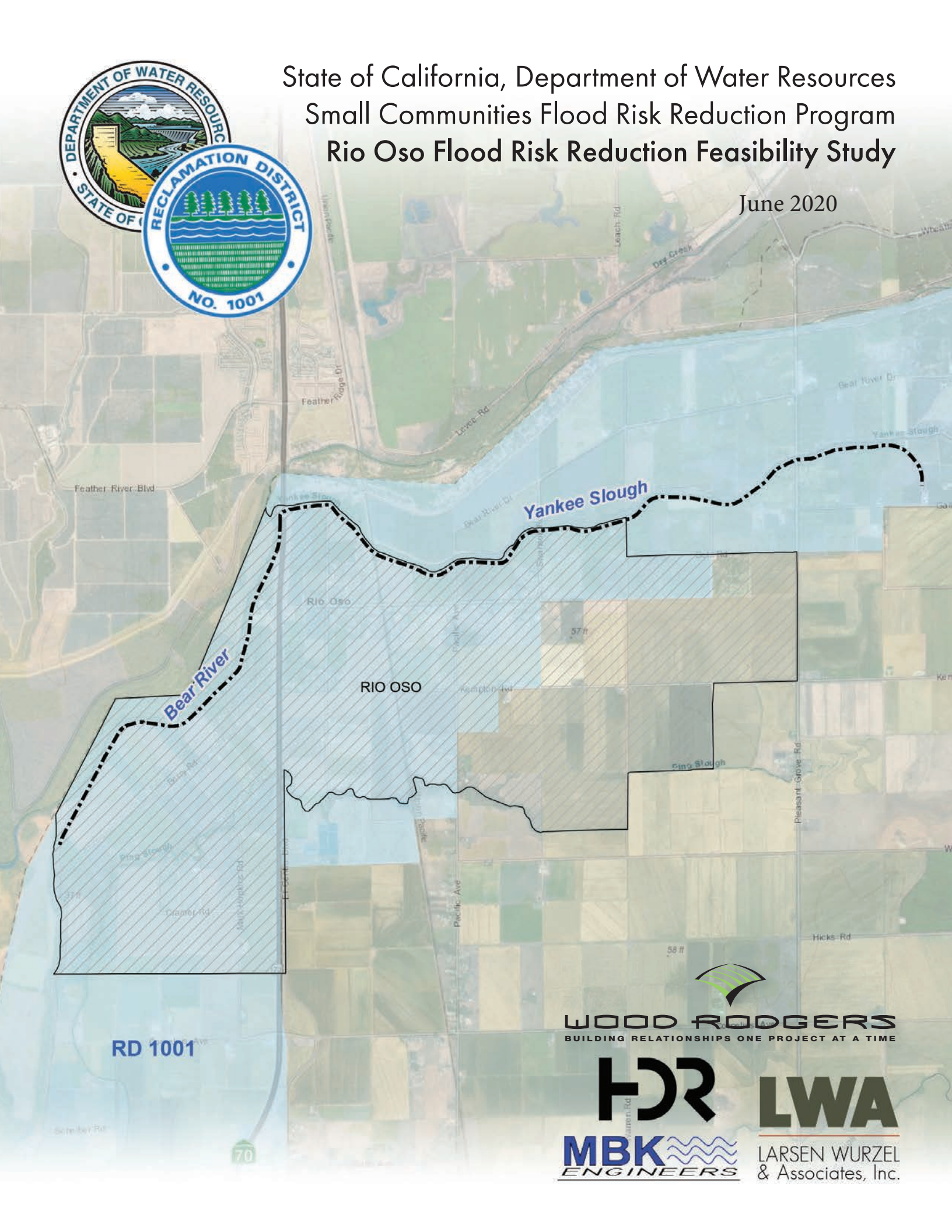
State of California, Department of Water Resources
Small Communities Flood Risk Reduction Program

Rio Oso Flood Risk Reduction Feasibility Study

June 2020



WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME

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MBK ENGINEERS

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1. ACRONYMS AND ABBREVIATIONS

AEP – Annual Exceedance Probability
AC – Acre
BCR – Benefit to Cost Ratio
BFE – Base Flood Elevation
Cal-IPC – California Invasive Plant Council
CDFW – California Department of Fish and Wildlife
CDIAC – California Debt and Investment Advisory Commission
CEQA – California Environmental Quality Act
CIP – Capital Improvement Program
CPA – Conservation Planning Areas
CRPR – California Rare Plant Rank
CVFED – Central Valley Floodplain Evaluation and Delineation Project
CVFPB – Central Valley Flood Protection Board
CVP – Central Valley Project
DFM – Division of Flood Management
DPS – Distinct Population Segment
DWR – California Department of Water Resources
DWSE – Design Water Surface Elevation
EIP – Early Implementation Program
ESU – Evolutionary Significant Unit
FDRP – Flood Damage Reduction Projects
FEMA – Federal Emergency Management Agency
FIRM – Floodplain Insurance Rate Maps
FIS – Flood Insurance Study
FMA – Flood Mitigation Assistance
FPS – Feet Per Second
FRMP – Flood Risk Management Plan
FRP – Fish Restoration Program
FSRP – Flood System Repair Projects
FT – Feet or Foot
FY – Fiscal Year
GAR – Geotechnical Assessment Report
GGS – Giant Garter Snake
GIS – Geographic Information System
GO – General Obligation
GOR – Geotechnical Overview Report

HERP – Habitat Enhancement and Restoration Program
HMGP – Hazard Mitigation Grant Program
HSI – Habitat Suitability Index
IWC – Inland Wetlands Conservation Program
LAMP – Levee Analysis and Mapping Procedures
LiDAR – Light Detection and Ranging
LF – Lineal Feet
LS – Landside
MOU – Memorandum of Understanding
NAVD 88 – The North American Vertical Datum of 1988
NGVD 29 – The National Geodetic Vertical Datum of 1929
NEPA – National Environmental Policy Act of 1969
NMFS – National Marine Fisheries Service
NRHP – National Register of Historic Places
NULE – Non-Urban Levee Evaluations
O&M – Operation and Maintenance
OMRRR – Operation, Maintenance, Repair, Replacement, and Rehabilitation
PDM – Pre-Disaster Mitigation
PIR – Problem Identification Report
RACER – Remedial Alternatives and Cost Estimates Report
RD – Reclamation District
RMA – Resource Management Associates
ROW – Right-of-Way
RWQCB – California Regional Water Quality Control Board
SCFRR – Small Communities Flood Risk Reduction
SCFRRP – Small Communities Flood Risk Reduction Program
SFHA – Special Flood Hazard Area
SPFC – State Plan of Flood Control
SR – State Route
SRFCP – Sacramento River Flood Control Project
TCE – Temporary Construction Easement
ULE – Urban Levee Evaluations
UPRR – Union Pacific Railroad
USACE – US Army Corps of Engineers
WFPO – Watershed and Flood Prevention
WPIC – Western Pacific Interceptor
WS – Waterside
WSE – Water Surface Elevation
YFFPP – Yuba Feather Flood Protection Program

2. EXECUTIVE SUMMARY

The purpose of the Rio Oso Feasibility Study (Feasibility Study) is to advance flood risk reduction for the community of Rio Oso and the surrounding areas, with the ultimate goal of achieving a 100-year level of protection for this legacy small community.

The Feasibility Study was funded by the California Department of Water Resources (DWR) by way of a Small Communities Flood Risk Reduction Program (SCFRRP) grant. The grant funds are a part of the Disaster Preparedness and Flood Prevention Bond act of 2006 (Proposition 1E).

2.1. Background and Existing Conditions

The community of Rio Oso is located within Sutter County (County) between State Route (SR) 99 and SR 70 and is situated southeast of the Feather River left (south) bank levee, approximately 20-25 miles north of the city of Sacramento, California. The community is protected from flooding by State Plan of Flood Control (SPFC) levees along the left (south) bank of Yankee Slough, the left (south) bank of the Bear River, the left (east) bank of the Feather River, the right (north) bank of the Natomas Cross Canal (NCC), the right (west) bank of the East Side Canal, and the Reclamation District (RD) 1001 Main Drain and Main Pumping Plant. For a map showing the location of Rio Oso in relation to the levees, see **Figure 1** (attached).

To identify and quantify deficiencies associated with the existing flood control system protecting the community, a variety of relevant information was compiled, including flood history information from landowners and stakeholders in the study area, data and analyses developed during previous studies, and new investigations and analyses that were completed as part of this feasibility study.

2.2. Formulation of Alternatives

Structural remediation measures were developed to address the identified problems with the system under existing conditions. A broad preliminary array of alternatives was evaluated and screened down to two final structural alternative approaches for each reach. These final two alternatives consisted of an earthen berm remediation measure and a cutoff wall remediation measure. It should be noted that reaches that showed increased potential for seepage had a combination seepage/stability berm proposed in place of the standard stability berm. Additional technical evaluations were used to compare the benefits and costs of these alternatives, and a preferred structural alternative was selected based on the results. The cutoff wall was the selected alternative for both the Bear River East Levee and the Yankee Slough South Levee.

Non-structural measures and multi-benefit opportunities were also analyzed and discussions of these measures are included in the report. Recommended non-structural measures are listed below:

- Flood Emergency Evacuation Plan
- Flood Evacuation Warning System
- Emergency Flood Fight Plan
- Levee Relief Cuts
- Voluntary Structure Elevation & Flood-Proofing
- Changes to National Flood Insurance Program (NFIP)
- Agricultural Conservation Easements

It should be noted that these items are considered separate from the structural alternatives and therefore can be implemented independently of the structural alternative.

2.3. Findings and Recommendations

The analyses showed that the entire length of each of the studied levees contains one or more of the analyzed deficiencies (geotechnical stability, freeboard, crown width, and geometry) and therefore will require remediation along the entirety of the levee length. The feasibility-level cost estimate for the project containing the recommended structural alternative at each reach was approximately $83 million.

An analysis of the financial feasibility of the preferred Project found that, due to an anticipated lack of federal and state funding and the limited amount of local funding potential, other avenues for developing implementation funding will be necessary to fund the project. With an expected local funding capacity of between 1.47 percent and 1.88 percent of the total preferred alternative cost, the typical local cost share of 10 percent to 15 percent needed to qualify for state and federal programs is not feasible under current funding mechanisms.

2.4. Next Steps

With a preferred project now identified, and the limitations associated with local cost share development understood, it is recommended that the County further explore potential means to generate local cost sharing commensurate with State and Federal grant program requirements. A phasing plan that identifies elements of the overall Project that could be implemented over time and within the funding constraints should also be developed.

3. INTRODUCTION

The Feasibility Study was funded by the California Department of Water Resources (DWR) with a Small Communities Flood Risk Reduction Program (SCFRRP) grant. The grant funds are a part of the Disaster Preparedness and Flood Prevention Bond act of 2006 (Proposition 1E).

The community of Rio Oso is located within Sutter County (County) between State Route (SR) 99 and SR 70 and is situated southeast of the Feather River left (south) bank levee, approximately 20-25 miles north of the city of Sacramento, California. The community is protected from flooding by State Plan of Flood Control (SPFC) levees along the left (south) bank of Yankee Slough, the left (south) bank of the Bear River, the left (east) bank of the Feather River, the right (north) bank of the Natomas Cross Canal (NCC), the right (west) bank of the East Side Canal, and the Reclamation District (RD) 1001 Main Drain and Main Pumping Plant. For a map showing the location of Rio Oso in relation to the levees, see Figure 1 (attached).

The focus of this study is analysis of the levees on the left bank of the Bear River and the South Bank of Yankee Slough. The levee systems along the Feather River and the Natomas Cross Canal are being analyzed as part of a separate feasibility study effort for the community of Nicolaus, which is within the same hydraulic basin as Rio Oso. Since the two communities share the same basin, the levees near each community will impact each other; therefore, while the two levee systems are identified individually within two separate feasibility studies, they act as one system. As such, remediation of all levees protecting the basin will be required to achieve the same planned flood risk reduction goals. Furthermore, some of the analyses completed for this Feasibility Study looked at the project on a basin-wide level and, therefore, will be discussed in both Rio Oso and Nicolaus studies.

RD 1001 has the operation and maintenance (O&M) responsibility for the levees' drainage facilities and the pumping stations analyzed within this study. This Feasibility Study was developed under the direction of RD 1001 and its District Engineer, MBK Engineers (MBK). It should be noted that the East Side Interceptor Canal was not analyzed as part of this study.

4. BACKGROUND

A number of studies have been conducted in the past to evaluate the levee systems protecting the study area. A summary of each of these studies is provided below. A more detailed description of these studies can be found in the Geotechnical Summary Report included as **Attachment A** (attached) **(Reference 1)**.

4.1. DWR Non-Urban Levee Evaluation Project (2012)

The DWR's Levee Evaluation Program was initiated in 2006 and concluded in the spring of 2015. The Levee Evaluation Program was divided into two projects: the Urban Levee

Evaluations (ULE) Project and the Non-Urban Levee Evaluations (NULE) Project (**References 2, 3, 4** and **5**), which were further divided into multiple study areas. In 2012, the levees protecting the communities of Nicolaus and Rio Oso were evaluated as part of the NULE Project. The evaluation used existing geologic information; however, no new explorations were performed. The following hazards were identified and the prevalence of each as a percentage of the total reach length was identified:

- **Yankee Slough South Levee**: Underseepage (100%), Through seepage (100%), Stability (25%), and Erosion (40%).
- **Bear River South Levee**: Freeboard less than design (15%), Underseepage (100%), Stability (20%), Through seepage (100%), and Erosion (50%).
- **Feather River East Levee**: Underseepage (100%), Stability (50%), Through Seepage (100%), and Erosion (50%).
- **Natomas Cross Canal (NCC) North Levee**: Underseepage (75%), Stability (50%), Though Seepage (25%), and Erosion (100%).

The program also identified erosion, bank caving, and/or seepage instabilities as "Critical" in six locations. These sites subsequently qualified for funding assistance through DWR's Flood System Repair Project (FSRP) and the district is waiting for approximately $4.1 million in funds to be made available from DWR. Repair of these critical items has not yet been accomplished.

4.2. U. S. Army Corps of Engineers (USACE) Mid-Valley Area, Phase III

In 1994, the USACE prepared the Mid-Valley Area, Phase III Study (**Reference 6**) to determine the need for levee repairs within the Mid-Valley study area. This study area includes the Sacramento River East Levee between the Tisdale Bypass and the Sacramento Bypass, the Yolo Bypass north of the Sacramento Bypass, the Sutter Bypass West Levee, the Feather River South Levee between the Bear River and the Natomas Cross Canal, Yankee Slough, the Knights Landing Ridge Cut East Levee, the Natomas Cross North Levee, and the East Side Canals. The study was based upon four previous exploration programs, new site inspections, new explorations, new laboratory testing, and new seepage and stability analyses at various sites. The study identified twenty-nine total sites for remediation, including four within the Nicolaus and Rio Oso study area (Sites 20-23). Due to funding limitations, these sites have not been addressed by a subsequent construction project and no Federal action is expected to occur.

4.3. Feather River Regional Flood Management Plan

The Nicolaus and Rio Oso study areas are described within the Mid & Upper Feather River Regional Flood Management Plan (FRRFMP) (**Reference 7**). Within the FRRFMP, the flooding history of the area is described, the results and actions of the NULE project are identified, and a listing of locally proposed projects is provided. **Table 1** (below), which describes each of the projects and their anticipated costs, is excerpted from the FRRFMP below. Although some of the projects have been advanced through DWR's FSRP (L2: re-rock levee crown patrol roads) and Deferred Maintenance Program (L3: Repair, replace, or abandon existing drains and pipes through the levees), none of the major projects in the table have been advanced to a planning study or design phase.

Table 1: RD 1001 Structural Flood Protection Improvements (FRRFMP)

ID	DESCRIPTION	ESTIMATED COST	COMMENTS
L1	Address specific seepage, underseepage, erosion, and stability concerns for the Feather River Levee, from the Natomas Cross Canal to the River Oaks Golf Course (Levee Unit 4, Levee Miles 5.2 to 13.4) and repairs to the Natomas Cross Canal downstream of SR 99.	$5.4 M	50% of 8.2 miles of seepage berm; seepage berm 80' x 4' with collection pipe.
L2	Re-rock levee crown patrol roads	$1.5 M	AB for 75% of levees in district
L3	Repair, replace, or abandon existing drains and pipes through the levees.	$86,680	Replacement and repair expected to be completed by farmer. District would only abandon. Grouting 2/mile. 14" pipe, 70' total length. Assumed 10' below WSE.
L4	Improve erosion protection along the Bear River South Levee.	$2.6 M	12.6 miles total. 50% erosion protection 2' thick.
L5	Upgrade the Main Drain Pumping Plant	$500,000	Assumption for whole project?
L6	Construct a replacement pumping plant on the Cross Canal at end of Lateral 4.	$500,000	Assumption for whole project?
L7	Phased improvements to the RD 1001 levee system to achieve 100-year FEMA levee protection		
L7A	Natomas Cross Canal North Levee	$123.9 M*	Use NULE RACER Segment 284
L7B	Feather River east levee, Cross Canal to River Oaks Golf Course	$349.8 M*	NULE RACER Segment 247

ID	DESCRIPTION	ESTIMATED COST	COMMENTS
L7C	Bear River south bank, Yankee Slough to Pleasant Grove Road	$75.2 M*	NULE RACER Segment 283
L7D	Yankee Slough north and south banks, from confluence to Pleasant Grove Road	$57.6 M*	NULE RACER Segments 144, 145
L7E	Bear River south bank, Pleasant Grove Road to high ground	$109.7 M*	NULE RACER Segment 246
L7F	Coon Creek Group Interceptor Canal Levee, Natomas Cross Canal to high ground	$13.5 M*	NULE RACER Segment 285

[1]*Due to potential effects on stages upstream of Fremont Weir in the lower Sutter Bypass and the Feather River*
**Estimates from North NULE Study Area Remedial Alternatives and Cost Estimates Report (RACER)*

5. EXISTING CONDITIONS AND PROBLEM IDENTIFICATION

This section describes the methods and analyses utilized to determine existing conditions and to identify existing problems within the Project area.

5.1. Hydrology and Hydraulic Analyses

5.1.1. Design Water Surface

Water surface profiles corresponding to the 100-year recurrence interval event and the 1957 design flood profile were developed for each of the streams in the study area for use in the Feasibility Study. Hydraulic routings from the Sacramento River General Re-Evaluation Report (Sac-GRR) were analyzed to develop 100-year water surface profiles for the Feather and Bear Rivers, Natomas Cross Canal, and Yankee Slough. The Sac-GRR analyzed alternatives that included widening of the Fremont Weir, which is in geographic proximity to the communities of Rio Oso and Nicolaus. That analysis also included a USACE required Central Valley Hydrology Study (CVHS) event selection process, which refined the flood centering of major tributaries in this area. A design water surface profile that considers the maximum water surface elevation for centerings that concentrate flows for each tributary was thus produced.

5.1.2. Levee Breach Analyses

As is performed for Federal Emergency Management Agency (FEMA) flood mapping, critical levee section breach analyses was performed to characterize the existing flood risk to the community. The levee sections along the Feather River South Levees at SR 99 and the South Bear River Levees at SR 70 were breached to determine the resulting flood inundation. The breach along the Feather River Levees at a location just south of the Bear/Feather Rivers confluence has the potential to draw in a large volume of water from

the Sutter Bypass, Feather and Bear Rivers. The breach on the South Bear River Levees was selected because it is representative of a higher initial breach water surface elevation for the basin, which has the potential to result in greater flood depths and a flood wave through the community of Rio Oso provided that there is sufficient flood volume emanating from the Bear River.

Levee breaches are assumed to occur wherever the water surface elevation (WSE) exceeds the original design WSE for a federal/state project levee. This height is measured from the top-of-levee downwards and is identified as the levee reduction height (Reference 2). The levee reduction height is determined through geotechnical assessment and is a concept derived from the NULE program. Once the levees fail, the levee structure is assumed to erode completely to the landside levee toe elevation. The analysis is discussed in more detail in **Attachment B (Reference 8**).

5.1.2.1. Feather River Breach

A breach on the Feather River results in southwesterly flows and the filling of the RD 1001 basin. Once flood depth in the basin exceeds the crown elevation of SR 99, the floodwater backs up northeasterly towards SR 70 in the area of Rio Oso. Flood depths in this scenario reach more than 20 feet in the lower lying areas. The floodwaters also have the potential to overtop the north (right bank) Natomas Cross Canal Levee without adequate relief cuts to allow water back into the Feather River.

5.1.2.2. Bear River Breach

For a breach on the Bear River, floodwaters overtop SR 70 and flow southwesterly towards RD 1001. Similar to the Feather River Levee breach, floodwater fills the RD 1001 basin to an elevation that floods all of the area between the Bear/Feather/Natomas Cross Canal and SR 99 to the northeast. The flood source from this breach is not solely from the Bear River watershed. The breach opening size has the potential to divert most of the Bear River and draw additional water from the Feather River into the basin. Further, because of the elevation of the Bear River compared to the interior basin, this breach has the potential for significant flood waves and high flows through the upper portion of the basin.

5.2. Geotechnical Analyses

The existing conditions geotechnical analyses for the Rio Oso study area included a study of the past performance of the levee segments protecting Rio Oso. This study is documented in the NULE GAR (Reference 2) and discussed in more detail in the Attachment A (Reference 1). Past performance events include a levee break, underseepage, through seepage, erosion, overtopping, and slope instability. The past studies of the Rio Oso area levees indicated

moderate to high likelihood of either levee failure or the need to flood-fight to prevent levee failure. Additionally, the studies also summarized that the subject levees lacked data to analyze the underseepage, through seepage, and stability performance. A supplementary exploration program was carried out as a part of the Feasibility Study to obtain additional subsurface information. Updated analyses were carried out using the 100-year WSE in order to evaluate threat of underseepage, through seepage, and slope stability. The summary of the existing conditions is shown in **Table 2**. The approach, results, and a discussion of geotechnical analyses is provided in Attachment A (Reference 1).

Table 2: Summary of Existing Condition for 100-Year WSE

Maintained By	Segment	Reach	Levee	Station	Levee Miles	Assessment Type		
						Under Seepage	Through Seepage	Stability
RD 1001	145	A	Yankee Slough Left Bank	YS 231+17 to YS 38+30	LM 0.0 to 3.7	Meets Criteria	Does Not Meet Criteria	Does Not Meet Criteria
RD 1001	283	A	Yankee Slough Left Bank and Bear River Left Bank	YS 38+30 to YS 4+64	LM YS 3.7 to 4 and BR 9.8 to 10.1	Meets Criteria	Does Not Meet Criteria	Does Not Meet Criteria
RD 1001	283	B	Bear River Left Bank	YS 4+64 to YS 0+00 and BR 130+72 to BR 85+00	LM BR 10.1 to 11	Does Not Meet Criteria	Does Not Meet Criteria	Meets Criteria
RD 1001	283	C	Bear River Left Bank	BR 85+00 to BR 0+00	LM BR 11 to 12.6	Does Not Meet Criteria	Does Not Meet Criteria	Does Not Meet Criteria

5.2.1. Seepage Analysis

Seepage analyses were conducted using a finite elements analysis on select cross-sections for the study area levees to evaluate the underseepage and through seepage performances. Underseepage problems commonly occur when a surficial layer of fine-grained, relatively impervious soils (also known as a blanket layer), overlays a layer of coarse-grained, more pervious soil. When the water level in a channel reaches an elevated stage, pressure builds up in the confined coarse-grained sublayers and can cause subsurface erosion or piping at or beyond the landside toe of the levee. Through seepage occurs when water enters the waterside slope of the levee and exits through the landside slope, passing through the levee core. Through seepage can cause surficial erosion at the landside slope face and (possibly)

internal erosion of the levee as soil particles are moved from the levee interior to the levee landside slope.

5.2.2. Stability Analyses

Stability analyses were conducted by analyzing the same cross sections to evaluate levee landside slope stability and waterside slope stability during a rapid draw-down condition. The steady-state case occurs when the water remains at or near flood stage levels long enough for a fully-saturated condition to become established in the embankment soil. Rapid draw-down is a condition where the levee experiences a sudden draw-down of the water surface following a fully saturated embankment condition, and the embankment remains saturated without an elevated water surface to counteract the weight of the saturated soil. When this condition occurs, the levee can experience a circular or wedge-type failure that results in the loss of levee thickness at the location of the failure. Thereafter, a heightened risk of levee breaching exists at the location.

5.2.3. Erosion Analyses

Erosion analyses were conducted to qualitatively assess what potential existed for erosion to occur within the study area. The analyses consisted of the collection and review of past erosion problem areas and analyses performed to determine the erosion risk. Updated erosion analyses were not carried out as a part of this study.

5.3. Freeboard and Geometry Analysis

An analysis of existing freeboard and a review of the exiting levee geometry was performed for the existing levee embankments in order to determine if the levees meet the minimum requirements of the Sacramento River Flood Control Project (SRFCP) authorized design. The SRFCP requires a minimum of three feet of freeboard above the DWSE, a 12-foot-wide or a 20-foot-wide levee crown (depending on the stream being analyzed as described below), a 3:1 waterside slope, and a 2:1 landside slope (see **Figure 2**) (**Reference 9**). The MOU between the USACE and the State of California (State), acting through the Reclamation Board dated November 6, 1953 (**Attachment G**) (**Reference 10**), states that levee crown widths for all levees shall be 20 feet in width, unless the waterway is designated as a "minor tributary" and listed as an exception within the MOU. These exceptions are required to have a crown width of 12 feet instead of the normal 20 feet.

Following this criterion, the Bear River East Levee shall be required to have a 20-foot crown, but the Yankee Slough Levee is listed as an exception within the MOU and therefore only requires a 12-foot crown.

The freeboard and geometry analysis was conducted using available topographic data developed in 2007 for use on the DWR CVFED Program. Cross sections of the existing levee were evaluated every 100 feet for slope and crown width deficiencies. The elevations of the levee crest from these cross sections were compared to the DWSE in order to determine if the available freeboard meets SRFCP requirements. The DWSE is considered the greater of both the 100-year water surface elevation provided by the hydraulic analysis from MBK and the 1955/57 DWSE. Any cross section that did not meet the criteria for slope, crown width, or freeboard was considered deficient and was flagged as requiring geometry or freeboard remediation. Results from this analysis show that nearly 100 percent of the levees within the study area have geometry deficiencies and that will require correction through future projects. See **Attachment H** for strip maps displaying locations of geometric deficiencies. See **Attachment I** for exhibits of the evaluated cross sections overlain by a theoretical SRFCP levee geometry template. Freeboard and geometry analysis results are also included in Attachment I.

5.4. Existing Problems

The Feasibility Study identified a number of problems with the existing Bear River East Levee and Yankee Slough South Levee. The identified geotechnical problems included underseepage, through seepage, and erosion. Additionally, portions of the existing levees do not have the required minimum freeboard above the design water surface elevation, and a majority of the levee lengths do not meet the minimum SRFCP geometry requirements. These identified problems reduce the ability of the existing levees to provide the minimum level of protection sought for small communities such as Rio Oso.

A description of past levee performance follows below.

5.4.1. Past Levee Performance

The past performances of the levees analyzed within this Feasibility Study included are documented in the NULE Geotechnical Assessment Report (GAR) (URS, 2011). Past performance events documented by the NULE include a levee break, underseepage, through seepage, erosion, overtopping, and slope instability. This study was focused on the levee alignments on the left banks of Bear River and Yankee Slough. Since the construction, levees at Rio Oso have experienced multiple high-water events, including high water in 1950, 1986, 1997, 2006, and 2007. Detailed descriptions of levee segment past performance based on information contained in the NULE project are provided below.

5.4.1.1. Yankee Slough – NULE Segment 145

Segment 145 is located along the left (south) bank of Yankee Slough. The segment extends from the beginning of the left bank levee of Yankee Slough to the east,

extending approximately 3.7 miles west to the confluence of Yankee Slough with the Bear River. The segment is 3.7 miles long and is maintained by RD 1001. The levee segment was originally constructed during the early 1900s. The base map of the Sacramento River Valley (dated 1910) shows the proposal to build Levee Mile (LM) 1 to LM 2. The map dated 1925 shows that the segment was constructed to its proposed grade around 1925. The levee was reconstructed by the USACE around the 1950s. A levee break, overtopping, and erosion have been reported for Segment 145. The locations, types of events, and documented mitigations for Segment 145 are detailed below in **Table 3**.

Table 3: NULE Segment 145 Reported Levee Performance Events

Flood Season	Reported Performance Event	Approximate Location (LM)	Mitigation
Unknown	Waterside erosion	1.17	Repair may or may not have occurred, not documented.
1950	Levee break	3.36 to 3.45	Repaired by the USACE.
1997	Overtopping resulting in crown damage	3.12	Repair made, but not documented.
2006	Waterside erosion	1.28 to 1.30	Repair made, but not documented.
2006	Waterside erosion	1.39 to 1.43	Repair made, but not documented.
2006	Waterside erosion	1.48 to 1.54	Repair made, but not documented.
2006	Waterside erosion	1.62 to 1.64	Repair made, but not documented.
2006	Waterside erosion	1.82 to 2.22	Repair made, but not documented.
2006	Waterside erosion	2.24 to 2.28	Repair made, but not documented.
2007	Waterside erosion, approximately 950 feet of intermittent erosion sites.	1.0 to 1.8	Repaired under PL 84-99[1]

Source: Reference 2

1. PL 88-49: Public Law 84-99 authorizes an emergency fund to be expended at the discretion of Chief of Engineers (USACE) for flood fighting and rescue operations; repair or restoration of flood control works threatened, damaged, or destroyed by flood, or nonstructural alternatives; where-in local maintaining agencies in good standing can solicit and receive repair funding through federal government appropriations.

Additionally, in 2012, as part of the US Army Corps of Engineers' (USACE) Periodic Inspection of the RD 1001 levee systems and in FSRP, a small erosion site was identified on the left bank of Yankee Slough, just upstream of the Union Pacific Railroad crossing of the Bear River and Yankee Slough. According to the report, the site was approximately 100 feet in length and had up to an 11-foot face at the waterside levee toe. RD 1001 designed and permitted the repair of this site through Yuba Feather Flood Protection Program (YFFPP) funding. Repairs were completed in 2017 and included using existing material to reestablish the slope on the waterside of the levee to

match the adjacent upstream and downstream grades. Approximately 100 tons of clean rock revetment was then placed beginning at the base of the embankment slopes, covered with a minimum six inches of soil cover and reseeded with native grasses.

5.4.1.2. Bear River and Yankee Slough – NULE Segment 283

Segment 283 is located along the left (south) bank of the Bear River and Yankee Slough. The segment extends from the left bank of Yankee Slough approximately 0.35 miles upstream of confluence with the Bear River, continues downstream along the left bank of the Bear River approximately 2.65 miles, ending at the confluence of the Bear River and the Feather River. The Segment is 3 miles long and maintained by RD 1001. The construction of the levee segment was originally begun in the late 1800s and was completed in 1964. The levee was reconstructed by the USACE in 1959 from LM 9.42 to LM 12.60. The levee section was reconstructed by the State Division of Highways in 1961 at the SR 70 crossing. Reported levee performance events for Segment 283 include a levee break as well as several underseepage and erosion events. The locations, types of events, and documented mitigations for Segment 283 are detailed below in **Table 4**.

Table 4: NULE Segment 283 Reported Levee Performance Events

Flood Season	Reported Performance Event	Approximate Location (LM)	Mitigation
Unknown	Erosion, 300 feet long.	10.07	Not documented.
Recurring	Underseepage, 100 to 200 feet away from levee.	10.14 to 12.60	Not documented.
1950	Levee breach.	9.9	Not documented.
1986	Underseepage was reported along the stretch from SR 70 to Berry Road.	10.14 to 12.60	Not documented.
1986	225 feet of erosion, 15 to 18 feet of embankment. Two sinkholes developed as a result of erosion.	10.4	Repair made, but not documented.
1986	Bank erosion approximately 150 feet long. Rodent holes were observed on eroded levee slope and one sinkhole developed.	11.85 to 11.95	Repair made, but not documented.
1997	Waterside erosion.	4.14 (Yankee Slough)	Not documented.
1997	Waterside berm erosion.	9.80 to 9.81	Not documented.
1997	Waterside erosion.	9.91	Not documented.

