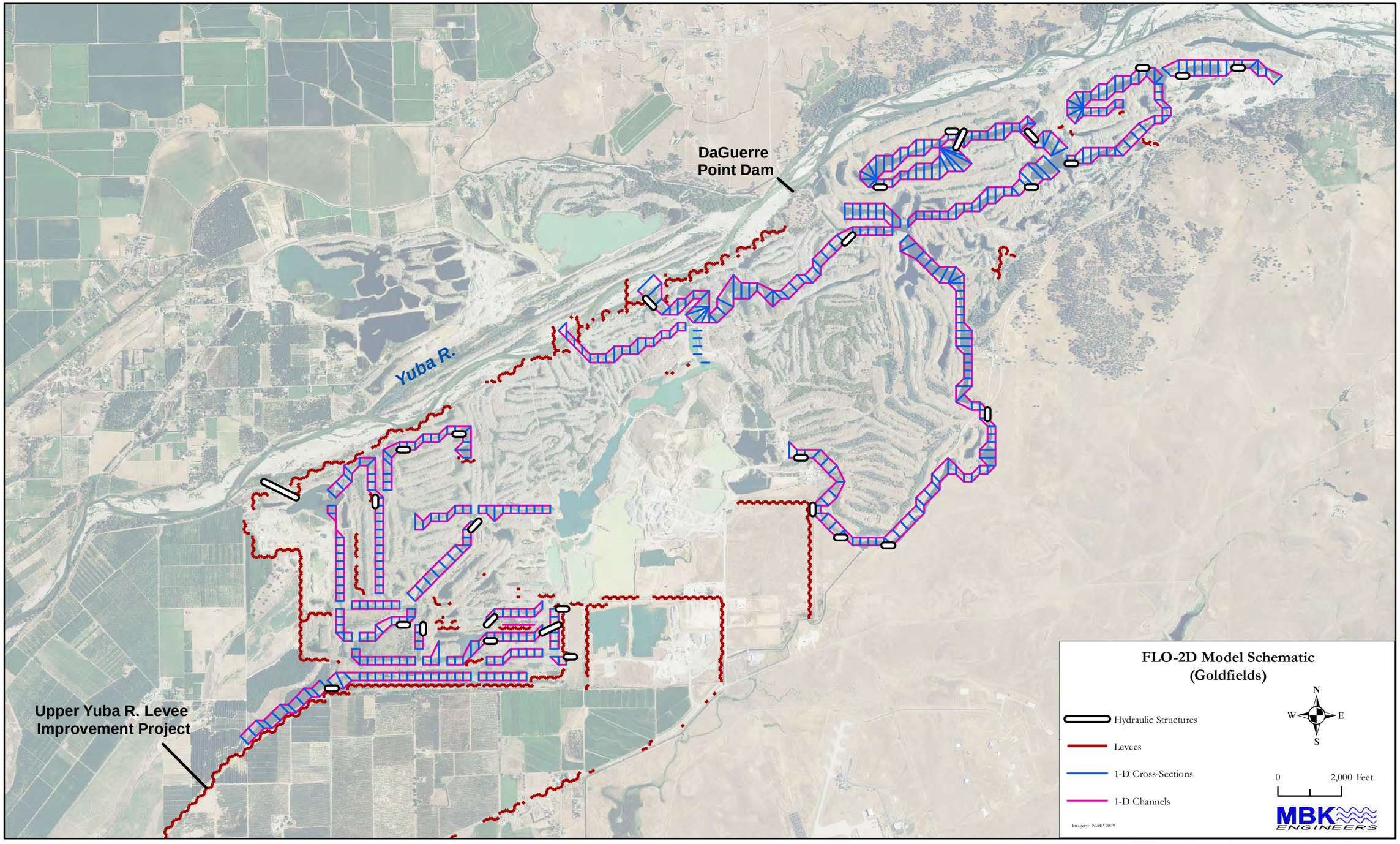
Figure 1

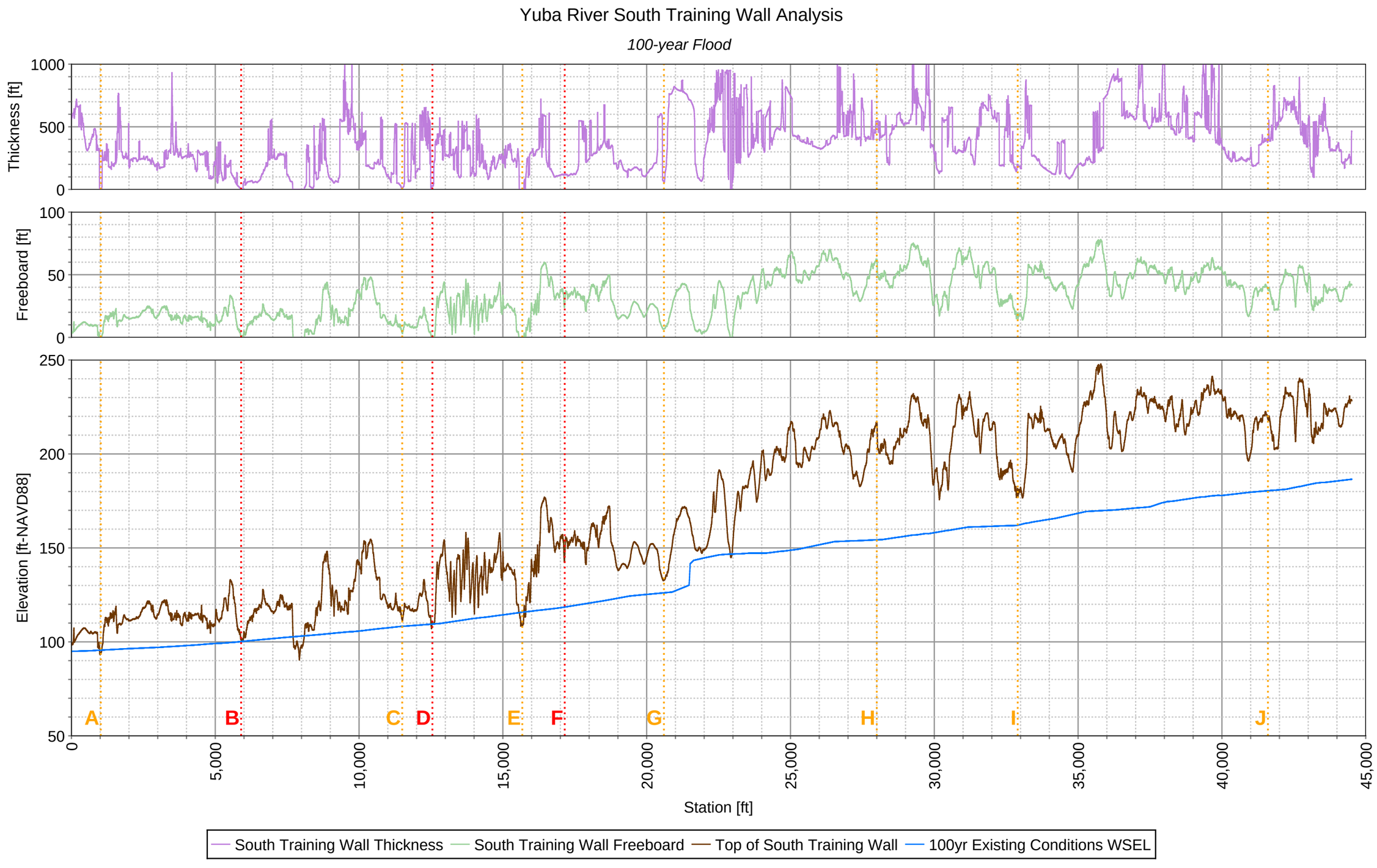

DaGuerre
Point Dam
Yuba River
Upper Yuba R. Levee
Improvement Project
Goldfields Overview
Goldfields Waterways
Goldfields Ponds
Embankments
Project Levee
Yuba River
N
W
E
S
0
2,000 Feet
Imagery: NAIP 2009
MBK
ENGINEERS


DaGuerre
Point Dam
Yuba River
Upper Yuba R. Levee
Improvement Project
South Training Wall
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Project Levee
Yuba River
N
W
E
S
0
2,000 Feet
Imagery: NAIP 2009
MBK
ENGINEERS


HEC-RAS Model Schematic
Legend
Yuba River lateral weir
Storage areas connection
Out of system
South Yuba Training Wall
Embankments
Yuba River Cross-Sections
N
W
E
S
0
0.5
1
Miles
MBK ENGINEERS
Yuba River
DaGuerre Point Dam
Upper Storage Area
Middle Storage Areas
Upper Yuba R. Levee Improvement Project
7.09
7.34
7.5
7.635
7.7
7.765
7.83
8.09
8.34
8.59
8.85
9.08
9.35
9.59
9.85
10.09
10.34
10.59
10.83
11.08
11.34
11.58
11.67
11.77
11.87
12.1
12.34
12.59
12.85
13.1
13.18
13.26
13.34
13.42
13.50
13.59
13.84
14.03
14.27
14.55
14.76
14.95
15.15
15.37
15.56


Yuba R.
Feather R.
WPIC
Bear R.
FLO-2D Model Schematic
(Overall)
Hydraulic Structures
Levees
1-D Cross Sections
1-D Channels
Width Reduction Factors
Area Reduction Factor
High : 0.7
Low : 0.01
Imagery: NAIP 2009
N
W
E
S
0
2,500
5,000
10,000
Feet
MBK
ENGINEERS


DaGuerre
Point Dam
Yuba R.
Upper Yuba R. Levee
Improvement Project
FLO-2D Model Schematic
(Goldfields)
Hydraulic Structures
Levees
1-D Cross-Sections
1-D Channels
N
W
E
S
0
2,000 Feet
Imagery: NAIP 2009
MBK
ENGINEERS


Yuba River South Training Wall Analysis
100-year Flood
Thickness [ft]
1000
500
0
Freeboard [ft]
100
50
0
Elevation [ft-NAVD88]
250
200
150
100
50
A
B
C
D
E
F
G
H
I
J
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
Station [ft]
South Training Wall Thickness
South Training Wall Freeboard
Top of South Training Wall
100yr Existing Conditions WSEL

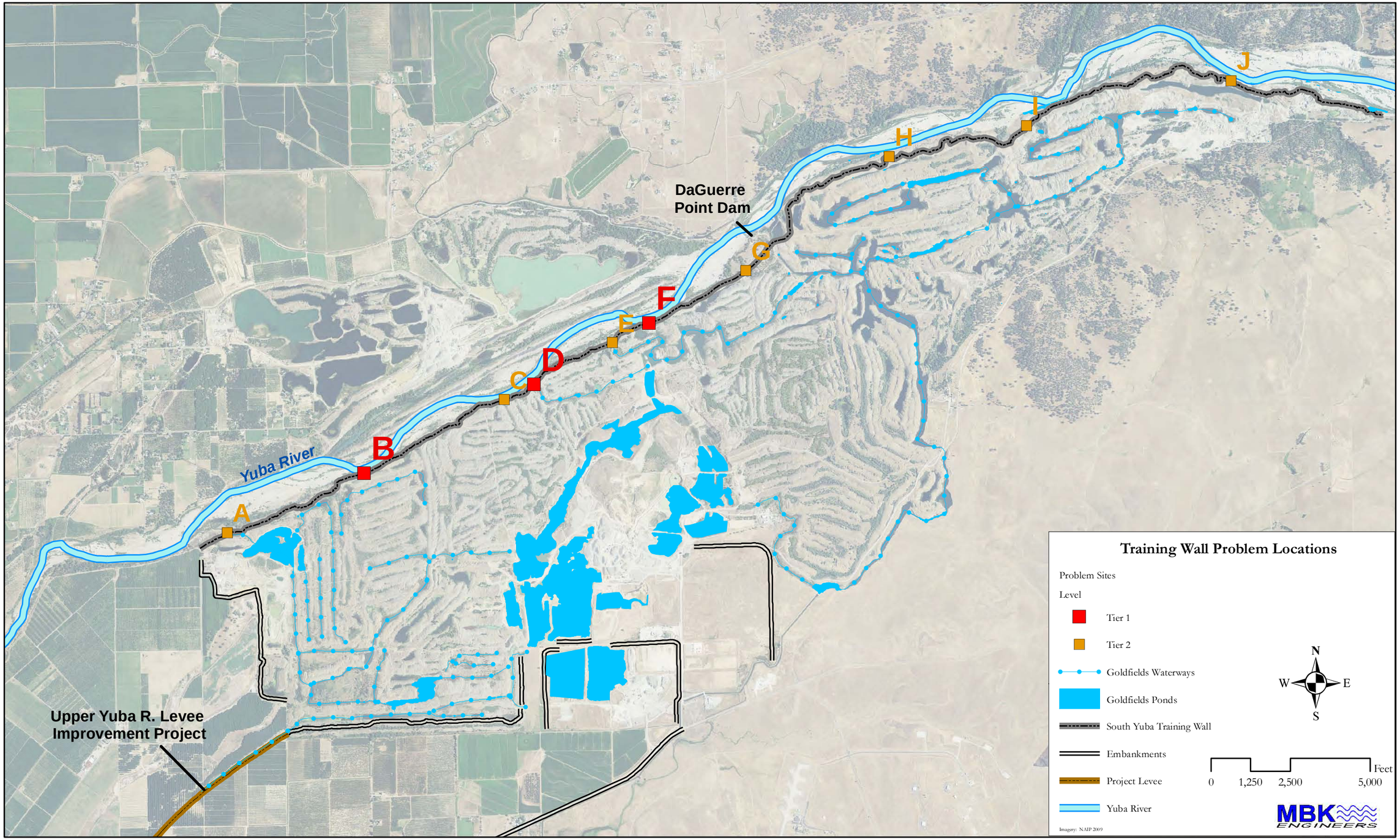
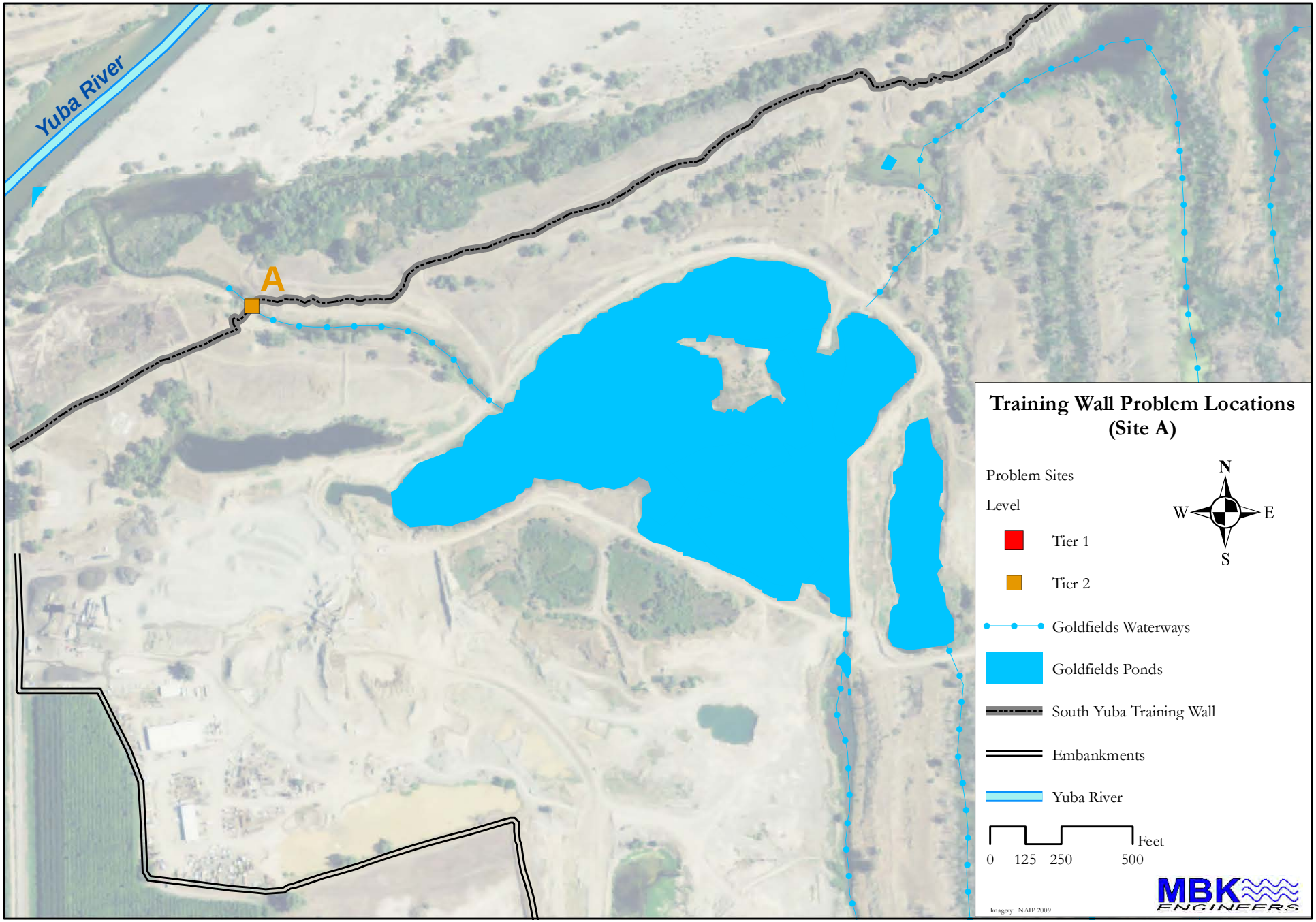

DaGuerre
Point Dam
Yuba River
Upper Yuba R. Levee
Improvement Project
A
B
C
D
E
F
G
H
I
J
Training Wall Problem Locations
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Project Levee
Yuba River
N
W
E
S
0
1,250
2,500
5,000
Feet
MBK
ENGINEERS
Imagery: NAIP 2009

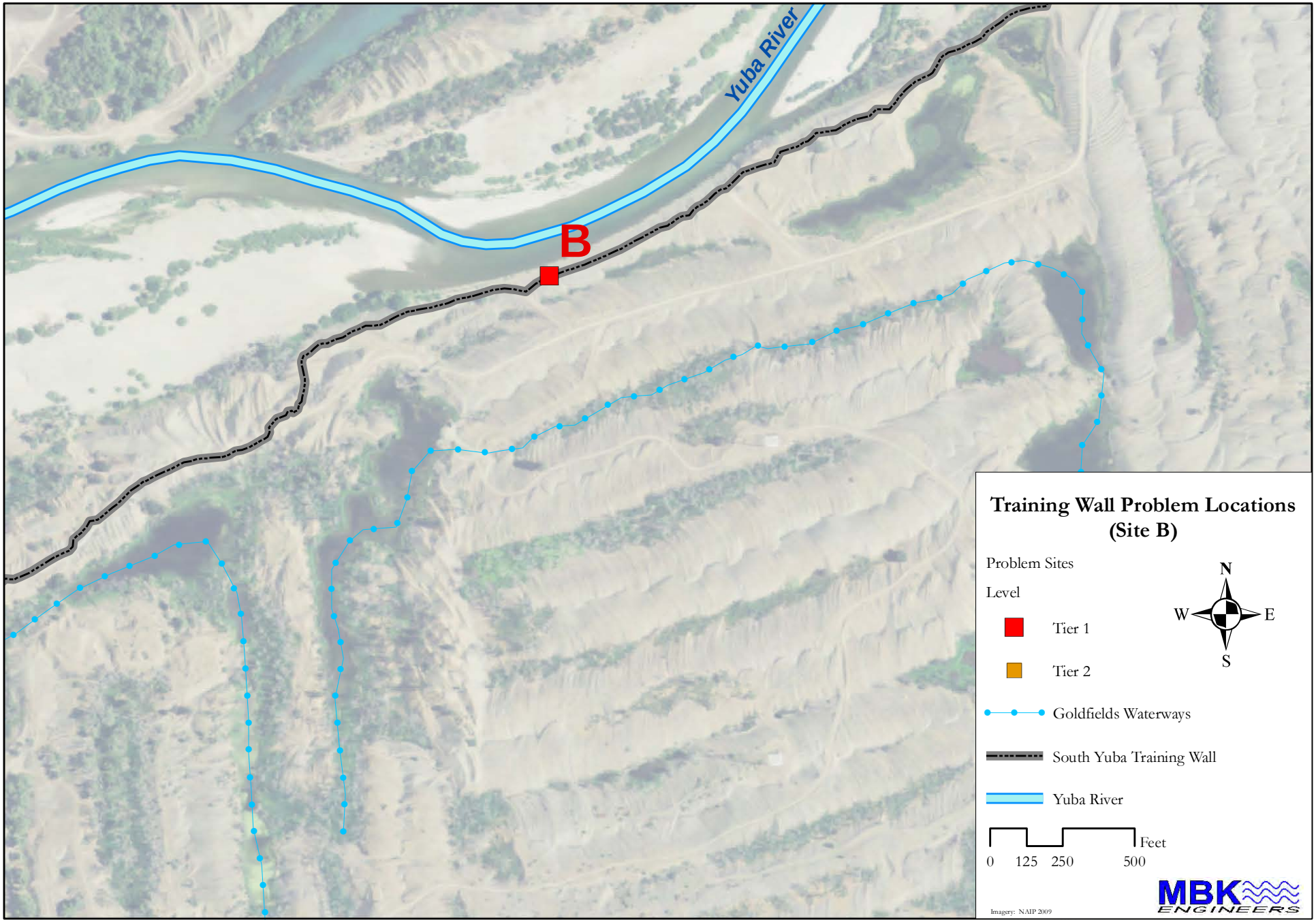
Figure 8


Yuba River
A
Training Wall Problem Locations
(Site A)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Site A site photo – June 27, 2011