Flood Season	Reported Performance Event	Approximate Location (LM)	Mitigation
1997	Underseepage was reported along the stretch from SR 70 to Berry Road.	10.14 to 12.60	Not documented.
1997	Crown damage from overtopping.	10.74	Not documented.
1997	Waterside bank eroded.	11.0 to 12.0	Repair made, but not documented.
2006	Waterside erosion.	10.7	Not documented.
2006	Waterside erosion, approximately 1,200 feet.	11.1	Repair in progress.
2006	Waterside erosion.	11.58	Not documented.
2007	Waterside erosion.	11.83	Repair in progress.
2007	Erosion, whole bank rotational failure, 237 feet.	12.2	Not documented.

Source: Reference 2

During the 2017 flood erosion occurred along the Bear River at RM 12.1. The damage was repaired in 2017 through the Storm Damage – DWR Emergency Rehabilitation (SDDER) in 2017, Site LMA-21. DWR repaired approximately 150 feet of erosion along the Bear River by placing soil covered rock slope protection and replanting with native grasses.

5.4.2. Past Levee Performance Issues Identified by Stakeholders and Landowners

As part of this study, outreach efforts were made to area stakeholders and landowners to foster community involvement in the study process. As part of this outreach, stakeholders were invited to a meeting at the RD 1001 main office so that the study's initial findings on past levee performance could be shared and stakeholder input on those findings could be solicited. This outreach meeting was well attended, with many of the local landowners coming to participate. After the findings had been presented, the consensus of the stakeholders present was that all known past performance issues had been identified within the initial effort. As such, the study was able to proceed with confidence that all past levee issues had been identified.

5.5. Levee Encroachments and Penetrations

A number of encroachments are present along the Bear River and Yankee Slough levees within the Study Limits

In order to identify existing encroachments, the USACE Levee Enterprise Geographic Information System (EGIS) (**Reference 11**), and the DWR Utility Crossing Inventory

Program (UCIP) (**Reference 12**) to identify existing encroachments along the levees. A table of the identified encroachments is included in **Attachment L**. The Central Valley Flood Protection Board (CVFPB) encroachment permit number for an identified encroachment, where known, is included. As-built data for each encroachment was not available during the feasibility analysis, but major encroachments (e.g.: utility poles, private irrigation facilities, electrical transmission towers, houses and other structures) were identified where possible. Costs to acquire properties and remove or relocate encroachments outside of the proposed right-of-way were included in each of the analyzed alternatives. Future design phases of the work should review each individual encroachment to determine appropriate remedial alternatives in order to meet current requirements.

5.6. Biological Resources

Desktop and reconnaissance biological surveys were mapped in support of the Feasibility Study. Seven vegetation communities were identified in the Project area: irrigated agriculture, oak woodland, orchard, pasture, rice, riparian vegetation, and urban landscaping. The review of the Project area also described the observed wildlife, evaluated the potential for special-status species, and described United States Fish and Wildlife Service (USFWS) designated critical habitat units, other sensitive habitats, protected areas, conservation easements, and wildlife movement corridors. Additional detail is provided in **Attachment C** (**Reference 13**).

5.6.1. Wildlife Observed

Wildlife observed during the February 12, 2019 site visit included numerous bird species such as red-winged blackbird (Agelaius phoeniceus), yellow-billed magpie (Pica nuttalli), California scrub jay (Aphelocoma californica), Brewer's blackbird (Euphagus cyanocephalus), great egret (Ardea albus), and other water fowl. Also included in this group were raptors such as red-tailed hawk (Buteo jamaicensis) and red-shouldered hawk (Buteo lineatus). Numerous domestic sheep and chickens were also observed within pastures and urban areas. No special-status species were observed during the survey, but they still have the potential to occur in the Project area and are discussed in more detail below.

5.6.2. Special-Status Species

Database query results returned a large number of special-status species with a potential to occur in the vicinity of the Project area. Through review of these results, many species were determined to not have the potential to occur in the Project area due to absence of suitable habitat or because the Project area is located outside of known species ranges. Additional detail on the species is provided in Attachment C (Reference 13).

5.6.3. Critical Habitat

There are no critical habitat units within the Project area. However, final designated critical habitat for steelhead and Chinook salmon occurs along the Bear River, to the west and north of the Project area. Additional detail and a map on the habitat units are provided in Attachment C (Reference 13).

5.6.4. Sensitive Habitats and Aquatic Resources

Several aquatic resources and vegetation communities in the Project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resources be completed prior to any work in order to determine the level of impact on sensitive communities.

5.6.5. Protected Areas, Conservation Easements, and Wildlife Movement Corridors

There are no protected areas or easements within the Project area. However, there are numerous protected areas and easements on the lands surrounding the Project area. There are six protected areas located within two miles of the Project area, as well as land parcels with conservation easements within two miles of the Project area.

The Sutter Bypass is located approximately six miles southwest of the Project area. The bypass is part of a large engineered floodway that runs adjacent to the Sacramento River beginning north of the Sutter Buttes and continuing south to the Sacramento-San Joaquin Delta, and that acts as a wildlife movement corridor for numerous terrestrial and aquatic species.

5.7. Cultural Resources

A preliminary review of potential cultural resources constraints was conducted through records search requests from relevant databases and a field reconnaissance survey.

Archaeological and built environment sensitivity within the Project area and a 0.25-mile buffer are variable and contingent on the type of resource (prehistoric vs. historical) and geography (proximity to the river or one of the historical ranch complexes). For most of the Project area, near-surface archaeological sites have likely been disturbed, and possibly destroyed, by decades of agricultural practices and levee construction. However, there may be remnants of these sites. Most of the Project area has not been previously surveyed for archaeological sites and, accordingly, there is a low-to-moderate potential for near-surface

unrecorded prehistoric or Native American sites within the unsurveyed portions of the Project area. There is also a moderate-to-high potential for buried archaeological sites throughout the entire Project area because of the existence of a floodplain located along the Sacramento and Feather Rivers where it is common to find archaeological sites that have been buried by alluvial sediment. Sensitivity for historic-era archaeological sites and historical built-environment resources ranges from low to high throughout the Project area and is largely contingent on proximity to historical roadways, residences, and ranches.

Additional detail on the cultural resources is provided in Attachment C (Reference 13).

6. GEOTECHNICAL REMEDIATION ANALYSIS

The existing condition analyses of the levees protecting the Rio Oso study area indicated various deficiencies for a 100-year flood stage. Feasibility-level remedial measures were developed for the deficient segments. The remedial measures include at least two remediation alternatives for each deficient segment. The preferred remedial measure may be considered based on land acquisition, stakeholder interest, the presence of environmental or cultural resources, cost, or other pertinent limitations. The analysis of the levee segments and the determination of the remediation alternatives are discussed in more detail in Attachment A (Reference 1). In general, the remediation alternatives considered consisted of cutoff walls, drained stability berms, drained seepage berms, combined drained stability and seepage berms, landside ditch fill, landside slope flattening, and waterside rock slope protection.

6.1. Underseepage Analysis

Underseepage analysis consists of a finite elements steady state seepage analysis to evaluate the exit gradient at and near the landside toe of the levee. The steady state condition represents the circumstances when the water remains at or near flood stage levels long enough to fully saturate the embankment soil. During this time, the hydraulic load on the levee builds up seepage pressure in the confined coarse-grained sublayers underneath the fine-grained blanket layers. Eventually, water can be pushed through discontinuities within the blanket layer and can carry soil particles with the water as it travels to the surface, potentially forming seeps that lead to internal erosion and sand boils. Over a period of time, this could lead to failure of the levee foundation as increasing amounts of soil are internally eroded away.

In the Rio Oso study area, the Bear River Left Bank Levee Segment 283, Reaches B and C do not meet the criteria for underseepage. The remedial alternatives considered include cutoff walls, combined drained stability and seepage berms, and a drained stability berm.

6.2. Through Seepage Analysis

Through seepage occurs when water exits through the landside slope above the toe. This could cause surficial erosion at the landside slope as well as internal erosion as soil particles are carried by the seeping water. The levee embankment materials generally govern the potential for through seepage. Levees constructed of easily-erodible materials (e.g.: silt, sandy silt, and sand, etc.) are most susceptible to through seepage erosion.

In the Rio Oso study area, all of the levee segments on the Yankee Slough Left Bank Levee, and Bear River Left Bank Levee are susceptible to through seepage failure. The remedial measures for through seepage involve either lowering the phreatic surface to be at or below the landside toe elevation or providing a filtered exit for the seeping water in order to reduce the potential for internal erosion. The remedial alternatives considered include cutoff walls, combined drained stability and seepage berms, and drained stability berms.

6.3. Landside Slope Stability

The landside slope stability analysis consisted of the performance of a limit-equilibrium analysis to evaluate the factor of safety of the landside slope under steady state seepage conditions. The pore water pressure from the steady state seepage condition is used to determine the phreatic surface for the stability analysis. The ratio of the resisting forces to the driving forces for failure of the slope is obtained as the factor of safety from the limit equilibrium analysis. With a higher flood stage, a larger proportion of the levee embankment is saturated, and that results in lower material strength and an increasing likelihood of failure.

In the Rio Oso study area, all the levee segments on the Yankee Slough Left Bank Levee and the Bear River Left Bank Levee are susceptible to landside slope stability failure. The remedial measures for landside slope stability are either to lower the phreatic surface in order to reduce the saturated portion of embankment and minimize the loss of strength, or to construct a berm that will provide a physical buttress to improve slope stability. Additionally, materials on the levee embankment and foundation can be modified or replaced with materials of higher strength to counteract the loading placed on the segment. The remedial alternatives considered include cutoff walls, combined drained stability and seepage berms, and drained stability berms.

6.4. Rapid Drawdown Waterside Slope Stability

A rapid drawdown slope stability analysis is used to analyze the stability of the waterside slope when high water conditions fully saturate the levee and then recede quickly before the levee embankment soil can drain. This condition represents a critical case for waterside slope failure. The limit equilibrium method applied in stages is used to analyze the levee for rapid

drawdown failure. Under this method, the lower of the drained and undrained strength of the non-free draining material is used.

In the Rio Oso study area, Bear River Left Bank Levee Segment 283, Reach C is susceptible to waterside rapid drawdown failure. The remedial measure for rapid drawdown failure involves armoring of the waterside slope to provide adequate protection from the rapidly receding water stages. Rock slope revetment can also be used as a remedial measure because it provides free drainage for the saturated soil and protects the slope from instability caused by rapid drawdown.

6.5. Results Summary

The summary of the feasibility-level remedial alternatives for the levee segments with respect to the 100-year WSE is shown below in **Table 5**. Each levee reach includes a minimum of two remedial alternatives that were identified in the geotechnical evaluation.

Table 5: Remediation Alternatives

Segment	Reach	Station	Levee Miles	Remediation Alternative 1	Remediation Alternative 2
145	A	YS 231+17 to YS 38+30	LM 0.0 to 3.7	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials	Cutoff Wall – 14 feet below 1/2 levee degrade; 16 feet below 1/3 levee degrade
283	A	YS 38+30 to YS 4+64	LM YS 3.7 to 4 and BR 9.8 to 10.1	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials	Cutoff Wall – 14 feet below 1/2 levee degrade; 16 feet below 1/3 levee degrade
283	B	YS 4+64 to YS 0+00 and BR 130+72 to BR 85+00	LM BR 10.1 to 11	Combined Drained Stability and Seepage Berm - 150 feet wide	Cutoff Wall – 35 feet below 1/2 levee degrade; 40 feet below 1/3 levee degrade
283	C	BR 85+00 to BR 0+00	LM BR 11 to 12.6	Waterside Slope - Rock Slope Protection; Landside - Combined Drained Stability and Seepage Berm - 60 feet wide	Waterside Slope - Rock Slope Protection; Cutoff Wall – 55 feet below 1/2 levee degrade; 60 feet below 1/3 levee degrade

7. PROJECT ALTERNATIVES

7.1. Study Goals, Objectives, Measures/Management Actions

The primary purpose of the Feasibility Study is to identify all of the deficiencies within the levee system and to recommend a preferred project to rehabilitate the levees. It is recognized that implementation of all measures may be difficult for small communities with limited resources and, therefore, measures can be implemented independently to reduce flood risk and consequences of flooding in a prioritized manner. Objectives of the study also included minimizing impacts to adjacent prime agriculture and preserving the general rural nature of the community. Other objectives include being consistent with the goals and objectives of the CVFPP and FRRFMP.

A summary of the measures/management actions to fulfill this purpose can be found in the sections below.

7.2. Alternatives Screened Out of the Feasibility Study

In the preliminary stages of this study, a preliminary array of alternatives was developed; as the study progressed, alternatives were screened out when they were found to be infeasible. These screened alternatives did not require detailed analysis, because it was clear that they would not meet Project objectives by simple inspection. Below is a brief description of each alternative that was considered as part of the preliminary array, but was screened out prior to detailed analysis.

7.2.1. No Action Alternative

As the name implies, this alternative proposes that no action be taken. This alternative was screened out because it does not increase the flood protection of the study area and would not be satisfactory to stakeholders.

7.2.2. Ring Levee

This alternative would propose building ring levees around areas deemed important within the study area, such as where urbanization has occurred within the community. This alternative was screened out as infeasible because the rural nature of the area is characterized by dispersed buildings and residences that cannot readily be encircled by a levee

7.2.3. Floodwall

This alternative would propose a floodwall along the study area in lieu of levee raising. This was found to be infeasible as floodwalls are significantly more expensive than levee raising on a per-lineal-foot basis, and would increase maintenance costs due to restricted access. Furthermore, a floodwall would not mitigate for seepage and stability issues that are prevalent throughout the study area.

7.2.4. Setback Levee

This alternative would propose building setback levees in lieu of remediating the existing levees. While setback levees can provide flood benefits by increasing the conveyance capacity of the channels while also providing environmental benefits by returning land to the floodplain promoting regular inundation of riparian habitat, the alignment of the study area, unfortunately does not lend itself to the construction of setback levees. Due to the geographic location of the basin near the confluence of the Feather River, Sacramento River, Sutter Bypass and Fremont Weir creating significant backwater conditions in the System, there are no appreciable hydraulic benefits to setting these levees back.

Furthermore, similar to the previously discussed floodwall alternative, this alternative is costly in comparison to remediation of the existing levee.

7.2.5. Purchase Flood Easements

This alternative would propose to purchase flood easements covering much of the land within the study area, with the intent of allowing flooding to occur on a regular basis. This alternative was deemed infeasible as the study area is made up of valuable farmland and would be very costly. Further, this alternative would not be satisfactory to the landowners and other stakeholders within the study area.

7.3. Final Structural Alternatives

Using the information in Section 4, as well as the results of the analyses described in Sections 5 and 6, deficiencies were identified for the levee systems within the study area. These include deficiencies caused by through seepage, underseepage, slope stability, embankment geometry, and erosion. The team analyzed these deficiencies to develop management actions for their mitigation.

The following is a description of the structural alternatives that were considered for each reach within the study area.

7.3.1. Bear River Reach C (Station 0+00 to Station 85+00, 8,500 feet)

7.3.1.1. Combination Seepage/Stability Berm

A 60-foot-wide drained combination seepage/stability berm is recommended to meet the criteria for through seepage and under seepage mitigation. Rock slope protection (see **Figure 7)** is also recommended for the waterside slope to protect against erosion. The combination berm (see **Figure 4**) would be constructed along the proposed landside toe following the geometry remediation required to meet SRFCP requirements (see Figure 2 and **Figure 3**). The construction of the landside combination berm will require the acquisition of additional rights-of-way for the proposed mitigation plus additional land at the landside toe to provide a 20-foot wide operation and maintenance corridor (see **Figure 8**). It should be noted that the current CVFPB Title 23 Standards only require a 15-foot-wide maintenance corridor, but a 20-foot-wide corridor was analyzed in this study in order to take into account the proposed changes to the standards as part of the Title 23 Tier II update.

7.3.1.2. Seepage Cutoff Wall

A soil-bentonite seepage cutoff wall constructed to a depth of 60 feet from the one-third levee height elevation is recommended to meet the criteria for through seepage

and underseepage mitigation. Rock protection is also recommended for the waterside slope to protect against erosion. Although cost estimates assume rock protection for the entire reach, several sections have been previously revetted and costs may be significantly lower. Further design evaluations will be required to determine appropriate reaches where protection is required. Construction of a seepage cutoff wall (see **Figure 5**) will incorporate a one-third levee degrade. After cutoff wall installation, the levee will be reconstructed to address geometry deficiencies in order to meet current requirements (see Figures 2 and 3). The geometry remediation will require the acquisition of additional rights-of-way plus additional land at the landside toe in order to provide a 20-foot-wide operation and maintenance corridor (see Figure 8).

7.3.2. Bear River Reach B (Bear River Station 85+00 to Station 130+72, Yankee Slough Station 0+00 to Station 4+64, 5,036 feet)

7.3.2.1. Combination Seepage/Stability Berm

A 150-foot-wide drained combination seepage/stability berm is recommended to meet the criteria for through seepage and underseepage mitigation. The combination berm (see Figure 4) would be constructed along the landside toe following the geometry remediation required to meet current requirements (see Figures 2 and 3). The construction of the landside combination berm will require the acquisition of additional rights-of-way for the proposed mitigation plus additional land at the landside toe to provide a 20-foot wide operation and maintenance corridor (see Figure 8). Seepage Cutoff Wall

A soil-bentonite seepage cutoff wall constructed to a depth of 40 feet from the one-third levee height elevation is recommended to meet the criteria for through seepage and underseepage mitigation. Construction of a seepage cutoff wall (see Figure 5) will incorporate a one-third levee degrade. After cutoff wall installation, the levee will be reconstructed to address geometry deficiencies in order to meet current requirements (see Figures 2 and 3). The geometry remediation will require the acquisition of additional rights-of-way plus additional land at the landside toe to provide a 20-foot-wide operation and maintenance corridor (see Figure 8).

7.3.3. Yankee Sough Reach A (Yankee Slough Station 4+61 to Station 231+17, 22,653 feet)

7.3.3.1. Drained Stability Berm

A 15-foot-wide drained stability berm is recommended to meet the criteria for through seepage mitigation. It is also recommended that any depressions along the landside of the levee be backfilled with locally available material. The stability berm (see **Figure 6**) would be constructed along the proposed landside toe following the geometry remediation required to meet current requirements (see Figures 2 and 3). The construction of the landside stability berm will require the acquisition of additional rights-of-way for the proposed mitigation plus additional land at the landside toe to provide a 20-foot-wide operation and maintenance corridor (see Figure 8).

7.3.3.2. Seepage Cutoff Wall

A soil-bentonite seepage cutoff wall constructed to a depth of 16 feet from the one-third levee height elevation is recommended to meet the criteria for through seepage mitigation. Construction of a seepage cutoff wall (see Figure 5) will incorporate a one-third levee degrade. After cutoff wall installation, the levee will be reconstructed to address geometry deficiencies in order to meet current requirements (see Figures 2 and 3). The geometry remediation will require the acquisition of additional rights-of-way plus additional land at the landside toe to provide a 20-foot-wide operation and maintenance corridor (see Figure 8).

7.4. Non-Structural Alternatives

A discussion on non-structural alternative recommendations can be found in Section 8.5. It should be noted that these non-structural measures would not impact the structural alternatives presented above.

7.5. Multi-Benefit Concepts

A discussion on the multi-benefit concepts that were analyzed as part of this study can be found in Section 8.6.

8. EVALUATION OF ALTERNATIVES

Several factors were incorporated into the evaluation effort in order to identify the preferred alternative. A summary of each factor can be found in the sections below.

8.1. Environmental Constraints Analysis

The purpose of including an environmental constraints analysis (Attachment C) (Reference 13) within the feasibility study is to assist with the identification of key environmental issues that should be given due consideration during the planning and design phase of a project.

The analysis of constraints is intended to facilitate the project planning process, assist with the evaluation of various alternatives, define a recommended project, and assess potential permitting and mitigation requirements. Specifically, the environmental constraints analysis: 1) identifies potential constraints based on the anticipated presence or absence of environmental resources; 2) describes the consistency and/or compliance of each alternative with existing policies; and 3) identifies potential environmental mitigation costs for each alternative site. This analysis also provides basic permit information.

The California Environmental Quality Act (CEQA) Guidelines Section 15262 states that a project involving only feasibility or planning studies for possible future actions which an agency, board, or commission has not approved, adopted, or funded does not require the preparation of an Environmental Impact Report (EIR) or a Negative Declaration. Section 15262 of the CEQA Guidelines does not apply to the adoption of a plan that will have a legally binding effect on later activities. Therefore, no documentation under CEQA has been prepared for the Feasibility Study.

8.2. Project Costs

To estimate preliminary project costs, unit prices were developed and material quantities were calculated for all project features. Estimated quantities for alternatives in each reach were developed using specific cross sections taken at locations where the existing levee geometry was representative of the reach. The representative cross section was applied to the whole segment in order to estimate quantities. Cross sections that were used to estimate quantities for the alternatives considered are included in Attachment I and **Attachment J**. Unit prices for typical levee construction (e.g.: site clearing, borrow excavation and hauling, levee embankment fill, and rock slope protection) were determined based upon recent contractor bid summaries for similar levee improvement projects in Northern California. Where recent bid tabulations were not available, cost-determination publications, such as RS Means' *Heavy Construction Cost Data*, were used to develop costs.

For the purposes of this Study, it was assumed that levee degrade material cannot be reused, and would have to be hauled off-site and disposed of. Levee embankment material used to regrade the levee and to address freeboard/geometry deficiencies is assumed to come from borrow sites within 15 miles of the Project. Seepage berm material is also assumed to come from Project borrow sites. Embankment material shrinkage is assumed to be 20 percent, and borrow acreages were estimated assuming a borrow depth of five feet.

Included in each cost estimate line item is a contingency amount of 30 percent. Where costs are known with greater certainty, a lower contingency was used. Planning, Engineering, and Design were included at eight percent, and Construction Management at six percent.

Cost estimates reflect 2019 cost levels escalated to 2022 costs at a rate of 3.3 percent per year.

This escalation rate was determined from a review of the Engineering News Record (ENR) Historical Cost Index for the years of 2015 through 2018. Unit costs used for this Study and detailed cost estimates for each levee system are included in **Attachment K**.

8.3. Rights-of-Way

To accommodate the expanded footprint that may be required due to levee geometry corrections, toe berms, stability berms, seepage berms, and cutoff fill and cutoff wall remediation. It should be noted that the current CVFPB Title 23 Standards only require a 15-foot-wide maintenance corridor, but a 20-foot-wide corridor was analyzed in this study to take into account proposed changes to the standards as part of Title 23 Tier II update. Acquisition will include land required for remediation, a 20-foot-wide operation and maintenance easement along the landside toe to be consistent with current requirements, and a 10-foot-wide additional temporary easement that provides a 30-foot construction corridor when combined with the operation and maintenance easement.

Due to the lack of available easement data, it was assumed that no easements currently exist outside the levee prism within the cost determinations. The costs associated with permanent and temporary ROW are preliminary and will need to be further reviewed at the time of project design or implementation.

8.4. Alternative Cost Analysis

8.4.1. Bear River East Levee

Costs for remedial alternatives for the Bear River East Levee can be found in **Table 6,** below. Each remedial alternative includes remediation to address geometry deficiencies.

Table 6: Bear River East Levee Alternative Costs

NULE Seg.	Project Reach	Project Station Range	Remedial Alternative	Cost
283	B	BR 58+00 -130+72 YS 0+00 - 4+64	Combination Seepage/Stability Berm	$20,426,800
			Seepage Cutoff Wall*	**$9,630,500**
283	C	BR 0+00 - 85+00	Combination Seepage/Stability Berm w/ Rock Slope Protection	$50,572,100
			Seepage Cutoff wall w/ Rock Slope Protection*	**$45,105,800**
			Total Cost of Preferred Alternative:	**$54,736,300**

*Preferred Alternative for single segment

8.4.2. Yankee Slough South Levee

Costs for remedial alternatives for the Yankee Slough South Levee can be found below in **Table 7**. Each remedial alternative includes remediation to address geometry deficiencies.

Table 7: Yankee Slough South Levee Alternative Costs

NULE Seg.	Project Reach	Project Station Range	Remedial Alternative	Cost
283	A.1	YS 4+64 - 38+30	Drained Stability Berm	$5,231,900
			Seepage Cutoff Wall*	**$5,217,000**
145	A.2	YS 38+30 - 231+17	Drained Stability Berm	$34,552,100
			Seepage Cutoff Wall*	**$23,430,200**
			Total Cost of Preferred Alternative:	**$28,647,200**

*Preferred Alternative for single segment

8.5. Non-Structural Recommendations

Residual risk is defined as the product of: 1) the chance of damage or other adverse consequence; and 2) the impact or damage resulting from the adverse consequence, after flood management actions have been taken. Therefore, even after implementing the recommended alternative, Rio Oso would still face residual risk from flooding. Although it is not possible to completely eliminate residual risk, it can be reduced with the implementation of non-structural measures that improve flood system performance for existing facilities and/or reduce the exposure, vulnerability, and consequences of flooding by adapting to the natural floodplain or inherent features of the floodplain.

For this study, several non-structural measures were evaluated for future consideration by Rio Oso. The measures are presented in order of their potential feasibility and benefit to the community:

1. Flood Emergency Evacuation Plan
2. Flood Evacuation Warning System
3. Emergency Planning
4. Levee Relief Cuts
5. Voluntary Structure Elevation & Flood-Proofing
6. Changes to National Flood Insurance Program (NFIP)
7. Agricultural Conservation Easements

The results of the non-structural measures evaluation are summarized in this section. A more detailed overview of the non-structural measure's evaluation is presented in **Attachment M** (**Reference 14**).

8.5.1. Flood Emergency Evacuation Plan

Flood emergency evacuation plans can help a community address residual risk by reducing the time required to initiate and execute a community evacuation when necessary. The Sutter County Emergency Operations Plan (EOP) (**Reference 15**) was updated in 2015 and provides a detailed flood emergency evacuation plan for Sutter County. In the event of an emergency, this plan would be implemented by the County Administrative Officer, the Sheriff, the County Fire Chief, or the Incident Commander as appropriate. Many factors need to be considered during evacuations such as the magnitude of the hazard, its intensity, and its anticipated duration. These factors are essential for determining the scope and timeframe for any evacuation that is considered necessary in response to an emergency.

According to the EOP, Sutter County has the responsibility for monitoring hazardous situations as they develop and then determining the areas that are most likely to be impacted by the event. Sutter County may issue one of two types of evacuations in response to an emergency: advisory and mandatory. The State of California and Sutter County are to coordinate together to ensure the appropriate deployment of resources, monitor and communicate evacuee shelter capacity, and direct modifications to evacuation routes as necessary.

8.5.2. Flood Evacuation Warning System

The flood evacuation warning system for the community, which can help reduce residual risk by increasing the flood warning time associated with a forecasted flood event, is also detailed within the Sutter County EOP. There are three types of flooding that may occur in the Sutter County Operational Area. The first type is localized flooding due to severe rainfall and flash flooding. The second is slow-rise flooding due to rising river levels in response to continued and heavy precipitation. The last type is flooding that corresponds to a catastrophic dam failure, including the Oroville Dam, the New Bullards Bar Dam, or the Camp Far West Dam.

The EOP presents information regarding public notifications for preparations of evacuation orders, outlines the responsible agencies and their respective duties, provides information on slow-rise flood threats from river stages on the Feather River, and outlines dam and/or levee failure planning and response.

8.5.3. Emergency Planning

Emergency planning can help a community address residual risk by increasing the ability to respond to floods by pre-identifying actions that facilitate flood response and emergency actions. In 2013, Sutter County developed an Updated Local Hazard Mitigation Plan (LHMP) (**Reference 16**) to make the County and its residents less vulnerable to future hazards. The purpose of the LHMP Update is to reduce or eliminate long-term risk to people and property from hazards including flooding. According to the Sutter County LHMP Update, one of the mitigation actions for RD 1001 includes a Flood Emergency Response Project. This Project includes the development of a hazard response training video, coordination of training, establishment of an evacuation location, and the purchase of emergency equipment and supplies.

In 2018, Sutter County received a Statewide Flood Emergency Response grant from DWR to update its countywide Emergency Operations Plan and develop emergency response plans for various communities, including Rio Oso. The Sutter County Board of Supervisors approved a resolution to begin the update process during the summer of 2019.

8.5.4. Levee Relief Cuts

Attachment B presents a hydraulic analysis to evaluate the stage reduction benefits associated with the proposed relief cuts that could be implemented to reduce flooding associated with a breach on the Feather River levees near SR 99. Levee relief cuts are pre-identified areas where a levee section can be lowered or removed during a flood event to return floodwaters to the main river channel. Relief cuts can address residual risk by

limiting the total depth of flooding that occurs in areas upstream of the cut and by reducing the overall duration of the flood event. . The proposed site of the relief cut is at the Feather River left (east) bank near Verona. Three potential relief cuts were explored in the hydraulic analysis with varying widths. The three different widths of the potential relief cuts are 100 feet, 500 feet, and 1,000 feet, respectively. The final crest elevation for all of the relief cuts is 40 feet utilizing the North American Vertical Datum of 1988 (NAVD 88). The approximate amount of time that would be necessary to implement an effective relief cut after a breach occurs is 24 hours for all of the relief cut alternatives. The results of the hydraulic analysis indicate that the maximum flood stage reduction resulting from a relief cut is 0.1 foot to 0.6 foot as a result of breach inflows far exceeding the relief cut outflows. However, relief cuts could provide additional benefits with lower river stages and would allow floodwaters to be more quickly evacuated form the basin once the breach is closed. Therefore, it is recommended that relief cuts be considered as part of future emergency operations planning.

8.5.5. Voluntary Structure Elevation & Flood-Proofing

The 2012 Central Valley Flood Protection Plan (CVFPP) (**Reference 17**), the 2017 Update of the CVFPP (**Reference 18**), and the Feather River Regional Flood Management Plan (RFMP) (Reference 7) assert DWR's interest in the elevation and flood-proofing of structures in small communities. Structure elevation and flood-proofing can address residual risk by reducing flood damages to existing structures. A GIS analysis was performed to assess structures that are potential candidates for flood-proofing by comparing the 2012 CVFPP structure inventory data points to a composite of maximum WSEs from the hydraulic analysis. Of the 58 structures in Rio Oso and the surrounding areas, 48 would experience less than three feet of flooding and, therefore, would be potential candidates for dry flood-proofing. The remaining 10 would have flood depths greater than three feet and, thus, would be candidates for elevating.

More outreach and education are required to determine if a structure elevation and flood-proofing program would be viable in Sutter County. A program such as this would require public acceptance and willing landowners. In addition, there may be concerns that structure elevations and flood-proofing would only benefit certain landowners and may divert funds from needed levee improvements that would benefit more of the basin. Therefore, a voluntary program may be considered if the County is able to secure funding.

8.5.6. Changes to Nation Flood Insurance Program (NFIP)

Changes to the NFIP have been proposed by previous studies. Based on the 2012 CVFPP (Reference 17), 2017 Update of the CVFPP (Reference 18), and the RFMP (Reference 7); some proposed changes to the NFIP include:

1. Revising FEMA Operating Guidance 12-13 to designate areas behind a certified levee reach as Zone X (Shaded) if the certified reach of levee is part of a larger levee system and is providing protection from the Base Flood. Currently, FEMA's Operating Guidance 12-13 does not allow accreditation of a reach of levee unless the entire levee system can be certified and accredited and, therefore, Zone D is used.

2. Setting insurance rates for structures protected by non-accredited levees by affording some credit for the presence of the existing levee, even if it is also not accredited. The current flood insurance mapping standards treat a non-accredited levee as non-existent.

In order for Option 1 to be feasible, the levees required for identifying a Zone X (Shaded) would need to be evaluated and certified by an engineer and accredited by FEMA.

In order for Option 2 to be feasible, a change to Code of Federal Regulations (CFR) 65.10 may be required. In the case of Rio Oso, even after changes to the NFIP, additional hydraulic analyses and levee evaluations/improvements would be needed to determine the level of risk.

FEMA recently made changes to the NFIP that apply to new businesses and renewals, effective April 1, 2019. These changes include premium increases, changes to primary residence determination, introduction of a Severe Repetitive Loss (SRL) Premium, and clear communication of these changes to policy holders. To date, DWR has not developed a program for funding any changes to the NFIP standards. Without sufficient funding, it is highly unlikely that changes to the NFIP would be a feasible non-structural alternative for Rio Oso at this time.

8.5.7. Agricultural Conservation Easements

While agricultural easements do not address the current risk, they do address potential future residual risk by preventing development in the agricultural areas of the floodplain. The 2012 CVFPP (Reference 17) and 2017 Update of the CVFPP (Reference 18) both assert DWR's interest in acquiring agricultural conservation easements to limit rural development. However, DWR has not yet developed a program for acquiring agricultural easements and funding has not been made available. If DWR acquires funding and develops a program for agricultural easements, then the community of Rio Oso should evaluate the program as it would apply in the Rio Oso area and make a determination as to whether or not the program would reduce the impacts of the current flood threat on the community.

Participation would be on a voluntary basis with only willing sellers. This could provide the community with more resiliency during major flood events. The Rio Oso area comprises only a small portion of the lands protected by the State Plan of Flood Control and it is currently mapped by FEMA as a Special Flood Hazard Area. DWR's funding for agricultural conservation easements in the Rio Oso area may be very limited.

8.6. Multi-Benefit Opportunities

A number of opportunities to promote multi-benefit concepts were evaluated as a part of the Feasibility Study. These multi-benefit concepts include the following:

8.6.1. Nelson Slough Improvements

The Feather River Wildlife Area - Nelson Slough Unit is located on the right bank of the Feather River immediately upstream of the Sutter Bypass and is owned and managed by CDFW. The unit occupies a terrace that is from 500 to 3,800 feet wide between the levee and the low-flow channel along a 3.5-mile reach of the river. State Route 99 bisects the unit via a bridge and causeway. A debris weir is located where the Feather River empties into the Sutter Bypass. The weir was originally constructed to keep Feather River sediment from being deposited into the Sutter Bypass; however, the functionality of the weir has been reduced by the accumulation of approximately 15 feet of sediment on the upstream side. In addition, the weir may be adversely affecting the hydraulics and sediment deposition dynamics of the Feather River that could threaten the integrity of the levee on the opposite bank by directing the flow of the river into the right bank during high flows.

The Nelson Slough Unit is currently managed to provide riparian habitat for migratory birds and special-status species, as well as to provide public opportunities for wildlife-oriented recreation. The unit is located on previously farmed terraces formed by thick deposits of sandy hydraulic mining debris between the levee and the river. A number of low areas, such as sloughs, side channels, remnant borrow pits, and floodplain scour depressions presently support healthy vegetation and provide excellent rearing habitat for juvenile salmonids. A dense riparian canopy is present at the base of the Feather River levee along the sloughs fed by the Feather River. The extent of these habitats is limited at the unit, and vegetation does not naturally regenerate or become established in most areas because the terraces are too high and dry as well as being dominated by dry grassland habitat.

Ecosystem restoration could be implemented at the Nelson Slough Unit by rehabilitating or removing the weir and lowering the floodway. This would create a variety of flood surface elevations that would support a diversity of habitats (e.g.: riparian woodland and scrub, marsh, native grassland, and frequently inundated floodplain) while also providing

additional flood conveyance through the removal of accumulated sediment. Additionally, side channels could be excavated to provide spawning areas for anadromous fish and to limit fish stranding after flood events. Along with side channels, benches and shelves could be graded from the floodplain to reconnect the flows or re-engineer the floodplain. Because the Nelson Slough Unit occurs at the junction of the Feather River with the Sutter Bypass, large volumes of sediment are deposited in the area during flood events. Thus, ongoing maintenance of the area would probably be required to maintain the ecosystem functions and services of any habitats that were created within the Nelson Slough Unit. It should be noted that the Nelson Rock Weir is currently part of the SPFC and therefore would require a substantial effort to remove it from the SPFC before it could be modified.

8.6.2. Natomas Cross Canal Stability Berm and Channel Habitat Improvements Project

The Natomas Cross Canal Stability Berm and Channel Habitat Improvements Project would construct a stability berm along 11,000 feet of the NCC Levee in areas that have not been previously repaired, and would plant additional riparian vegetation to act as a natural wind-induced wave defense. The project will also enhance local aquatic and riparian habitat through vegetation management; enhance terracing and grading of the in-channel geometry near the NCC and Sacramento River confluence; and reconfigure downstream portions of the NCC into a more meandering channel. This effort will utilize waterside berm plantings of varietal native understory and native plant species; thus, it will provide a natural wind-wave buffer that will also afford shaded riverine aquatic habitat over an additional 2,400 linear feet along the channel edge. These habitat enhancements and channel modifications will benefit water quality, improve water flow along the channel, and provide more non-natal rearing habitat for juvenile salmon – particularly winter-run salmon and other commercially important fishes (including fall-run Chinook, steelhead, and green sturgeon). In addition, the habitat enhancements and channel modifications will also provide an additional flood control conveyance and natural erosion protection feature. Fish screens will also be installed on existing intakes to protect the fish within their new environment.

Construction of the proposed in-channel habitat improvements will yield a large enough quantity of borrow to construct up to 11,000 linear feet of stability berm. The NCC Stability Berm & Channel Habitat Improvement Project plans to add riprap, soil, and plants on another 3,600 linear feet of the north NCC Levee between the RD 1001 main pumping plant, the NCC, and the Sacramento River confluence, to correct channel scour that is encroaching into the levee prism. These features will also provide adequate waterside berm to allow riparian habitat between the levee toe and the channel.

These various improvements of the Stability Berm and Habitat Improvement Project will support many of the Central Valley Protection Plan's Conservation Strategy goals. At the same time, these improvements will reduce flood risk, provide significant fish and wildlife habitat benefits, maintain the existing high-water quality within the NCC, and protect local agricultural and forested landscapes. These actions and benefits are also consistent with the State of California's planning priorities.

8.6.3. Sutter Bypass Hook Levee.

The Sutter Bypass Hook Levee is a discontinuous training levee located on the right bank of the Feather River at Nelson Slough. Implementing this project would increase river floodway capacity, reduce the high velocities that are associated with flood flows in the channel bend, and reduce scour of the riverbed near the left-bank levee. Hydraulic and sediment transport modeling of the 10-year and 100-year floods conducted by CBEC, Inc. indicates that deep channel scour and very high velocities occur within the constricted channel, between the training hook levee and the east levee of Feather River, and that depositional patterns exist upstream of the artificial constriction. Additional hydraulic and geomorphic analysis is needed to determine the best realignment of the training levee and to evaluate the feasibility of relocating the hook levee westward (farther from the left bank of the Feather River). The hook levee and a rock weir at Nelson Slough were constructed before construction of flood control dams at Oroville and New Bullards Bar, in order to reduce sediment deposits in the Sutter Bypass and prevent avulsion of the Feather River into the bypass. Since then, the bed of the river has continued to incise relative to the elevation of the high floodplain at Nelson Slough. Recent sediment-transport modeling does not indicate a tendency for channel migration at this location, but deep scour potential at the levee toe is a concern.

9. RECOMMENDED PROJECT

A summary of costs for the recommended geotechnical remedial alternatives can be found below in **Table 8**. It should be noted that the recommended geotechnical remediation measure is not always the least-cost alternative. In these instances, the purpose of selecting the higher cost alternative is to maintain a continuous geotechnical remediation measure among consecutive levee segments (decreasing overall project costs).

The recommended remediation measure for the Bear River East Levee is a seepage cutoff wall with rock slope protection on Reach C. As part of this effort, the levee embankment would be raised, widened, and/or slope flattened in localized areas where freeboard and/or embankment geometry were found to be deficient.

The recommended remediation measure for the Yankee Slough South Levee is a seepage cutoff wall. As part of this effort, the levee embankment would be raised, widened, and/or the slopes flattened in localized areas where freeboard and/or embankment geometry were found to be deficient.

Table 8: Summary of Recommended Project Costs

Levee	NULE Seg	Project Reach	Project Station Range	Remedial Alternative	Cost
Bear River East Levee	283	B	BR 58+00 - 130+72 YS 0+00 - 4+64	Seepage Cutoff Wall	$9,630,500
	283	C	BR 0+00 - 85+00	Seepage Cutoff Wall w/ Rock Slope Protection	$45,105,800
Yankee Slough South Levee	283	A.1	YS 4+64 - 38+30	Seepage Cutoff Wall	$5,217,000
	145	A.2	YS 38+30 - 231+17	Seepage Cutoff Wall	$23,430,200
Total Cost of Preferred Alternative:					**$83,383,500**

Due to the high cost of the preferred structural alternative cited above, the Community should consider implementing non-structural alternatives to reduce the consequences of flooding. From a structural risk reduction standpoint, incremental improvements to the upper portion of the Bear River (Reaches B, and C) would provide the greatest incremental flood risk reduction benefit for the Community of Rio Oso and also allow for some potential relief from FEMA rates by reducing the base flood elevation in the upper portion of the basin.

Development and implementation of an appropriate EOP is also recommended. The relief cut at on the Feather River near Verona should be included as part of this EOP, as it has been shown to reduce flood stages and the amount of inundated lands during a flood scenario. In an emergency situation, both time and the availability of equipment are constraining factors; however, in order to maximize the benefits of the relief cut, it is recommended that the cut be made as wide as possible. A full discussion on the relief cut analysis can be found in Attachment B.

Advancement of the multi-benefit projects discussed in Section 8.6 is also recommended.

9.1. Environmental Documentation and Permitting

The following sections contain summary information on the expected environmental documentation and permitting for the project.

9.1.1. California Environmental Quality Act (CEQA)

Based on the results of the Environmental Constraints Analysis (Attachment C), it is probable that the recommended alternative would result in an impact on the environment and, therefore, CEQA documentation would be required. The CEQA requires that all state and local government agencies consider the environmental consequences of the projects they propose to carry out or over which they have discretionary authority, before implementing or approving those projects. As specified in Section 15367 of the State CEQA Guidelines, the public agency that has the principal responsibility for carrying out or approving a project (as defined above and as described in more detail below) is the lead agency for purposes of CEQA. As specified in Section 15064(a) of the State CEQA Guidelines, if there is substantial evidence (such as the results of an Initial Study (IS)) that a Project, either individually or cumulatively, could have a significant effect on the environment that cannot effectively be mitigated to a less-than-significant level, the lead agency must prepare EIR. The lead agency may prepare a Mitigated Negative Declaration (MND), if in the course of the IS analysis, the agency finds that the Project would have no significant environmental impacts or could have a significant impact on the environment but that implementing specific mitigation measures would reduce any such impacts to a less-than-significant level (State CEQA Guidelines, Section 15064[f]). The level of CEQA documentation that would be required for the proposed Project would be determined during the permitting process.

9.1.2. National Environmental Policy Act (NEPA)

Based on the results of the Environmental Constraints Analysis (Attachment C), it is likely that the Project would require compliance with federal regulations, such as the Clean Water Act, Section 404; National Historic Preservation Act, Section 106; and Endangered Species Act (ESA), Section 7. Because these federal permits and consultations would probably be required, compliance with the NEPA could be triggered. In addition, the levee systems protecting the project area are part of the SPFC and, thus, are identified as state/federal facilities; therefore, any modifications to the levees could also trigger the need for NEPA compliance and for a Rivers and Harbors Act, Section 408 Permit. The level of NEPA documentation that would be required for the proposed Project would be determined during the permitting process.

9.1.3. Permits and Approvals

Several federal, state, and local permits and/or authorizations are anticipated for the proposed Project. Attachment C summarizes the permits and approvals that may be associated with the proposed Project. The regulations and ordinances listed below represent a preliminary assessment of permitting requirements, which would be refined through subsequent Project design and preparation of a detailed Project description.

The proposed alternatives would directly and indirectly affect sensitive natural resources, including waters of the United States (U.S.). All potential waters of the U.S., including wetlands, identified within the Project area, may be regulated by the USACE through Section 404 of the Clean Water Act (CWA) and by the Regional Water Quality Control Board (RWQCB) as waters of the State through Section 401. All ecological systems associated with drainages (i.e.: potential waters of the U.S.), and drainage features with bed and bank topography may also be regulated by Sections 1600-1616 of the California Fish and Game Code. In conjunction with the USACE Section 404 Permit, impacts on wetlands and waters would require a Section 401 Water Quality Certification or Waste Discharge Requirement from RWQCB and CDFW Section 1602 Streambed Alteration Agreement. In addition, the proposed Project has the potential to affect more than 1.0 acre of soil, triggering the requirement of a National Pollutant Discharge Elimination System (NPDES) General Permit from the RWQCB.

Finally, the proposed Project has the potential to adversely affect special-status species. Direct and/or indirect impact on federal- and state-listed species and their habitats would require formal consultation with the USFWS (Biological Opinion/Take Statement for federal-listed species) and CDFW (2081 Incidental Take Permit for State-listed species) to determine the levels of take.

9.2. Project Implementation

9.2.1. Financial Feasibility Constraints

9.2.1.1. Demonstrating Federal Interest

The USACE planning process has a defined approach to determine flood risk reduction benefits. The USACE analysis is based on the value of damageable property and the projected reduction in flood damages once flood risk reduction measures are implemented. Less densely populated areas with agricultural land produce lower benefits than do densely populated areas. This makes demonstrating a federal interest in small communities situated in agricultural regions very difficult.

Securing federal funding for flood risk reduction projects will continue to become more competitive. In the past, funding for authorized projects has relied heavily on prioritizing appropriations based on a project's Benefit to Cost Ratio (BCR). This approach limits federal investments to areas that can achieve a very robust BCR and, generally, these projects are in urban areas where significant flood damage reduction benefits exist. In fiscal year (FY) 2019 budget requests, the current administration sought to limit funding to ongoing flood risk reduction projects with a BCR greater than 2.5 to 1. While the BCRs for projects vary each year, the competition for limited federal funding also increases as authorizations continue to outpace appropriations.

9.2.1.2. Limited Availability of Federal Funds

The USACE has historically been a major financial contributor in the development of flood risk reduction infrastructure in California. It is estimated that the USACE has a backlog of authorized projects with budgets totaling greater than $96 billion. Annual appropriations for construction funding in FY 2018 and FY 2019 were $2.1 billion and $2.2 respectively, or just over two percent of the total backlog of authorized projects. However, some of the backlogged appropriations are related to projects that are unlikely to be constructed, as throughout the nation they are not competitive when compared against other projects.

There are multiple factors contributing to the growth of the USACE's backlog: authorizations have outpaced appropriations, aging infrastructure requires more significant financial investments, and construction-related costs continue to escalate.

In summary, the potential to obtain federal funding for construction of the features identified in this Feasibility Study is considered to be low.

9.2.1.3. Availability of State Funds

Following the passage of the Water Resources Development Act of 1986, non-federal interests were required to share more of the financial and management burdens. These new requirements, coupled with more stringent environmental regulations, resulted in a further reduction of the federal share of spending for flood and water management projects. With the reduction in federal authorizations and the more stringent conditions on State and local financing of flood management projects, the State turned to general obligation (GO) bonds.

In 2006, the State passed water management Bond Propositions 84 and 1E. The Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1E) authorized $4.09 billion in GO bonds to rebuild and repair California's most vulnerable flood control structures. This was done in order to protect homes and prevent loss of life from flood-related disasters, including levee failures, flash floods, and mudslides; it was also done to protect California's drinking water supply system by rebuilding delta levees that are vulnerable to earthquakes and storms. Proposition 84 enhanced these efforts with an additional $800 million for flood projects. Proposition 1 was passed on November 4, 2014, and it included $395 million for flood projects. Proposition 68 was passed on June 5, 2018, and it included another $550 million for flood projects.

Proposition 1E funds have been allocated to conduct Feasibility Study investigations that are consistent with DWR's SCFRRP Guidelines (2016) and support the (2012 and 2017) Central Valley Flood Protection Plan goals of promoting flood risk management actions to reduce flood risk to people and property protected by State Plan of Flood Control facilities. The study objectives include the following: assessing a community's existing flood hazards; evaluating structural, non-structural and multi-benefit projects; and making recommendations to implement a flood risk protection project that integrates other resources' needs, as much as is feasible.

9.2.1.4. Limited Local Funding Sources/Proposition 218 Assessment

Funding local infrastructure and services (including flood and water management projects) became more difficult when voters in California passed Proposition 13 in 1978, Proposition 62 in 1986, and Proposition 218 in 1996. Proposition 13 limited ad valorem taxes on California properties. The proposition limited the amount of tax that could be collected based on the assessed value of private property, including real estate, to 1 percent of the assessed value of the property. Proposition 13 also decreased the assessed value of the properties to 1975 values (negating three years of increased value), and limited increases of assessed value to a maximum of 2 percent per year. Property that is sold or declines in value after an initial purchase may be reassessed. The enactment of Proposition 13 cut local property tax revenue significantly, causing cities and counties to raise user fees and other local taxes. In response, voters approved Proposition 62, the Voter Approval of Taxes Act, in 1986. This proposition required that new general taxes be approved by two-thirds of the local agency's governing body and a majority of voters, and also that new special taxes be approved by a two-thirds majority of voters. This led local agencies and communities to use assessments and property-related fees (among other fees)

to pay for government services. Proposition 218 was passed by voters in 1996, and added requirements and limits on local governments' ability to impose or increase assessments and fees.

Proposition 26, which was passed in 2010, redefined many existing fees as taxes. The impacts of institutional and legal constraints associated with raising local funding for flood infrastructure and services is described in greater detail in a 2014 Public Policy Institute of California's report, *"Paying for Water in California"*. Constraints from Propositions 218 and 13 have been thoroughly documented by the State and also highlighted as a major challenge in DWR's January 2005 White Paper, "*Responding to California's Flood Crisis*."

9.2.1.5. Tax Rate and Infrastructure Burden Consideration

In order to consider an area's ability to generate new revenue through special taxes and assessments, the uses of taxing capacity for all infrastructure and services should be considered. The California Debt and Investment Advisory Commission (CDIAC) promulgates guidelines with respect to land-secured financing, including the use of assessments and Mello-Roos Special Taxes. The CDIAC's Mello-Roos Guidelines (1991) suggests that jurisdictions should integrate Mello-Roos financing into the land use regulatory framework. Local governments can create a process for coordinating the use of land-secured financing through the provision of this form of integration. The main concern is that, in the absence of coordinated planning, property owners/taxpayers could find themselves vulnerable to onerous overlapping property tax burdens imposed by a multitude of local governments that may provide services to the same group of properties. Furthermore, the services funded by these burdens may not reflect property owners' collective priorities for services and infrastructure. This issue is analogous to the current ongoing efforts associated with planning for the future of flood management infrastructure to the extent that there are a multitude of planning efforts, all developing concurrent funding and financing strategies. These efforts should be coordinated in order to ensure that there is sufficient funding capacity available from the identified beneficiaries and that the funding is dedicated toward the beneficiaries' collective highest priorities.

9.2.1.6. Preferred Alternative Costs Summary

The small communities for Nicolaus and Rio Oso are within the same hydraulic basin and, therefore, remediation of levees near each community impacts the entire basin. All of the levee improvements are required to achieve the planned flood risk reduction goals. A breach in the levees in the Nicolaus plan would inundate Rio

Oso, and a breach in the levees in the Rio Oso plan would inundate Nicolaus. Therefore, a combined cost for the preferred alternative was prepared for both communities. Through geotechnical evaluation, an alternative alignment with multiple alternative remediations was identified for the Nicolaus and Rio Oso Projects. For the purpose of this analysis, the minimum and maximum repair costs associated with each remediation alternative was considered in determining the recommended approach. **Table 9** includes a list of Project costs estimates provided by the Nicolaus Project team for the remediation measures. **Table 10**, below, includes a list of Project costs estimates provided by the Rio Oso Project team for the remediation measures. **Table 11,** below, displays the combined costs for both the Nicolaus and Rio Oso Projects. The estimated construction costs for the region is $465,678,200 under the preferred alternative plan.

Table 9: Project Costs Estimates for Community of Nicolaus

System	Station	Station	Preferred Alternative	Min	Max
	Start	End	[1]	[2]	[3]
Feather River Reach D	0+00	531+55	$171,836,000	$171,836,000	$224,986,800
Feather River Reach C	531+55	580+40	$30,870,400	$30,870,400	$33,807,400
Feather River Reach B	580+40	640+20	$14,284,600	$13,137,400	$14,284,600
Feather River Reach A	640+20	700+89	$11,331,900	$11,331,900	$39,945,500
Cross Canal Reach A	0+00	284+80	$153,971,800	$153,971,800	$171,733,700
Total			**$382,294,700**	**$381,147,500**	**$484,758,000**

Notes:
1. Preferred Repair Costs Per Remediation Area Provided by Nicolaus Project Team.
2. Minimum Repair Costs Per Remediation Area Provided by Nicolaus Project Team.
3. Maximum Repair Costs Per Remediation Area Provided by Nicolaus Project Team.

Table 10: Project Costs Estimates for Community of Rio Oso

System	Station	Station	Preferred Alternative	Min	Max
	Start	End	[1]	[2]	[3]
Bear River Reach C	0+00	85+00	$45,105,800	$45,105,800	$50,572,100
Bear River Reach B	85+00	130+72	$9,630,500	$9,630,500	$20,426,800
Yankee Slough Reach A.1	4+64	38+30	$5,217,000	$5,217,000	$523,190
Yankee Slough Reach A.2	38+30	231+17	$23,430,200	$23,430,200	$34,552,100
Total			**$83,383,500**	**$83,383,500**	**$106,074,190**

Notes:
1. Preferred Repair Costs Per Remediation Area Provided by Rio Oso Project Team.
2. Minimum Repair Costs Per Remediation Area Provided by Rio Oso Project Team.
3. Maximum Repair Costs Per Remediation Area Provided by Rio Oso Project Team.

Table 11: Cost Summary

Alternative	Nicolaus	Rio Oso	Total Construction Cost Estimate
Preferred	$382,294,700	$83,383,500	$465,678,200
Min	$381,147,500	$83,383,500	$464,531,000
Max	$484,758,000	$106,074,190	$590,832,190

9.2.1.7. Financial Feasibility

The small communities of Nicolaus and Rio Oso are within the same hydraulic basin, and remediation of levees near each community impacts the entire basin. All of the levee improvements are required to achieve the planned flood risk reduction goals. A breach in the levees in the Nicolaus plan would inundate Rio Oso, and a breach in the levees in the Rio Oso plan would inundate Nicolaus. Therefore, a combined financial feasibility analysis was performed for Nicolaus and Rio Oso. The first step in analyzing financial feasibility starts with the assumption that a property-based special assessment will be utilized to raise the local funding required for a flood risk reduction project. The general approaches utilized are summarized below:

1. Estimate the assessment rates required to generate, on an aggregate basis, $100,000 of annual revenue, and review the resulting rates to determine whether any land use assessment rate exceeds a level that could preclude approval of the assessment;

2. Establish the O&M funding requirements based on the project teams' input, and determine whether or not there is sufficient revenue to fund adequate levee maintenance;

3. Establish criteria based on an assumed maximum single-family residence assessment rate ($200) developed by the project team; and

4. Estimate the maximum amount of annual revenue that could be generated from project beneficiaries in the local community.

The methodologies utilized to determine the project beneficiaries and the relative benefits received are documented in **Attachment D (Reference 21)** and are based upon the assumption that a Proposition 218 Assessment will fund the local cost share of the project.

The capital costs of the remediation alternatives were compared to the two community's ability to generate local matching funds as a percent of the total project cost. The ability to pay analysis was a three-step screening process. First, a new maximum annual land-based assessment was calculated assuming the limitations noted above along with the proportionality requirements of Proposition 218 for the benefited area. Second, based on the calculated assessment revenue, it was determined that $88,000 in new assessment revenue would be allocated toward the local share of the capital costs either on a pay-go basis or to service debt. Finally, the project team determined that the existing local assessment generates a total annual revenue of $953,000, of which $470,000 will cover required O&M costs. Sixty-five percent (65%) or $313,950 of the remaining existing assessment revenue, in addition to $88,000 in new assessment capacity, was allocated toward the capital assessment capacity of $401,950. This represents the total amount of local assessment capacity available to advance the preferred alternative.

The results of the local funding analysis are shown in the **Table 12** below. The preferred, minimum, and maximum alternatives would raise between $5.62 million to $7.16 million on varying debt financing interest rates between 3% to 5%. A range of local capital amount was developed and compared to the estimated alternative cost to determine the percent of local matching funds available for the range of remediation alternatives. The alternatives are ranked based on the percent of the project that could be paid with local capital.

Table 12: Local Funding Analysis Results

Alt.	Capital Assessment Capacity ($)	Low Interest Rate (Millions $) [1,2,4]	High Interest Rate (Millions $) [1,3,4]	Project Cost (Millions $)	Local		Non-Local		Fund Capacity Ranking
					High (%)	Low (%)	High	Low	
Preferred	$401,950	$7.16	$5.62	$382.29	1.87%	1.47%	98.53%	98.13%	2
Min	$401,950	$7.16	$5.62	$381.15	1.88%	1.47%	98.53%	98.12%	1
Max	$401,950	$7.16	$5.62	$484.76	1.48%	1.16%	98.84%	98.52%	3

Notes:
1. Assumes 1.1 Debt Coverage Ratio
2. Low Interest Rate for Debt Issuance Assumed to be 3%
3. High Interest Rate for Debt Issuance Assumed to be 5%
4. Term for Bond Repayment Assumed to be 30 Years

9.2.1.8. Funding Source Analysis

This Study also evaluated potential State and federal funding sources available to match local funding. These sources include partners for the multi-benefit portions, structural and non-structural projects. **Table 13** provides a summary of potential

State and federal funding sources that could be sought to complete the proposed improvements. A detailed summary of these findings is provided in the Funding Sources Analysis, which is attached as **Attachment F (Reference 23)**.

Table 13: State and Federal Funding Sources Summary Table

Funding Program	Agency	Structural		Non-Structural		Study / Plan / O&M	
		Levees/ Floodwalls/ Dams/ Erosion	Bypasses	Changes to NFIP	Relief Cuts	Feasibility Study/Flood Management Plan	OMRR&R
Urban Stormwater and Waterways Improvement Program	CNRA	X	X		X		
Urban Green Infrastructure Program	CNRA	X	X		X		
Flood Control Subventions Program (FCSP)	DWR	X	X		X		
Central Valley Tributaries Program (CVTP)	DWR	X	X		X		
Flood Damage Reduction Projects (FDRP)	USACE	X	X		X	X	
Flood Related Continuing Authorities Program (FRCA)	USACE	X	X		X	X	
Sacramento River Bank Protection Project (SRBPP)	USACE	X	X		X		
Watershed and Flood Prevention (WFPO)	USDA	X			X		
Inland Wetlands Conservation Program (IWC)	WCB	X	X		X		

Source: Reference 23

9.2.1.9. Funding Plan

The County should work to determine if advancing a land-based assessment would be a viable approach and if it should refine assumptions associated with the amount

of funding required to complete the proposed improvements. In order to secure local funding, the County will need to prepare a detailed Project financing plan and a cash flow model to support a land-based assessment. This plan would ultimately become part of a required Engineer's Report. The County should advance design and environmental compliance of the preferred alternative in order to develop a construction-ready project that can better compete for state and federal funding.

The Project Team determined that existing local funding revenues are sufficient to fund all of the Alternative Remediations' O&M costs for the two small communities. The remaining capacity of the local assessment net O&M costs could be used to raise between 1.47 percent and 1.88 percent of the total Preferred Alternative project costs. In LWA's experience, typical capital improvement projects require at least 10 percent to 15 percent of the local matching funds in order to qualify for state and federal funding programs.

The County should explore developing a regional assessment district to fund a regional Capital Improvement Program (CIP) that could leverage a larger benefit assessment area than the two small communities to generate local funds to match state and federal funding. The regional assessment district could initially be utilized to fund SCFRRP projects within the County, and then other critical projects within Sutter County.

As part of developing a larger regional program and CIP, the County would need to determine how to address governance prior to advancing the preferred alternative under this regional approach.

For further details regarding this analysis, refer to the Financial Conceptual Plan that is attached as **Attachment E (Reference 22)**.