MBK ENGINEERS

Figure 10


Yuba River
B
Training Wall Problem Locations
(Site B)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Site B site photo – June 27, 2011

MBK ENGINEERS

Figure 12

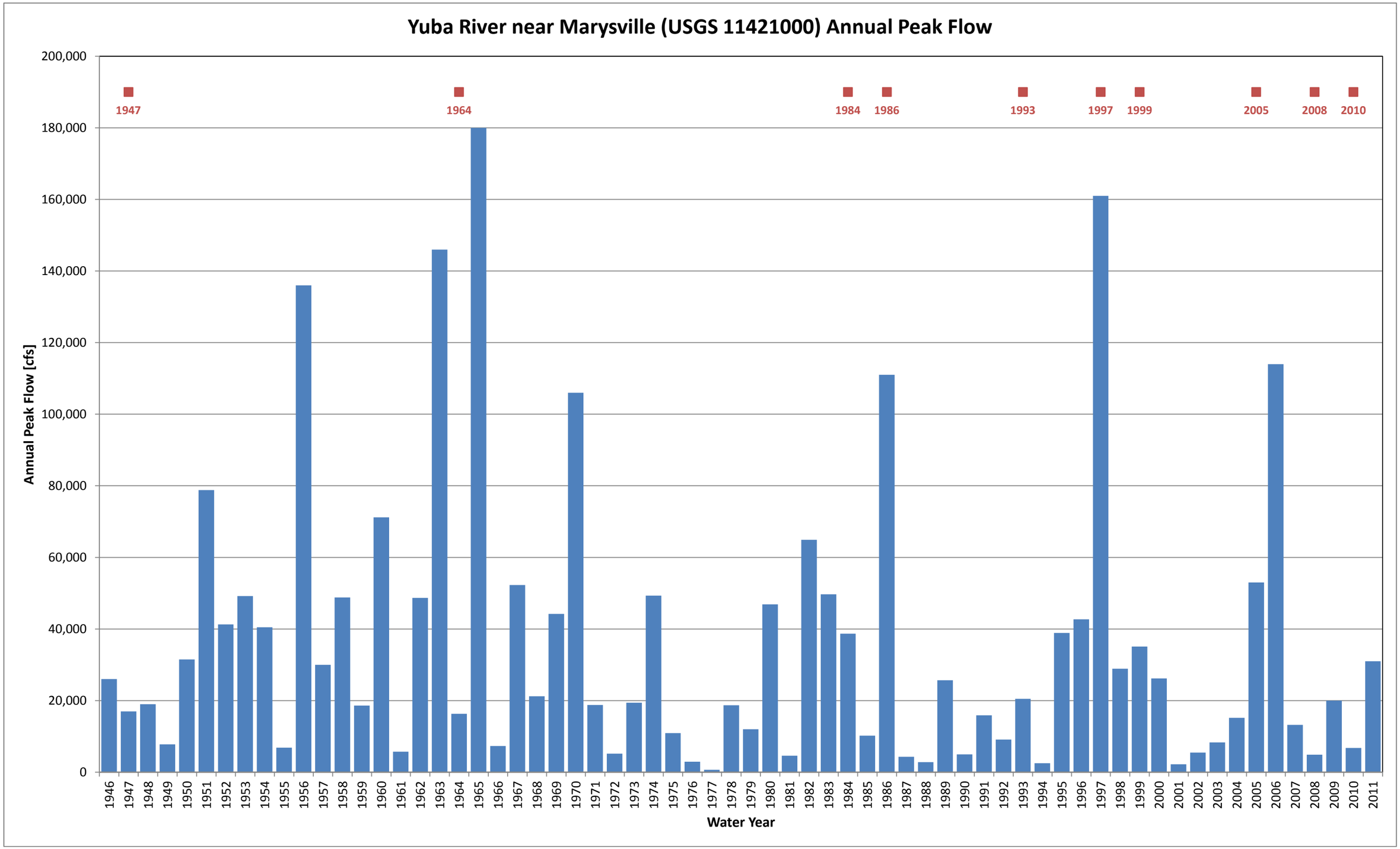

Yuba River near Marysville (USGS 11421000) Annual Peak Flow
Annual Peak Flow [cfs]
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1947
1964
1984
1986
1993
1997
1999
2005
2008
2010
1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Water Year

Figure 13

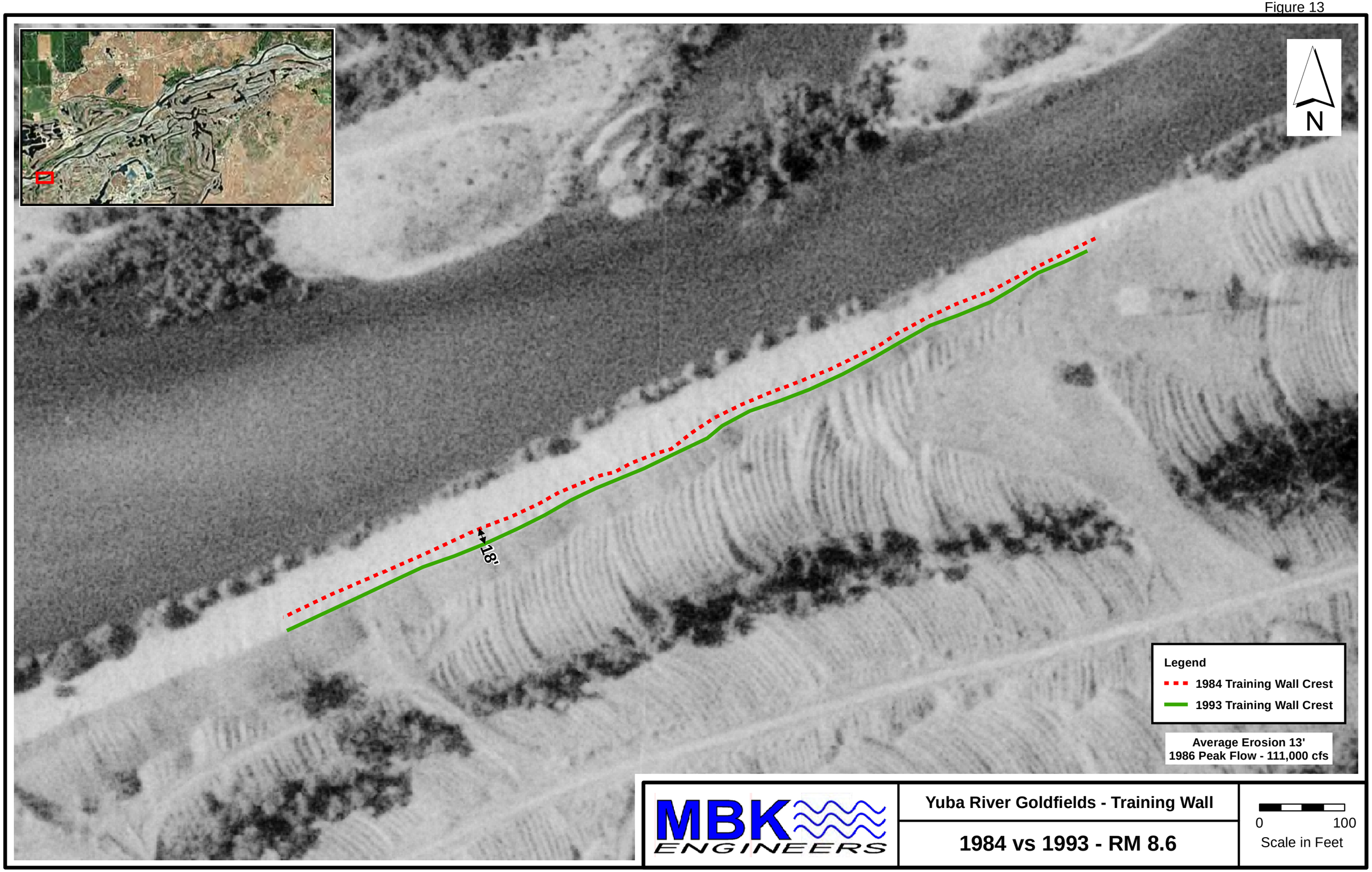

N
18'
Legend
1984 Training Wall Crest
1993 Training Wall Crest
Average Erosion 13'
1986 Peak Flow - 111,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1984 vs 1993 - RM 8.6
0
100
Scale in Feet

Figure 14

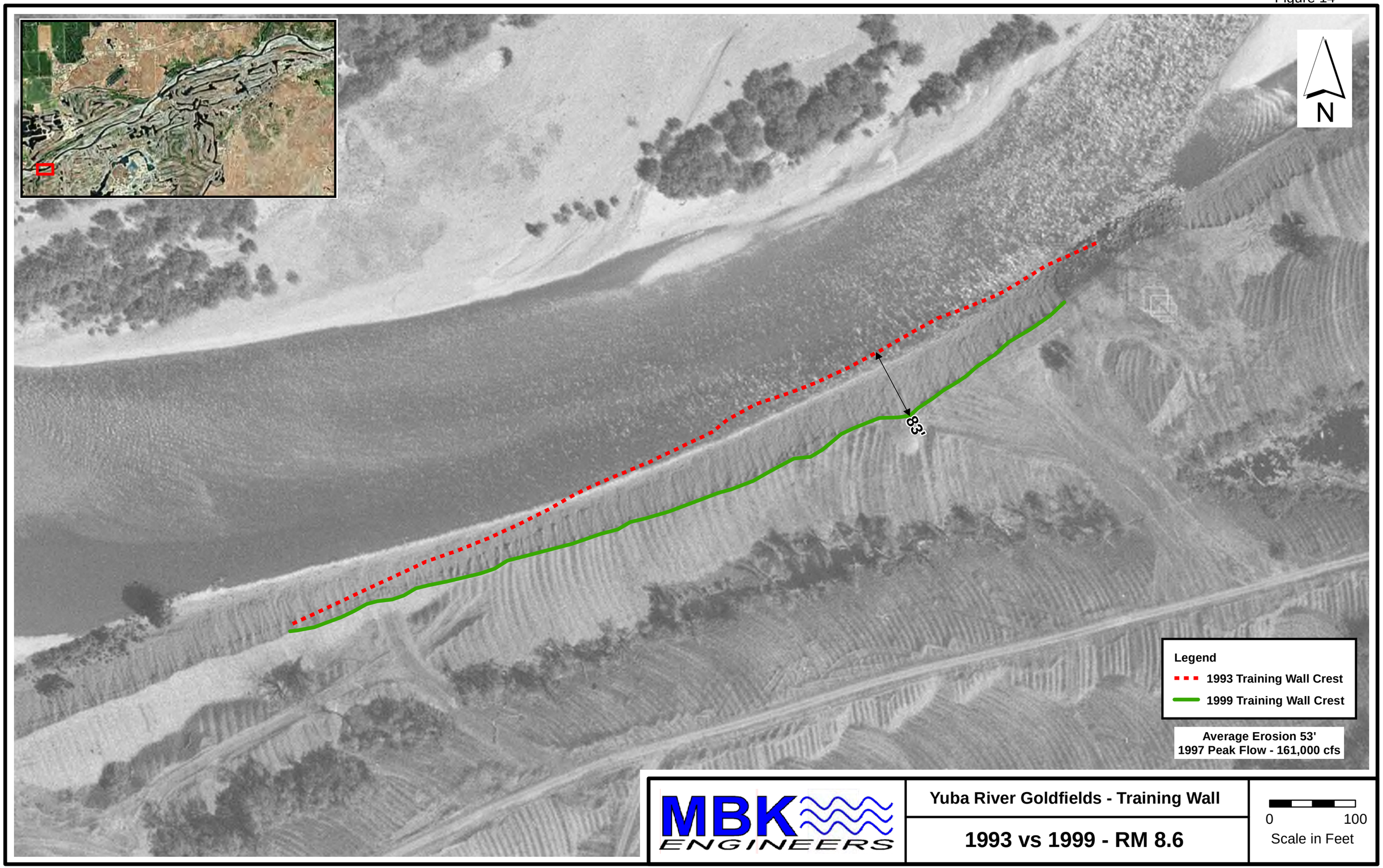

N
83'
Legend
1993 Training Wall Crest
1999 Training Wall Crest
Average Erosion 53'
1997 Peak Flow - 161,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1993 vs 1999 - RM 8.6
0
100
Scale in Feet

Figure 15

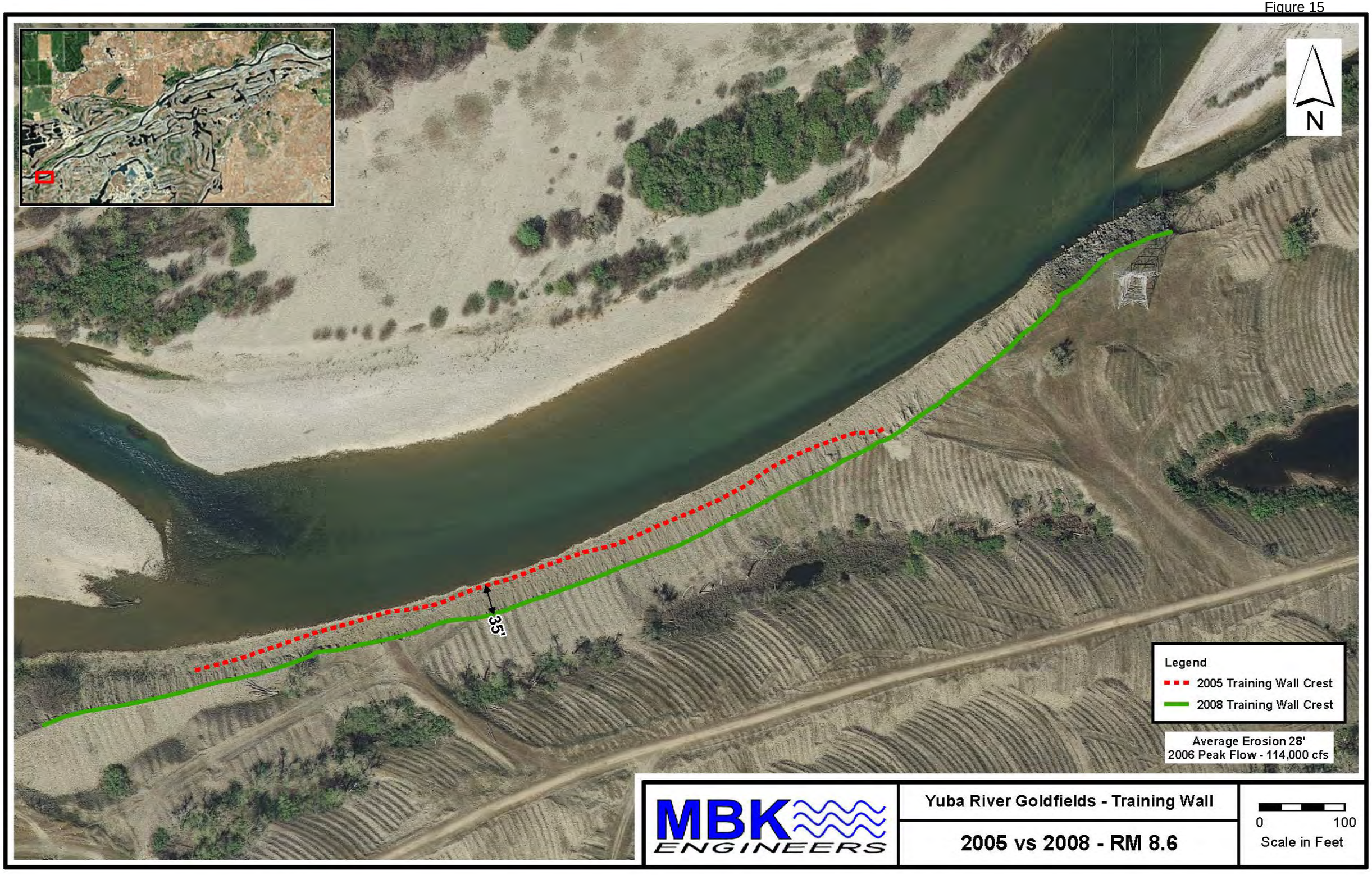
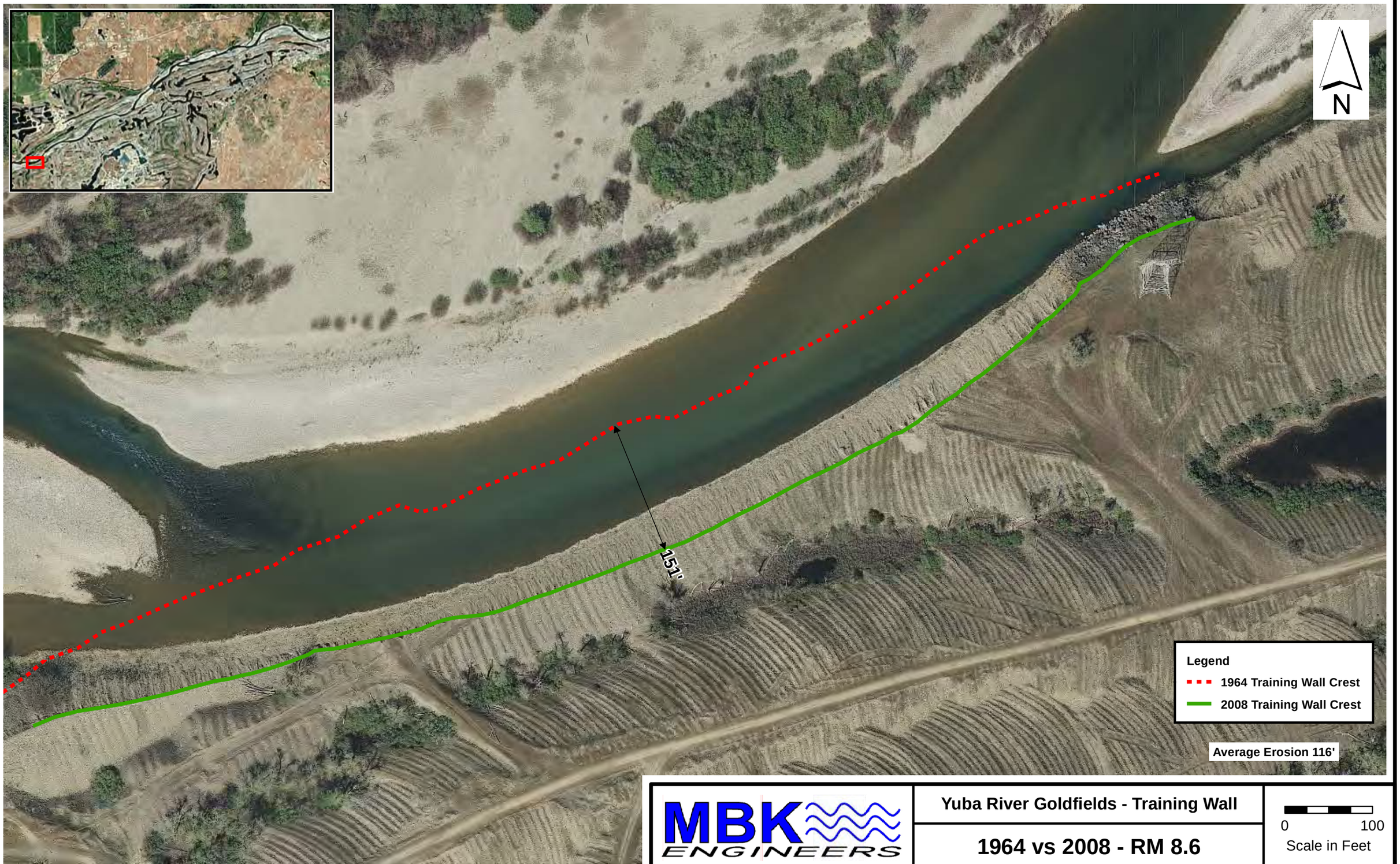

N
35'
Legend
2005 Training Wall Crest
2008 Training Wall Crest
Average Erosion 28'
2006 Peak Flow - 114,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
2005 vs 2008 - RM 8.6
0
100
Scale in Feet