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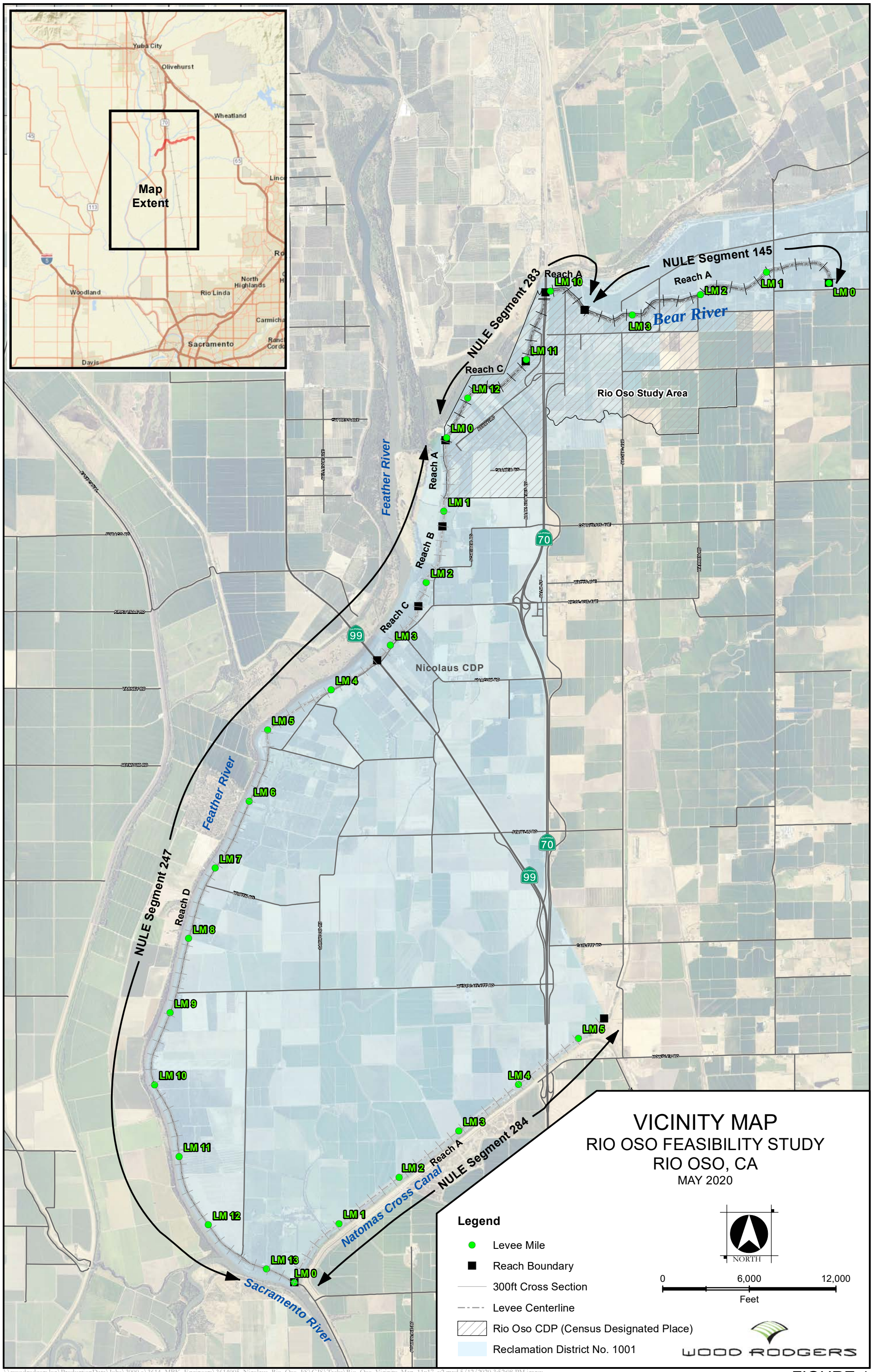
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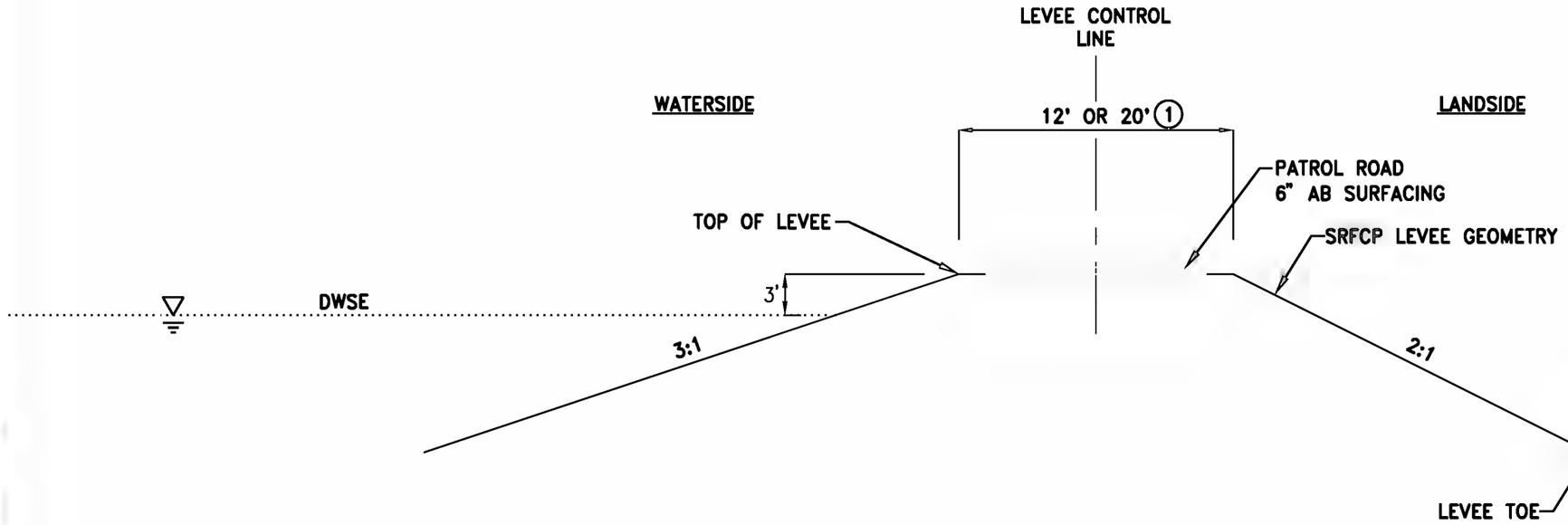
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FIGURE 1



TYPICAL SECTION
SRFCP AUTHORIZED DESIGN - LEVEE GEOMETRTY

SCALE: N.T.S.

LEGEND

	EXISTING GROUND
———	ULDC LEVEE GEOMETRY
.....	DESIGN WATER SURFACE ELEVATION (DWSE)

NOTES

(1) MINIMUM 12' CROWN WIDTH FOR MINOR STREAM LEVEES
MINIMUM 20' CROWN WIDTH FOR MAJOR STREAM LEVEES

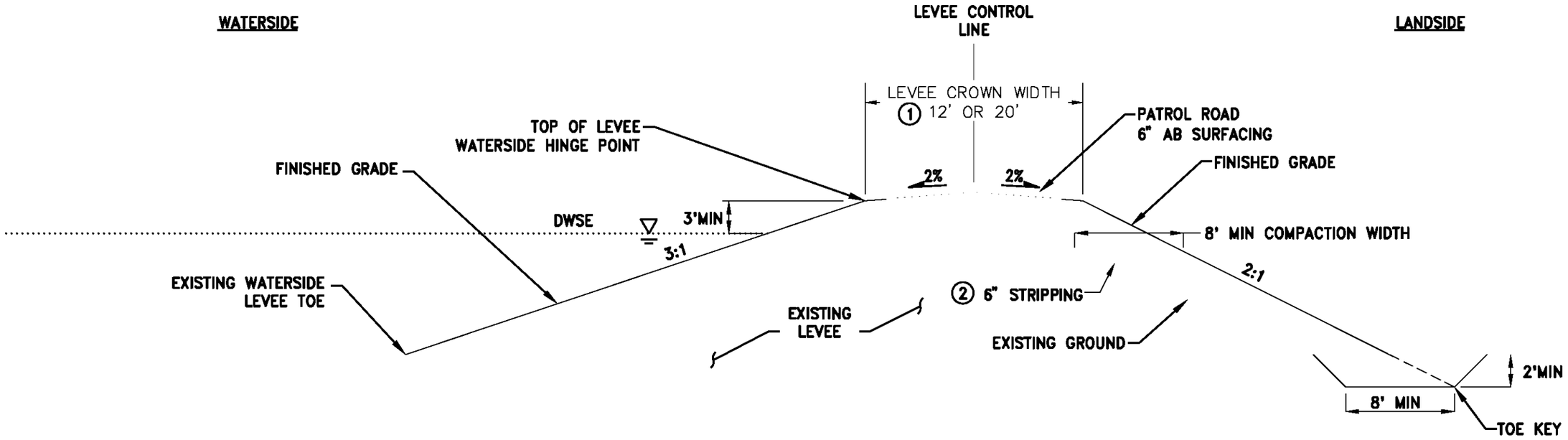
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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

SRFCP AUTHORIZED DESIGN – LEVEE GEOMETRY TYPICAL SECTION

FIGURE 2

8:51 AM Chuck Hilliard



NOTE

① LEVEE CROWN WIDTH SHOWN AS 20'. ACTUAL CROWN WIDTH MAY VARY. BEAR RIVER EAST LEVEE CROWN WIDTH SHALL BE 20'. YANKEE SLOUGH SOUTH LEVEE CROWN WIDTH SHALL BE 12'.

② EXCAVATE LEVEE SLOPE, AS NEEDED, TO CREATE MINIMUM COMPACTION WIDTH.

TYPICAL SECTION
LEVEE RAISE AND GEOMETRY IMPROVEMENT - LANDSIDE

SCALE: N.T.S.

LEGEND

EXISTING GROUND

FINISHED GRADE

DWSE

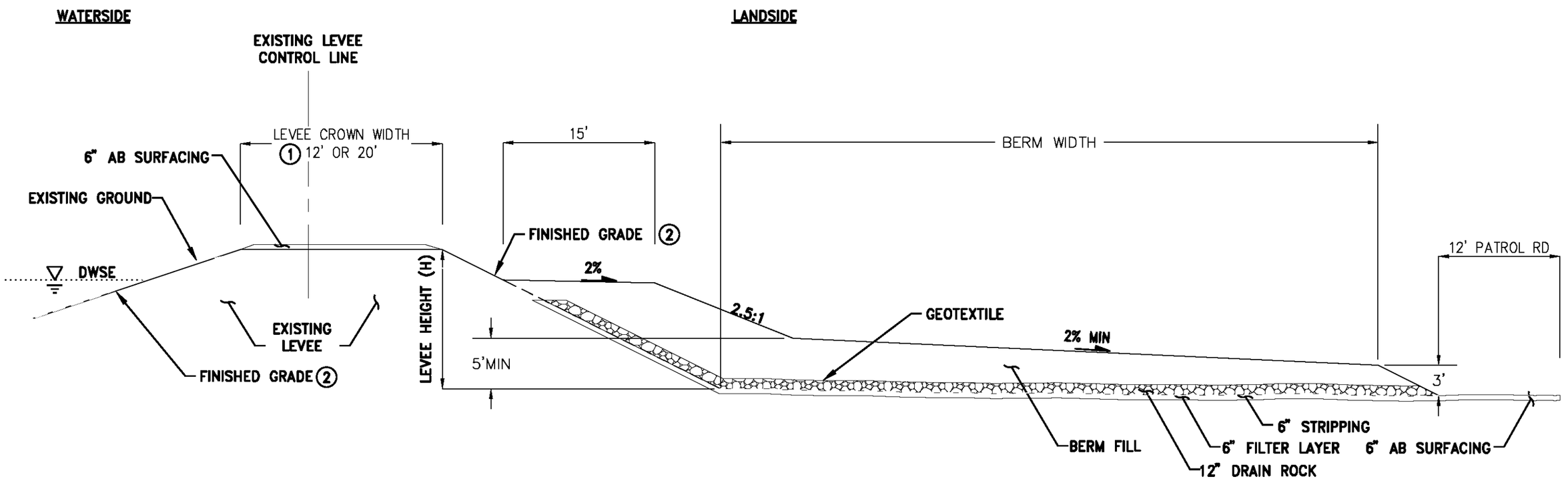
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LEVEE RAISE AND GEOMETRY IMPROVEMENT – LANDSIDE TYPICAL SECTION

FIGURE 3

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NOTE

① LEVEE CROWN WIDTH SHOWN AS 20'. ACTUAL CROWN WIDTH MAY VARY. BEAR RIVER EAST LEVEE CROWN WIDTH SHALL BE 20'. YANKEE SLOUGH SOUTH LEVEE CROWN WIDTH SHALL BE 12'.

② SEE FIGURE 2 FOR TYPICAL GEOMETRY FIX CROSS SECTION.

③ TOP OF BERM SHALL BE SET AT THE DWSE.

TYPICAL SECTION
LANDSIDE COMBINATION SEEPAGE/STABILITY BERM

SCALE: 1" = 10'

LEVEE	STATION RANGE	BERM WIDTH
BEAR RIVER	0+00 – 85+00	60
	85+00 – 130+72	150
YANKEE SLOUGH	0+00 – 4+64	150

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- PROJECTED FINISHED GRADE
- DWSE
- DRAIN ROCK
- FILTER SAND

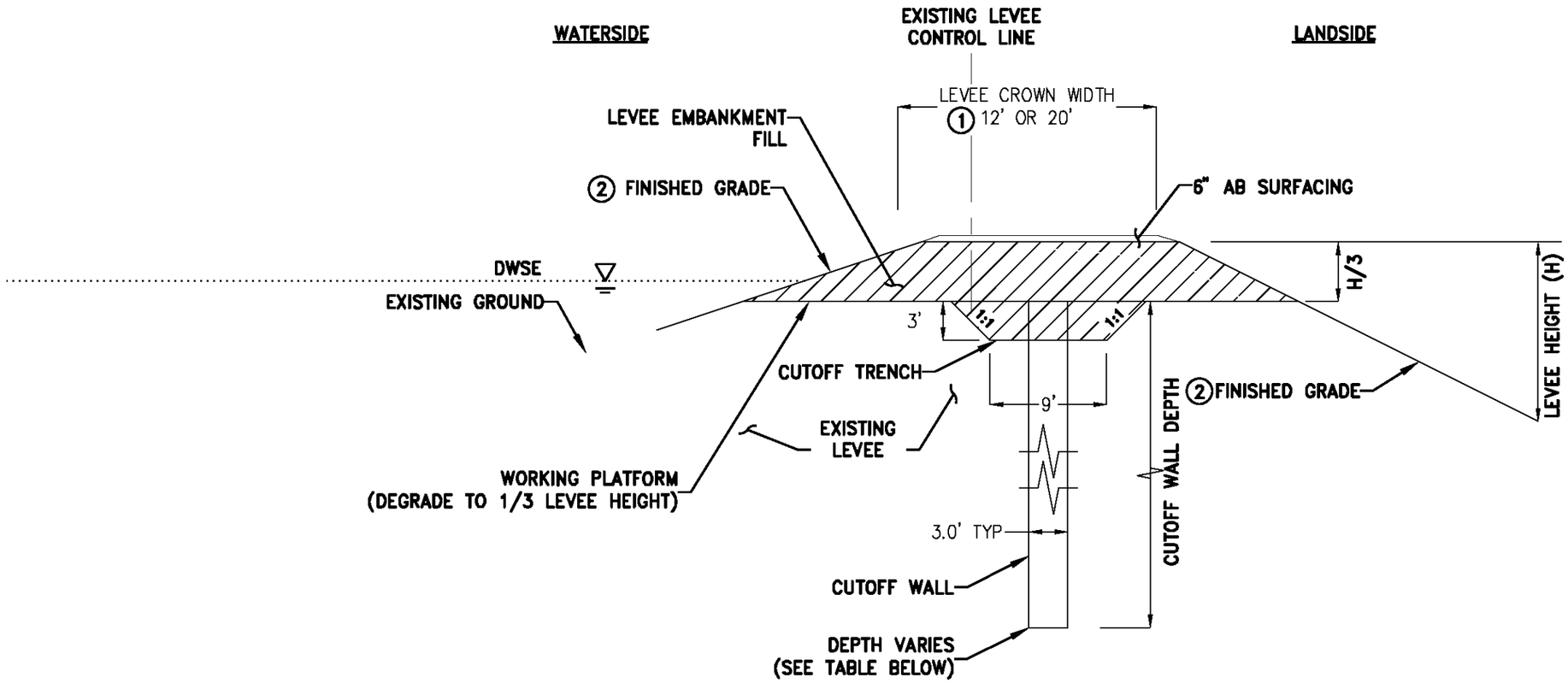
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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

LANDSIDE COMBINATION SEEPAGE/STABILITY BERM TYPICAL SECTION

FIGURE 4

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TYPICAL SECTION
SOIL BENTONITE SEEPAGE CUTOFF WALL

SCALE: 1" = 10'

LEVEE	STATION RANGE	CUTOFF WALL DEPTH (FT)
BEAR RIVER	0+00 – 85+00	60
	85+00 – 130+72	40
YANKEE SLOUGH	4+64 – 38+30	16
	38+30 – 231+17	16

NOTE

(1) LEVEE CROWN WIDTH SHOWN AS 20'. ACTUAL CROWN WIDTH MAY VARY. BEAR RIVER EAST LEVEE CROWN WIDTH SHALL BE 20'. YANKEE SLOUGH SOUTH LEVEE CROWN WIDTH SHALL BE 12'.

(2) SEE FIGURE 2 FOR TYPICAL GEOMETRY FIX CROSS SECTION.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- CUTOFF WALL EXCAVATION
- CUTOFF WALL
- DWSE

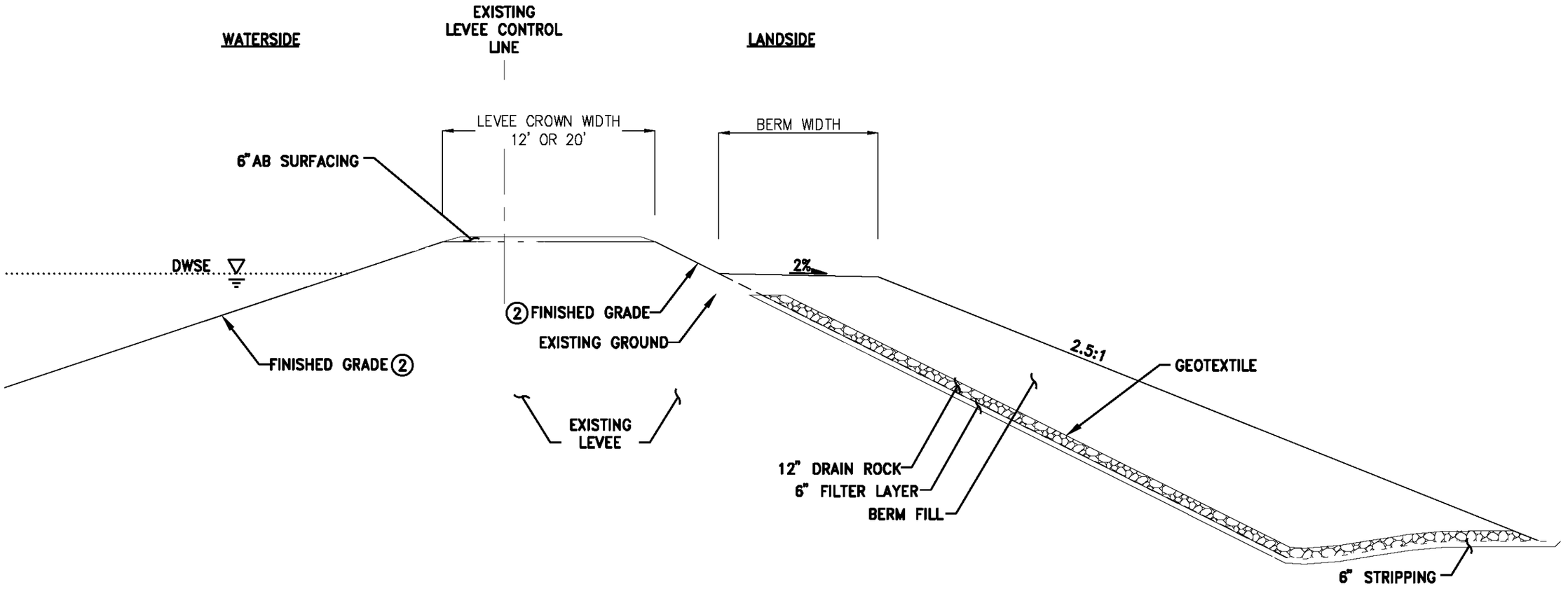
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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

SOIL BENTONITE SEEPAGE CUTOFF WALL TYPICAL SECTION

FIGURE 5

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NOTE

1. LEVEE CROWN WIDTH SHOWN AS 20'. ACTUAL CROWN WIDTH MAY VARY. BEAR RIVER EAST LEVEE CROWN WIDTH SHALL BE 20'. YANKEE SLOUGH SOUTH LEVEE CROWN WIDTH SHALL BE 12'.
2. SEE FIGURE 2 FOR TYPICAL GEOMETRY FIX CROSS SECTION.
3. TOP OF BERM SHALL BE SET AT THE DWSE.

TYPICAL SECTION
DRAINED STABILITY BERM

SCALE: 1" = 10'

LEVEE	STATION RANGE	BERM WIDTH
YANKEE SLOUGH	4+64 – 38+30	15
	38+30 – 231+17	15

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- PROJECTED FINISHED GRADE
- DWSE
- DRAIN ROCK
- FILTER SAND

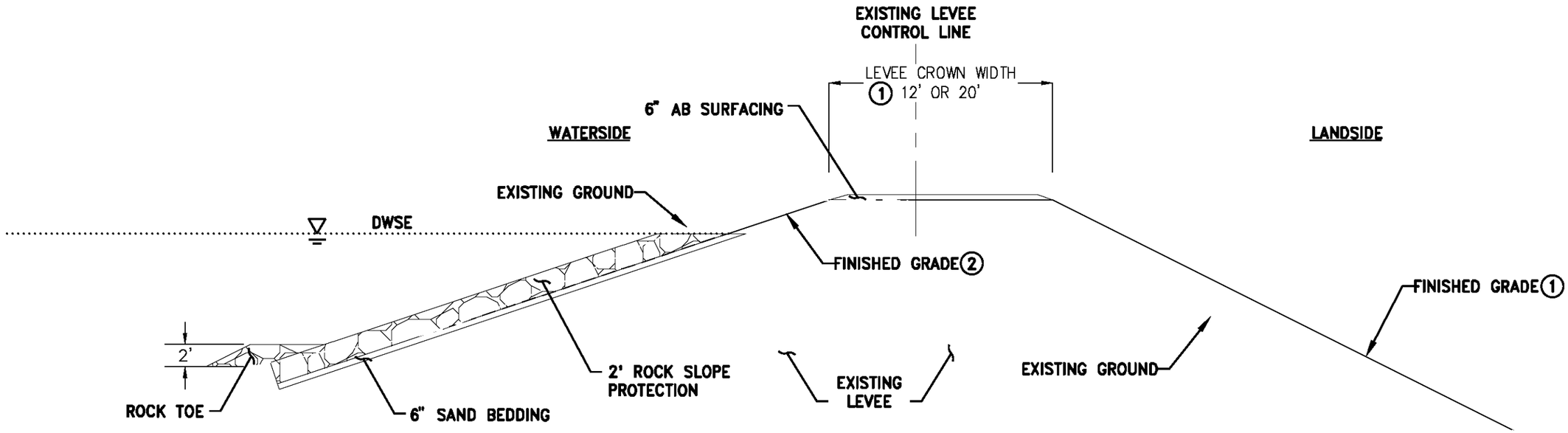
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DRAINED STABILITY BERM
TYPICAL SECTION

FIGURE 6

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NOTE

(1) LEVEE CROWN WIDTH SHOWN AS 20'. ACTUAL CROWN WIDTH MAY VARY. BEAR RIVER EAST LEVEE CROWN WIDTH SHALL BE 20'. YANKEE SLOUGH SOUTH LEVEE CROWN WIDTH SHALL BE 12'.

(2) SEE FIGURE 2 FOR TYPICAL GEOMETRY FIX CROSS SECTION.

TYPICAL SECTION
ROCK SLOPE PROTECTION

SCALE: 1" = 10'

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- DWSE
- ROCK SLOPE PROTECTION
- SAND BEDDING

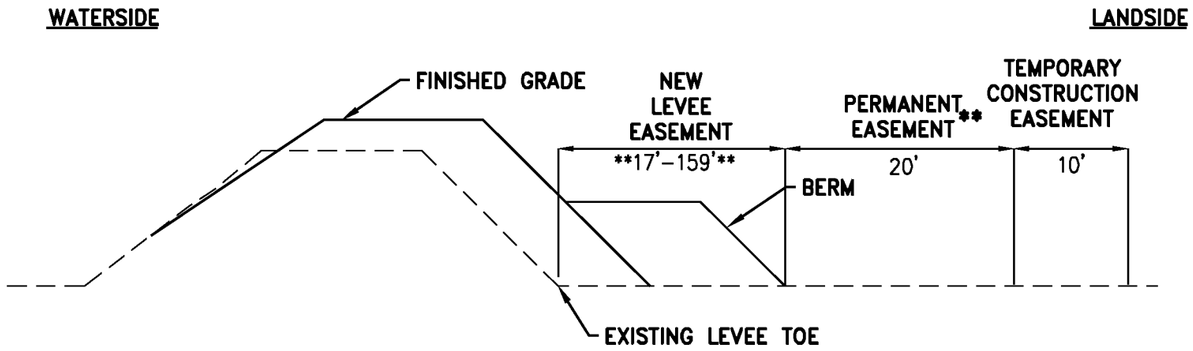
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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

ROCK SLOPE PROTECTION
TYPICAL SECTION

FIGURE 7

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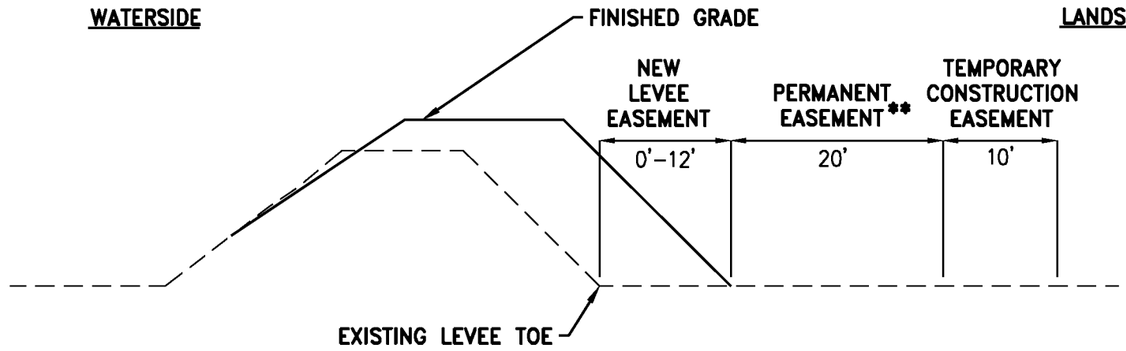


* ASSUME NO EXITING LEVEE EASEMENT BEYOND EXISTING LEVEE TOE

** PERMANENT EASEMENT IN ACCORDANCE WITH CVFPB

COMBINATION / DRAINED STABILITY BERM

SCALE: N.T.S.

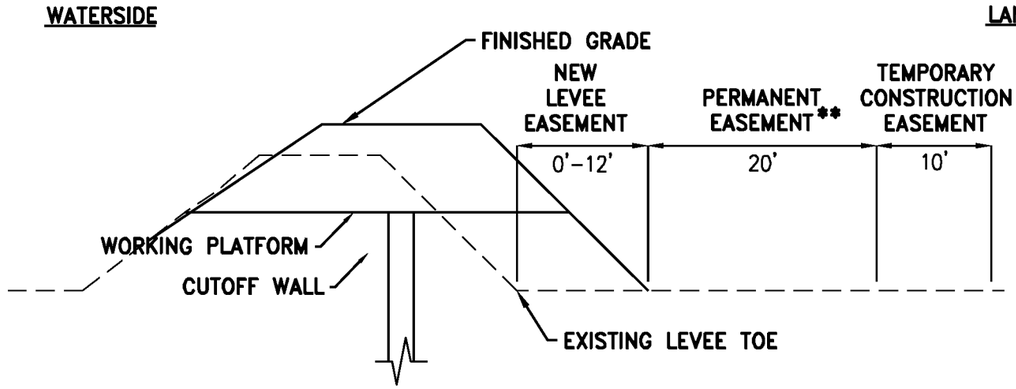


* ASSUME NO EXITING LEVEE EASEMENT BEYOND EXISTING LEVEE TOE

** PERMANENT EASEMENT IN ACCORDANCE WITH CVFPB

LEVEE RAISE/ GEOMETRY FIX

SCALE: N.T.S.



* ASSUME NO EXITING LEVEE EASEMENT BEYOND EXISTING LEVEE TOE

** PERMANENT EASEMENT IN ACCORDANCE WITH CVFPB

CUTOFF WALL

SCALE: N.T.S.

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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

LAND ACQUISITION
TYPICAL SECTIONS

FIGURE 8

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ATTACHMENTS

Attachment A – Geotechnical Summary Report, Rio Oso Flood Risk Reduction Feasibility Project

Attachment B – Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus

Attachment C – Draft Environmental Constraints Analysis, Rio Oso Flood Risk Reduction Feasibility Study

Attachment D – Financial Feasibility – Technical Memorandum

Attachment E – Conceptual Finance Plan – Technical Memorandum

Attachment F – Funding Sources – Technical Memorandum

Attachment G - Memorandum of Understanding Respecting the Sacramento River Flood Control Project

Attachment H – Freeboard and Geometry Analysis - Levee Deficiencies Strip Maps

Attachment I – Freeboard and Geometry Analysis - Levee Cross Sections

Attachment J – Cost Estimate Cross Sections

Attachment K – Cost Estimate – Summary

Attachment L – Levee Encroachments Table

Attachment M – Draft Nonstructural Measures, Rio Oso Flood Risk Reduction Feasibility Project

ATTACHMENT A

Geotechnical Summary Report, Rio Oso Flood Risk Reduction Feasibility Project



Geotechnical Summary Report

Rio Oso Flood Risk Reduction Feasibility Project

Rio Oso

Sutter County, CA
December 2, 2019

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1 Introduction

1.1 Background

As part of the State of California Department of Water Resources (DWR) Small Community Flood Risk Reduction Program (SCFRRP), Sutter County is preparing the Rio Oso Flood Risk Reduction Feasibility Project (Project) for the town of Rio Oso. Sutter County has retained the services of a project team consisting of MBK Engineers, HDR Engineering, Inc. (HDR), Wood Rodgers, and Larsen Wurzel & Associates, Inc. The project team has been tasked with performing a feasibility level baseline assessment of the Project for a 100-year flood event.

Rio Oso is situated upstream of State Highway 70 along the Bear River as shown on Figure 1 – Vicinity Map. Reclamation District (RD) 1001 maintains the levees surrounding Rio Oso. The town of Rio Oso is protected from flooding by State Plan of Flood Control (SPFC) levees along the left (south) bank of Yankee Slough, the left (south) bank of Bear River, and the left (east) bank of the Feather River. The levee segments near the study area are shown on Figure 2 – Project Location Map. This study includes Segments 283 and 145 and a similar study carried out for the town of Nicolaus covers Segment 247.

1.2 Purpose and Scope

The purpose of the project is to perform a feasibility level evaluation of the project levees protecting the town of Rio Oso. This report documents the feasibility level geotechnical evaluation performed by HDR. As part of this study, HDR performed the following:

- Reviewed existing geotechnical exploration data and analysis performed by others from DWR's NULE program.
- Performed geotechnical subsurface exploration with four Cone Penetration Tests (CPT) and one mud-rotary boring.
- Performed slope stability and seepage analysis on selected levee cross-sections.
- Evaluated potential seismic hazard considerations.
- Evaluated potential remediation alternatives to deficient levee segments.
- Evaluated potential borrow area locations near the town of Rio Oso, and
- Prepared this technical memorandum documenting our evaluation.

1.3 Datum and Stations

The vertical datum used for the project is the North American Vertical Datum of 1988 (NAVD88). The horizontal datum is the North American Datum of 1983 (NAD83). All coordinates and elevations are presented in feet.

2 Levee Past Performance

The past performance of levees included in this geotechnical assessment for the town of Rio Oso is documented in the NULE Geotechnical Assessment Report (GAR) (URS, 2011). Past performance events documented by NULE include levee break, underseepage, through seepage, erosion, overtopping, and slope instability. The summary of past performance for the levee segments maintained by RD 1001 is shown in Figure 3 – Past Performance Summary Map. This study was focused on the levee alignments on the left banks of Bear River and Yankee Slough.

Since construction, the levees protecting Rio Oso have experienced multiple high water events, including high water in 1950, 1986, 1997, 2006, and 2007. Detailed descriptions of levee segment past performance, based on NULE documents, are provided below.

2.1 Segment 145

Segment 145 is located along the left (south) bank of Yankee Slough. The segment extends from the beginning of the left bank levee of Yankee Slough to the east, extending about 3.7 miles west to the confluence of Yankee Slough with the Bear River. The segment is 3.7 miles long and maintained by RD 1001. The levee segment was constructed during the early 1900s. The base map of Sacramento River Valley dated 1910 shows the proposal to build Levee Mile (LM) 1 to LM 2. The map dated 1925 shows the segment was constructed to the proposed grade around 1925. The levee was reconstructed by the USACE around the 1950s.

A levee break, an overtopping, and erosions have been reported for Segment 145. The locations, types of events, and documented mitigations for Segment 145 are detailed in Table 1.