Figure 16



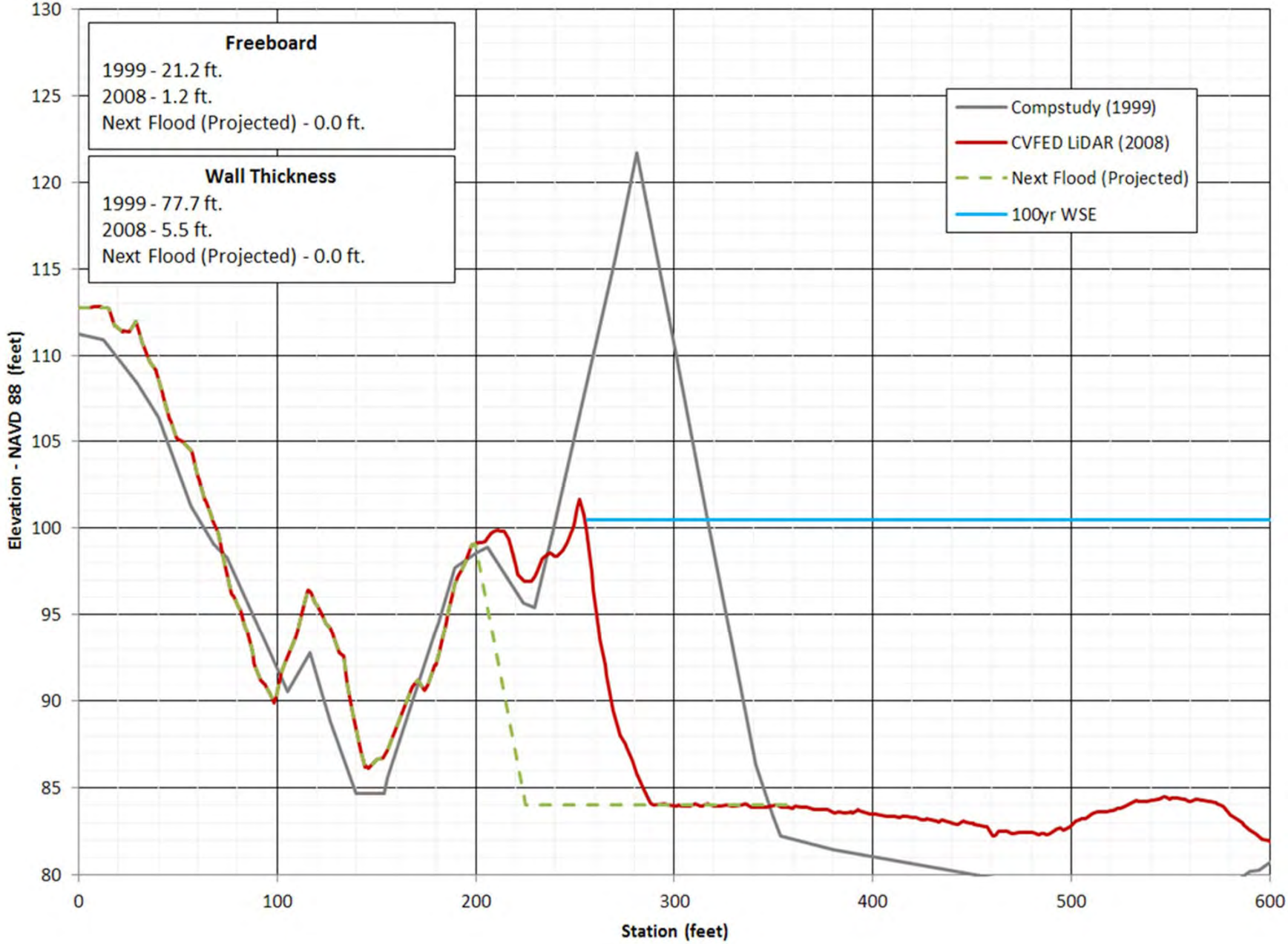
MBK ENGINEERS

Yuba River Goldfields - Training Wall

1964 vs 2008 - RM 8.6

0 100
Scale in Feet

Figure 17



MBK ENGINEERS

Figure 18

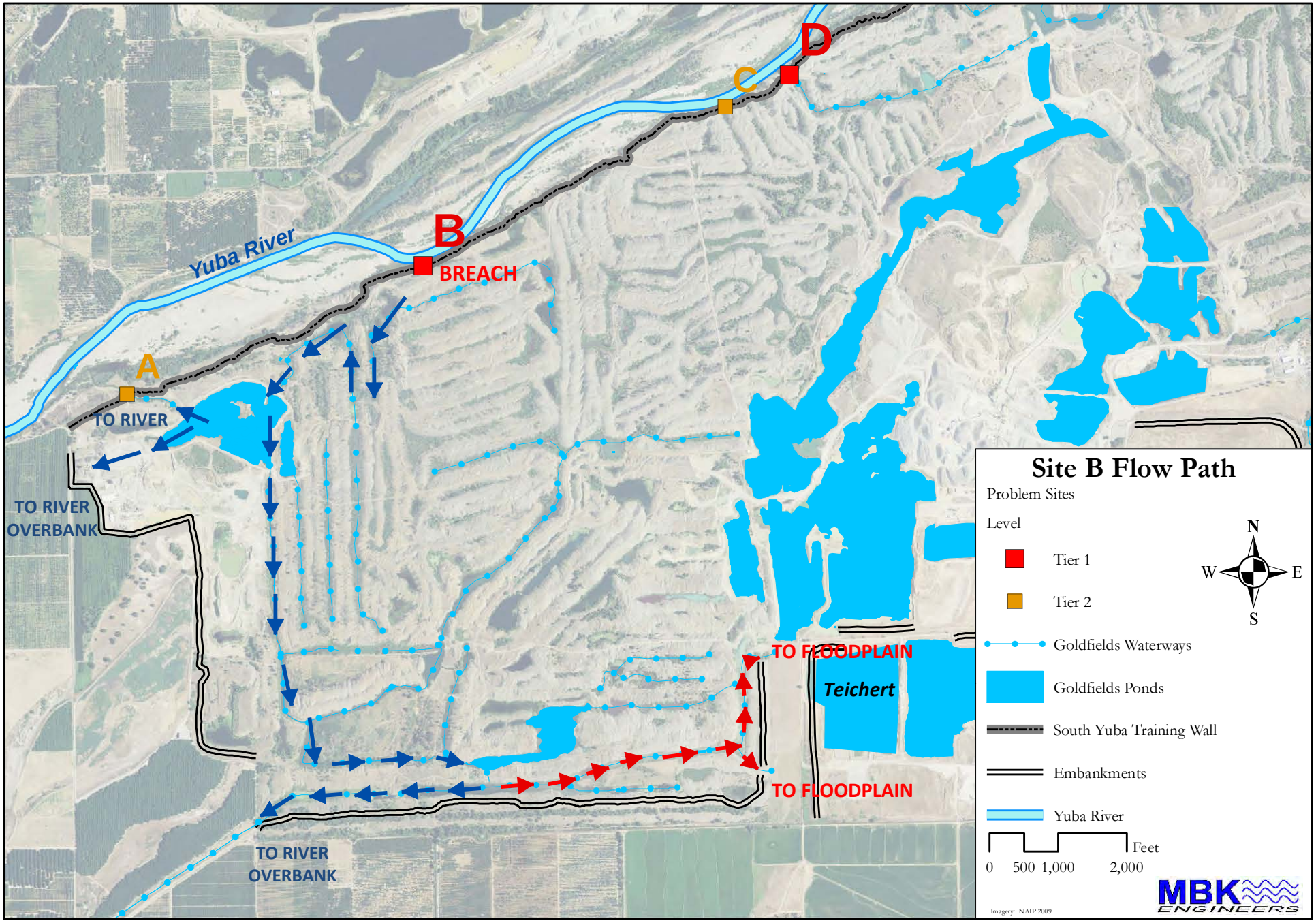

Site B Flow Path
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Yuba River
Feet
0 500 1,000 2,000
N
W
E
S
MBK ENGINEERS
Imagery: NAIP 2009
Yuba River
A
B
BREACH
C
D
TO RIVER
TO RIVER OVERBANK
TO RIVER OVERBANK
TO FLOODPLAIN
TO FLOODPLAIN
Teichert

Figure 19

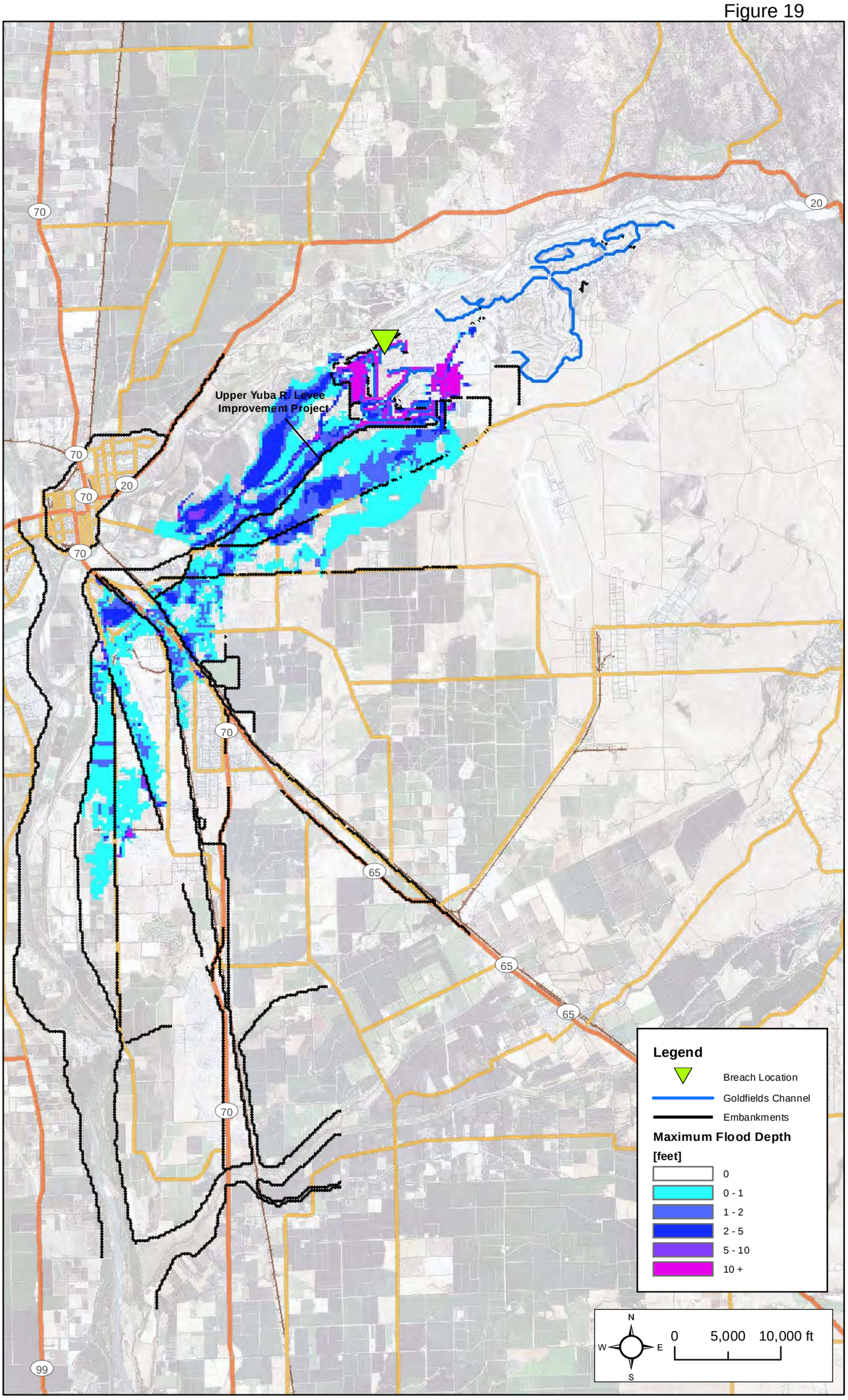
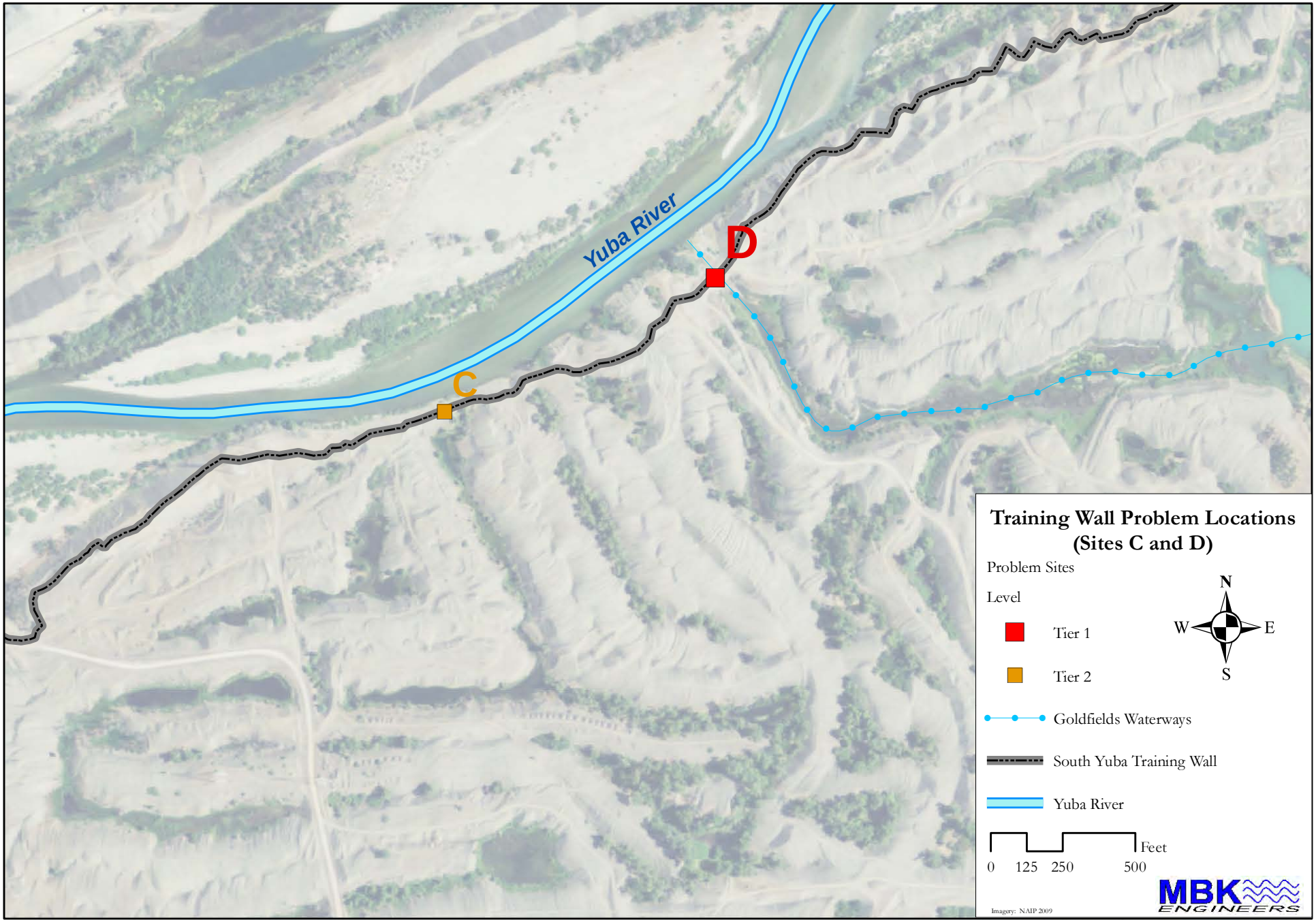

Upper Yuba R. Levee
Improvement Project
70
20
65
99
Legend
Breach Location
Goldfields Channel
Embankments
Maximum Flood Depth
[feet]
0
0 - 1
1 - 2
2 - 5
5 - 10
10 +
N
W
E
S
0
5,000
10,000 ft

Figure 20


Yuba River
C
D
Training Wall Problem Locations
(Sites C and D)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Site C site photos – May 17, 2011

MBK ENGINEERS

Figure 22

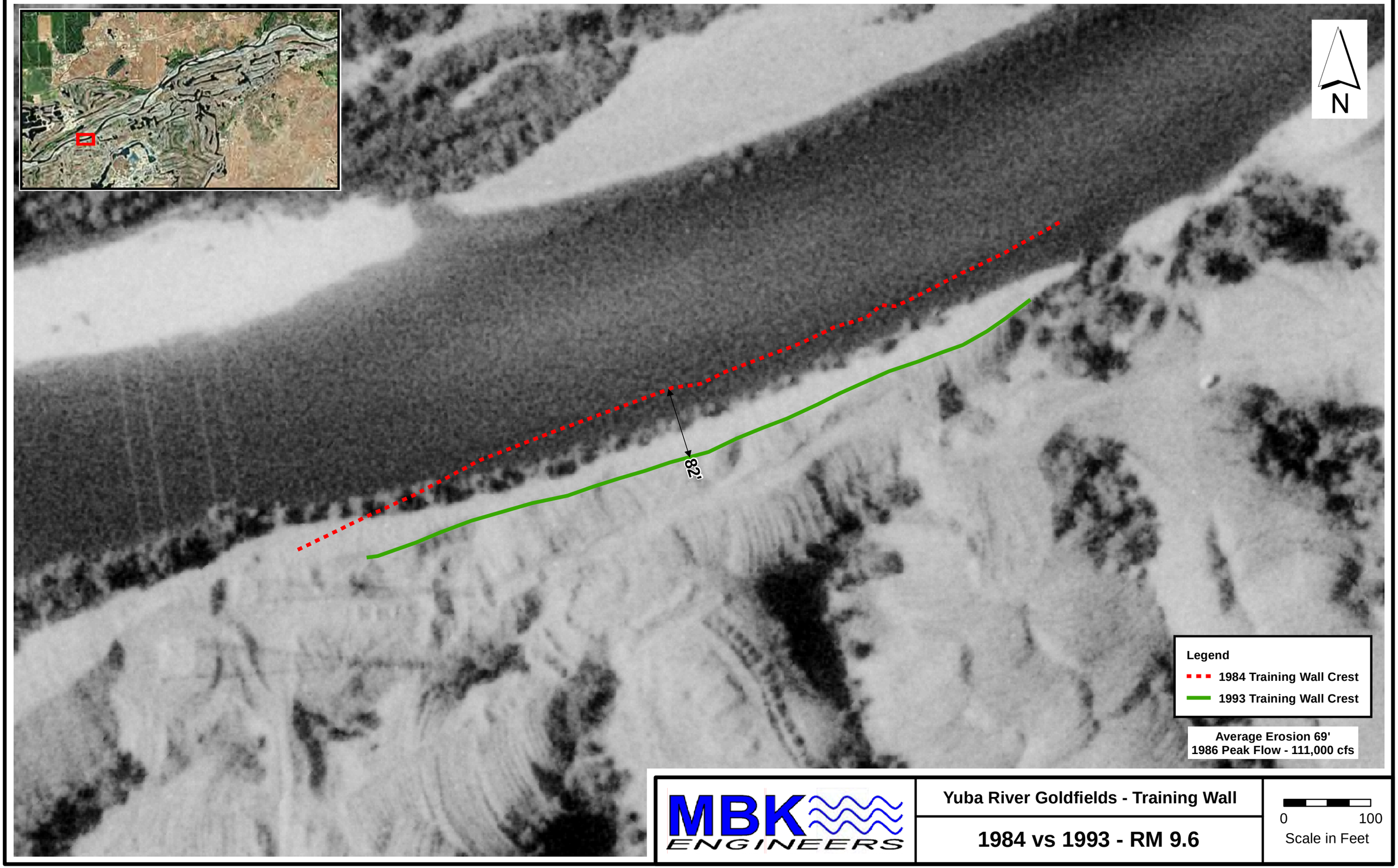

N
82'
Legend
1984 Training Wall Crest
1993 Training Wall Crest
Average Erosion 69'
1986 Peak Flow - 111,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1984 vs 1993 - RM 9.6
0
100
Scale in Feet

Figure 23

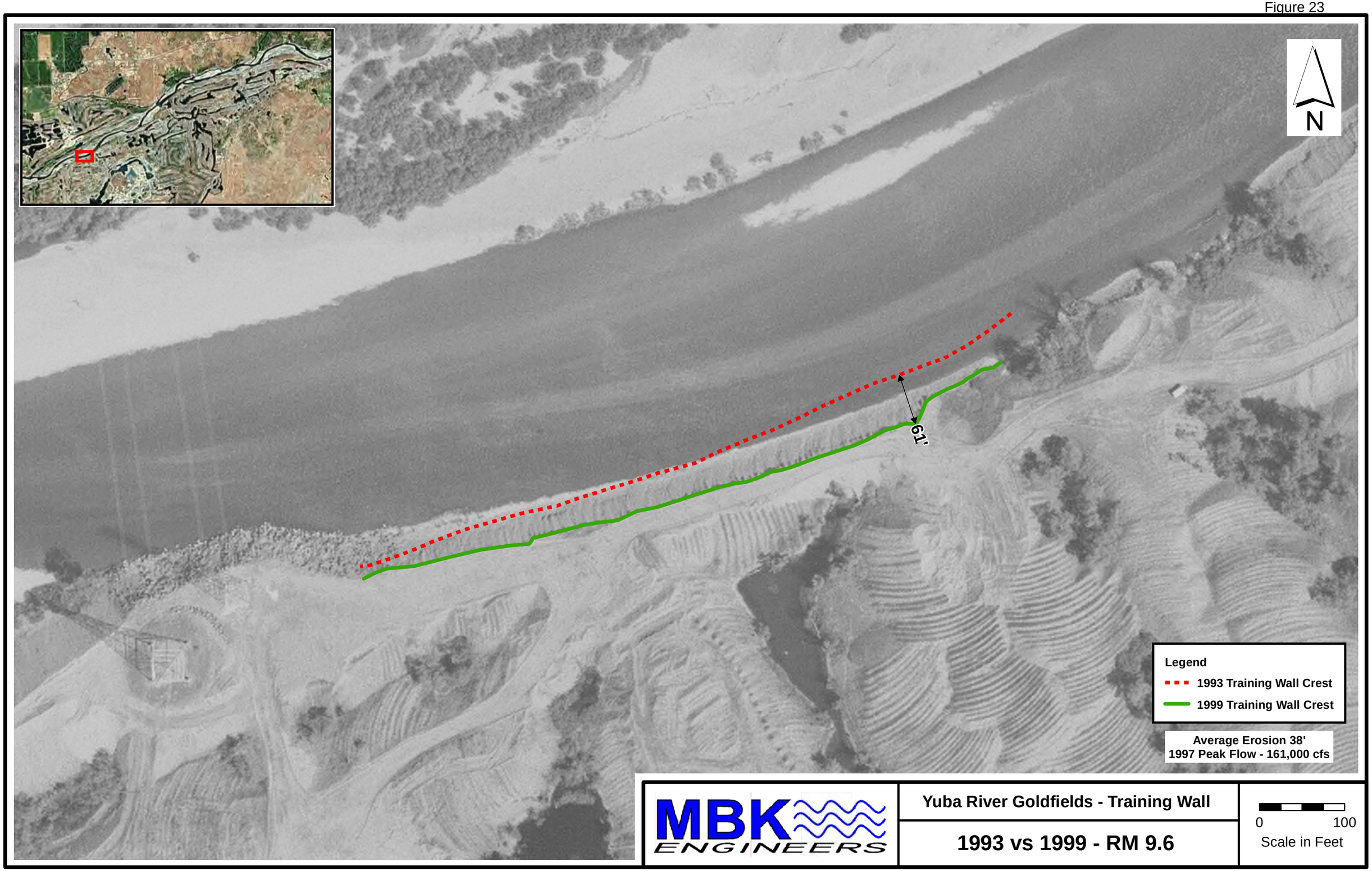

N
61'
Legend
1993 Training Wall Crest
1999 Training Wall Crest
Average Erosion 38'
1997 Peak Flow - 161,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1993 vs 1999 - RM 9.6
0
100
Scale in Feet

Figure 24

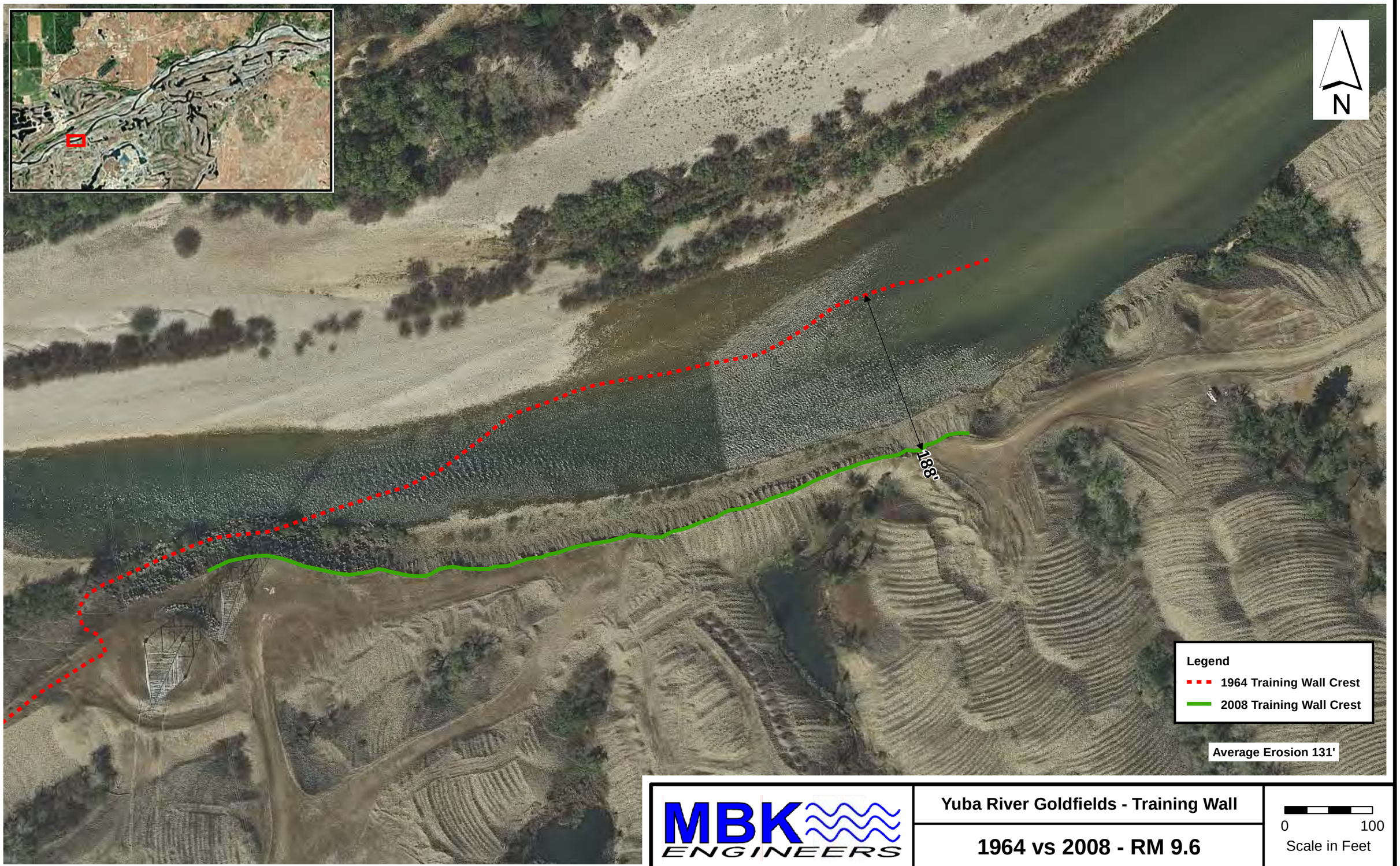
MBK ENGINEERS

Yuba River Goldfields - Training Wall

2005 vs 2008 - RM 9.6

0 100
Scale in Feet

Figure 25



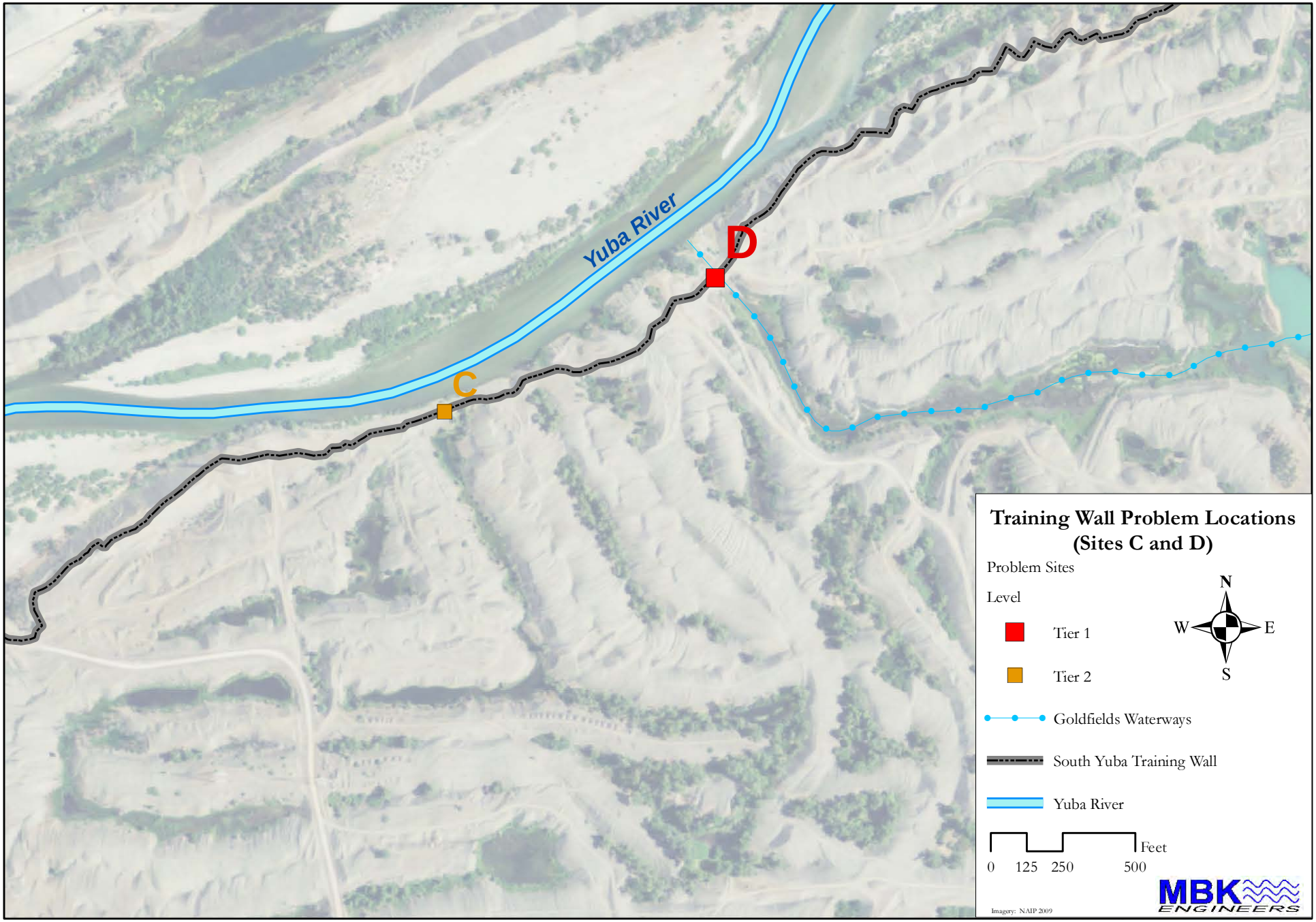
MBK ENGINEERS

Yuba River Goldfields - Training Wall

1964 vs 2008 - RM 9.6

0 100
Scale in Feet

Figure 26

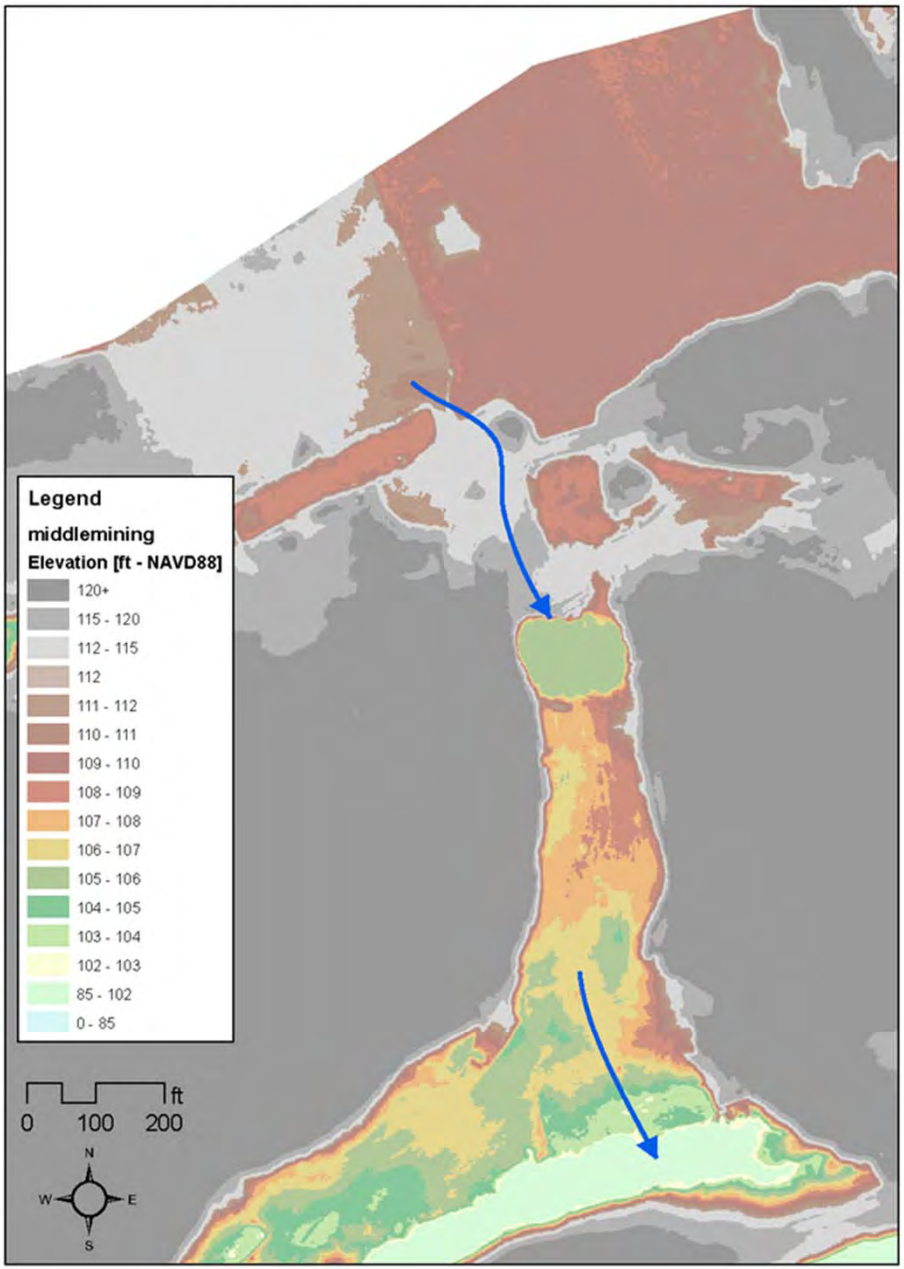

Yuba River
C
D
Training Wall Problem Locations
(Sites C and D)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Site D site photo – May 17, 2011

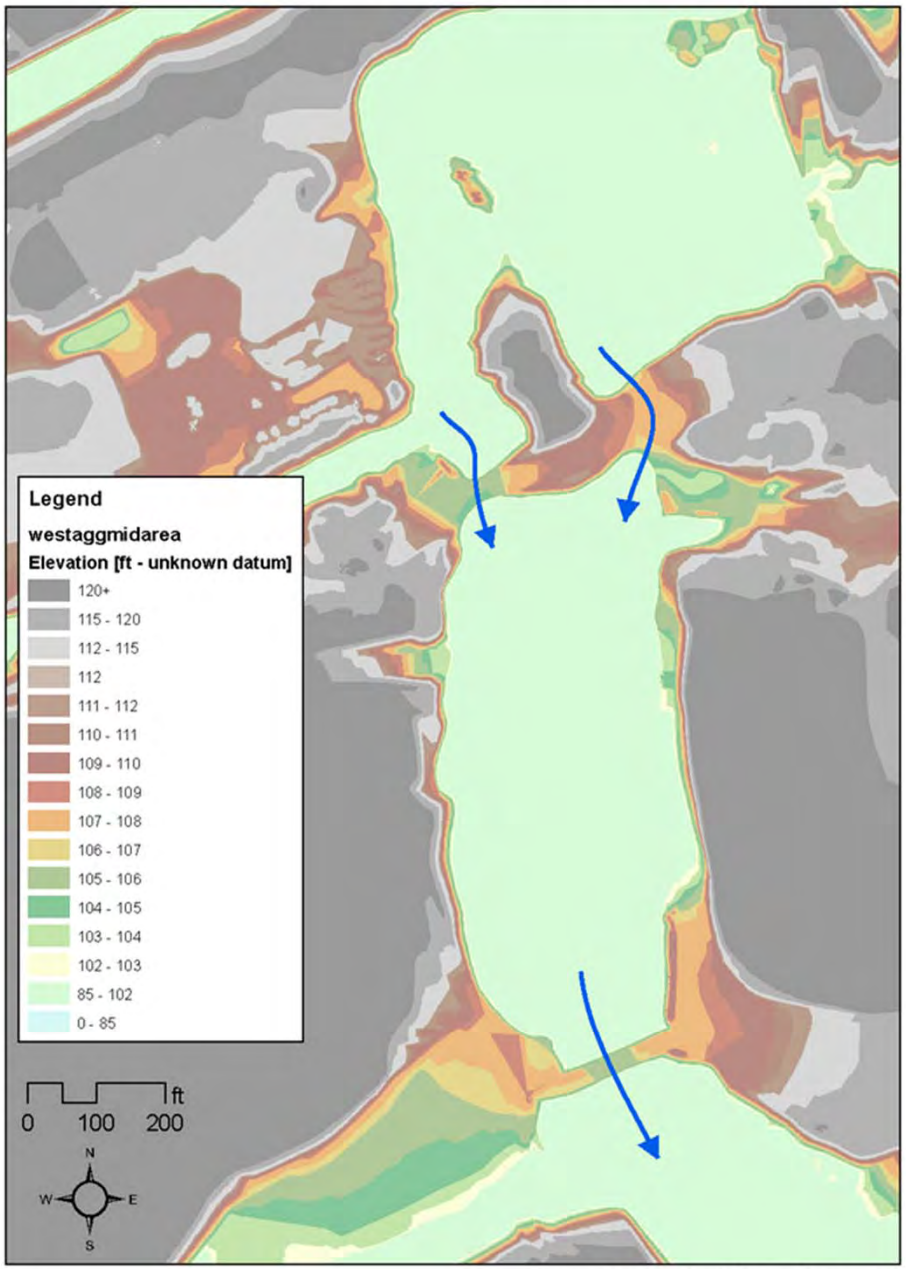
MBK ENGINEERS

Figure 28

Crossing #20 [Pre-Dredging; 2008 Condition]



Crossing #20 [Post-Dredging; Recent Condition]



Topographic Data from Western Aggregate
Unknown Vertical Datum

MBK ENGINEERS

Figure 29

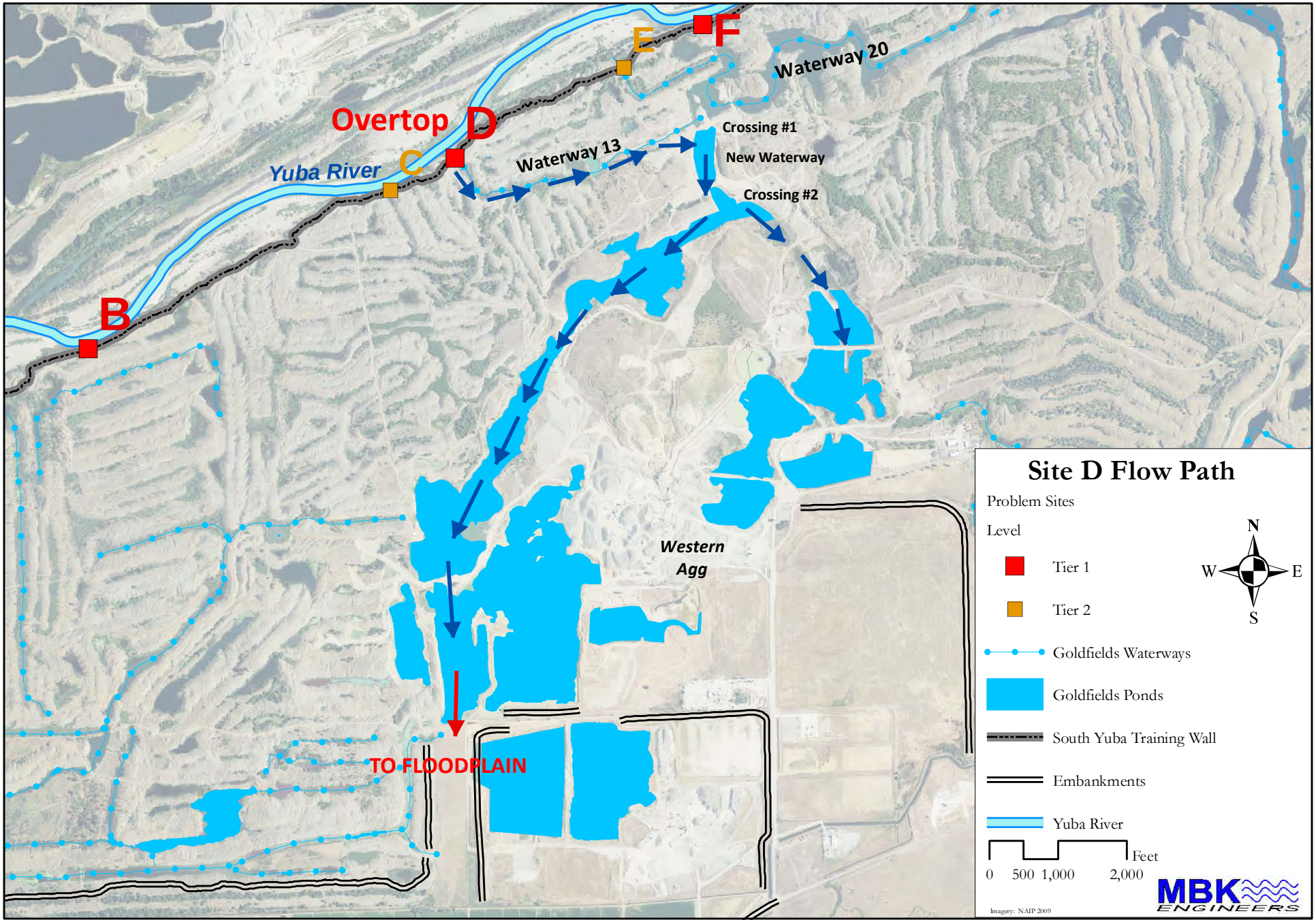

Site D Flow Path
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Yuba River
0 500 1,000 2,000 Feet
N
W
E
S
MBK ENGINEERS
Imagery: NAIP 2009
Overtop
D
C
B
E
F
Yuba River
Waterway 13
Waterway 20
Crossing #1
New Waterway
Crossing #2
Western Agg
TO FLOODPLAIN