Table 1. Segment 145 Reported Levee Performance Events

Flood Season	Reported Performance Event	Approximate Location (LM)	Mitigation
Unknown	Waterside erosion	1.17	Repair may or may not have occurred, not documented.
1950	Levee break	3.36 to 3.45	Repaired by the USACE.
1997	Overtopping resulting in crown damage	3.12	Repair may or may not have occurred, not documented.
2006	Waterside erosion	1.28 to 1.30	Repair made, but not documented.
2006	Waterside erosion	1.39 to 1.43	Repair made, but not documented.
2006	Waterside erosion	1.48 to 1.54	Repair made, but not documented.
2006	Waterside erosion	1.62 to 1.64	Repair made, but not documented.
2006	Waterside erosion	1.82 to 2.22	Repair made, but not documented.
2006	Waterside erosion	2.24 to 2.28	Repair made, but not documented.
2007	Waterside erosion, approximately 950 feet of intermittent erosion sites.	1.0 to 1.8	Repaired under PL 84-99

Source: URS, 2011
PL 88-49: Public Law 84-99 authorizes an emergency fund to be expended at the discretion of Chief of Engineers (USACE) for flood fighting and rescue operations; repair or restoration of flood control works threatened, damaged, or destroyed by flood, or nonstructural alternatives; where-in local maintaining agencies in good standing can solicit and receive repair funding through federal government appropriations.

2.2 Segment 283

Segment 283 is along the left (south) bank of the Bear River and Yankee Slough. The segment extends from the left bank of Yankee Slough for about 0.35 miles before its confluence with the Bear River, then continues downstream along the left bank of the Bear River for about 2.65 miles, and ending at the confluence of the Bear River and the Feather River. The segment is 3 miles long and maintained by RD 1001. The levee segment was constructed beginning in the late 1800s and completed in 1964. The levee was reconstructed by the USACE in 1959 from LM 9.42 to LM 12.60. The levee section was reconstructed by the State Division of Highways in 1961 at the State Highway 70 crossing.

Reported levee performance events include a levee break, and several underseepage and erosion events. The locations, types of events, and documented mitigations for Segment 283 are detailed in Table 2.

Table 2. Segment 283 Reported Levee Performance Events

Flood Season	Reported Performance Event	Approximate Location (LM)	Mitigation
Unknown	Erosion, 300 feet long.	10.07	Not documented.
Recurring	Underseepage, 100 to 200 feet away from levee.	10.14 to 12.60	Not documented.
1950	Levee breach.	9.9	Not documented.
1986	Underseepage was reported along the stretch from Highway 70 to Berry Road.	10.14 to 12.60	Not documented.
1986	225 feet of erosion, 15 to 18 feet of embankment. Two sinkholes developed as a result of erosion.	10.4	Repair made, but not documented.
1986	Bank erosion approximately 150 feet long. Rodent holes were observed on eroded levee slope and one sinkhole developed.	11.85 to 11.95	Repair made, but not documented.
1997	Waterside erosion.	4.14 (Yankee Slough)	Not documented.
1997	Waterside berm erosion.	9.80 to 9.81	Not documented.
1997	Waterside erosion.	9.91	Not documented.
1997	Underseepage was reported along the stretch from Highway 70 to Berry Road.	10.14 to 12.60	Not documented.
1997	Crown damage from overtopping.	10.74	Not documented.
1997	Waterside bank eroded.	11.0 to 12.0	Repair made, but not documented.
2006	Waterside erosion.	10.7	Not documented.
2006	Waterside erosion, approximately 1200 feet.	11.1	Repair in progress.
2006	Waterside erosion.	11.58	Not documented.
2007	Waterside erosion.	11.83	Repair in progress.
2007	Erosion, whole bank rotational failure, 237 feet.	12.2	Not documented.

Source: URS, 2011

3 Geology

3.1 Area Geology

Rio Oso is located near the confluence of the Bear River and the Feather River in the northern part of the Sacramento Valley which lies in the Great Valley geomorphic province. The Great Valley geomorphic province extends through much of central California and is broadly comprised of the Sacramento Valley to the north and the San Joaquin Valley to the south, each drained by their namesake rivers. The Sacramento Valley is bounded by the Sierra Nevada Range to the east and the Coast Ranges to the west. The Great Valley geomorphic province is a large, elongated structural trough that contains a thick sequence of predominantly sedimentary formations that range in age from Jurassic (206 to 144 million years old) to Recent. From the late Triassic Period until the late Jurassic, this area was part of the continental shelf and ocean floor on which the marine Great Valley sequence was deposited. By the early Pleistocene Epoch (about 1.8 million years ago), after uplift of the Coast Ranges, the present boundaries of the Great Valley were well developed and deposition changed from marine to mostly continental. Surficial units within the project area are predominantly Pleistocene and Holocene alluvial deposits.

Materials underlying the northern portion of the Sacramento Valley consist primarily of Holocene alluvial deposits from the Sacramento River and its east-flowing tributaries that drain the Coast Ranges located west of the project area. These Holocene materials consist of stream and basin deposits from clay to boulder size and overlie older alluvial formations.

3.2 Study Area Surficial Geology and Geomorphology

The Rio Oso study area lies in the eastern Sacramento Valley, between the Sacramento River to the west and the Sierra Nevada foothills to the east, near the confluence of the Bear and Feather Rivers (URS, 2011). The Bear River is the principal west-flowing drainage between the Yuba and American Rivers, and its watershed has been highly altered in the past with hydraulic gold mining. Yankee Slough is a tributary to the Bear River located to the north of Rio Oso and confluences with the Bear River near the State Highway 70 Bridge. Geomorphic analyses for NULE consisted of mapping of geomorphology/surficial geology in corridors along the Project and non-Project NULE levees. The mapping was carried out at two levels. Level 2-I mapping was based primarily on the compilation and analysis of existing regional geologic and geomorphic information at a final scale of 1:62,000. Level 2-II mapping was original mapping at a scale of 1:24,000. More details regarding the DWR geomorphic assessment are provided in Geotechnical Data Report (GDR) URS (2012) and summarized below.

The Level 2-II geomorphic mapping indicates Holocene deposits at depth with a veneer of historical alluvium at the surface on the south side of Yankee slough. The gravelly and silty sands comprising the historical alluvium are unconsolidated and highly permeable. On the upper part of Yankee slough, the levee overlies older sediments, including Holocene alluvium or the Pleistocene Riverbank Formation. Upper Yankee Slough is partially underlain by the dense alluvium fan sediments of the Riverbank Formation with

a two to three feet thick duripan at or near the surface. Based on these geological conditions, underseepage would be expected near the lower portion of the Yankee Slough, with decreasing potential for underseepage on the upper portion.

The Bear River and its watershed have been highly altered with hydraulic gold mining in the past. Up to 15 feet of mining debris has been measured near Bear River in the past studies based on sediment probing. The mining debris, primarily sand with some gravel and silt, blankets the former valley floor of the Bear River and the existing levees are built atop this debris. Yankee Slough is unaffected by the mining debris except in the downstream stretch where it flows through Bear River sediment before their confluence. Level 2-II geomorphic mapping of the study area for NULE is included as Appendix A.

3.3 Area Seismicity

The Sacramento area has a relatively low seismic hazard when compared to other parts of California. The most active faults, such as the San Andreas, Hayward, Calaveras, and others, are at least 60 miles away from the project area. The California Department of Conservation, Earthquakes of California (magnitude 5+), 1769 to 2015 database showed 1892 Vacaville Winters earthquake event of Mw 6.6 as the nearest event of significant historical seismicity (i.e. > Magnitude (Mw) 5.0) near Rio Oso located approximately 40 miles to the southeast (Eaton, 1986).

The closest seismically capable structures to the project are the Foothill fault system and the Great Valley Fault Zone (GVFZ), also known as the Coast Ranges Fault Zone or Coast Ranges-Sierra Block fault zone. The Foothills fault zone comprises of northwest trending, steeply east-dipping to vertical faults in the western foothills of the Sierra Nevada Mountains. The GVFZ comprises a series of blind (i.e. no surface expression of the fault plane) reverse faults along the western margin of the Great Valley that constitute the boundary between the Coast Ranges block and the Sierra Nevada block. Some of the faults in this system have ruptured recently, namely the Coalinga fault, suggesting that this fault system is active along its entire length (Helley and Harwood, 1985).

The closest fault to the project within the GVFZ is the Dunnigan Hills Fault. The Dunnigan Hills fault is Quaternary active fault with a slip rate best estimate of 0.6 mm/yr and a maximum magnitude of 6.5 (Field et al., 2013). The closest fault to the project within the Foothills fault system in the Swain Ravine – Spenceville fault with a slip rate best estimate of 0.05 mm/yr and a maximum magnitude of 6.5 (Anderson and Ake, 2008). Due to the very low slip rates, the impact of hazard from the Foothills fault system is low. A fault map showing the project locations and earthquake events is included as Figure 4 – Fault Map.

4 Geotechnical Data Summary

4.1 Site Conditions

4.1.1 Levee Geometry

The levee height of Segment 145 varies between10 to 15 feet (measured from the landside toe) at the west end of the segment. At approximately LM 2.7, the levee height is about 10 feet and begins decreasing to about 6 to 7 feet at the east end of the segment (LM 0).

The levee height of Segment 283 varies from 23 to 25 feet (also measured above the landside toe) at the west end of the segment at the confluence of the Bear River and the Feather River down to about 17 to 18 feet at the east end of the segment near the confluence with Yankee Slough and the Bear River.

Crest widths range from approximately 20 to 30 feet for both Segments 283 and 145. For both segments, the landside slopes are inclined approximately 2H:1V to 3H:1V, and the waterside slopes are inclined approximately 3H:1V to 3.5H:1V (URS, 2011).

4.1.2 Encroachments and Penetrations

Fifteen pipes penetrate Segment 145 with pipe diameters ranging from 3 to 36 inches and located approximately 1 to 15 feet below the levee crown. No penetrations are recorded for Segment 283. Swanson Road and Pleasant Grove Road cross Segment 145 at LM 2.55 and LM 0.8 respectively. Highway 70 crosses Segment 283 at LM 10.1 (URS, 2011). Additional survey for levee penetrations within the study area was not carried out.

4.2 Previously Existing Explorations

No previous geotechnical explorations exist for Segment 145. USACE records show that 29 borings were drilled near the Bear River to a maximum depth of 104 feet. The borings were carried out for the State Highway 70 Bridge on the Bear River. Caltrans boring 02-9 for the Bear River Bridge widening project, located approximately on the crest of the Segment 283 levee, indicates the levee consists of loose to medium-dense silty sands and sandy silts and the foundation soils consist of loose to medium dense silty sands, clayey silty sands, coarse sands, and gravel. Geotechnical explorations have not been conducted as a part of the NULE program.

The available subsurface explorations generally indicate the Segment 283 levee consists of loose to medium dense silty sands to sandy silts and the foundation materials consist of loose to medium-dense silty sands, clayey silty sands, coarse sands, and gravel. No previously existing geotechnical investigations were available for Segment 145.

4.3 Subsurface Conditions

Based on the level 2-II geomorphic mapping conducted by URS (URS, 2012), Segment 145 overlies Holocene alluvium, Pleistocene Modesto Formation, historical overbank

deposits, alluvium, and channel deposits. The levee consists primarily of sands and silty sands, and the foundation soils consist of stiff to hard clays and silty clays with occasional sand and gravel layers.

Segment 284 overlies alluvial and overbank deposits from LM 0.0 to about LM 1.1, mainly consisting of sands, silts, and minor clays and gravels. From LM 1.1 to LM 4.0, the levee is underlain by basin deposits consisting of fine-grained materials like silts and clays. The rest of the levee, from LM 4.0 to LM 5.4, is underlain by Late Pleistocene Lower Modesto Formation which likely consists of unconsolidated to semi-consolidated clays and silts with some sand and gravel.

4.4 Supplemental Explorations

The review of existing geotechnical exploration showed geotechnical explorations have not been conducted as part of past investigations for the existing levees surrounding Rio Oso. For this study, four CPTs and one mud-rotary boring were advanced to the depth of 50 feet. The supplemental exploration locations are shown on Figure 5 – Supplemental Exploration Location. The explorations were carried out on the landside of the levee toe outside of the levee easements. The CPT sounding logs and boring logs from the exploration program along with the existing explorations are presented in Appendix B. Laboratory testing was carried out on representative samples from the mud-rotary boring. The laboratory test results are presented in Appendix C.

The exploration program showed the existing levee is underlain by a layer of clay and silt which, in turn, is underlain by a layer of silty sand and silt. The stratigraphy indicates a potential for underseepage issues due to the presence of a ditch near the landside toe. The levee prism was assumed to be primarily composed of silty sands. The silty sand material is predominantly available in the area alongside the levee as indicated by the supplemental explorations and geomorphic mapping. The silty sand levee prism indicates high potential for through seepage issues.

5 Reach Summary

The levee segment in the study area was not subdivided into reaches as part of the NULE program. The existing geotechnical explorations and the explorations carried out for this study were used to divide the levee segments into reaches as shown on Figure 6 – Reach Summary. The goal was to identify the minimum number of reaches that could represent the most critical features in the levee segment.

A separate reach was identified when a major change in conditions potentially affecting levee performance was noted. Reasons for identifying a separate reach included significant change in levee geometry, the presence of a landside ditch, changes in subsurface conditions, or recorded levee performance issues during high water events.

The reach summary for the study area levees are shown in Table 3 below.

Table 3. Reach Summary

Maintained By	Segment	Reach	Levee	DWR Stationing	Levee Miles	Project Stationing
RD1001	145	A	Yankee Slough Left Bank	YS-L 1019+40 to 1211+75	LM 0.0 to 3.7	YS 231+17 to YS 38+30
RD1001	283	A	Yankee Slough Left Bank and Bear River Left Bank	YS-L 1019+30 to 1000+00 and BR-L 1150+00 to 1136+00	LM YS 3.7 to 4 and BR 9.8 to 10.1	YS 38+30 to YS 4+64
RD1001	283	B	Bear River Left Bank	BR-L 1136+00 to 1085+00	LM BR 10.1 to 11	YS 4+64 to YS 0+00 and BR 130+72 to BR 85+00
RD1001	283	C	Bear River Left Bank	BR-L 1085+00 to 1000+00	LM BR 11 to 12.6	BR 85+00 to BR 0+00

The number of reaches and reach boundaries developed as part of this study may change during the preparation of design documents. Further investigations and analyses required as part of final design and construction will provide an opportunity to refine the reaches and reach boundaries.

6 Engineering Analyses

6.1 NULE Program Analyses

The Rio Oso study area levees were not evaluated as part of NULE program. However, the preliminary information for the subject levees summarized in the GAR (URS, 2011) indicated the subject levees are lacking sufficient data to assign a hazard levels for underseepage, through seepage, and stability. The anticipated hazard level was low to moderate likelihood of either levee failure or the need to flood-fight to prevent levee failure.

6.2 Updated Existing Conditions Analysis

HDR's geotechnical assessment is focused on identifying feasibility level remediation alternatives for a 100-year level of protection. HDR performed geotechnical analyses to evaluate levee underseepage, through seepage, and slope stability using the 100-year WSE. Analyses were performed in general accordance with FEMA 44CRF65.10 and the following agency and industry standards:

- Engineering Manual (EM) 1110-2-1913 - Design and Construction of Levees (USACE, 2000).
- Engineering Technical Letter (ETL) 1110-2-569 - Design Guidance for Levee Underseepage (USACE, 2005).
- Engineer Regulation (ER) 1110-2-1806 - Earthquake Design and Evaluation for Civil Works Projects (USACE, 2016).
- Engineering Circular (EC) 1110-2-6067 - USACE Process for the National Flood Insurance Program (NFIP) Levee Systems Evaluation (USACE, 2010).
- Idriss and Boulanger (2008), Soil Liquefaction During Earthquakes.

6.2.1 Water Surface Elevation

The 100-year WSEs for the Bear River, and Yankee Slough were developed by MBK Engineers and provided for HDR's use in the feasibility level geotechnical assessment. The 100-year WSEs for the cross-sections analyzed for this study along the Feather River levee are presented in Table 4 below.

Table 4. Summary of Water Surface Elevations for Analyzed Cross Sections

Segment	Reach	DWR Stationing	100 year WSE (feet)
145	A	YS-L 1030+60	59.5
283	B	BR-L 1106+12	56.4
283	C	BR-L 1080+27	55.9

Source: MBK, 2019

6.2.2 Cross-Section Selection

Three cross-sections were selected for seepage and stability analyses using the 100-year WSE for the Feather River Levee. Additionally, one cross-section was selected to assess liquefaction triggering and seismically induced settlement based on the thick, loose, coarse-grained cohesionless soil (sand and gravel) identified by the explorations. The cross-sections and associated analyses performed are summarized in Table 5.

Table 5. Analyzed Cross-sections

Segment	Reach	DWR Stationing	Analyses Performed		
			Seepage	Stability	Liquefaction
145	A	YS-L 1030+60	X	X	
283	B	BR-L 1106+12	X	X	X
283	C	BR-L 1080+27	X	X	

6.2.3 Seepage Analyses

HDR performed a steady-state seepage analysis on the selected cross-sections identified in Table 5.

There are two modes of seepage that are of concern with regards to levee performance: underseepage and through seepage.

Underseepage problems commonly occur when a surficial layer of fine-grained, relatively impervious soils, also known as a blanket layer, overlays a layer of coarse-grained, more pervious soil. At times of flood stage, pressure builds up in the confined coarse-grained sublayers and can cause subsurface erosion or piping at or beyond the landside toe of the levee. This occurs when water is pushed through the discontinuities within the blanket layer and carries soil particles as it travels to the surface, potentially forming seeps that could lead to internal erosion and sand boils. Over a period of time, this could lead to failure of the levee foundation as increasing amounts of soil are internally eroded away.

Through seepage occurs when water enters the waterside slope of the levee and exits through the landside slope. Through seepage can cause surficial erosion at the landside face and possibly internal erosion of the levee as soil particles are carried through the slope. Through seepage also impacts the stability of the levee slope by increasing internal pore pressures, which can decrease the shear strength of the soil and make the slope more susceptible to failure. Levees constructed of silt material are most susceptible to through seepage erosion.

Seepage Criteria

Based on USACE's ETL 1110-2-569 (USACE, 2005), the seepage criteria shown in Table 6 were used to evaluate the subject levee.

Table 6. Seepage Criteria

Location	Allowable Exit Gradient
Underseepage: Average Vertical Exit Gradient at Landside Levee Toe (i_{ave})	≤ 0.5
Through Seepage	Phreatic surface should not exit the landside levee face if levee consists of erodible material.
Underseepage at Drainage Ditch or Low Point	Exit gradient in the bottom of the ditch should not exceed 0.5 at the landside levee toe and should not exceed 0.8 at a distance 150 feet landward of the landside levee toe and beyond. Between the landside levee toe and 150 feet landward of the landside levee toe, the maximum allowable exit gradient in the bottom of the ditch increases linearly from 0.5 to 0.8.

Hydraulic Conductivity

Material permeability characteristics for HDR analyses were adopted from the Guidance Document for Geotechnical Analyses (URS, 2015). Permeability characteristics include saturated hydraulic conductivity (k) and the ratio of vertical to horizontal permeability (anisotropy ratio). The hydraulic conductivity values used for each cross-section are shown on the seepage model figures presented in Appendix D.

Seepage Model Development

The finite element computer program SEEP/W, part of the Geostudio 2016 version 8.16 software package, was used to model the selected levee sections. The existing topography was obtained using the CVFED LiDAR data for study area. The hydraulic conductivity values were developed for each soil layer as described above. The models extend to the river channel centerline and landward 2,000 feet from the centerline of the levee.

The Guidance Document (URS, 2015) was used to determine the boundary conditions. Generally, the boundary conditions for the SEEP/W models are:

- Nodes along the channel bottom and waterside embankment slope were set to the 100-year WSE.
- Nodes along the waterside vertical edge were generally set to no flow condition based on Guidance Document for Geotechnical Analyses (URS, 2015).
- Nodes along the bottom of the model were set to have a no flow condition.
- Nodes on the landside vertical edge were set to the landside ground surface elevation.
- Nodes on the landside levee slope and the landside ground surface were modeled as potential seepage faces.

Steady-State Seepage Results

The average vertical exit gradient (i_{ave}) is calculated as the total head drop in the vertical direction at the landside levee toe or low spot divided by the blanket thickness. In addition, phreatic breakout above the levee landside toe was evaluated. The results of

the seepage analyses are presented in Table 7 and graphically in Appendix D. Reach A meets the underseepage criteria but does not meet the through seepage criteria. Reach B and C both do not meet the underseepage and through seepage criteria.

Table 7. 100-year WSE Seepage Analysis Results

Segment	Reach	DWR Stationing	WSE (feet)	i_{ave} (toe)	i_{ave} (low spot)	Through Seepage Breakout Point (feet above toe)	Erodible Levee Material
145	A	YS-L 1030+60	59.5	0.14	0.41	**4**	**Does not meet criteria**
283	B	BR-L 1106+12	56.4	**1.13**	-	**6.4**	**Does not meet criteria**
283	C	BR-L 1080+27	55.9	**1.36**	-	**7.0**	**Does not meet criteria**

Note: Bold values do not meet USACE criteria

6.2.4 Settlement

FEMA 44CFR65.10 states that the minimum freeboard must be maintained if levee settlement occurs. Typical causes of settlement are the compressibility of the levee embankment or foundation soils and liquefaction induced settlement.

The Rio Oso area levee embankment and foundation materials are mainly comprised of granular soils with layers of cohesive soils. Settlement in granular soils is normally small and occurs quickly with little additional long-term settlement, static settlement is expected to have occurred during or shortly after levee construction. For the levee embankment or foundation materials comprised of fine-grained soils like silt and clay, consolidation settlement can occur over a longer timeframe. However, due to the age of the study area levees, primary consolidation settlement is no longer expected to be occurring.

For this feasibility level geotechnical assessment, the liquefaction potential of levee foundation materials was estimated. Liquefaction potential was evaluated in general accordance with the standard penetration test (SPT) procedures described in Idriss and Boulanger (2008). The depth of water table was assumed at the elevation of the levee toe for the analysis. Ground motion characteristics considered as part of evaluation of liquefaction potential included the peak ground acceleration (PGA) with a 100-year recurrence interval, earthquake magnitude (moment magnitude, Mw), and distance to the seismic source (r). Rio Oso study area corresponds to seismic site class D. Ground motion characteristics for this analysis were determined using the USGS Unified Hazard Tool and are shown in Table 8. The liquefaction evaluation indicated that there is a low likelihood that significant liquefaction would occur at the levee based on a 100-year seismic event. Further analyses of liquefaction induced settlement and post-earthquake slope stability were not performed as part of this feasibility level geotechnical assessment.

Table 8. Ground Motion Characteristics

Latitude (deg)	Longitude (deg)	Site Class	Return Period (year)	PGA (g)	Mw	r (km)
38.961181	-121.53992	D	100	0.1	6.78	83.31

Source: USGS Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/)

6.2.5 Seismic Hazards

The levees in the study area are not located in the vicinity of any faults and therefore are not subject to fault surface rupture hazard or fault displacements. The main seismic hazard to the study area levees is ground shaking associated with earthquakes. The closest seismically capable structure is the Swain Ravine – Spenceville fault, which is part of the Foothills fault system; however, this fault system has a very low slip rate and hazard. Several other faults associated with the Great Valley fault zone are located approximately 30 miles from the study area and also have low slip rates and hazards.

6.2.6 Stability Analysis

Embankment and foundation stability analyses were performed using the same stratigraphy and models used for the seepage analyses. Stability analyses performed evaluated the landside slope under steady-state conditions using the 100-year WSE and the waterside slope under rapid drawdown (RDD) conditions. .

Stability Criteria

EM 1110-2-1913 (USACE, 2000) identifies four types (cases) of loading conditions for slope stability analysis as described below. The minimum slope stability factor of safety (FS) against failure for each case is presented in the Table 9.

Case 1 – End of construction

This case addresses slope stability at the end of construction of the levee. According to EM 1110-2-1913, this case represents undrained conditions for impervious levee embankments and foundation soils (i.e. excess pore pressure is present because the soil has not had time to drain since being loaded). Due to the elapsed time since construction was completed on the levees, this case was not analyzed.

Case 2 – Rapid Drawdown

This case represents a condition where the flood stage fully saturates a majority of the levee embankment; then the water falls from the 100-year WSE (before drawdown) to the elevation of the landside levee toe (after drawdown) faster than the soil can drain. The factor of safety against slope instability (FS) varies with persistence of the flood pool level. A minimum required FS of 1.0 applies when the water level is unlikely to persist for long periods preceding drawdown, and a minimum required FS of 1.2 applies when the water level is likely to persist for long periods prior to drawdown. For this study, minimum FS of 1.2 was used. Only the waterside slope of the levee is considered subject to potential failure under RDD conditions.

Case 3 – Steady-State

This case occurs when the water remains at or near flood stage levels, thus fully saturating the embankment soils.

Case 4 – Earthquake (Seismic) Loading

Earthquake loading is not typically considered in analyzing the stability of levees due to the low probability of an earthquake coinciding with periods of high water. However, it is recommended that seismic stability be considered if:

- The peak ground acceleration (PGA) for a 100-year earthquake is greater than 0.10 g for the site.
- If liquefaction is indicated based on the site PGA.

EC 1110-2-6067 recommends a minimum FS of 1.2 for post-earthquake stability of levees. Due to low liquefaction potential and PGA of 0.1g, seismic stability was not analyzed.

Table 9. Slope Stability Criteria

Condition	Allowable FS
End of Construction	Not Analyzed
Rapid Drawdown	≥ 1.2
Steady-State	≥1.4
Post-earthquake	Not Analyzed Based on Evaluation of Liquefaction Potential

Material Properties for Slope Stability Analyses

The effective shear strength, total shear strength, and unit weight values used for each cross-section analyzed were obtained from the Guidance Document for Geotechnical Analyses (URS, 2015). The strength values used for each cross-section are shown on the stability model figures in Appendix E.

Slope Stability Analysis Method

The limit equilibrium computer program SLOPE/W, part of the Geostudio 2016 version 8.16 software package, was used for the slope stability analysis of the select cross-sections identified in Table 5.

Spencer's Method of Slices was used for calculating factors of safety (FS). Pore pressures computed by SEEP/W were imported into SLOPE/W for use in the analyses. The entry and exit search method was used. For the steady-state slope stability analysis, the entry point ranged from the waterside to landside edges of the levee crest, and the exit point ranged from a point on the landside slope approximately one third of the levee height from the landside toe to a distance beyond the landside toe approximately equal to twice the embankment height. For the rapid drawdown stability analysis, the entry point range extended from the landside to waterside edges of the levee crest, and the

exit point ranged from a point beyond the waterside toe approximately equal to twice the embankment height to approximately one third up the waterside slope.

SLOPE/W performs analysis on each of the potential entry/exit combinations to find the critical slip surface. If the critical slip surface was located at the extremes of either the entry or exit range, the entry or exit range was extended to capture the critical slip surface. In order to eliminate identifying surficial failures, a minimum slip surface depth of five feet was used.

Results of Slope Stability Analysis

The results of the stability analyses using the 100-year WSE are presented in Table 10 and graphically in Appendix E. Reaches A and B do not meet the minimum recommended FS's for landside steady-state but meet the minimum FS's for waterside rapid drawdown. Reach C does not meet the minimum recommended FS's for landside steady-state and waterside rapid drawdown.

Table 10. 100-year WSE Slope Stability Analysis Results

Segment	Reach	DWR Stationing	WSE (feet)	Landside Steady State FS	Rapid Drawdown FS
145	A	YS-L 1030+60	59.5	**0.95**	1.51
283	B	BR-L 1106+12	56.4	**1.04**	1.4
283	C	BR-L 1080+27	55.9	**1.15**	**1.15**

Note: Bold values do not meet USACE criteria

6.3 Erosion, Freeboard, and Geometry

Erosion, freeboard, and geometry remediation recommendations were not evaluated for this study due to the lack of NULE data and no additional data were collected as part of this feasibility level geotechnical assessment.

7 Feasibility Level Levee Evaluation

7.1 Levee Deficiencies

Seepage and slope stability analyses were performed as previously described. The available information on the past performance of the subject levees were studied. The performance of the Rio Oso area levees analyzed for this study using the 100-year WSE is summarized in Table 11.

Table 11. 100 year WSE Deficiencies

Segment	Reach	Assessment Type			Notes
		Under Seepage	Through Seepage	Stability	
145	A	Meets Criteria	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Using 100 year WSE, underseepage criteria and waterside rapid draw down stability criteria were met. Past stability events noted. Ditch near the landside toe noted. Levee embankment assumed to consist of silty sand and does not meet through seepage criteria.
283	A	Meets Criteria	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Not analyzed. Similar to Segment 145, Reach A.
283	B	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Meets Criteria	Using 100 year WSE, underseepage criteria and landside steady state slope stability criteria were not met. Past stability and seepage events noted. Thin landside blanket layer. Levee embankment assumed to consist of silty sand and does not meet through seepage criteria.
283	C	**Does Not Meet Criteria**	**Does Not Meet Criteria**	**Does Not Meet Criteria**	Using 100 year WSE, underseepage criteria, waterside rapid draw down stability criteria, and landside steady state slope stability criteria were not met. Past seepage and stability events noted. Through seepage criteria not met using sandy silt levee embankment.

7.2 Potential Remediation Alternatives

The Segments and Reaches that did not meet the criteria for a 100-year flood were evaluated for one or more remediation alternatives. In general, the remediation alternatives considered consist of cutoff wall, drained stability berm, undrained seepage berm, drained seepage berm, combined drained stability and seepage berm, landside ditch fill, and waterside rock slope protection. Remediation alternatives for the 100-year WSE are shown in Table 12 and graphically in Appendix F.

Table 12. 100 year WSE Remediation Alternatives

Segment	Reach	DWR Stationing	Levee Miles	Project Stationing	Remediation Alternative 1	Remediation Alternative 2	Notes
145	A	YS-L 1019+40 to 1211+75	LM 0.0 to 3.7	YS 231+17 to YS 38+30	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials	Cutoff Wall – 14 feet below half-levee degrade/ 16 feet below one third-levee degrade	Geometry mitigation may be necessary in addition to cutoff wall for embankment sections smaller than standard size of 20 feet crown width or slopes steeper than 2H:1V on landside and 3H:1V on waterside.
283	A	YS-L 1019+30 to 1000+00 and BR-L 1150+00 to 1136+00	LM YS 3.7 to 4 and BR 9.8 to 10.1	YS 38+30 to YS 4+64	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials	Cutoff Wall – 14 feet below half-levee degrade/ 16 feet below one third-levee degrade	Geometry mitigation may be necessary in addition to cutoff wall for embankment sections smaller than standard size of 20 feet crown width and with slopes steeper than 2H:1V on landside and 3H:1V on waterside.
283	B	BR-L 1136+00 to 1085+00	LM BR 10.1 to 11	YS 4+64 to YS 0+00 and BR 130+72 to BR 85+00	Combined Drained Stability and Seepage Berm - 150 feet wide	Cutoff Wall – 35 feet below half-levee degrade/ 40 feet below one third-levee degrade	Low permeability stratum to key in the toe of the cutoff wall not available.
283	C	BR-L 1085+00 to 1000+00	LM BR 11 to 12.6	BR 85+00 to BR 0+00	Waterside Slope - Rock Slope Protection; Landside - Combined Drained Stability and Seepage Berm - 60 feet wide	Waterside Slope - Rock Slope Protection; Cutoff Wall – 55 feet below half-levee degrade/ 60 feet below one third-levee degrade	Low permeability stratum to key in the toe of the cutoff wall not available.