Figure 30

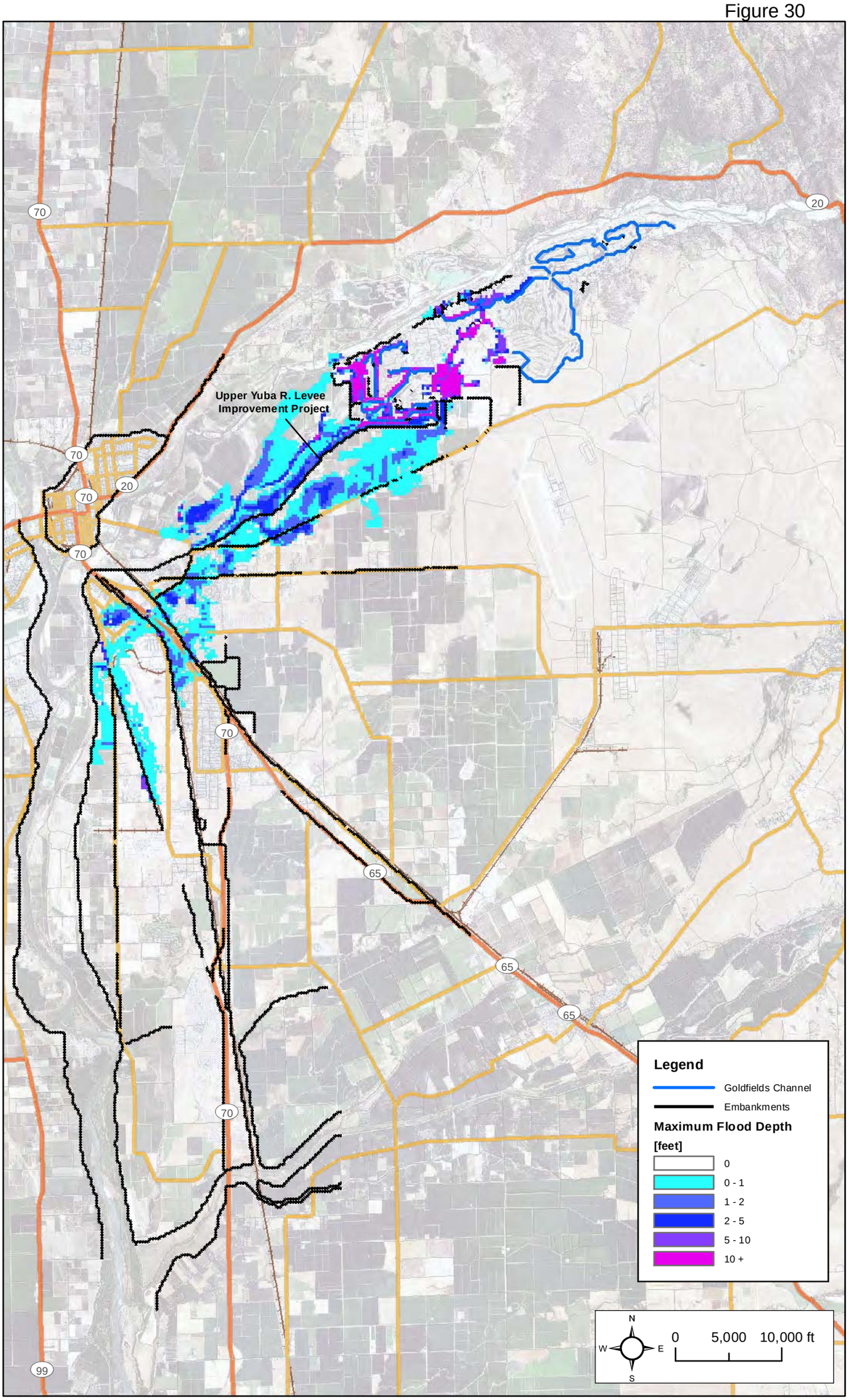
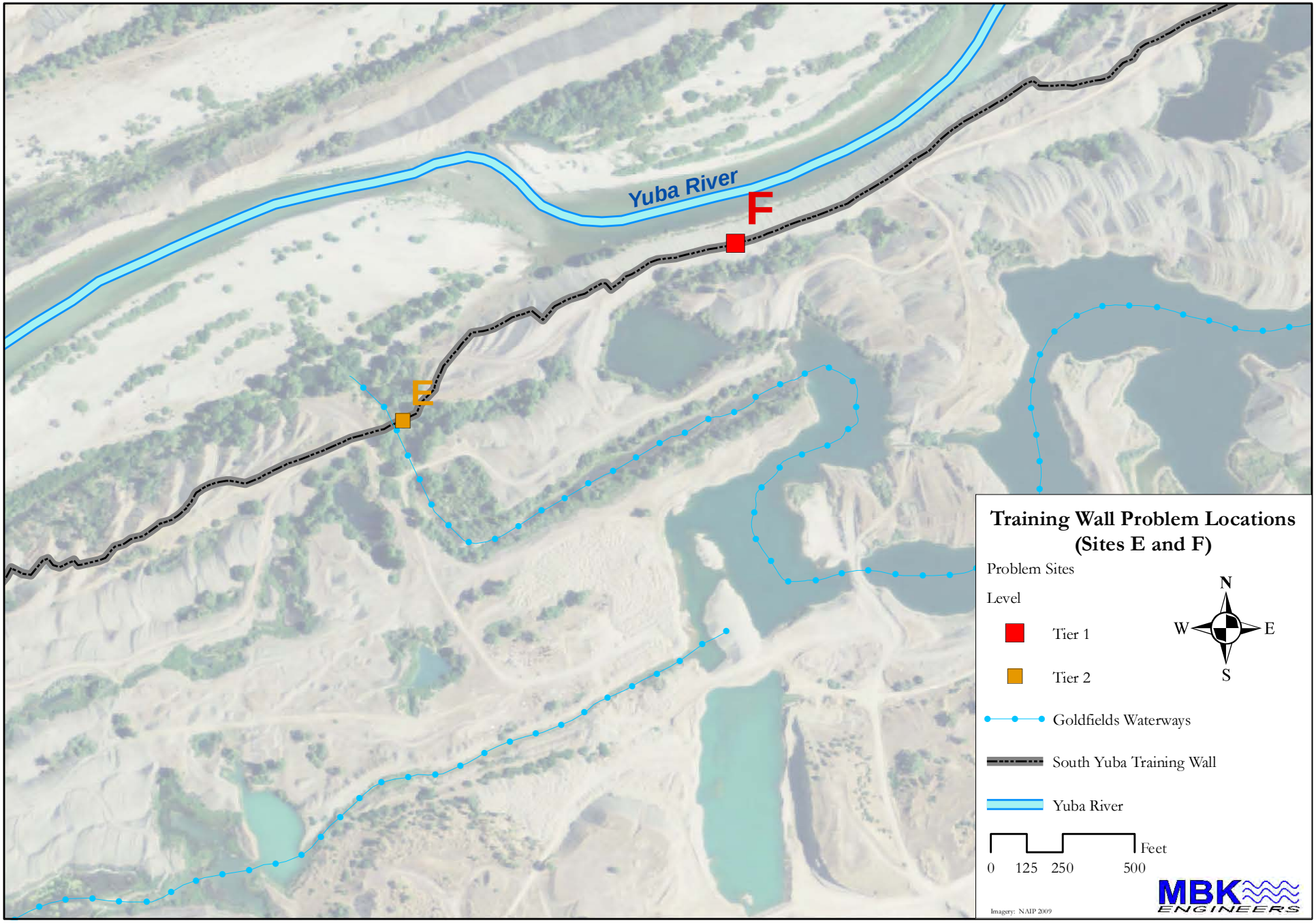

Upper Yuba R. Levee
Improvement Project
70
20
65
99
Legend
Goldfields Channel
Embankments
Maximum Flood Depth
[feet]
0
0 - 1
1 - 2
2 - 5
5 - 10
10 +
N
W
E
S
0
5,000
10,000 ft

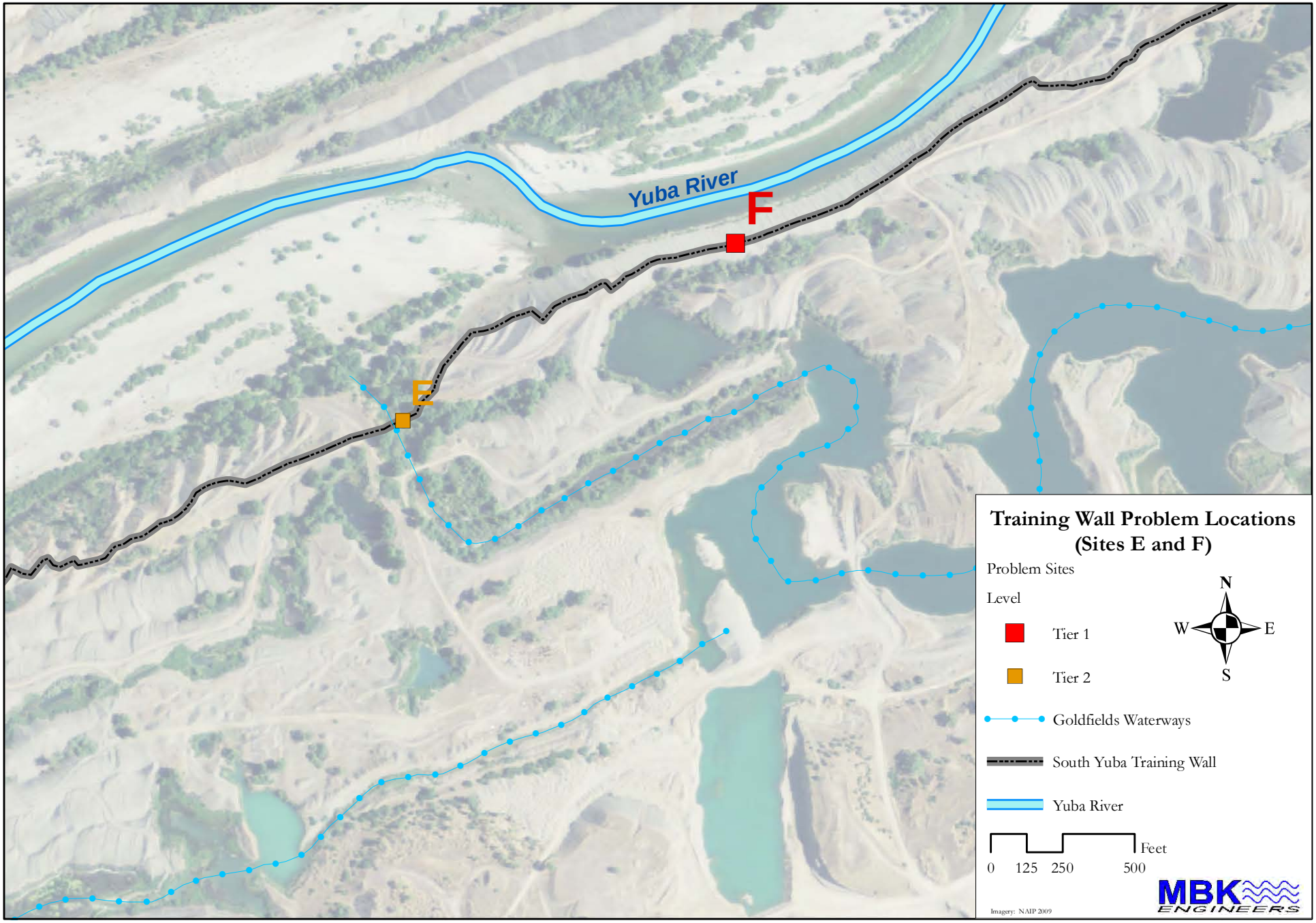
Figure 31


Yuba River
F
E
Training Wall Problem Locations
(Sites E and F)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
Feet
0
125
250
500
Imagery: NAIP 2009
MBK
ENGINEERS

Site E site photos – May 20, 2010

MBK ENGINEERS

Figure 33


Yuba River
F
E
Training Wall Problem Locations
(Sites E and F)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
Feet
0
125
250
500
Imagery: NAIP 2009
MBK
ENGINEERS

Site F site photo – May 17, 2011

MBK ENGINEERS

Figure 35

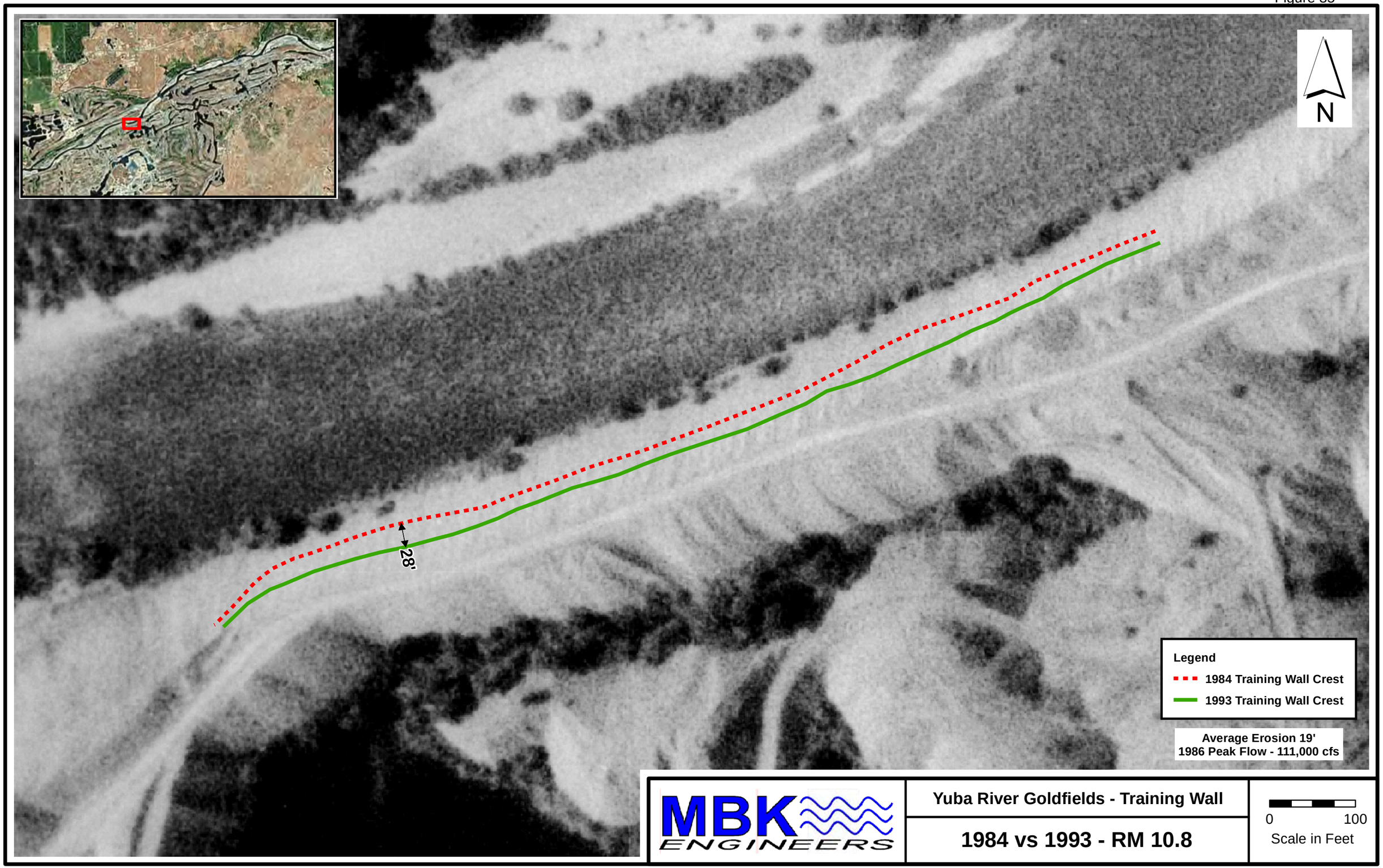

N
28'
Legend
1984 Training Wall Crest
1993 Training Wall Crest
Average Erosion 19'
1986 Peak Flow - 111,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1984 vs 1993 - RM 10.8
0
100
Scale in Feet

Figure 36

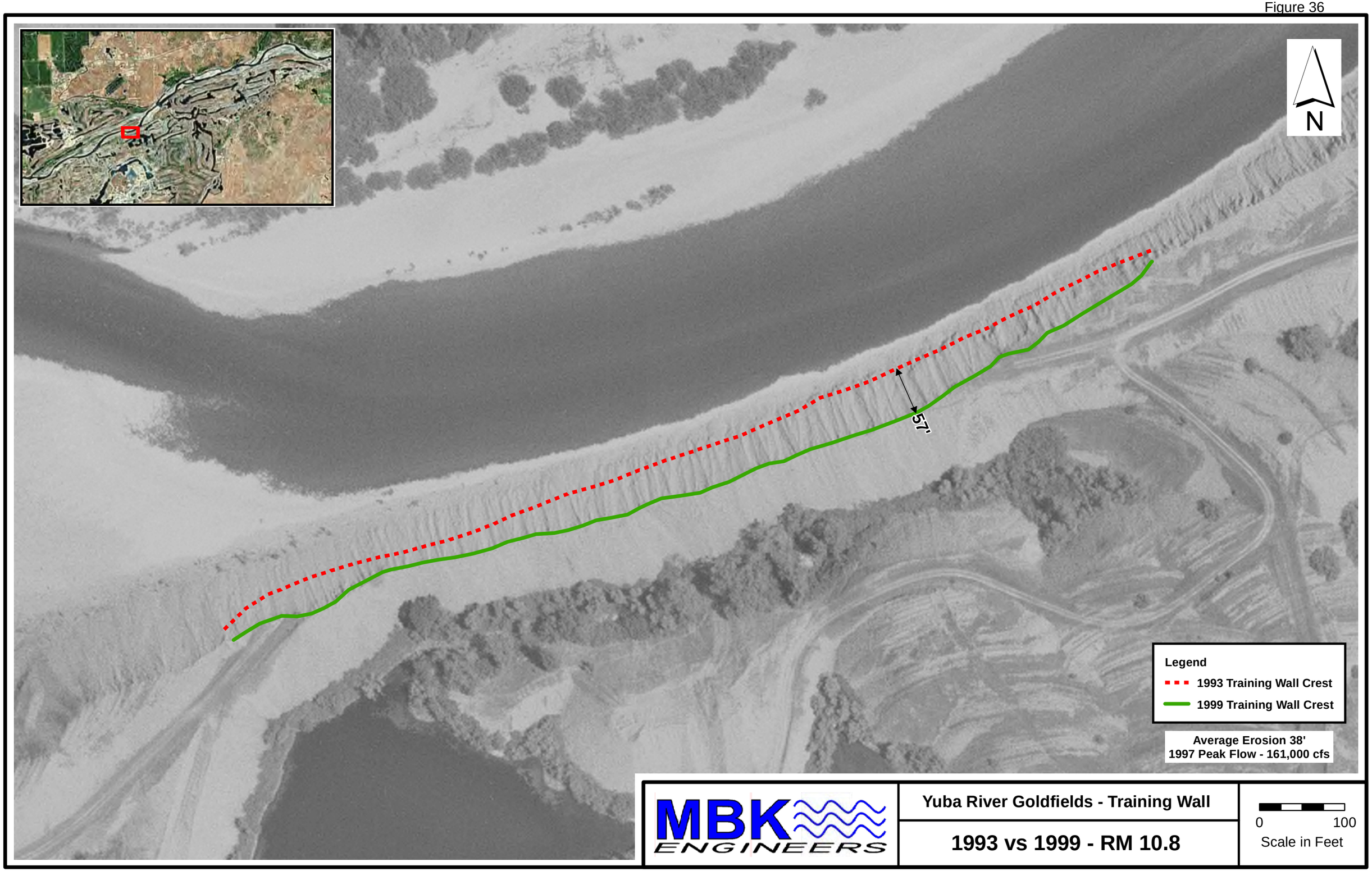

N
57'
Legend
1993 Training Wall Crest
1999 Training Wall Crest
Average Erosion 38'
1997 Peak Flow - 161,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1993 vs 1999 - RM 10.8
0
100
Scale in Feet

Figure 37

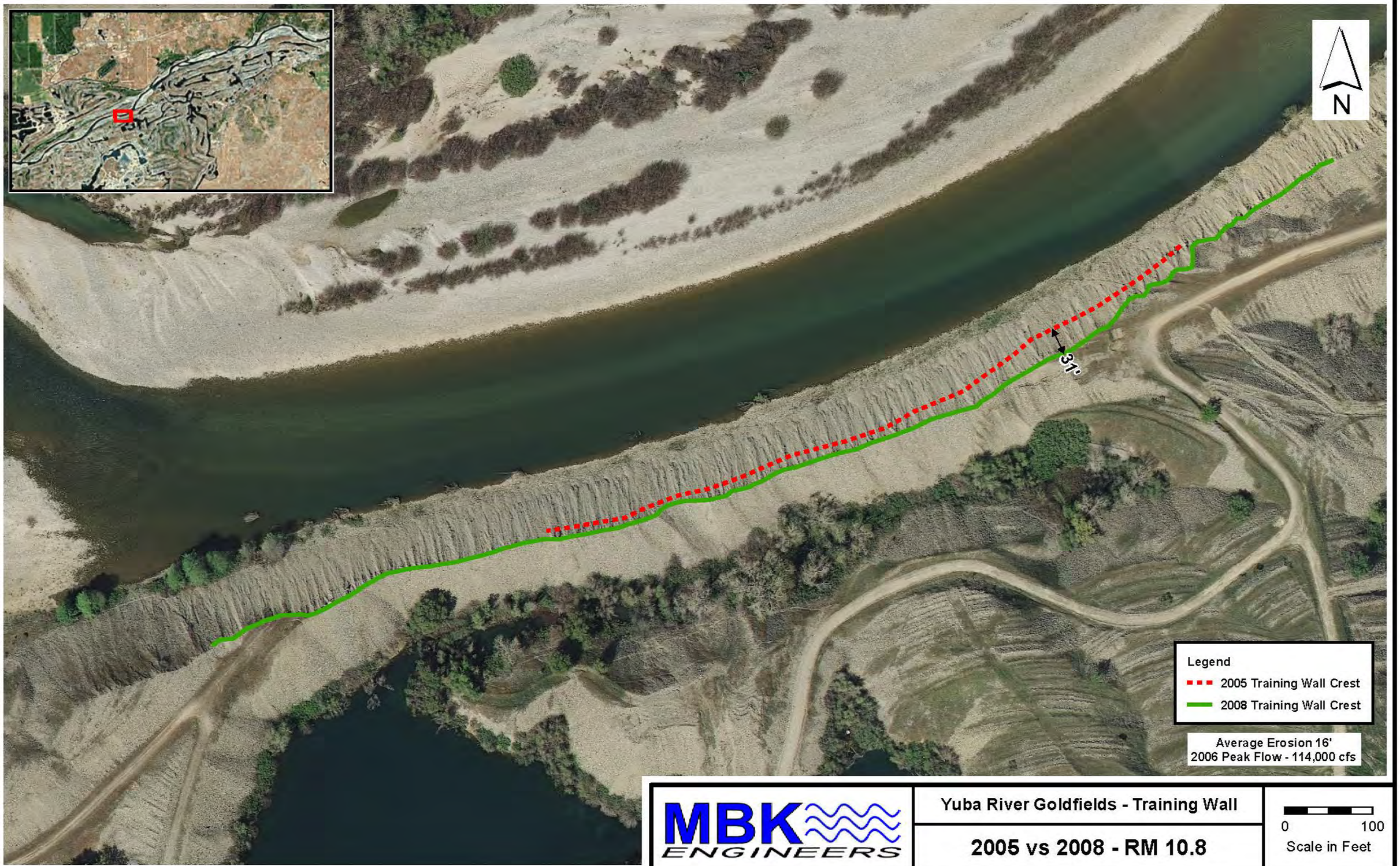

N
31'
Legend
2005 Training Wall Crest
2008 Training Wall Crest
Average Erosion 16'
2006 Peak Flow - 114,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
2005 vs 2008 - RM 10.8
0
100
Scale in Feet

Figure 38

MBK ENGINEERS

Yuba River Goldfields - Training Wall

1964 vs 2008 - RM 10.8

0 100
Scale in Feet

Figure 39

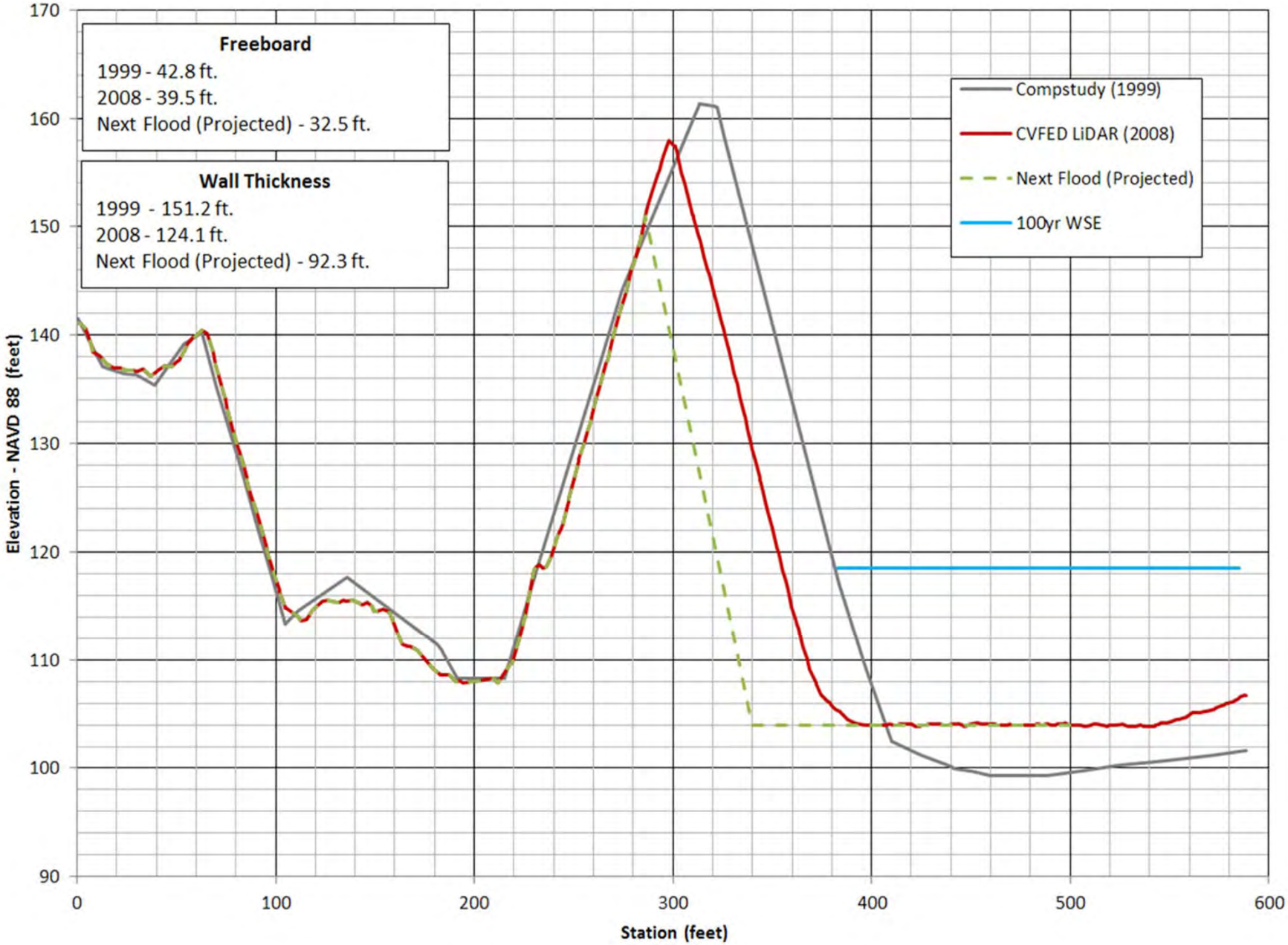


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Figure 40

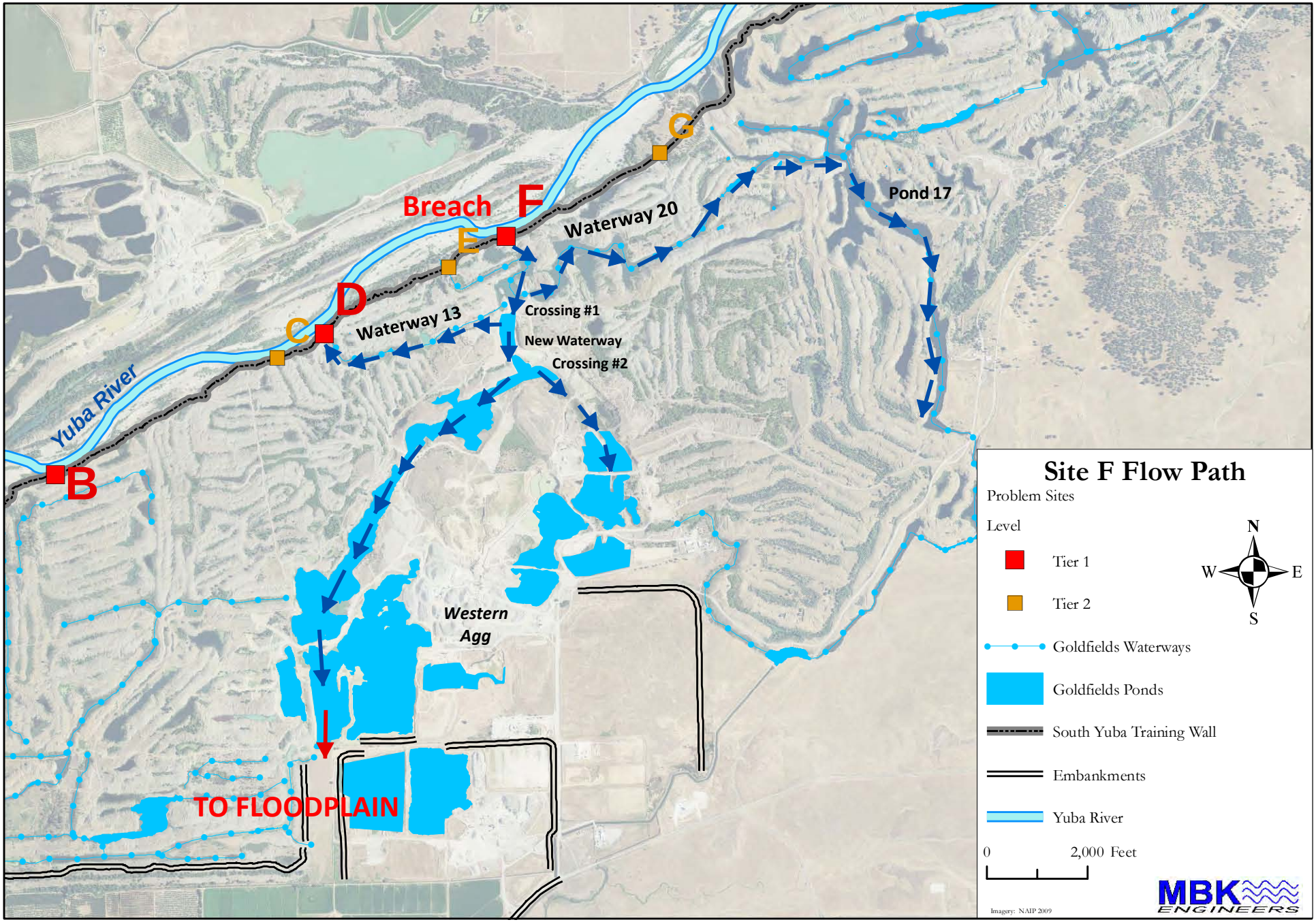

Breach
F
E
D
C
B
G
Waterway 20
Waterway 13
Crossing #1
New Waterway
Crossing #2
Pond 17
Yuba River
Western Agg
TO FLOODPLAIN
Site F Flow Path
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
Goldfields Ponds
South Yuba Training Wall
Embankments
Yuba River
0
2,000 Feet
N
W
E
S
Imagery: NAIP 2009
MBK ENGINEERS

Figure 41

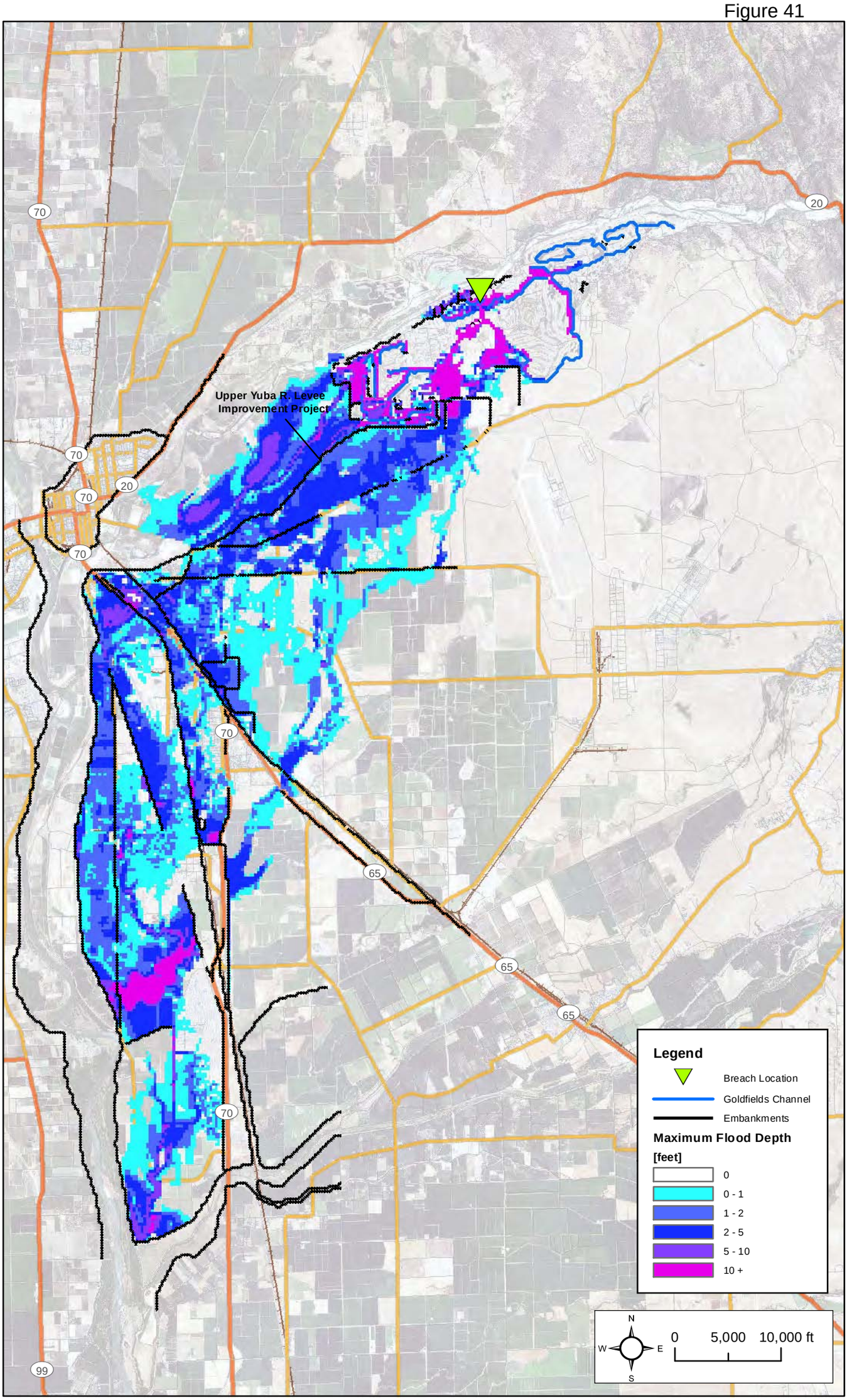

Upper Yuba R. Levee Improvement Project
70
20
65
99
Legend
Breach Location
Goldfields Channel
Embankments
Maximum Flood Depth
[feet]
0
0 - 1
1 - 2
2 - 5
5 - 10
10 +
N
W
E
S
0
5,000
10,000 ft

Figure 42

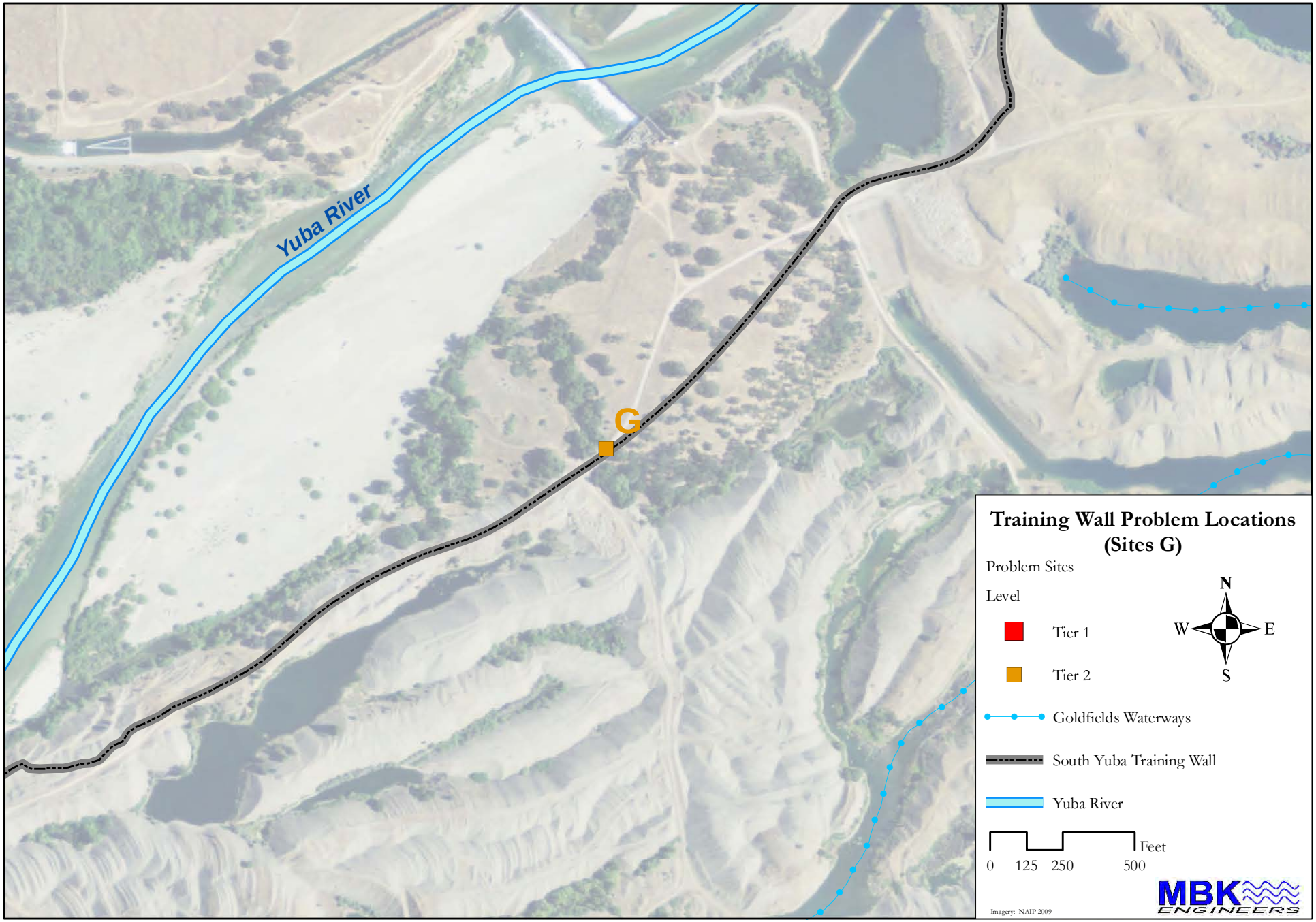
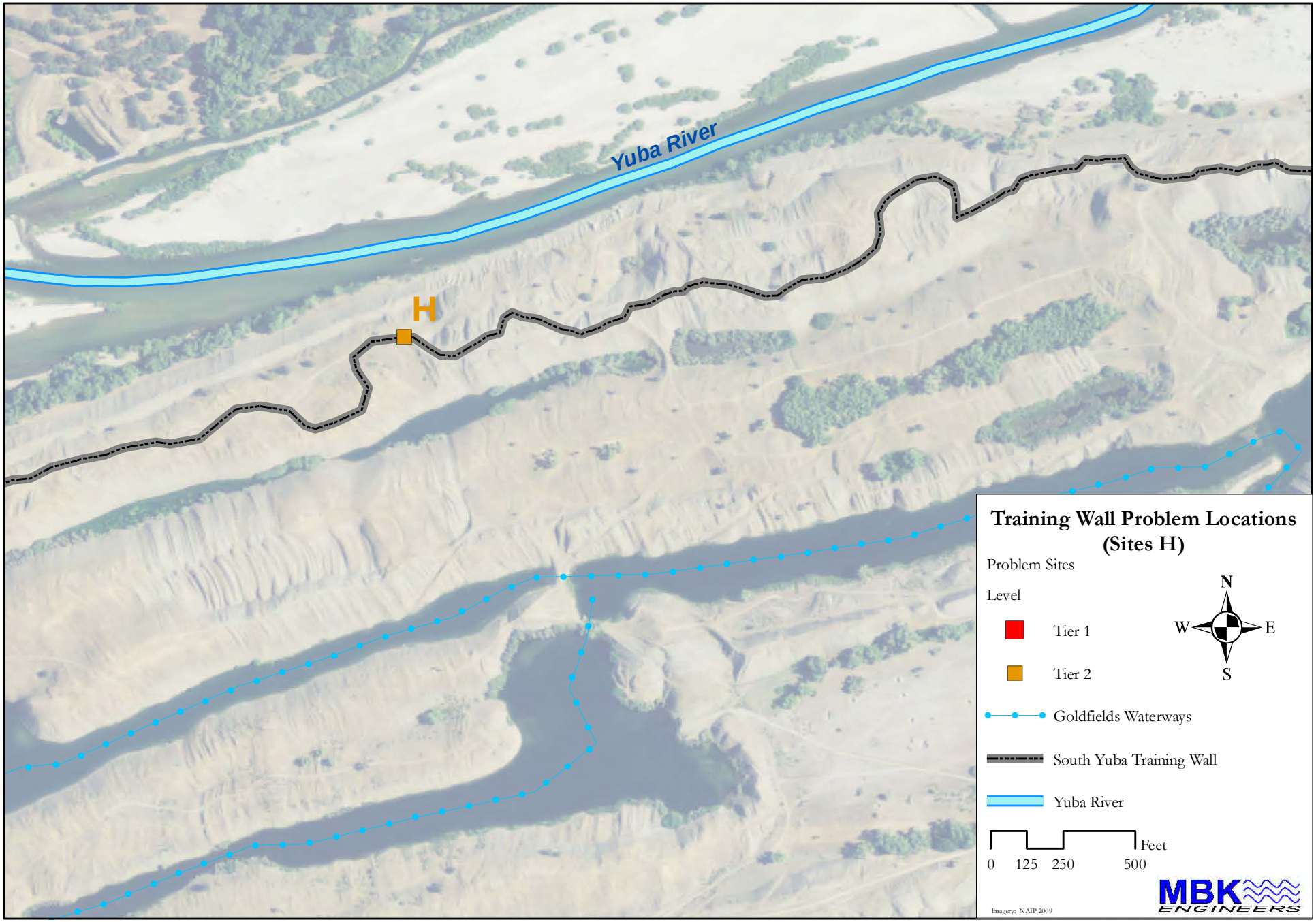

Yuba River
G
Training Wall Problem Locations
(Sites G)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
Feet
0
125
250
500
Imagery: NAIP 2009
MBK
ENGINEERS