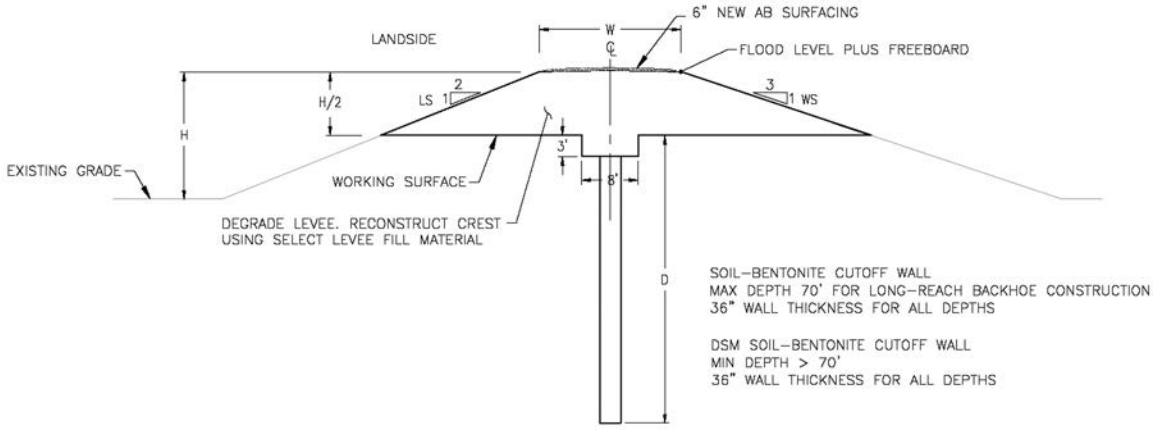
7.2.1 Cutoff Wall

Cutoff walls will mitigate underseepage by providing a seepage barrier within the levee and its foundation. Proposed cutoff walls should extend at least 5 feet into lower permeability stratum. If the lower permeability stratum is located at greater depths, use of a cutoff wall as a mitigation measure may become cost prohibitive. Cutoff walls could consist of conventional soil-bentonite (SB) material or soil, cement and bentonite (SCB) or if desired, interlocking sheetpiles. Penetrations through the levee would require special consideration if found to be in conflict with the cutoff wall.

For cutoff wall construction, the existing levee crown is degraded one third to one half of the current levee height to create a working platform that provides sufficient space for construction equipment. SB cutoff walls are constructed using an excavator with a long-reach boom capable of digging a trench to a maximum depth of approximately 70. The trench width is typically 3 feet. Bentonite or cement-bentonite slurry is placed in the trench as it is excavated to prevent caving while the backfill material is mixed. The

excavated soil is then mixed with the appropriate soil-bentonite (SB) slurry to achieve the required cutoff wall permeability, and then backfilled into the trench. Deep Soil Mixing (DSM) walls are used if the depth of the cutoff wall is greater than 70 feet. After installation of the cutoff wall, the levee is rebuilt to the pre-construction geometry using degraded levee material or imported fine-grained soils that meet requirements for select (impermeable) levee fill. A typical SB cutoff wall cross-section is shown as Exhibit 1.

Exhibit 1. Typical SB Cutoff Wall

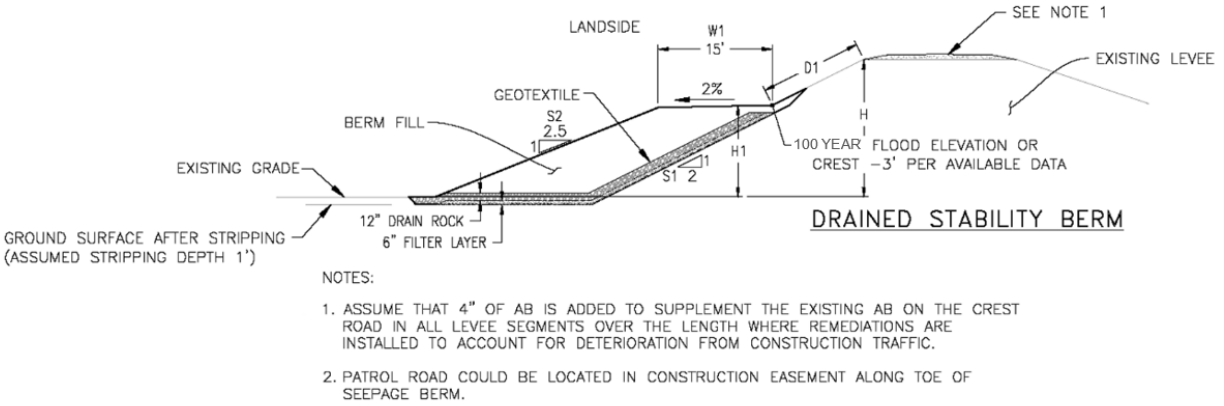


An interlocking sheetpile system could be used in lieu of a SB cutoff wall. The interlocking sheetpile system would be installed through the levee crown with minimal levee degrade. The wall alignment along the levee crown could be trenched 2 to 3 feet to allow driving the top of the sheetpiles below the levee crest.

7.2.2 Drained Stability Berm

Drained stability berms will mitigate landside slope stability and/or through seepage. In the case of mitigating landside stability, the drained stability berm will provide additional weight at the toe to resist forces that develop along a slip surface. In the case of mitigating through seepage, filter material will retain existing embankment material in place and allow seepage to safely flow from the embankment. Drained stability berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing filter material, placing drain material, and then placing a protected layer of embankment soil. A typical drained stability berm is shown as Exhibit 2. For the purposes of assessing project feasibility, assume that drained stability berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

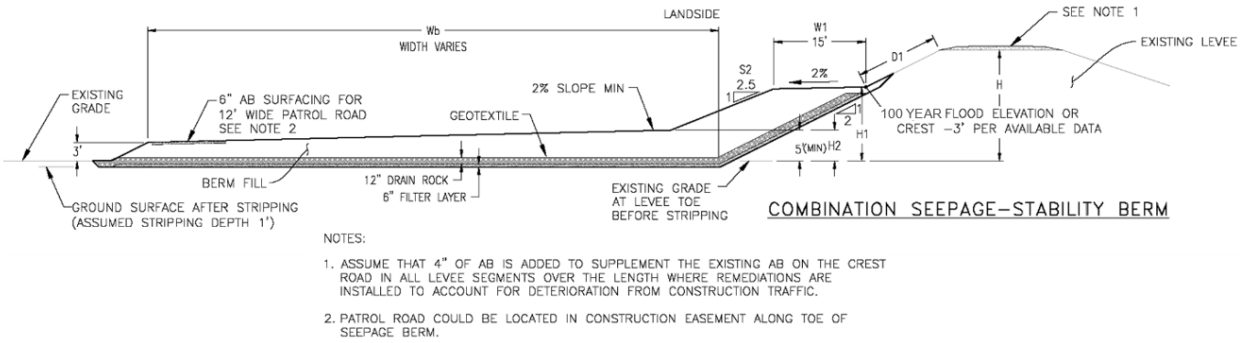
Exhibit 2. Typical Drained Stability Berm



7.2.3 Combined Drained Stability and Seepage Berm

Combined drained stability and seepage berms can be used to remediate underseepage, through seepage, and landside levee embankment slope instability. The berm includes a drainage layer on the foundation and levee landside slope that is comprised of drain rock over a sand filter layer placed on the foundation. A geotextile fabric separates the drain rock from the overlying berm fill. Berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing geotextile filter material, placing drain material, and then placing a protected layer of embankment soil. The berm fill should be more pervious than the existing levee and shallow foundation layer. A typical combined drained stability and seepage berm is shown as Exhibit 3. For the purposes of assessing project feasibility, assume that combined drained stability and seepage berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

Exhibit 3. Typical Combined Drained Stability and Seepage Berm

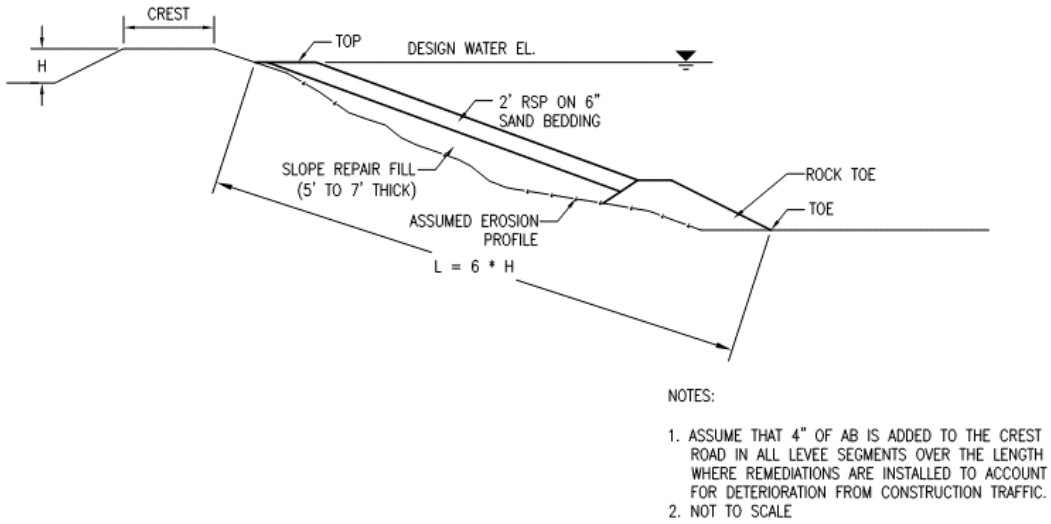


7.2.4 Erosion Remediation – Rock Slope Revetment

Rock slope revetment can be used to remediate erosion and generally consists of 6 inches of sand bedding overlain by 2 feet of rip-rap. Earthwork should be performed

before placing sand bedding to backfill eroded areas and reshape the surface. Rock slope revetment generally extends from the waterside toe to the design WSE. A typical rock slope protection is shown as Exhibit 4.

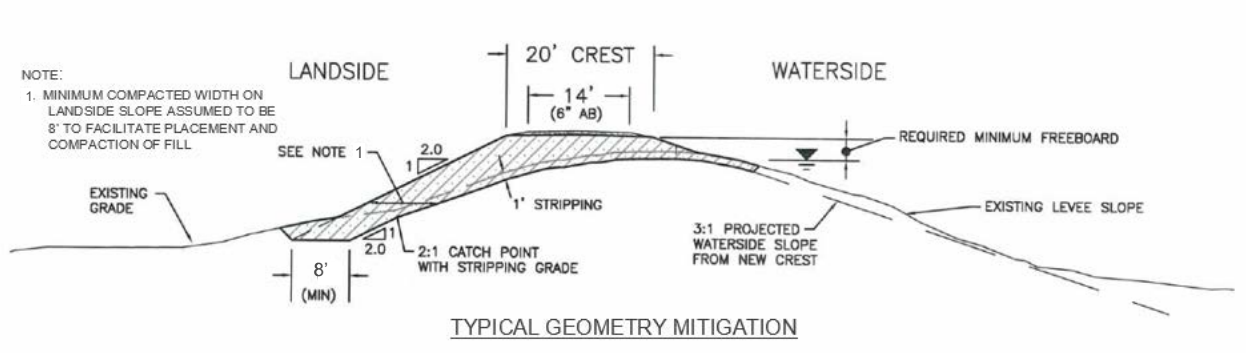
Exhibit 4. Typical Rock Slope Protection



7.2.5 Geometry Mitigation

Geometry mitigation can be used to remediate the existing levee embankment prism to the standard levee dimensions. Remediation should be performed by landside widening and crest raising. The minimum width of the landside widening is at least 8 feet to ensure that the new fill section is wide enough to facilitate placement and compaction of the material by construction equipment. This landside remediation method eliminates significant work on the waterside of the levee thus minimizing environmental impact. A typical geometry mitigation is shown as Exhibit 5.

Exhibit 5. Typical Geometry Mitigation



8 Borrow Area Recommendations

Potential borrow areas for the study area were located using the USDA Web Soil Survey (WSS) tool (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). The WSS tool was used to draw areas of interest adjacent to and near the levee reaches. A soil map was obtained from the WSS tool which delineated various soil types identified within the area of interest. Along with the soil map, a range of engineering properties for each soil unit used for classification was also obtained from the web tool. Comparing the typical engineering properties of each soil unit with the typical engineering properties of levee fill materials, potential borrow areas were identified and marked. Typical specifications of materials that are suitable for use as levee fill are shown in Table 13. Special construction details (e.g., 4:1 slopes) may be substituted where materials meeting the typical levee fill specifications are not readily attainable, but all levee fill materials must be free of organics and materials that cannot be properly compacted (e.g., saturated soils must be dried).

Table 13. Typical levee fill specifications

Specification	Levee Fill	ASTM Test
Percent Passing - 3 inch	100	D6913
Percent Passing - No. 200	≥ 20	D6913
Liquid Limit	≤ 50	D4318
Plasticity Index	≥ 8	D4318

In general, soil units identified as majority lean clay (CL) were selected as potential borrow areas. From these potential borrow areas, the locations closest to the levees were selected and marked. These potential borrow areas are shown in Figure 7 – Potential Borrow Area.

Additional screening for preliminary engineering design will need to evaluate actual soil engineering properties, depth to groundwater, landowner agreement(s), potential haul routes, and permitting requirements (e.g., erosion and sediment control, United States Army Corps of Engineers 404/401, environmental and cultural resources surveys, mining, others).

9 Geotechnical Design-Level Scope Recommendations

This document describes the feasibility level geotechnical assessment of the Rio Oso study area levees. The following items are recommended to be included in the design level scope:

- Supplemental explorations
  - Along the crown, waterside, and landside of the Bear River Left Bank Levee, and Yankee Slough Left Bank Levee in accordance with regulatory and industry standards for design.
  - As necessary based on the selected remediation alternative(s) to reduce the flood risk of Rio Oso.
- Seepage and Stability Analysis
  - Additional analysis for existing conditions using the additional investigations along the Bear River Levee, and Yankee Slough Levee.
  - Additional analysis for remediation alternatives using the additional investigations for the study area levees.
  - Supplemental analyses as necessary based on the selected remediation alternative(s).
- Perform detailed design analyses in accordance with regulatory and industry standards for the selected remediation alternatives.
- Update seismic hazard assessment and evaluate liquefaction potential for additional cross sections.
- Updated erosion, geometry and freeboard analysis for the study area levees.
- Evaluate end around seepage if a combination of cutoff wall and drained berm are considered due to site constraints.
- Develop an updated inventory of encroachments and penetrations.
- Identification and evaluation of the penetrations (majority pipelines) through the study area levees. Each penetration must be relocated above the 100 year WSE or evaluated by a qualified engineer with variance from Central Valley Flood Protection Board (CVFPB).
- Further investigate potential borrow areas for material compliance as embankment fill.

10 Limitations

This report has been prepared for the use of MBK Engineers and its consultants for specific application to the Rio Oso Flood Risk Reduction Feasibility Project in accordance with generally accepted geotechnical engineering practice. No warranty, express or implied, is made. The analyses and recommendations submitted are based on the data available to HDR at the time of this geotechnical investigation. This report does not reflect subsurface soil variations that may occur between the locations of the explorations or variations in groundwater conditions which may occur over a period of time. Variations in conditions may become evident during subsequent studies and construction, at which time re-evaluation of the conclusions may become necessary. Potential remedial measures for the Rio Oso Flood Risk Reduction Feasibility Project are presented in this report based upon review of investigations prepared by URS consultants for DWR as part of the NULE program and our professional interpretation of the geotechnical data. Four CPTs and one mud-rotary boring authorized as part of the grant funding for the feasibility level analyses were carried out. Levee penetrations, free board, geometry and effect due to encroaching structures were not evaluated as part of this study. Additional evaluations will be required to support the feasibility studies and development of the preliminary remedial design. The evaluations included herein are not suitable for work beyond this feasibility study.

In the event of design changes in the project after the final report is submitted, the recommendations should be reviewed and possibly modified with HDR's participation.

Historical explorations and testing were not performed by HDR, and HDR cannot vouch for the accuracy of data and information obtained by others. Data by others should not be relied upon unless the originator of that data is available to confirm its accuracy.

This geotechnical study did not include an investigation regarding the existence, location, or type of possible hazardous materials. If any hazardous materials are encountered during construction of the project, the proper regulatory officials should be notified immediately.

11 References

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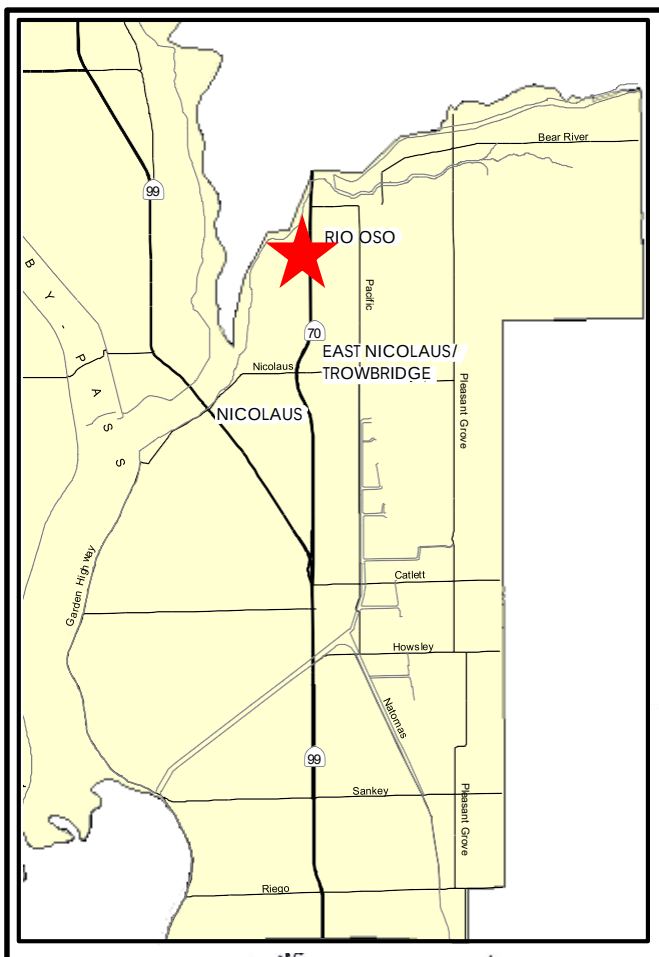
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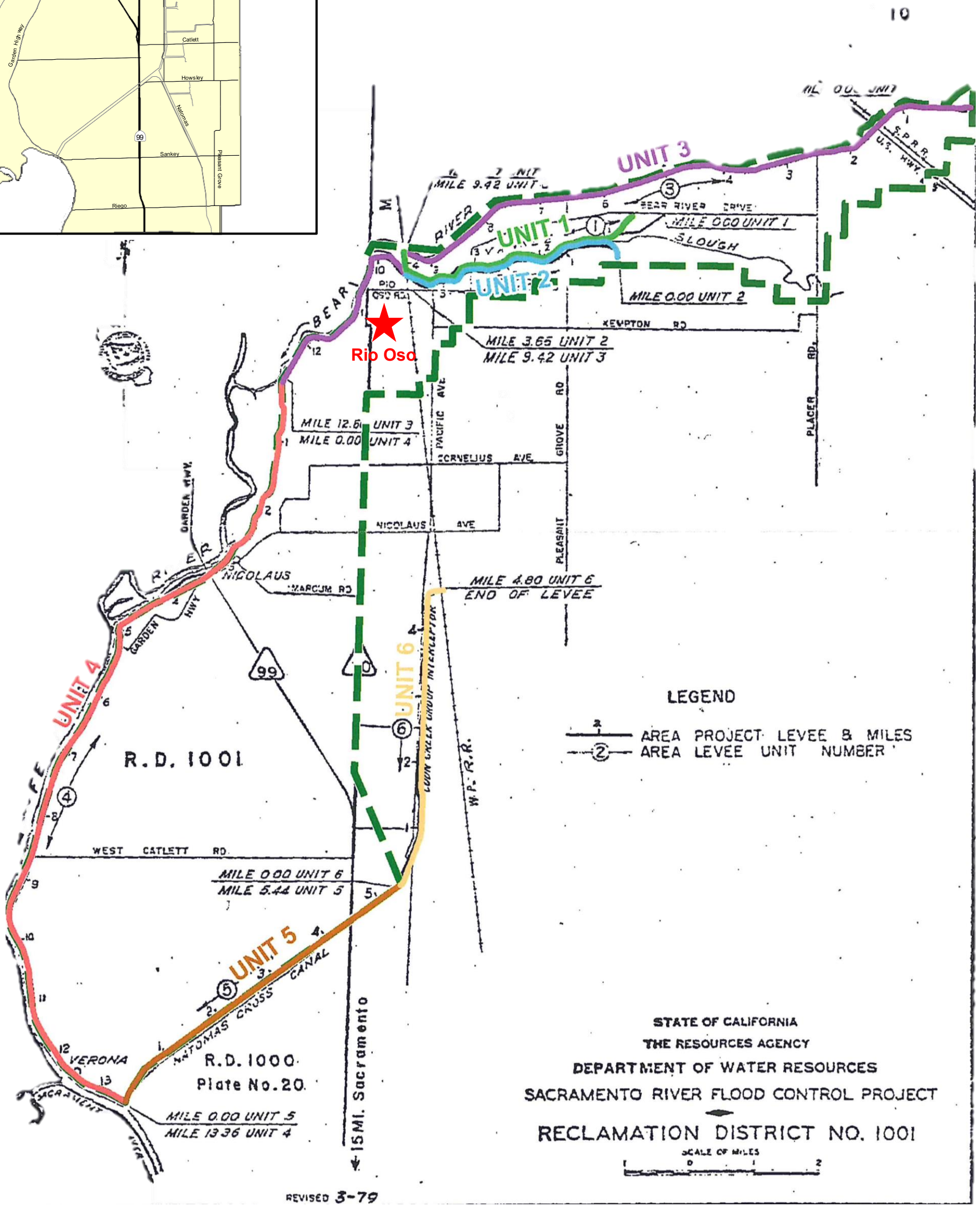
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Figures





Project Location

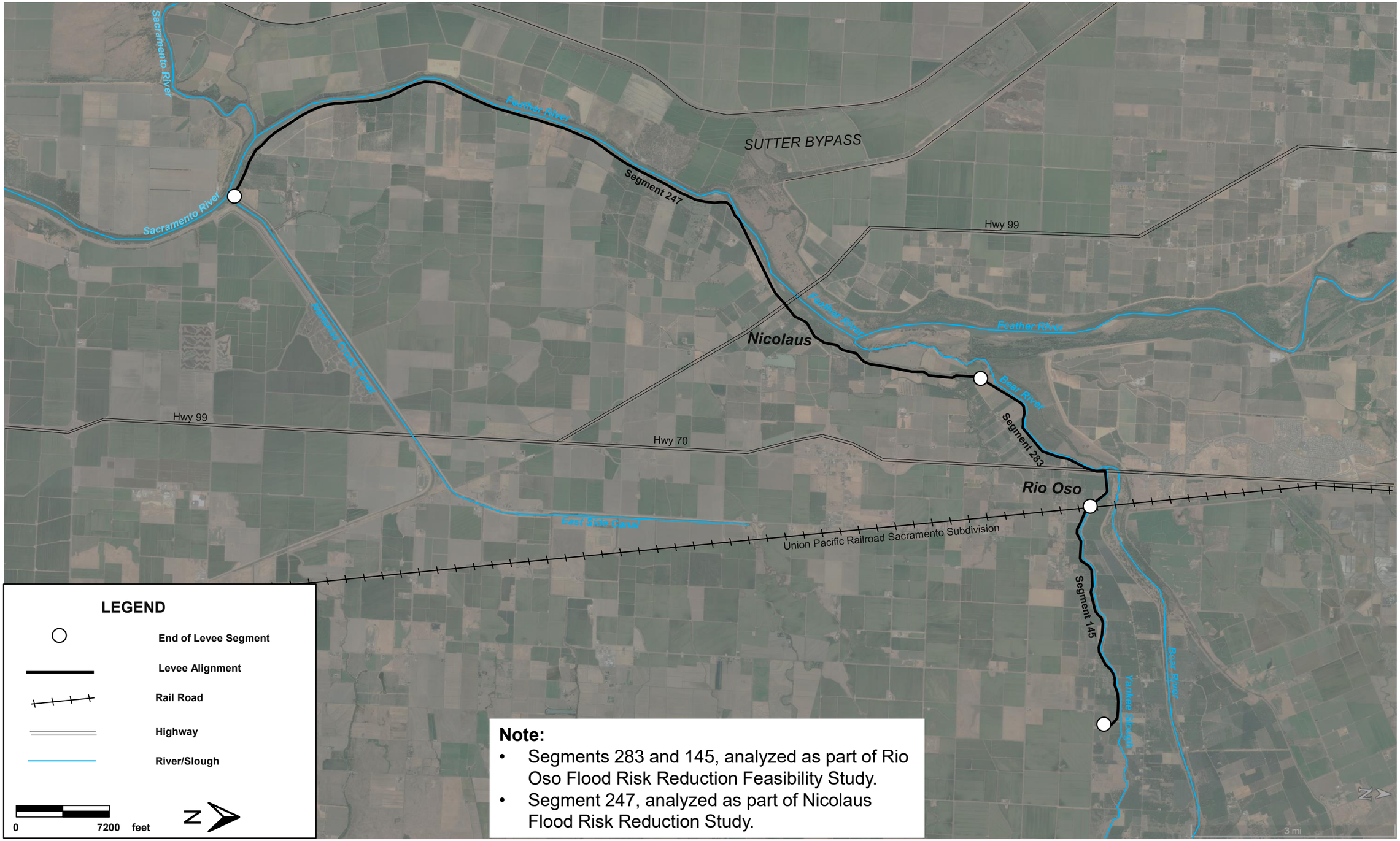
NOTES: Source: RD 1001

Rio Oso Flood Risk Reduction Feasibility Study

Vicinity Map

July 2019

FIGURE 1



Note:

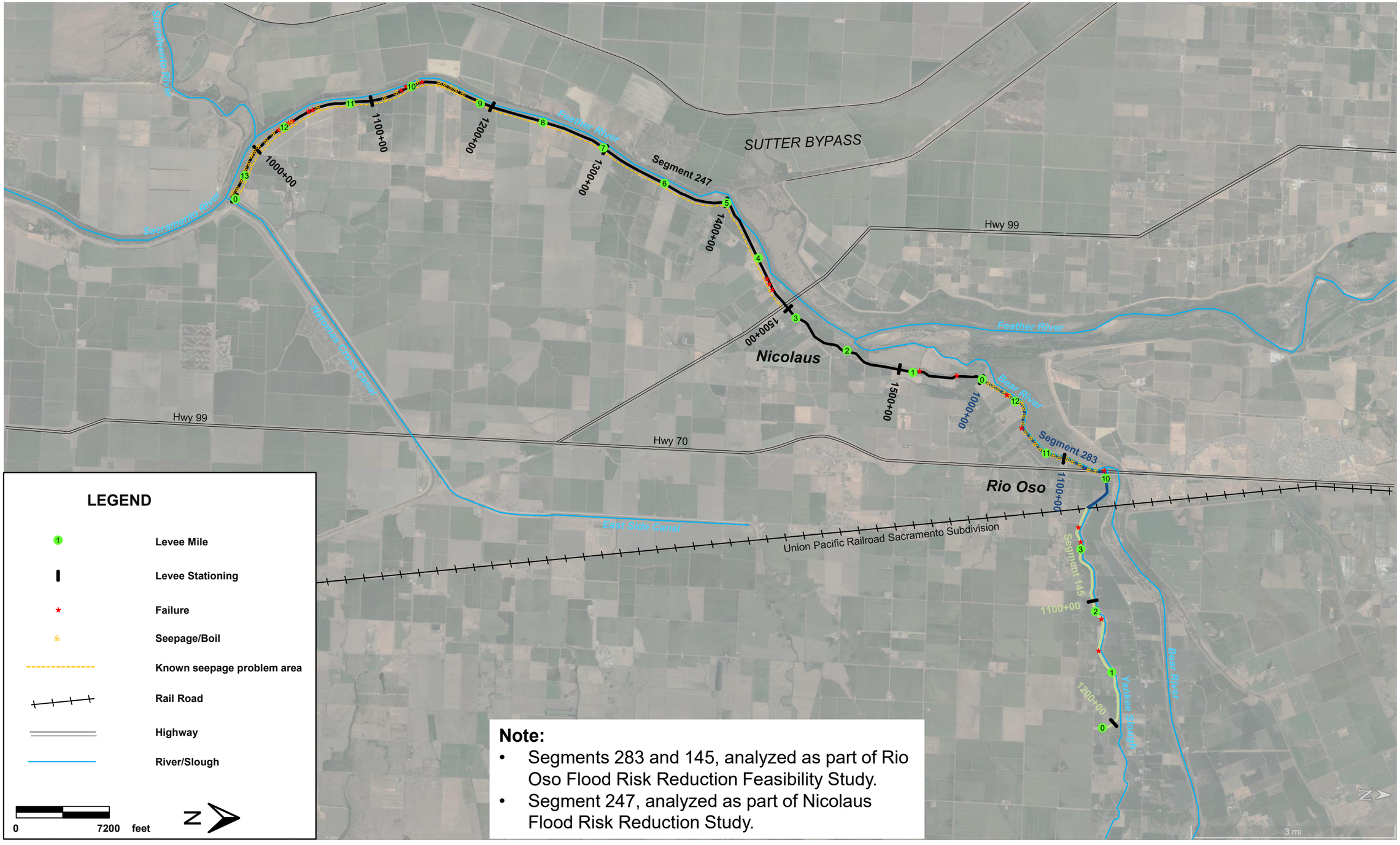
- Segments 283 and 145, analyzed as part of Rio Oso Flood Risk Reduction Feasibility Study.
- Segment 247, analyzed as part of Nicolaus Flood Risk Reduction Study.

NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Project Location Map

July 2019 FIGURE 2



LEGEND

- Levee Mile
- Levee Stationing
- Failure
- Seepage/Boil
- Known seepage problem area
- Rail Road
- Highway
- River/Slough

0 7200 feet

N

Note:

- Segments 283 and 145, analyzed as part of Rio Oso Flood Risk Reduction Feasibility Study.
- Segment 247, analyzed as part of Nicolaus Flood Risk Reduction Study.