Figure 43


Yuba River
H
Training Wall Problem Locations
(Sites H)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Site H site photos – July 01, 2010

MBK ENGINEERS

Figure 45

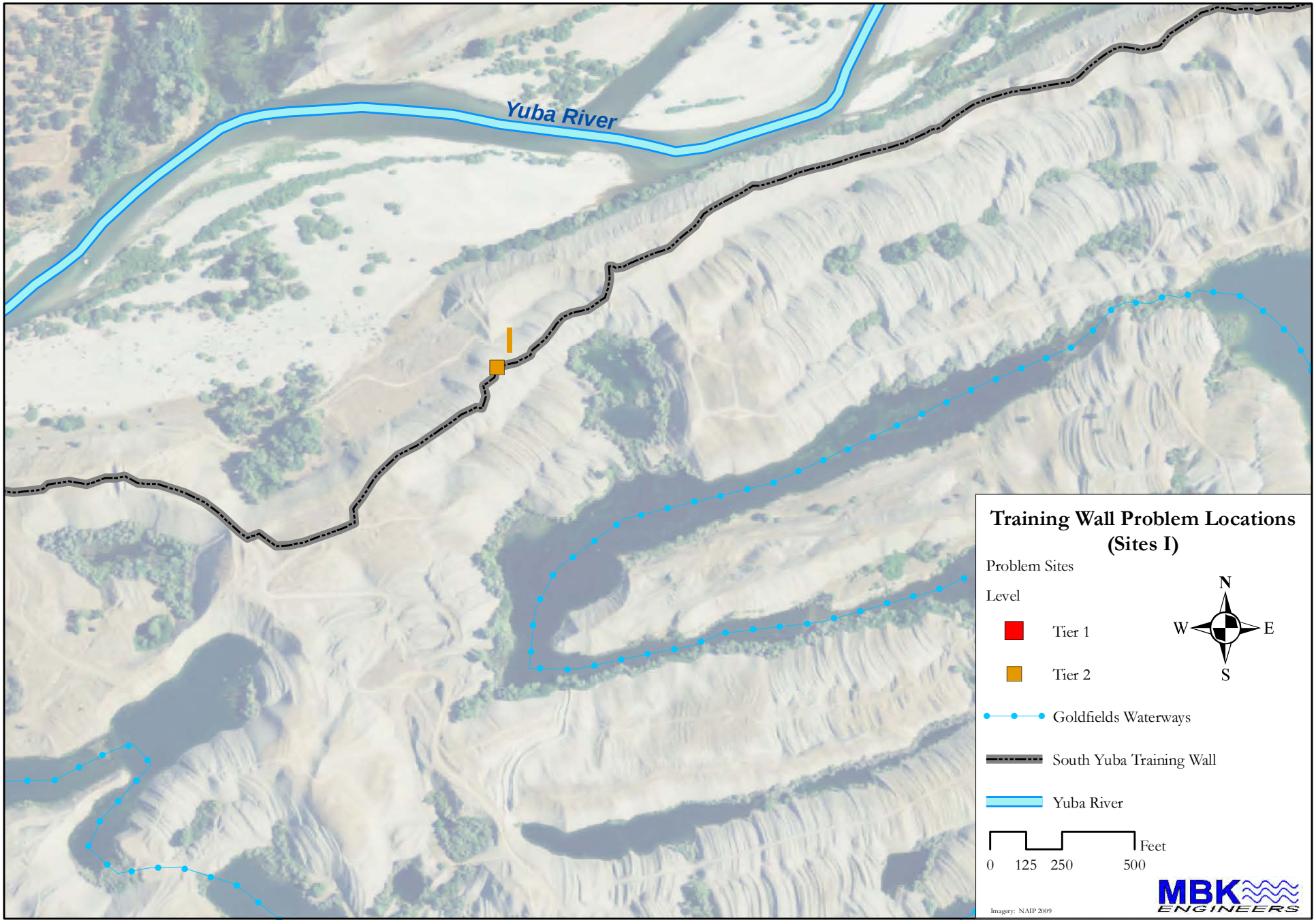
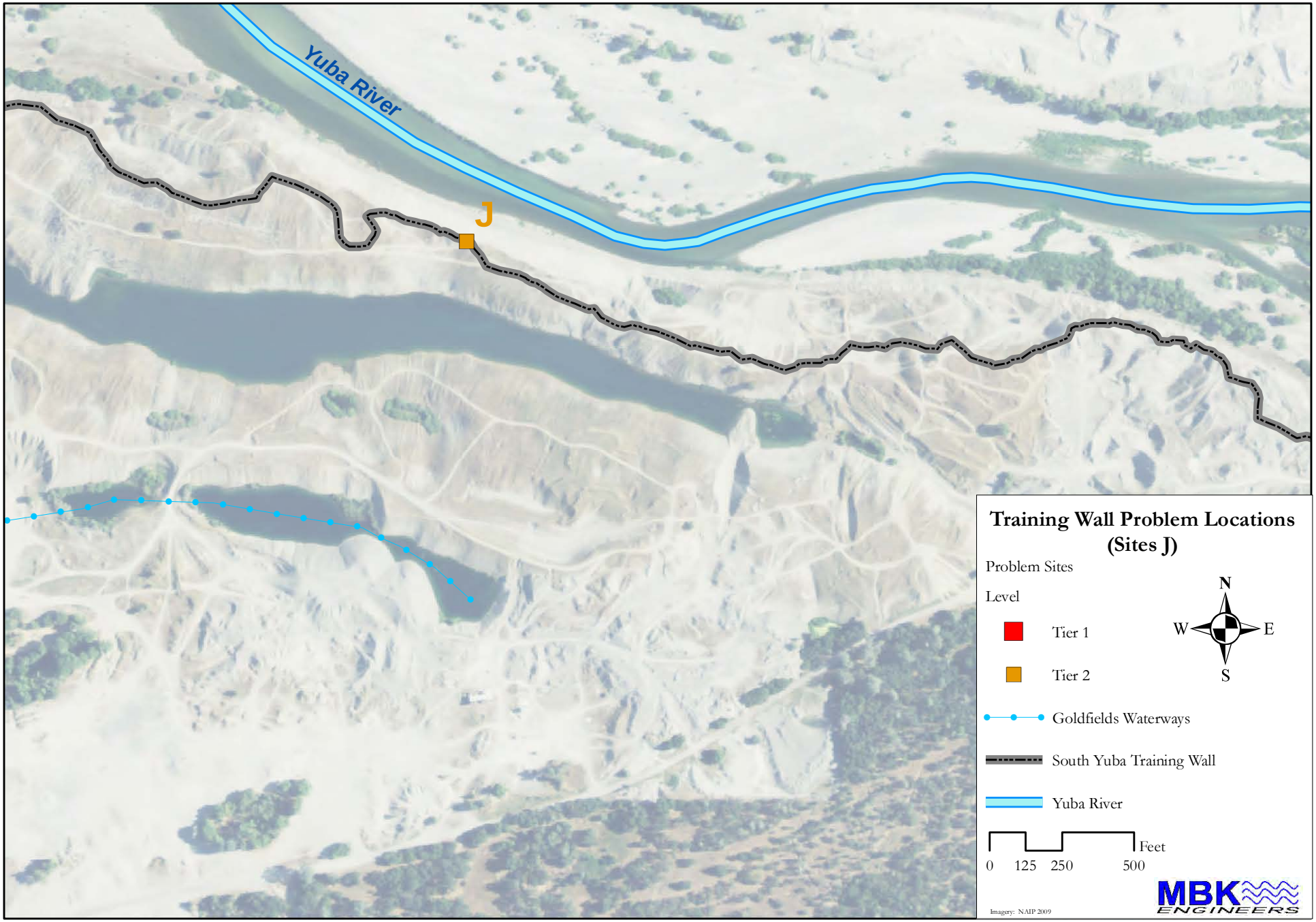

Yuba River
I
Training Wall Problem Locations
(Sites I)
Problem Sites
Level
Tier 1
Tier 2
Goldfields Waterways
South Yuba Training Wall
Yuba River
N
W
E
S
0
125
250
500
Feet
Imagery: NAIP 2009
MBK
ENGINEERS

Figure 46


Yuba River
J
Training Wall Problem Locations
(Sites J)
Problem Sites
Level
Tier 1
Tier 2
N
W
E
S
Goldfields Waterways
South Yuba Training Wall
Yuba River
Feet
0
125
250
500
Imagery: NAIP 2009
MBK
ENGINEERS

Site J site photos – July 01, 2010

MBK ENGINEERS

Figure 48

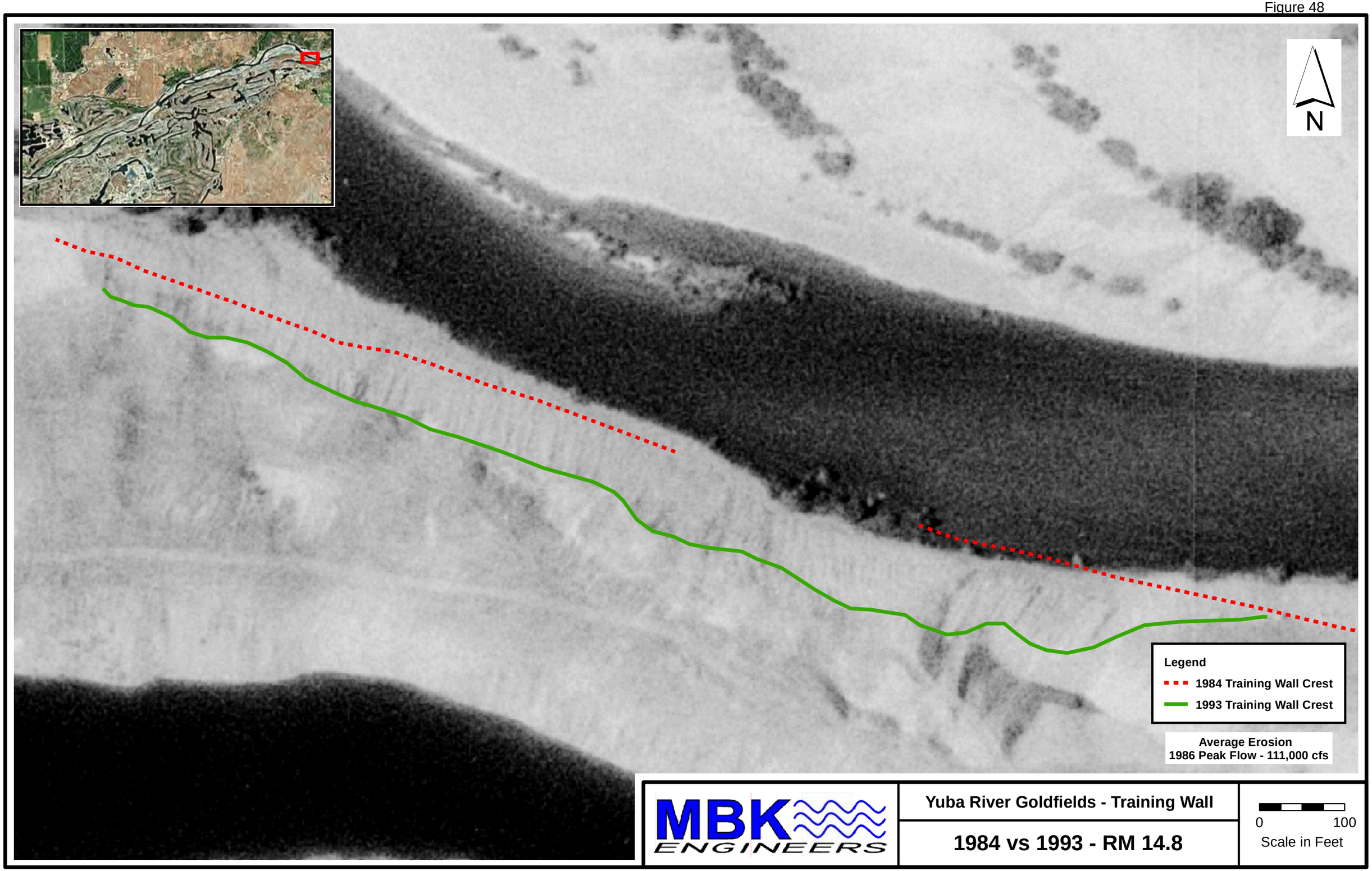

N
Legend
1984 Training Wall Crest
1993 Training Wall Crest
Average Erosion
1986 Peak Flow - 111,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1984 vs 1993 - RM 14.8
0
100
Scale in Feet

Figure 49

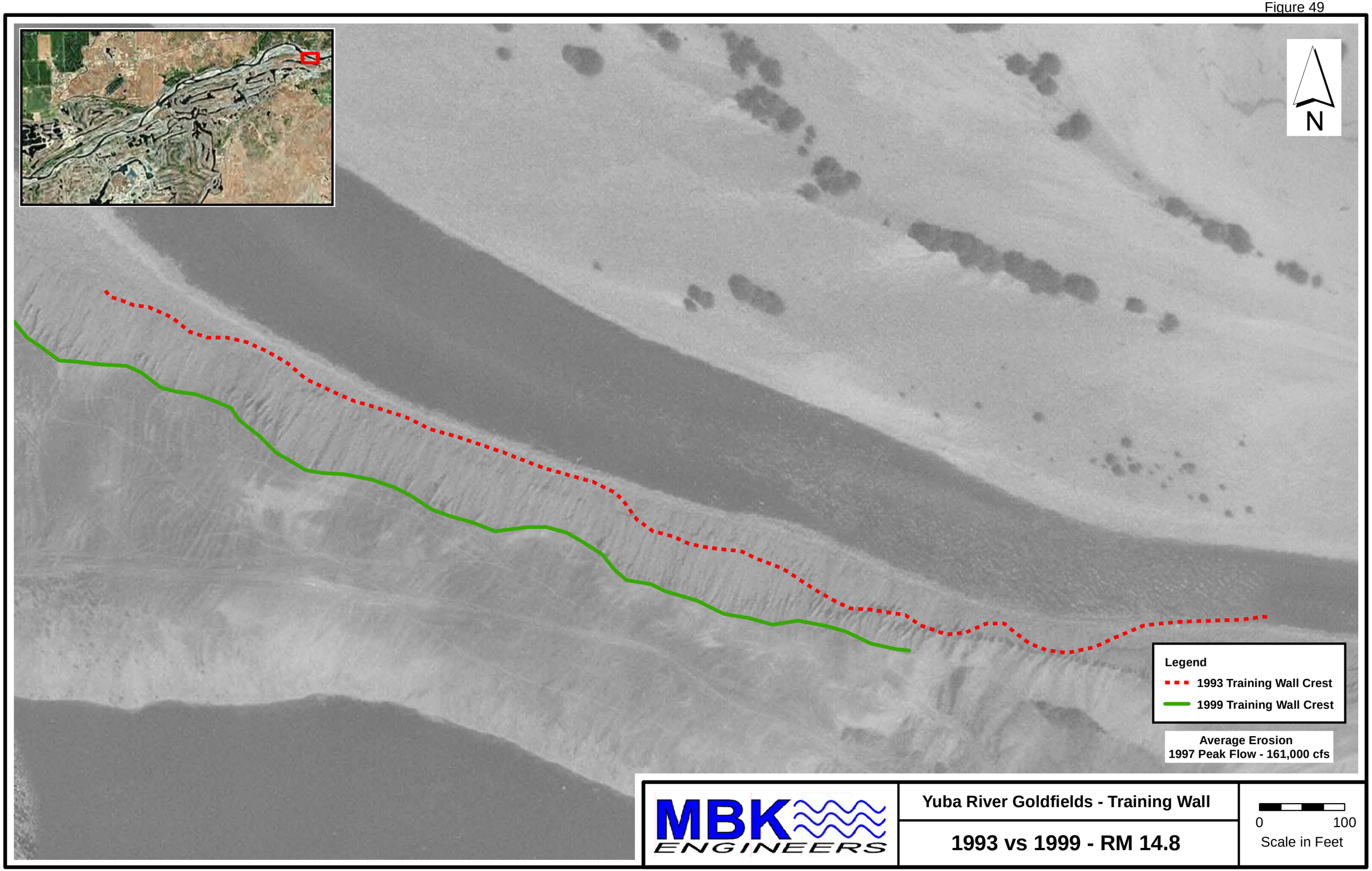

N
Legend
1993 Training Wall Crest
1999 Training Wall Crest
Average Erosion
1997 Peak Flow - 161,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
1993 vs 1999 - RM 14.8
0
100
Scale in Feet

Figure 50

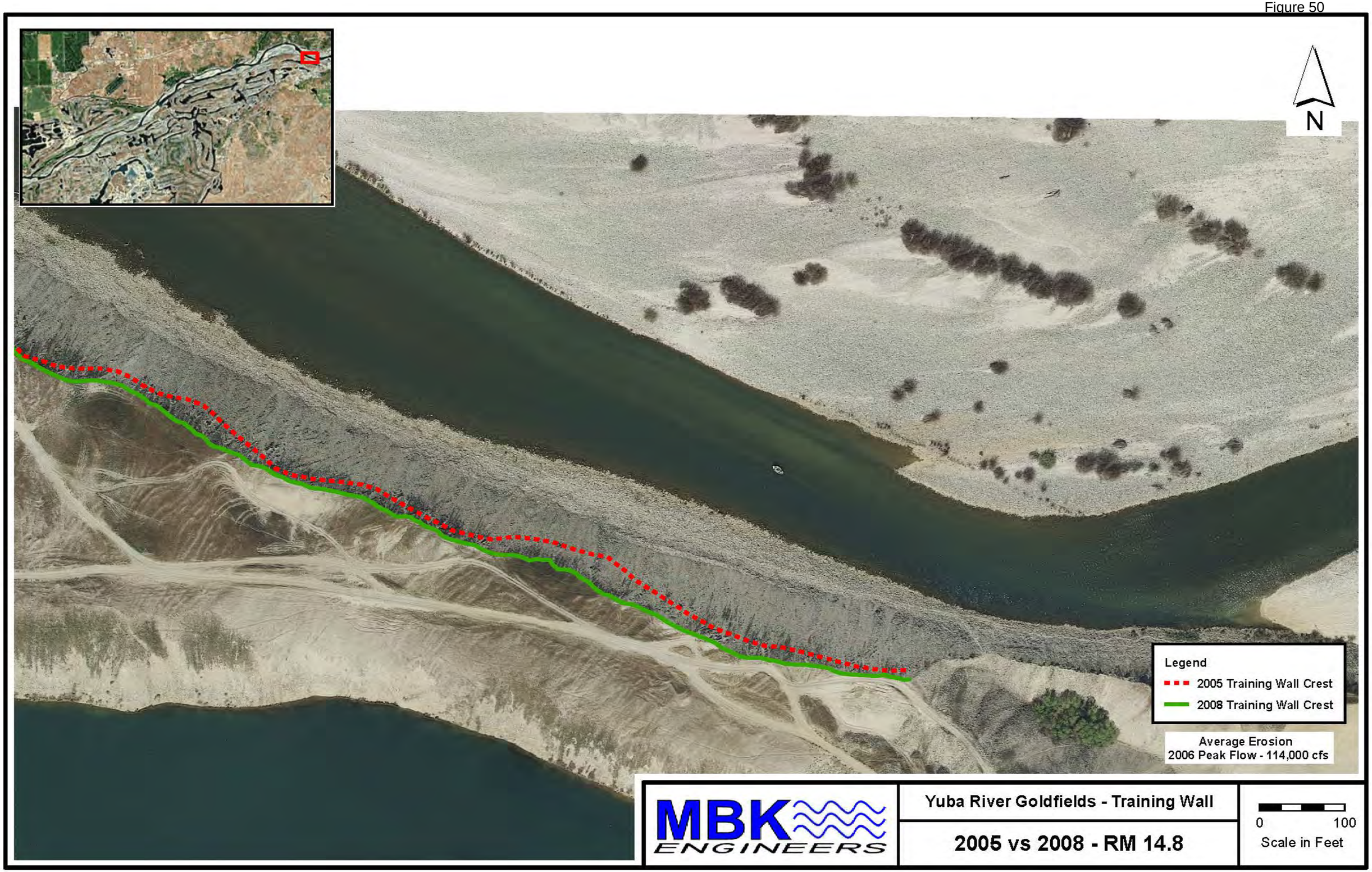
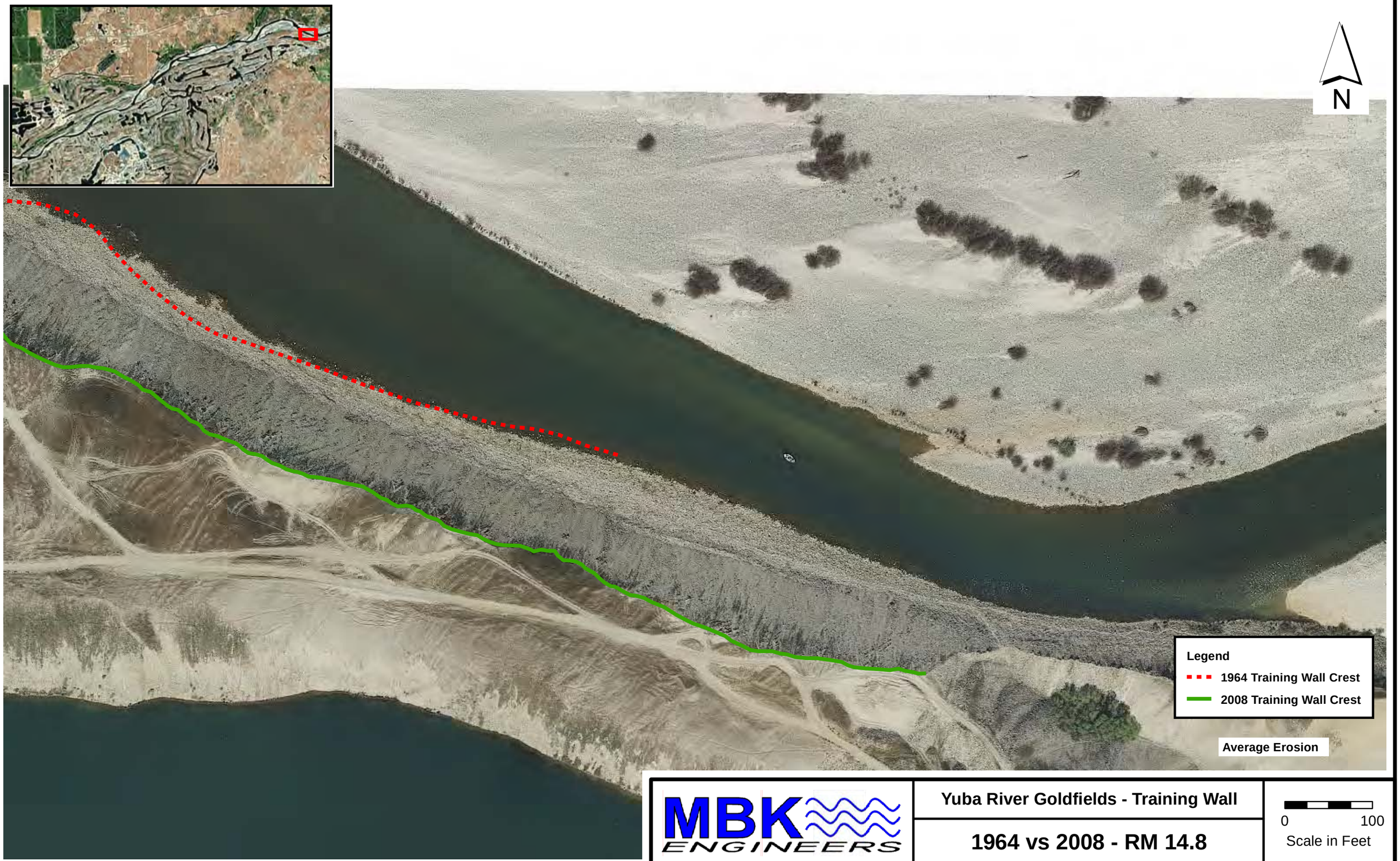