NOTES: NULE GAR (URS, 2011) – Source of past performance information

Rio Oso Flood Risk Reduction Feasibility Study

HDR

Past Performance Summary Map

July 2019 FIGURE 3



Project Location

Historic Earthquake Magnitude 5-6

Historic Earthquake Magnitude 6-7

Thrust Fault

Strike Slip Fault

N

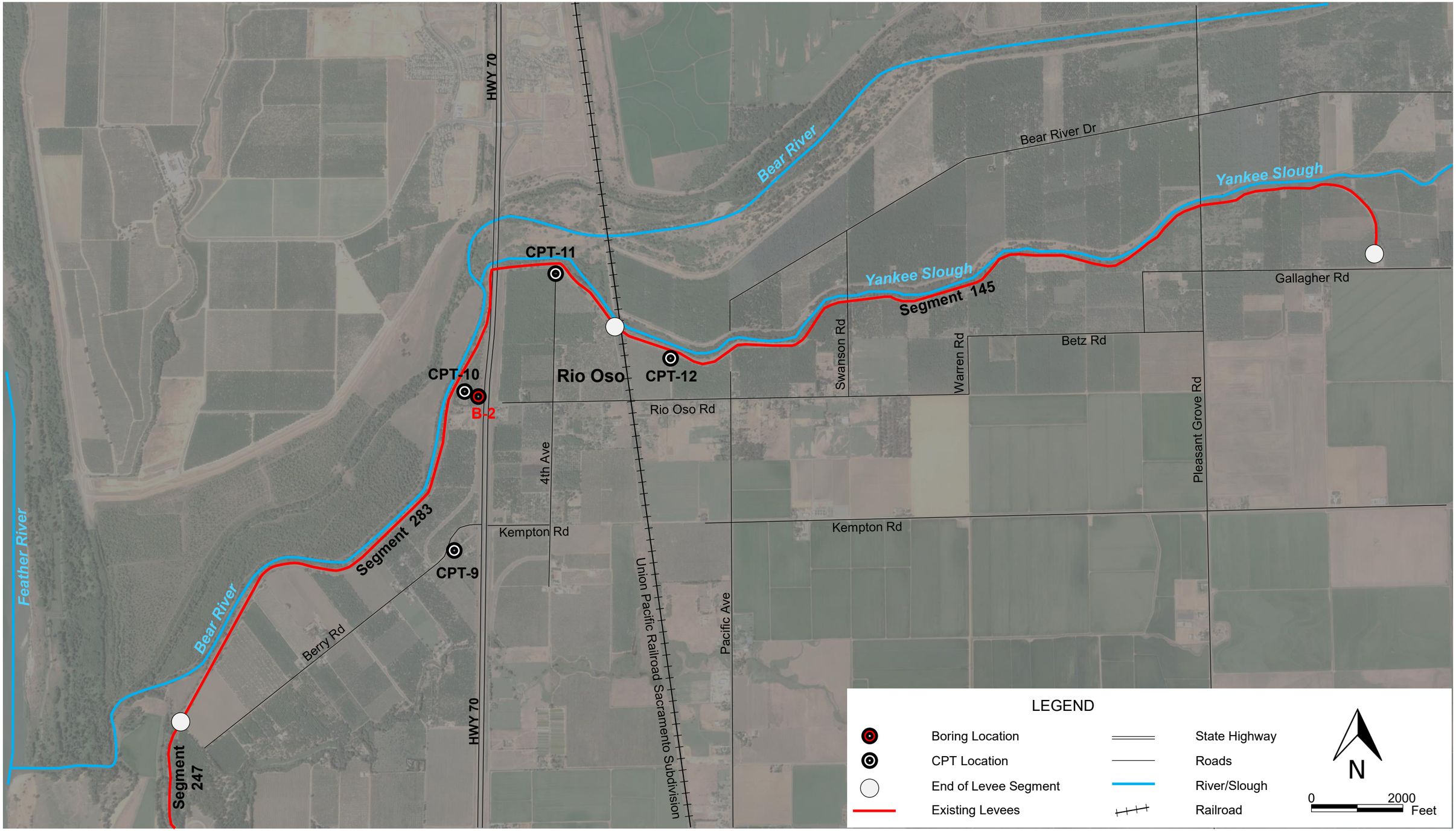
Not to Scale

NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Fault Map

July 2019 FIGURE 4



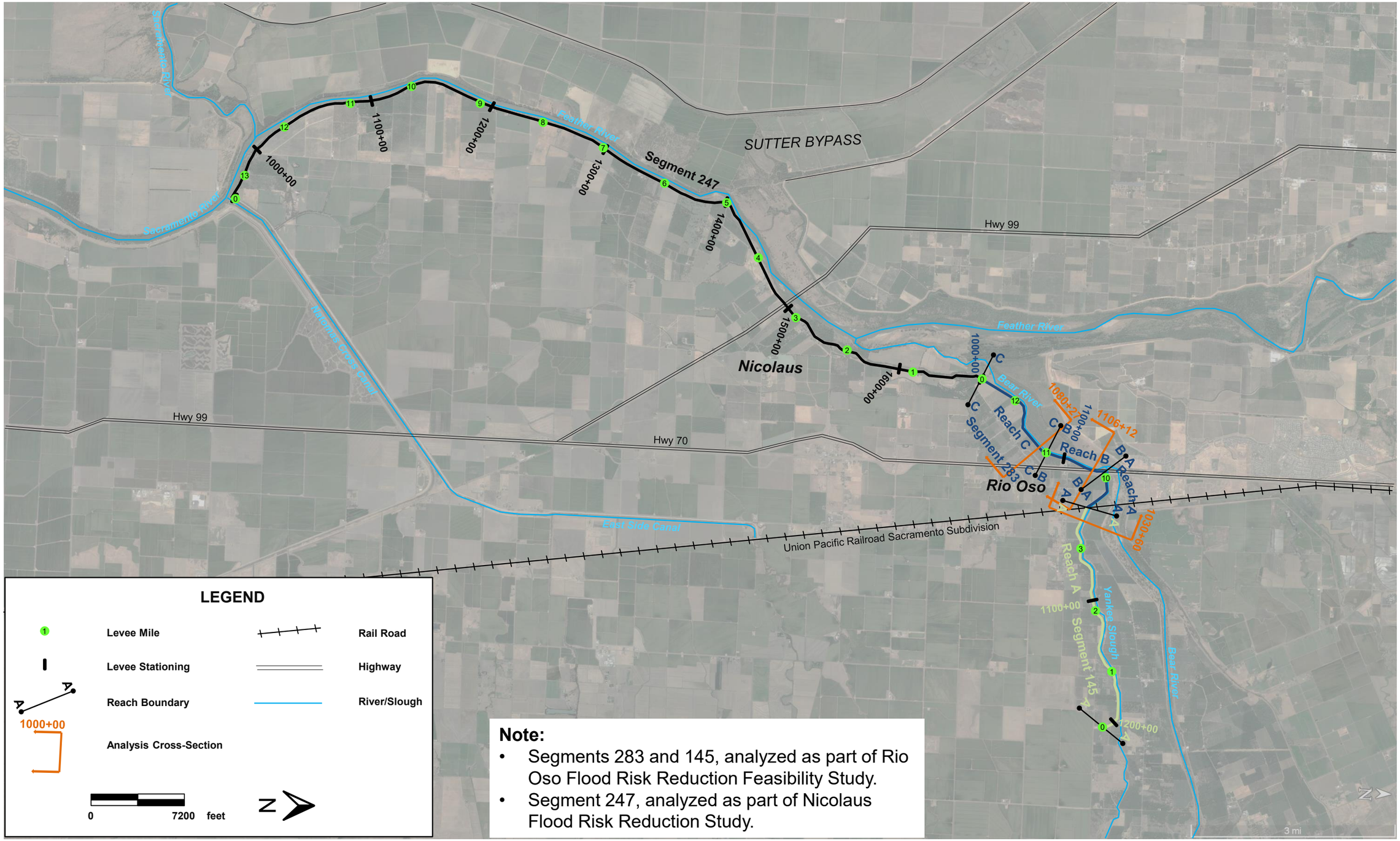
NOTES: Image Source: Google Earth Pro 2019

Rio Oso Flood Risk Reduction Feasibility Study

Supplemental Exploration Location

July 2019

FIGURE 5

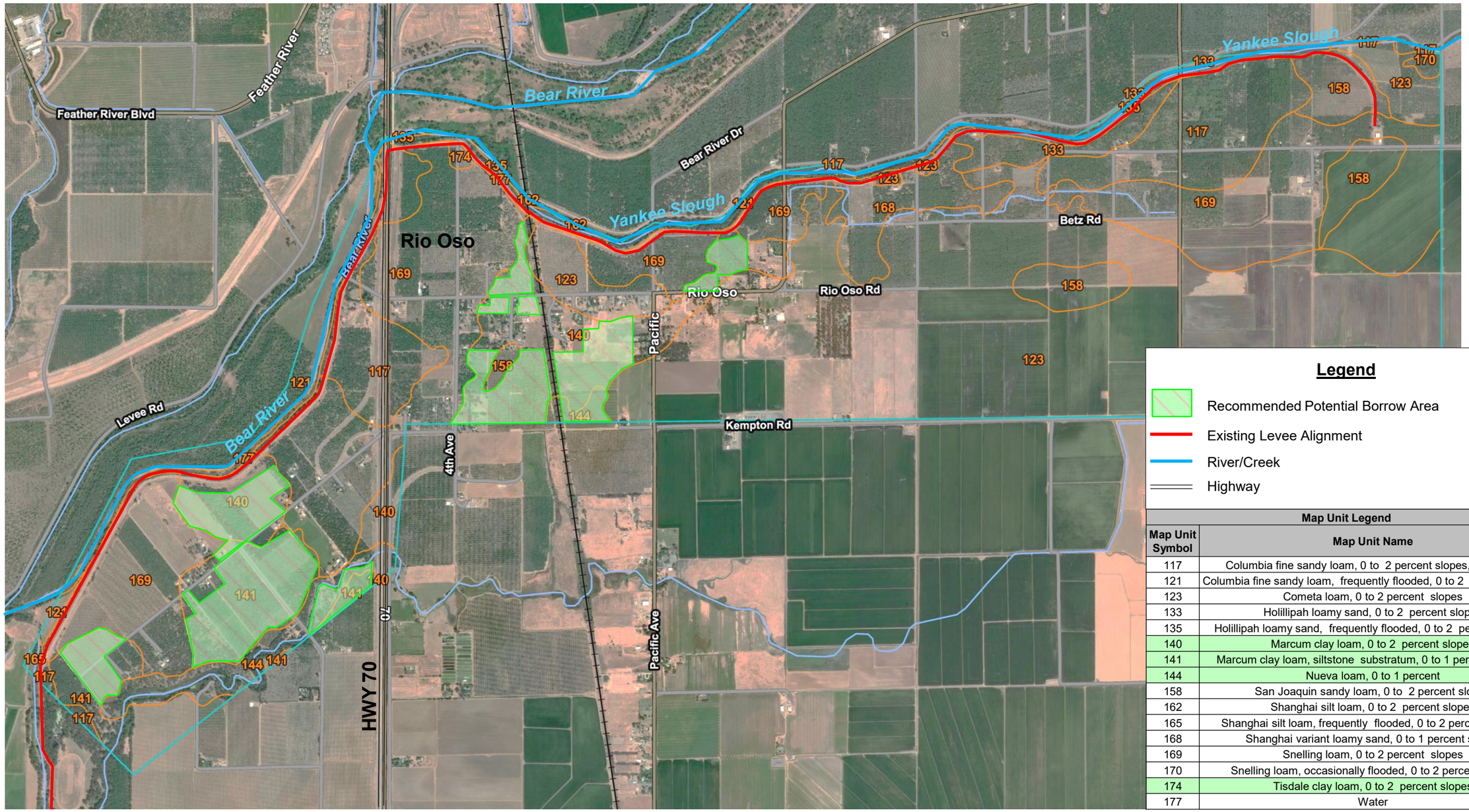


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach Summary

July 2019 FIGURE 6



Legend

- Recommended Potential Borrow Area
- Existing Levee Alignment
- River/Creek
- Highway

Map Unit Legend

Map Unit Symbol	Map Unit Name
117	Columbia fine sandy loam, 0 to 2 percent slopes, MLRA 17
121	Columbia fine sandy loam, frequently flooded, 0 to 2 percent slopes
123	Cometa loam, 0 to 2 percent slopes
133	Holillipah loamy sand, 0 to 2 percent slopes
135	Holillipah loamy sand, frequently flooded, 0 to 2 percent slopes
140	Marcum clay loam, 0 to 2 percent slopes
141	Marcum clay loam, siltstone substratum, 0 to 1 percent slopes
144	Nueva loam, 0 to 1 percent
158	San Joaquin sandy loam, 0 to 2 percent slopes
162	Shanghai silt loam, 0 to 2 percent slopes
165	Shanghai silt loam, frequently flooded, 0 to 2 percent slopes
168	Shanghai variant loamy sand, 0 to 1 percent slopes
169	Snelling loam, 0 to 2 percent slopes
170	Snelling loam, occasionally flooded, 0 to 2 percent slopes
174	Tisdale clay loam, 0 to 2 percent slopes
177	Water

NOTES:
Source: USDA Web Soil Survey
https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Map Units selected for borrow are highlighted with green color

Rio Oso Flood Risk Reduction Feasibility Study

Potential Borrow Area

July 2019 FIGURE 7

Appendix A – Geomorphic Mapping

This map shows surficial geologic deposits and levees as they existed in 1937. Map units and boundaries are drawn by interpretation of historical aerial photography supplemented by data from historical maps and surveys. For reference, the mapping is superimposed on modern U.S. Geological Survey 7.5' topographic base maps (individual maps referenced below). Screened back semi-transparent mapping shown on this plate is from Urban Levee Evaluation (ULE) program, RD-784 Study Area (WLA, September 2009), which is not assessed in this investigation. For clarity, the ULE surficial geologic map units are omitted from the Bear River explanation.
See accompanying technical memorandum for complete descriptions of map units, process descriptions and methodology. Adjacent polygons that have identical map unit symbols are employed to delineate sequences of sedimentation and landscape evolution.

Explanation

Underseepage Susceptibility Along Non-Urban Levee Alignment

Very High | High | Moderate | Low

Geologic contact; dashed where approximate, dotted where concealed, queried where uncertain; solid contacts accurate to within about 100' on either side of line shown on map. Dashed contacts are accurate to within about 250', and are generally gradational.

Narrow channel, generally <100 ft in width. Dashed where approximate, dotted where concealed.

Canal

Levee; artificial fill prism, generally <60 ft in width.

Vp — Vernal pool; seasonally submerged or saturated depression usually indicative of an underlying hardpan.

W 1937 — Water; date indicates year of historic dataset.

C — Canal, circa 1937.

BP/Ra — Borrow pit present in 1937; unit after slash indicates the deposit in which the borrow pit is located.

Geologic Units

HISTORICAL

- AF — Artificial fill, circa 1937.
- L — Levee (made of artificial fill), circa 1937.
- R — Road embankment (made of artificial fill), circa 1937.
- RR — Railroad embankment (made of artificial fill), circa 1937.
- Rob — Overbank deposits; sand with lesser silt and clay; deposited during high-stage water flow, overtopping channel banks.
- Rcs — Crevasse splay deposits; fine sand and silt deposited from breaching of natural or artificial levees.
- Rdf — Distributary fan deposits; sand and silt.
- Rch — Channel deposits; well-sorted sand and trace fine gravel.
- Rb — Channel bar deposits; fine gravel, sand, and silt deposited in or along channel lateral margins.
- Rcu — Cut off channel (chute); occurs on insides of meander bends within the river channel; sand and fine gravel.
- Rdc — Distributary channel deposits, sand, silt, and clay; channelized flow conducting sediment to floodplain.
- Rofc — Overflow channel deposits; vertically stratified sand, silt, and clay in floodplain channels occupied primarily when high-stage water overtops channel banks.
- Rt — Undifferentiated terrace; abandoned floodplain likely containing channel and overbank deposits.
- Ra — Alluvial deposits undifferentiated; sand, silt, and minor lenses of fine gravel.
- Ra/Qru — Veneer of historical alluvial deposits (less than 3-feet thick), overlying the upper member of the Riverbank Formation.

Derived from hydraulic mining debris

HOLOCENE

- Hob — Overbank deposits; silt, clay, and lesser sand; deposited during high-stage water flow, overtopping channel banks.
- Hch — Channel deposits; well-sorted sand and trace fine gravel.
- Ha — Alluvial deposits, undifferentiated; sand, silt, and minor lenses of gravel. (*) indicates Holocene deposits locally mantled by a thin veneer of historical sediment (less than 3' thick). (?) indicates deposits could be Upper Modesto Formation in age.
- Hs — Marsh deposits; silt and clay, possibly with organic-rich beds; perennially or seasonally submerged.

PLEISTOCENE

- Qmu — Modesto Formation; upper member; unconsolidated gravel, sand, silt, and clay.
- Qml — Modesto Formation; lower member; unconsolidated to semi-consolidated gravel, sand, silt and clay.
- Qru — Riverbank Formation; upper member, semi-consolidated to consolidated gravel, sand, silt and clay.
- Qrl — Riverbank Formation; lower member; consolidated gravel, sand, silt, and clay, generally capped by a paleosol.

PLIOCENE

- Tla — Laguna Formation, undifferentiated; interbedded alluvial gravel, sand, and silt. Pebbles and cobbles of quartz and metamorphic lithologies, locally with volcanic fragments.

Stratigraphic Correlation Chart

Time: Epoch	Depositional Environment: Channel deposits	Floodplain and alluvial-fan deposits	Flood basin deposits	Cultural deposits
Historical	Rch; Rcu, Rb, Rdc, Rofc	Ra; Rob, Rt, Rcs, Rdf	Hs	L, R, RR, AF
Holocene	Hch	Ha; Hob		
Latest Pleistocene		Qmu		
Pleistocene		Qml, Qru, Qrl		
Pliocene		Tla		

Map projection: UTM NAD83 Zone 10N

Topographic base USGS 7.5' quadrangles:
Camp Far West (ID: 39121-A3), published 1995; map scale 1:24,000, five foot contour interval.
Lincoln (ID: 38121-H3), published 1953, revised 1981; map scale 1:24,000, five foot contour interval.
Nicolaus (ID: 38121-H5), published 1992; map scale 1:24,000, five foot contour interval.
Olivehurst (ID: 39121-A5), published 1952, revised 1973; map scale 1:24,000, five foot contour interval.
Sheridan (ID: 38121-H4), published 1992; map scale 1:24,000, five foot contour interval.
Wheatland (ID: 39121-A4), published 1947, revised 1973; map scale 1:24,000, five foot contour interval.

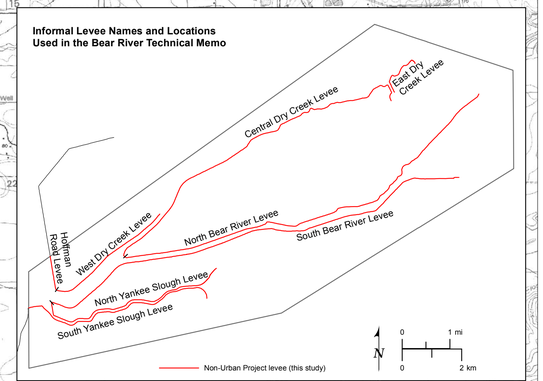
Geologic Mapping by C. Brossy, J. Pearce, J. Sowers
Digital Cartography by M. Ticci and J. Finley

N

0 2,000 ft
0 1 km
1:24,000

Scale is 1 in = 2,000 ft when printed at 36 inch by 24 inch page size

Informal Levee Names and Locations Used in the Bear River Technical Memo



Department of Water Resources
Division of Flood Management
Levee Evaluations Branch

URS in a joint venture with: Fugro William Lettis & Associates, Inc.

Surficial Geologic Map of the Bear River Study Area

NORTH NON-URBAN LEVEE EVALUATIONS

Plate 1

NULE Level 2-II: Bear River Geomorphic Assessment

1965_2_NULE_BearRiver_Plate.mxd MGT 12/21/2010

This map shows surficial geologic deposits and levees as they existed in 1937. Map units and boundaries are drawn by interpretation of historical aerial photography supplemented by data from historical maps and surveys. For reference, the mapping is superimposed on modern U.S. Geological Survey 7.5' topographic base maps (individual maps referenced below).
Screened back semi-transparent mapping shown on this plate is from Urban Levee Evaluation (ULE) program, Sutter, RD-784, and Natomas NWS Study Areas, which are not assessed in this investigation. For clarity, the ULE surficial geologic map units are omitted from the Feather River explanation.
See accompanying technical memorandum for complete descriptions of map units, process descriptions and methodology.
Adjacent polygons that have identical map unit symbols are employed to delineate sequences of sedimentation and landscape evolution.

Explanation

Underseepage Susceptibility Along Non-Urban Levee Alignment

- Very High
- High
- Moderate
- Low (not present in this Study Area)

Geologic contact; dashed where approximate, dotted where concealed, queried where uncertain; solid contacts accurate to within about 100' on either side of line shown on map; dashed contacts accurate to within about 250' on either side.

Narrow channel, generally <100 ft in width. Dashed where approximate, dotted where concealed.

A — A' Cross section location

Rm 2.3 River mile marker, from posted values on USGS topographic base map.

W 1937 Water; date indicates year of historical dataset.

BP Borrow pit present in 1937.

Geologic Units

	AF	Artificial fill, circa 1937.
	L	Levee (made of artificial fill), circa 1937.
	Rob	Overbank deposits; silt, clay, and lesser sand; deposited during high-stage water flow, overtopping channel banks.
	Rcs	Crevasse splay deposits; fine sand and silt with clay deposited from breaching of natural levees.
	Rdf	Distributary fan deposits; sand, silt and clay.
	Rch	Channel deposits; well-sorted sand and trace fine gravel.
	Rms	Channel meander scroll deposits; sand, silt, and clay from lateral channel migration.
	Rb	Channel bar deposits; fine gravel, sand, and silt deposited in or along channel lateral margins.
	Rdc	Distributary channel deposits, sand, silt, and clay; channelized flow conducting sediment to floodplain.
	Rofc	Overflow channel deposits; vertically stratified sand, silt, and clay in floodplain channels occupied primarily when high-stage water overtops channel banks.
	Ra	Alluvial deposits undifferentiated; sand, silt, and minor lenses of fine gravel.
	Hob	Overbank deposits; silt, clay, and lesser sand; deposited during high-stage water flow, overtopping channel banks.
	Hob/Qml	Veneer of overbank deposits (less than 5-feet thick), overlying the lower member of the Modesto Formation.
	Hcs	Crevasse splay deposits; fine sand and silt with clay deposited from breaching of natural or artificial levees.
	Hdf	Distributary fan deposits; sand, silt, and clay.
	Hch	Channel deposits; well-sorted sand and trace fine gravel.
	Hb	Channel bar deposits; fine gravel, sand, and silt deposited in or along channel lateral margins.
	Hdc	Distributary channel deposits, sand, silt, and clay; channelized flow conducting sediment to floodplain.
	Ha	Alluvial deposits, undifferentiated; sand, silt, and minor lenses of gravel.
	Hn	Basin deposits; fine sand, silt and clay.
	Hn/Qm	Veneer of basin deposits (less than 5-feet thick), overlying the Modesto Formation.
	Hs	Marsh deposits; silt and clay, possibly with organic-rich beds; perennially or seasonally submerged.
	Qmu	Modesto Formation; upper member; unconsolidated gravel, sand, silt, and clay.
	Qml	Modesto Formation; lower member; unconsolidated to semi-consolidated gravel, sand, silt and clay.
	Qru	Riverbank Formation; upper member, semi-consolidated to consolidated gravel, sand, silt and minor clay.
	Qrl	Riverbank Formation; lower member; consolidated gravel, sand, silt, and clay, generally capped by a paleo-soil with strong duripan horizon.

HISTORICAL · HOLOCENE · PLEISTOCENE

Stratigraphic Correlation Chart

Time (Epoch)	Channel deposits	Floodplain and alluvial-fan deposits	Flood basin deposits	Cultural deposits
Historical	Rch; Rms; Rb; Rdc; Rofc	Ra; Rob; Rcs; Rdf	Hs; Hn	L; AF
Holocene	Hch; Hb; Hdc	Ha; Hob; Hcs; Hdf		
Latest Pleistocene		Qmu		
		Qml		
Pleistocene		Qru		
		Qrl		

Depositional Environment

Map projection: UTM NAD83 Zone 10N

Topographic base USGS 7.5' quadrangles:
Knights Landing (ID: 38121-G6), published 1952, revised 1981; map scale 1:24,000, five foot contour interval.
Nicolaus (ID: 38121-H5), published 1992; map scale 1:24,000, five foot contour interval.
Sutter Causeway (ID: 38121-H6), published 1952, revised 1973; map scale 1:24,000, five foot contour interval.
Verona (ID: 38121-G5), published 1967, revised 1978; map scale 1:24,000, five foot contour interval.

Geologic Mapping by S. Dee and J. Pearce
Digital Cartography by M. Ticci and J. Finley

N

0 2,000 ft
0 1 km
1:24,000

Scale is 1 in = 2,000 ft when printed at 38 inch by 23 inch page size

Department of Water Resources
Division of Flood Management
Levee Evaluations Branch

URS in association with: Fugro
Fugro William Lettis & Associates, Inc.

Surficial Geologic Map of the Feather River South of Bear River Study Area

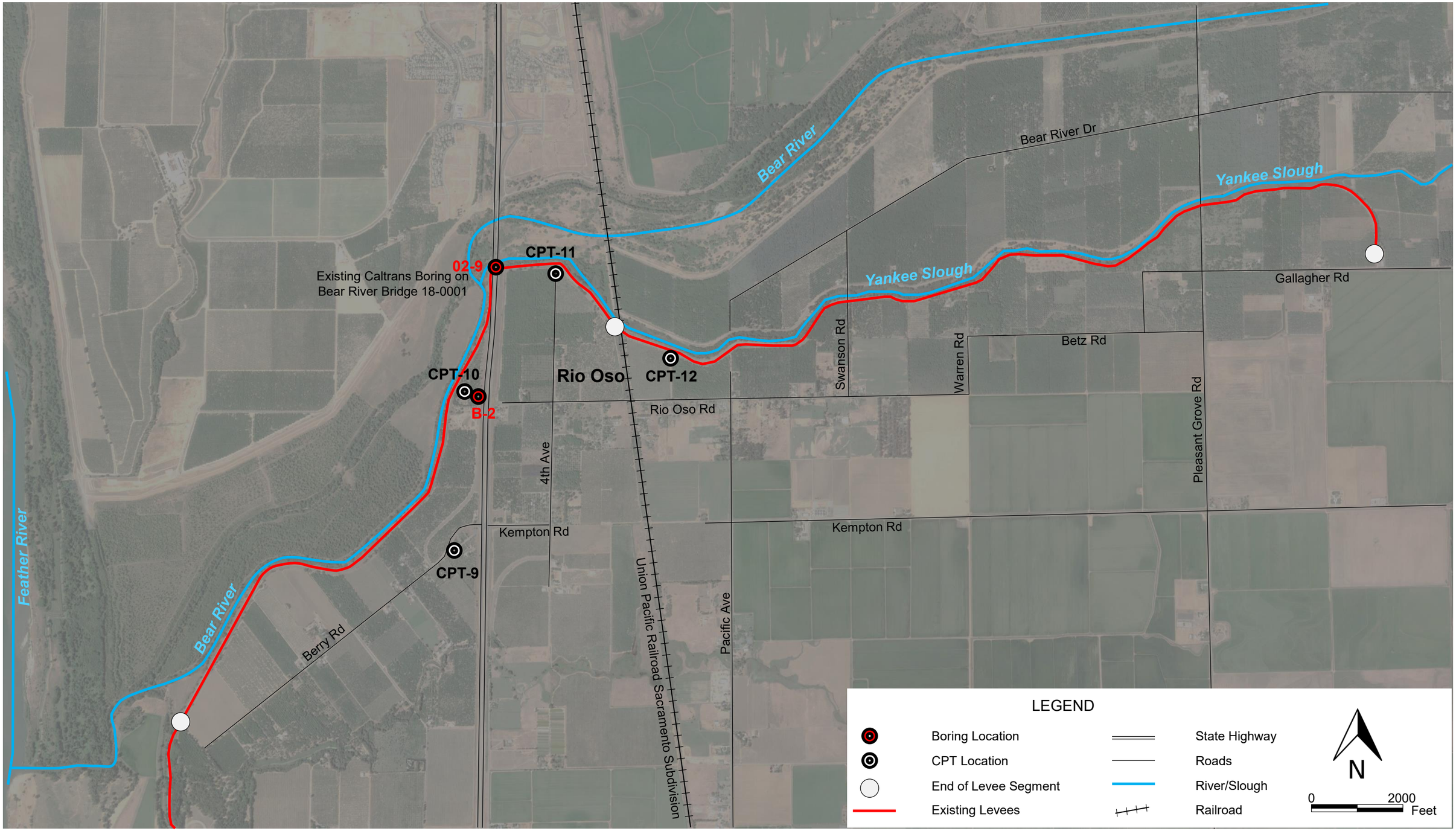
NORTH NON-URBAN LEVEE EVALUATIONS

Plate 1

NULE Level 2-II: Feather River South Geomorphic Assessment

1965_2_NULE_FeatherSouth_Plate.mxd MGT 12/21/2010

Appendix B – Boring and CPT Logs



NOTES: Image Source: Google Earth Pro 2019

Rio Oso Flood Risk Reduction Feasibility Study

Exploration Location

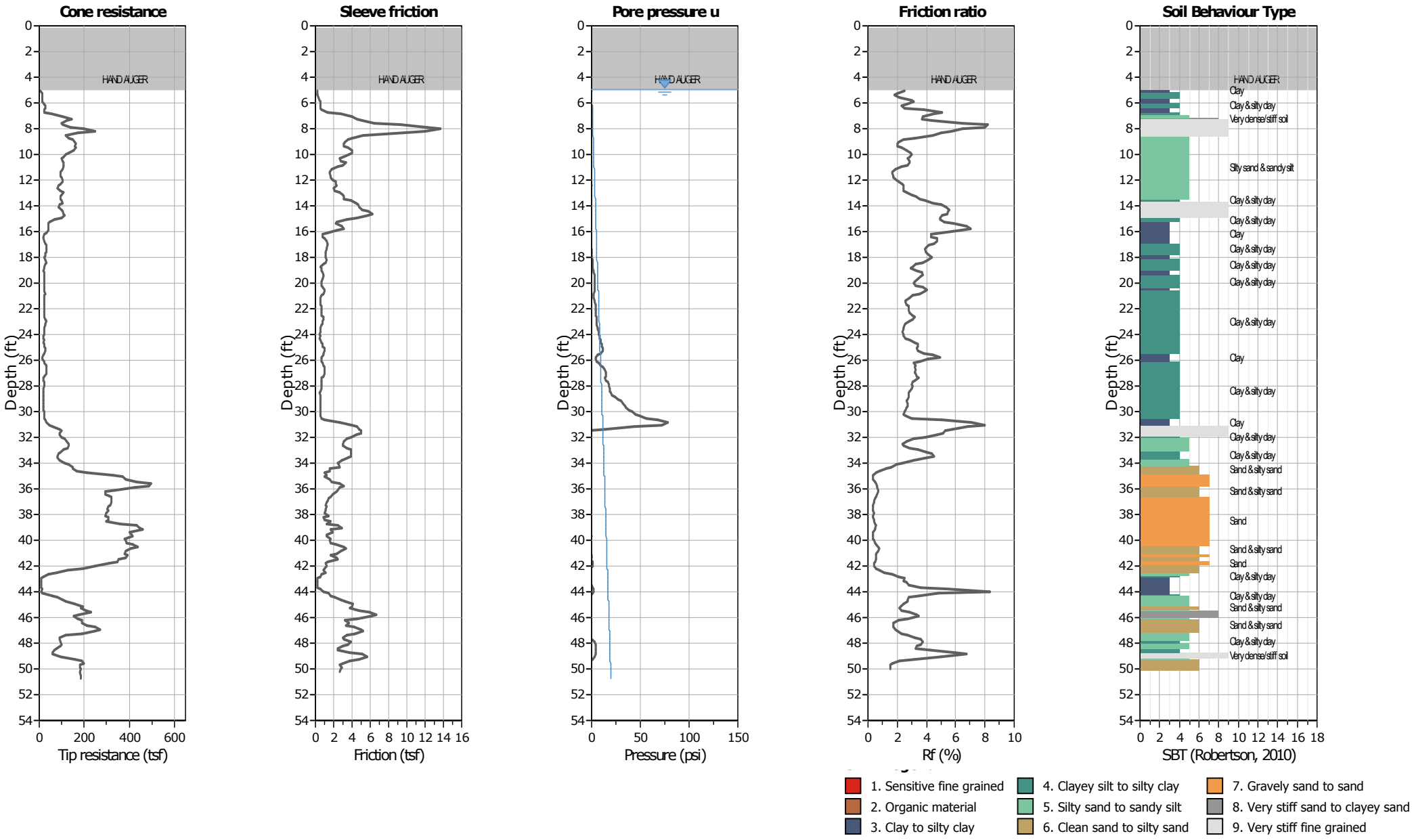
July 2019

FIGURE B-1

HDR Inc.
2365 Iron Point Rd.
Folsom CA, 95630

Project: **Rio Oso Flood Risk Reduction Feasibility Study**
Location: **Rio Oso, CA**