N
Legend
2005 Training Wall Crest
2008 Training Wall Crest
Average Erosion
2006 Peak Flow - 114,000 cfs
MBK ENGINEERS
Yuba River Goldfields - Training Wall
2005 vs 2008 - RM 14.8
0
100
Scale in Feet

Figure 51



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Yuba River Goldfields - Training Wall

1964 vs 2008 - RM 14.8

0 100
Scale in Feet

Action: Seal E-W lower Goldfields exit channels

Addresses: Problem Site B

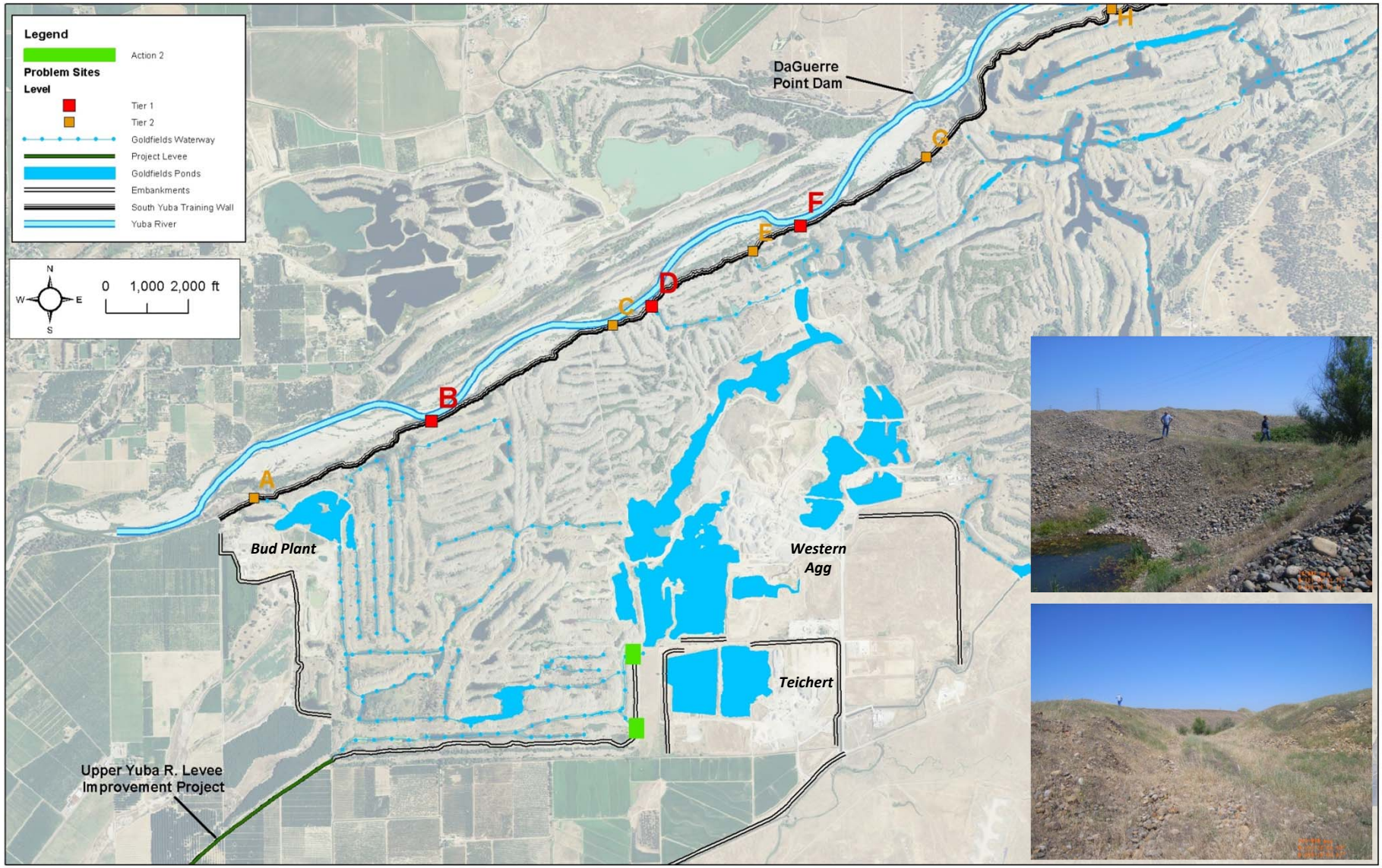


Figure 52

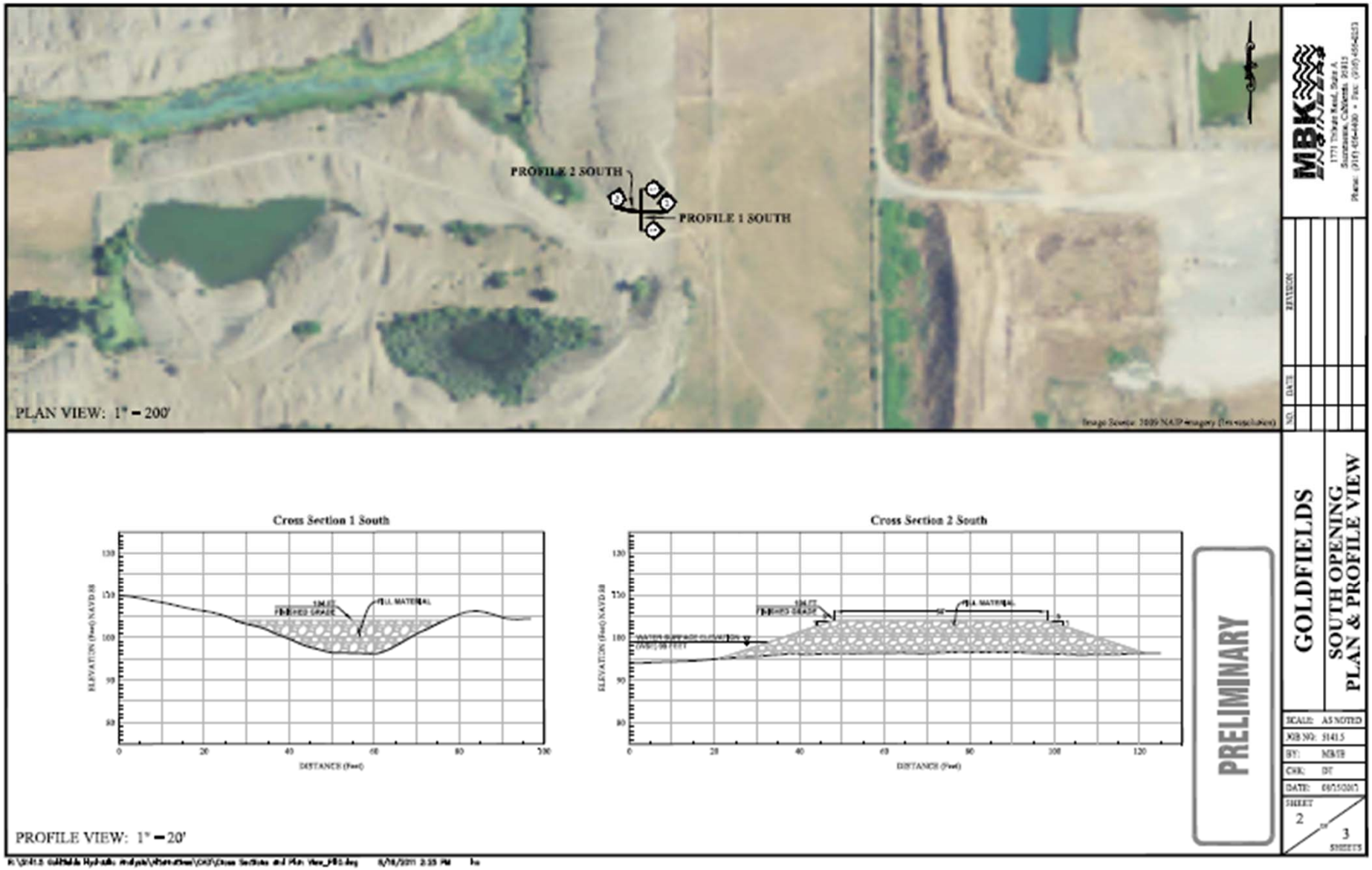

PROFILE 2 SOUTH
PROFILE 1 SOUTH
PLAN VIEW: 1" = 200'
Cross Section 1 South
Cross Section 2 South
ELEVATION (Feet) NAVD 88
DISTANCE (Feet)
FILL MATERIAL
PRELIMINARY
PROFILE VIEW: 1" = 20'
MBK ENGINEERS
GOLDFIELDS
SOUTH OPENING
PLAN & PROFILE VIEW
SCALE: AS NOTED
JOB NO: 31415
BY: MBTB
CHK: DT
DATE: 09/15/2017
SHEET 2 OF 3 SHEETS

Figure 53

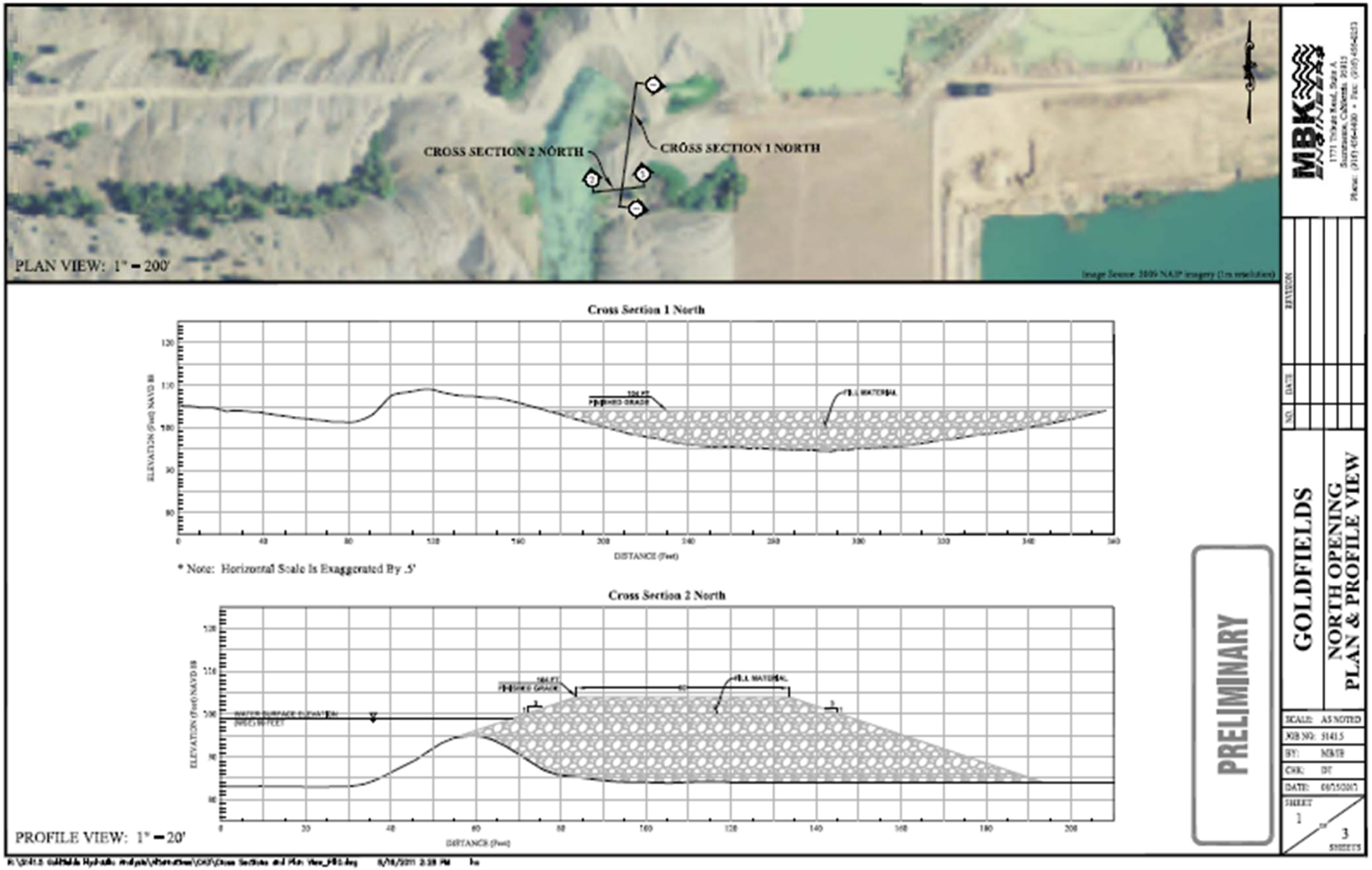

CROSS SECTION 2 NORTH
CROSS SECTION 1 NORTH
PLAN VIEW: 1" = 200'
Image Source: 2009 NAIP imagery (1m resolution)
Cross Section 1 North
ELEVATION (Feet) NAVD 88
DISTANCE (Feet)
FILL MATERIAL
* Note: Horizontal Scale Is Exaggerated By .5'
Cross Section 2 North
ELEVATION (Feet) NAVD 88
DISTANCE (Feet)
FILL MATERIAL
PROFILE VIEW: 1" = 20'
PRELIMINARY
MBK ENGINEERS
GOLDFIELDS
NORTH OPENING
PLAN & PROFILE VIEW
SCALE: AS NOTED
JOB NO: 51415
BY: MBB
CHK: DT
DATE: 08/15/2011
SHEET 1 OF 3 SHEETS

Figure 54

Action: Seal channel formed by excavated path

Addresses: Problem Sites D,F

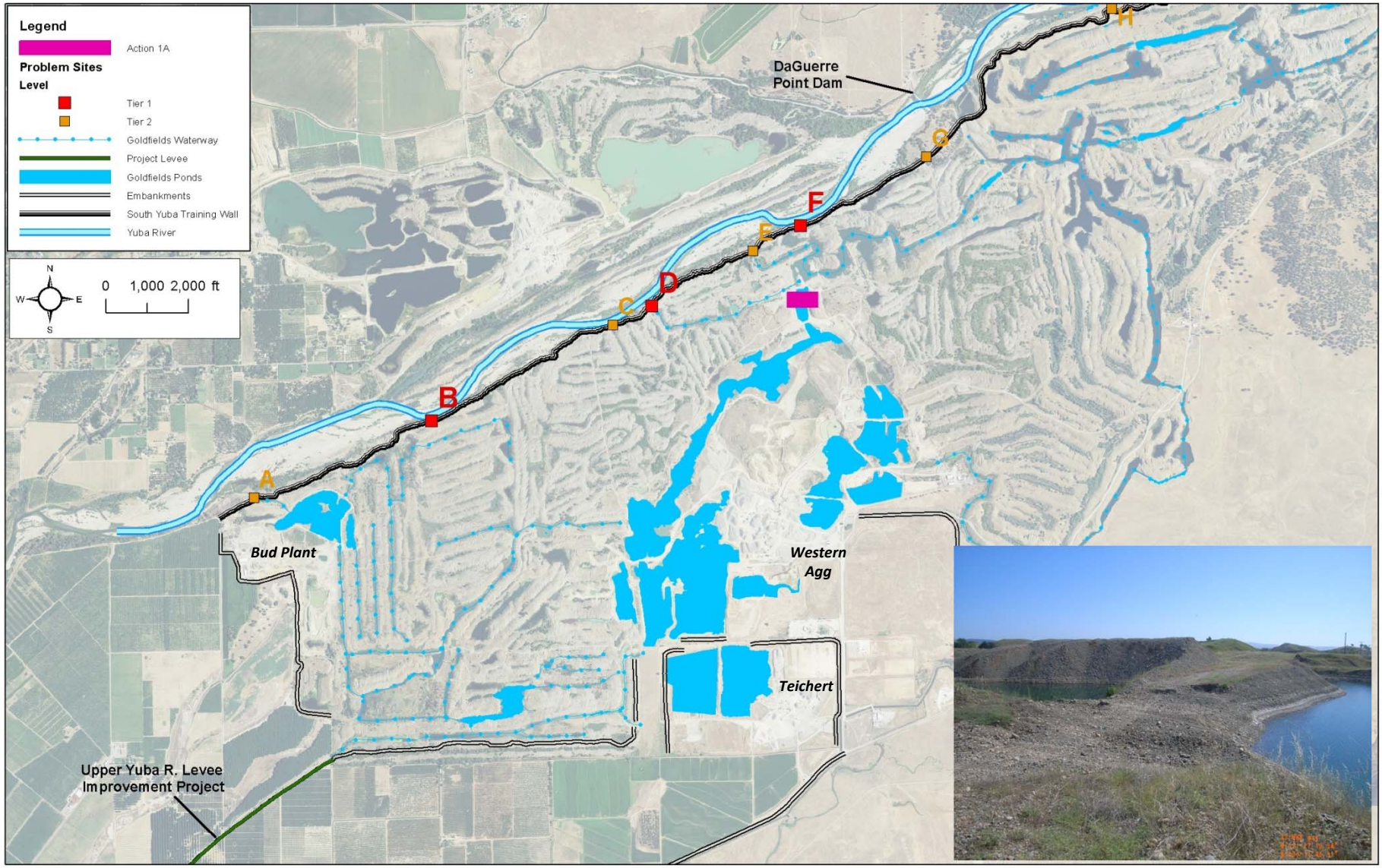
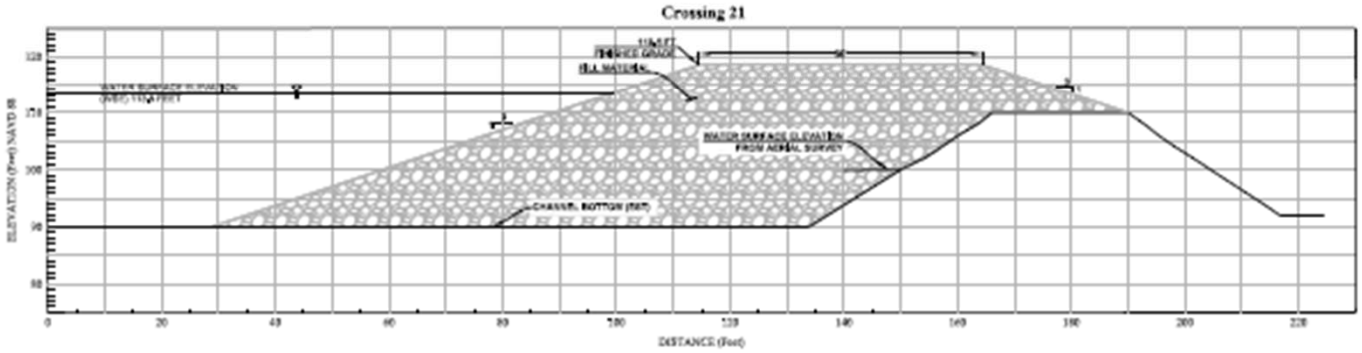


Figure 55



PROFILE VIEW: 1" = 20'

PRELIMINARY

MBK ENGINEERS
1771 Tribute Road, Suite A
Sacramento, California 95815
Phone: (916) 456-4400 • Fax: (916) 456-4253

NO.	DATE	REVISION

GOLDFIELDS

CROSSING 21
PLAN & PROFILE VIEW

SCALE: AS NOTED
JOB NO: 31415
BY: MBTB
CHK: DT
DATE: 08/15/2017
SHEET 3 OF 3 SHEETS

Figure 56