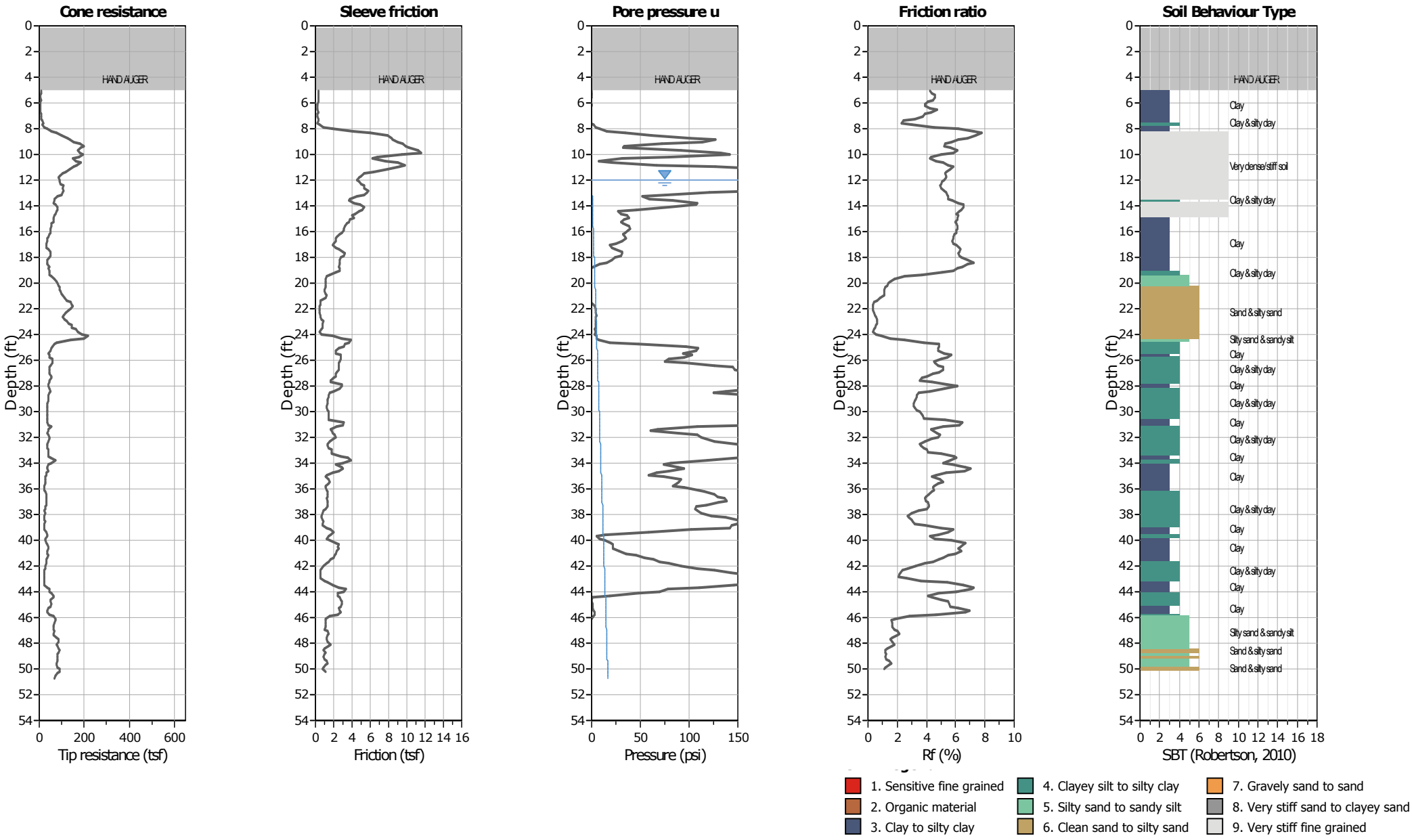
CPT: CPT-09
Total depth: 50.69 ft, Date: 3/27/2019
Surface Elevation: 43.00 ft
Coords: lat 38.952404° lon -121.546283°



HDR Inc.
2365 Iron Point Rd.
Folsom CA, 95630

Project: **Rio Oso Flood Risk Reduction Feasibility Study**
Location: **Rio Oso, CA**

CPT: CPT-10
Total depth: 50.69 ft, Date: 3/27/2019
Surface Elevation: 44.00 ft
Coords: lat 38.961717° lon -121.54525°



UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL
			$C_u < 4$ AND/OR $1 > C_c > 3$	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND
			$C_u < 6$ AND/OR $1 > C_c > 3$	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI<4 OR PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

OTHER SYMBOLS

MATERIALS

- Asphalt
- Aggregate Base
- Topsoil
- Bedrock

PIEZOMETER

- Grout Seal or Fill
- Bentonite Seal or Fill
- Sand Pack + Solid Pipe
- Sand Pack + Slotted Pipe

SAMPLERS

- SPT (2" OD)
- Modified California (3" OD)
- California (2.5" OD)
- Shelby Tube
- Pitcher Barrel
- HQ Core
- Grab/Bulk

- INITIAL WATER LEVEL MEASUREMENT(WITH DATE)
- STABILIZED WATER LEVEL MEASUREMENT(WITH DATE)

GRAIN SIZES

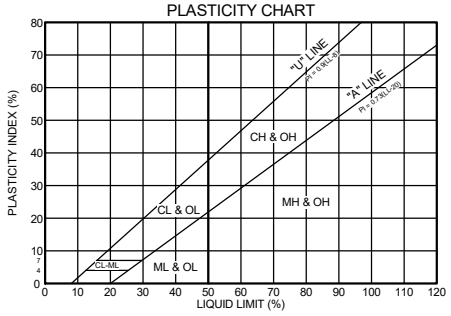
U.S. STANDARD SIEVE	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

PENETRATION RESISTANCE

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	UNC. COMP. STRENGTH (KSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 1	0 - 1/2
LOOSE	5 - 10	SOFT	2 - 4	1/2 - 1
MEDIUM DENSE	11 - 30	MEDIUM STIFF	5 - 8	1 - 2
DENSE	31 - 50	STIFF	9 - 15	2 - 4
VERY DENSE	OVER 50	VERY STIFF	16 - 30	4 - 8
		HARD	OVER 30	OVER 8

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

PLASTICITY CHART



LABORATORY TESTS

AT	ATTERBERG LIMITS
CD	CONSOLIDATED DRAINED TRIAXIAL
CN	CONSOLIDATION
CR	CORROSIVITY
CU	CONSOLIDATED UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
HY	HYDROMETER
PR	PERMEABILITY
RV	R-VALUE
SA	SIEVE ANALYSIS
TC	CYCLIC TRIAXIAL
UC	UNCONFINED COMPRESSION
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL
-200	% PASSING NO. 200 SIEVE

PROPERTIES

c	COHESION
DD	DRY DENSITY
EI	EXPANSION INDEX
LL	LIQUID LIMIT
MC	MOISTURE CONTENT
N_f	FIELD BLOW COUNT
PI	PLASTICITY INDEX
Su	UNDRAINED STRENGTH

UNDRAINED SHEAR STRENGTH

V	FIELD VANE
P	POCKET PENETROMETER
T	TORVANE
Q	UNCONFINED COMPRESSION
U	UNCONSOLIDATED UNDRAINED TRIAXIAL

INCREASING VISUAL MOISTURE CONTENT

WET
MOIST
DRY

Boring and Test Pit Legend

Rio Oso Flood Risk Reduction Feasibility Project
Rio Oso, CA

Date: JUN 2019

Figure: LEGEND

LEGEND_JULY 2016; 10147729 - SMALL COMMUNITIES - RIO OSO.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 6/4/19

Project: Rio Oso Flood Risk Reduction Feasibility Project		Boring ID: B-2	Sheet 1 of 2 Sheets
Project Location: Rio Oso, CA			
Project Number: 10147729			
Start Date: 2/28/2019	End Date: 2/28/2019	Logged By: Hamed Mousavi	Checked By: T. OBrien / Date Checked: 6/5/2019
Drilling Company (Rig Type): Taber Drilling (Diedrich D-120)	Inspector:	Weather Conditions: Cloudy/Sunny	
Drill Method: Mud / Hand	Drilled By: Rick	Elevation Top of Boring: 44.0 ft. Vertical Datum: NAVD88	
Drill Bit (Type/Size): Spade / 4 inch	Total Depth Drilled: 51.5 ft.	Latitude: 38.961697° Longitude: -121.545179° Horizontal Datum: WGS84	
Hammer Type: Automatic	Hole Backfill: Neat Cement Grout	Northing: Easting: Coordinate System:	
Hammer Efficiency:	Rod Type: AWJ	Total Number of Samples: 18 Disturbed: 18 Undisturbed: 0	Initial Groundwater Depth: 20 ft (;) Static Groundwater Depth:

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
						4" Asphalt.		S-1							Hand Auger to 5 ft
						Aggregate Base.									
						LEAN CLAY (CL): brown, moist, low plasticity.									
40	5		6 6 8	14		Stiff.	100	S-2	59	22	9	99	10	4.50 P	4" spade bit
			1 2 6	8		SANDY SILT (ML): medium stiff, brown, moist.	100	S-3							
35	10		6 15 24	39		Hard.	100	S-4	66	30	6		26	1.00 P	
			18 28 42	70		SANDY LEAN CLAY (CL): hard, brown, moist.	100	S-5	64	31	8		16	2.50 P	
30	15		21 28 37	65		Fine gray sand.	100	S-6	67	32	9		18	4.50 P	
			9 18 25	43			83	S-7						3.50 P	
25	20		4 7 12	19		CLAYEY SAND (SC): medium dense, brown, wet, fine sand.	100	S-8	29				24		Ground water at 20 feet
															Switched to mud rotary
20	25		8 12 16	28		Well-Graded SAND with Silt and Gravel (SW-SM): dense, dark gray, wet, with fine to coarse sand, fine to medium coarse subangular to rounded gravel up to 3/4".	56	S-9	8				12		
			4 5 9	14		SILT (ML): stiff, brown, moist.	61	S-10		42	10		42		Hole caved, driller pushed the casing. Mud leaked from between the casing and hole. Pushed casing to 31.5 ft depth to plug the leak.
15															

HDR SOIL BORING LOG_2017_MARCH_R1; 10147729 - SMALL COMMUNITIES - RIO OSO.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 6/17/19

HDR Engineering, Inc.

Project: Rio Oso Flood Risk Reduction Feasibility Project	Boring ID:	Sheet
Project Location: Rio Oso, CA	B-2	2 of 2 Sheets
Project Number: 10147729		

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N_f	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory: Fines	LL	PI	DD	MC	Su (ksf)	REMARKS
			6 8 9	17		Very stiff, coarse gravel in the upper 6" of sampler.	72	S-11						3.50 P	
10	35		7 8 15	23		SILT with Sand (ML): very stiff, brown, moist.	67	S-12	82	37	10	80	42	3.50 P	
			5 5 7	12		SILT (ML): stiff, brown, moist.	0	S-13							No recovery in ModCAL sampler.
5	40		7 7 8	15			100	S-14						1.00 P	
			6 6 1.5	7.5			100	S-15						1.50 P	
0	45		3 3 4	7		Medium stiff.	100	S-16						0.50 P	
			3 4 3	7			83	S-17							
-5	50		7 8 8	16		Very stiff.	100	S-18	88	35	8		39	1.50 P	
						Boring terminated at 51.5 feet depth. Backfilled with neat cement grout (8 bags cement).									

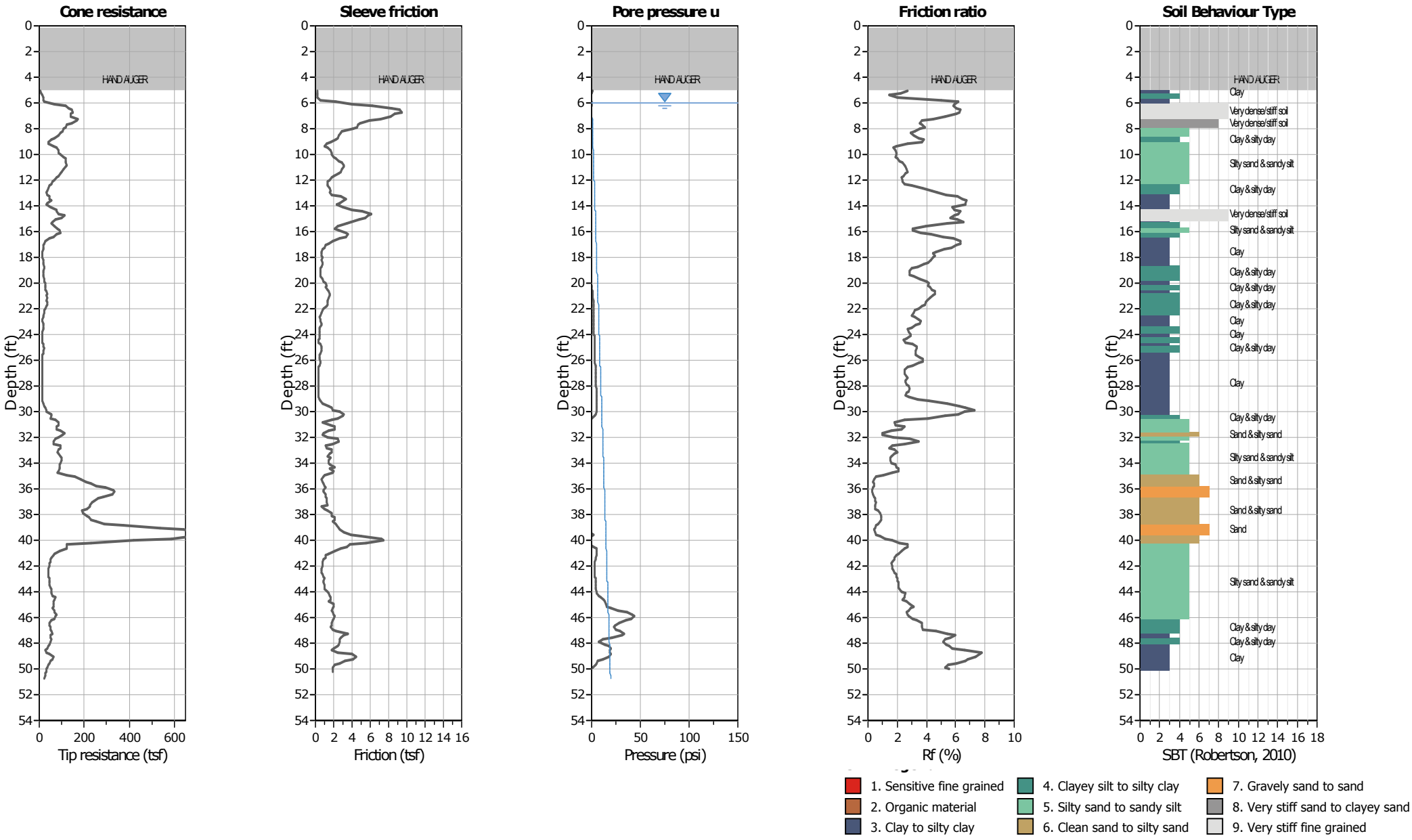
HDR SOIL BORING LOG_2017_MARCH_R1; 10147729 - SMALL COMMUNITIES - RIO OSO.GPJ; HDR_FOLSOM_OAKLAND_MARCH 2017_WIP.GLB; 6/17/19

HDR Engineering, Inc.

HDR Inc.
2365 Iron Point Rd.
Folsom CA, 95630

Project: **Rio Oso Flood Risk Reduction Feasibility Study**
Location: **Rio Oso, CA**

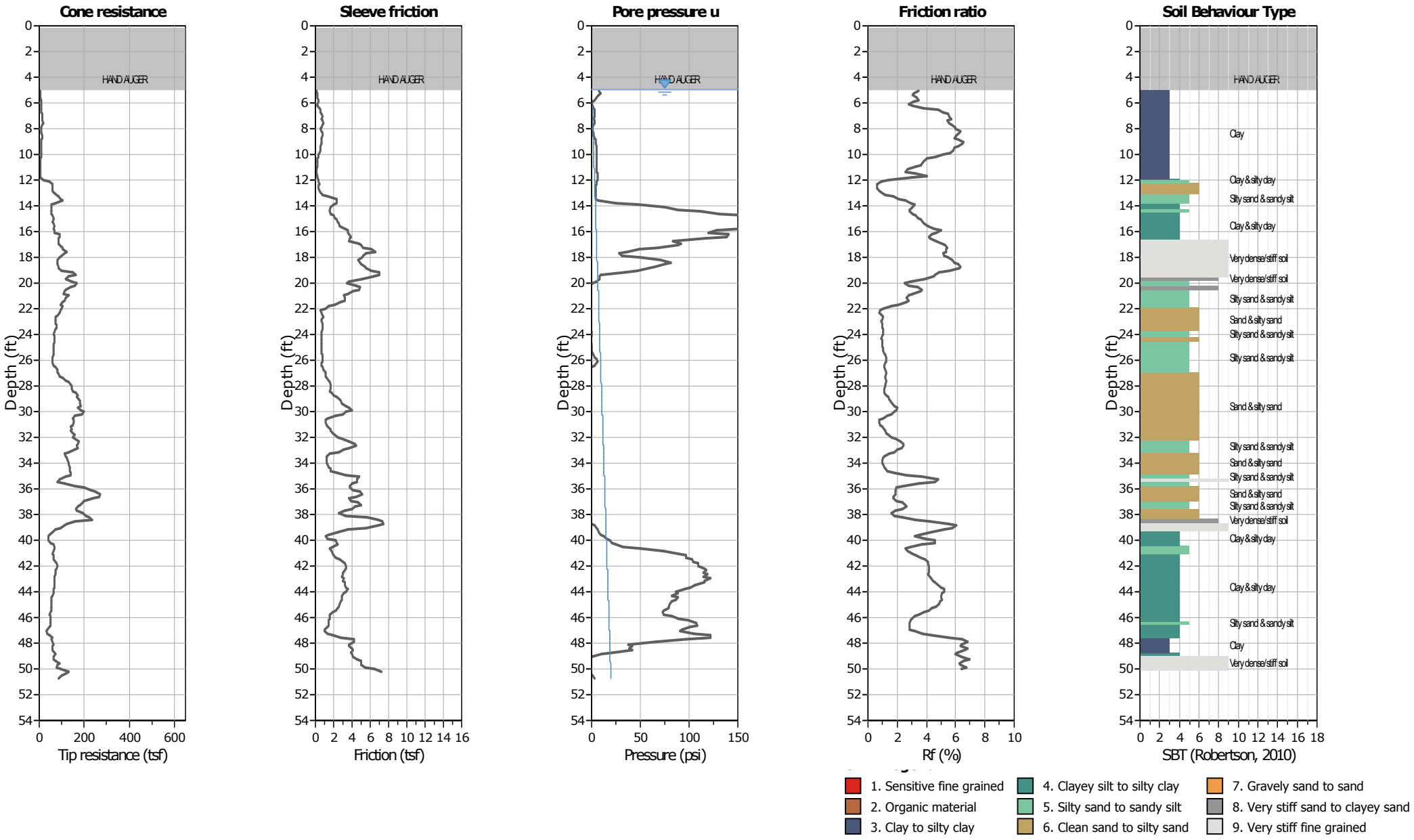
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Surface Elevation: 45.00 ft
Coords: lat 38.969318° lon -121.538308°

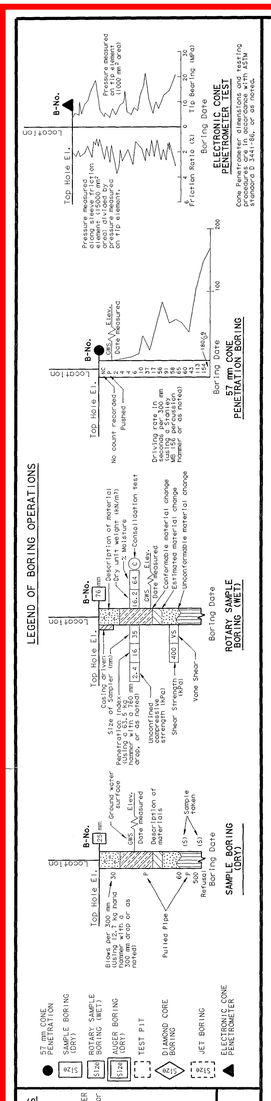


HDR Inc.
2365 Iron Point Rd.
Folsom CA, 95630

CPT: CPT-12
Total depth: 50.69 ft, Date: 4/22/2019
Surface Elevation: 44.00 ft
Coords: lat 38.964096° lon -121.529337°

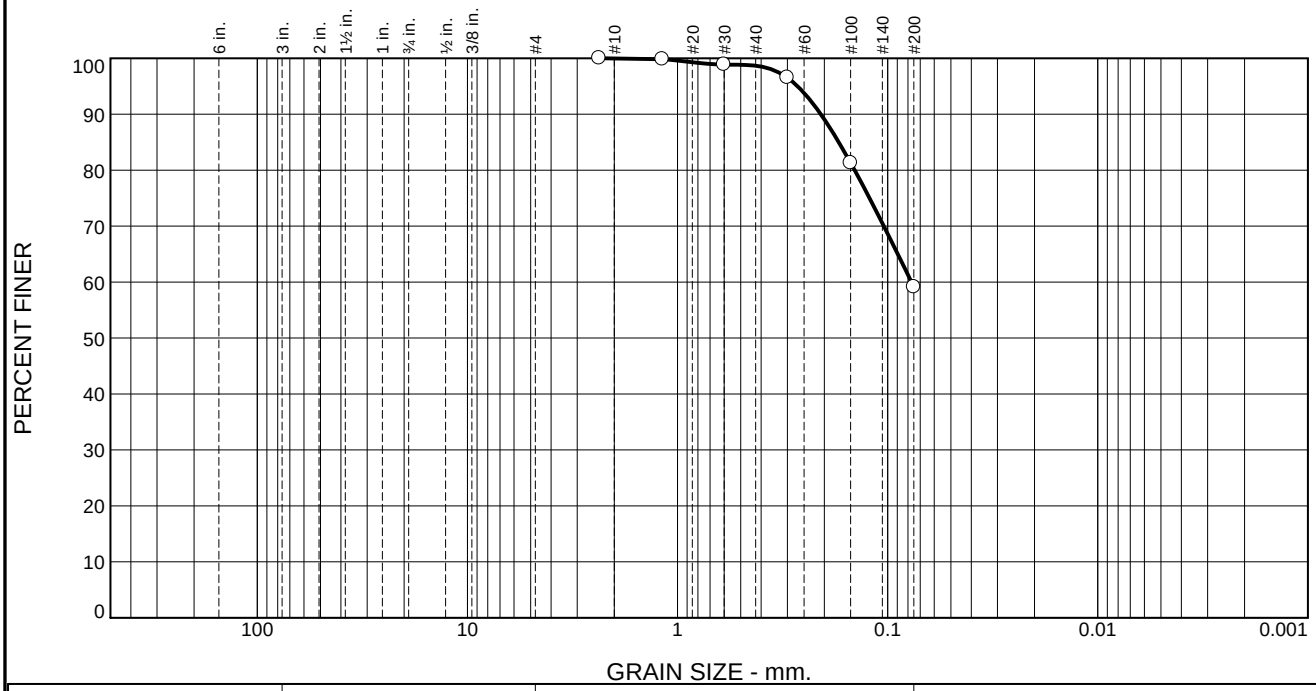
Project: **Rio Oso Flood Risk Reduction Feasibility Study**
Location: **Rio Oso, CA**




ELECTRONIC CONE PENETROMETER TEST
57 mm CONE PENETRATION BORING
ROTARY SAMPLE BORING (WET)
SAMPLE BORING (DRY)
Top Hole El.
Boring Date
Pressure measured on tip element
Pressure measured on friction element
Cone Penetrometer dimensions and testing procedures conform to ASTM standard D 3441-86, or as noted.
No count recorded
Pushed
Driving rate, 10 blows per 300 mm using a Fraipont hammer or as noted
Description of material
Sample remark
Ground water level
Date Measured
Vane Shear
Pulled
Blows per 300 mm using 13.7 kg Rod 300 mm drop or as noted
Pulled Pipe
Sample remark
Recovery %
Rock Quality Designation (RQD)
Core Barrel Size
Core Hardness
Fracture Index
Strength of Rock Material
Weathering
Discontinuity Description
Color
Bedding
Cementation
Structure
Hardness
Texture
Mineralogy
Grain Size
Plasticity
Moisture
Dry unit weight (kN/m3)
Consolidation test
Unconfined compressive strength (kPa)
Torvane Shear
Laboratory Classification Method
Sieve Analysis
Hydrometer Analysis
Liquid Limit
Plastic Limit
Plasticity Index
Organic Content
Soil Classification (USCS)
Soil Classification (AASHTO)
Material Description
Base Course
Subbase
Other
Depth Base of Sample
Sample Number
Graphic Log of Soil and Rock Types
Water Content
Blow Count or Compressive Strength
Depth Scale
Elevation Scale
Bore Hole Number
Bore Hole Diameter
Elevation
Coring Information
Size of Sampler (mm)
Penetration Resistance (Blows per 0.3 m) or Rock Quality Designation (RQD)
Recovery
Ground water Level
Date Measured
Description of Material
Sample Remark

Appendix C – Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	40	59

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#8	100		
#16	100		
#30	99		
#50	97		
#100	81		
#200	59		

* (no specification provided)

Material Description

Dark red-brown

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 0.2080 D_{85}= 0.1710 D_{60}= 0.0770
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.23

Date Received: 4/19/19 **Date Tested:** 4/30/19

Tested By: JM

Checked By: JML

Title: PM

Location: MOD CAL: B-2
Sample Number: 42770 **Depth:** 5.5'-6.5'

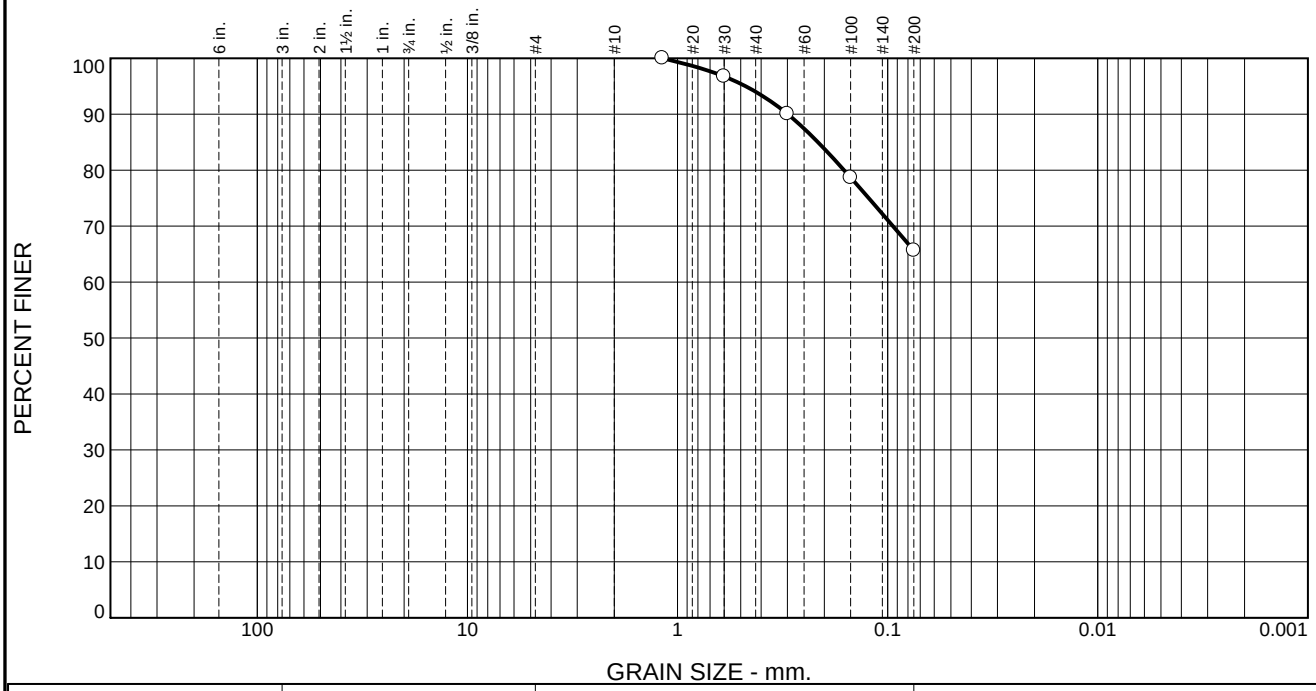
Date Sampled: -

GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.
Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	6	28	66

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100		
#30	97		
#50	90		
#100	79		
#200	66		

* (no specification provided)

Material Description

Brown sandy silt

Atterberg Limits (ASTM D 4318)

PL= 24 **LL=** 30 **PI=** 6

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(3)

Coefficients

D_{90}= 0.2985 D_{85}= 0.2147 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.35

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42763 **Depth:** 10.5'-11.5'

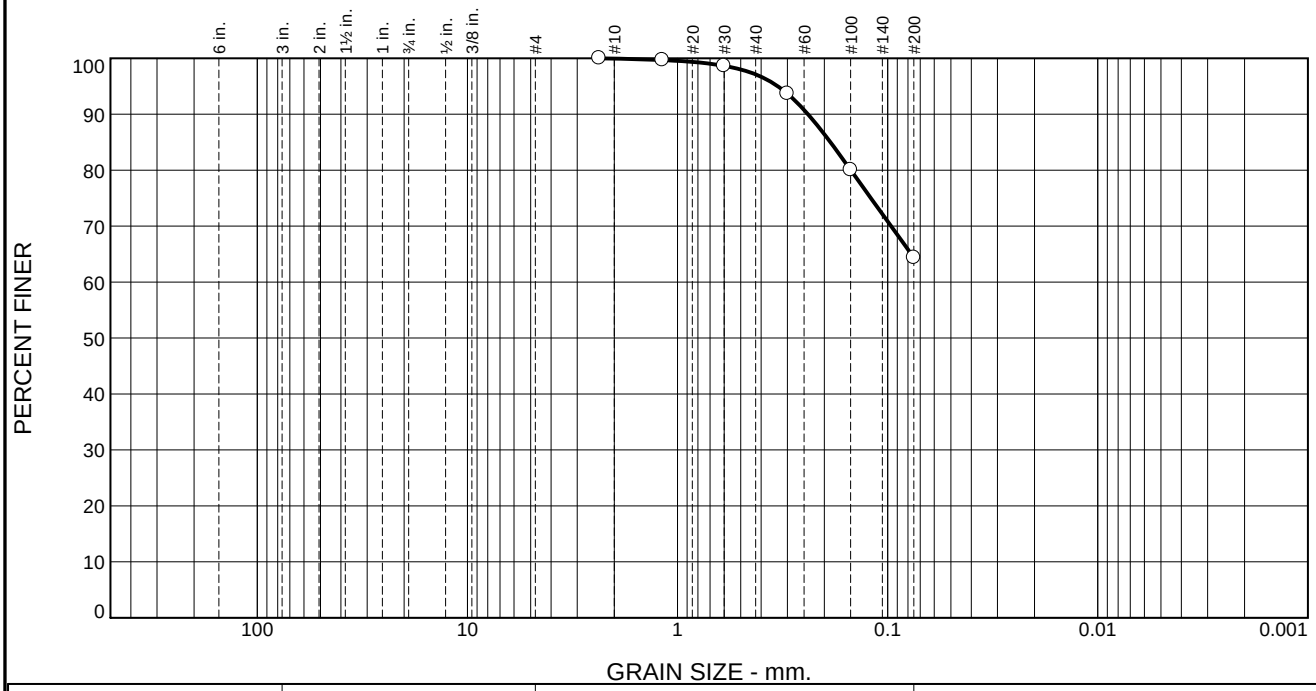
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	3	33	64

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#8	100		
#16	100		
#30	99		
#50	94		
#100	80		
#200	64		

* (no specification provided)

Material Description

Brown sandy lean clay

Atterberg Limits (ASTM D 4318)

PL= 23 **LL=** 31 **PI=** 8

Classification

USCS (D 2487)= CL **AASHTO (M 145)=** A-4(4)

Coefficients

D_{90}= 0.2393 D_{85}= 0.1873 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.28

Date Received: 4/19/19 **Date Tested:** 5/15/19

Tested By: JM

Checked By: JML

Title: PM

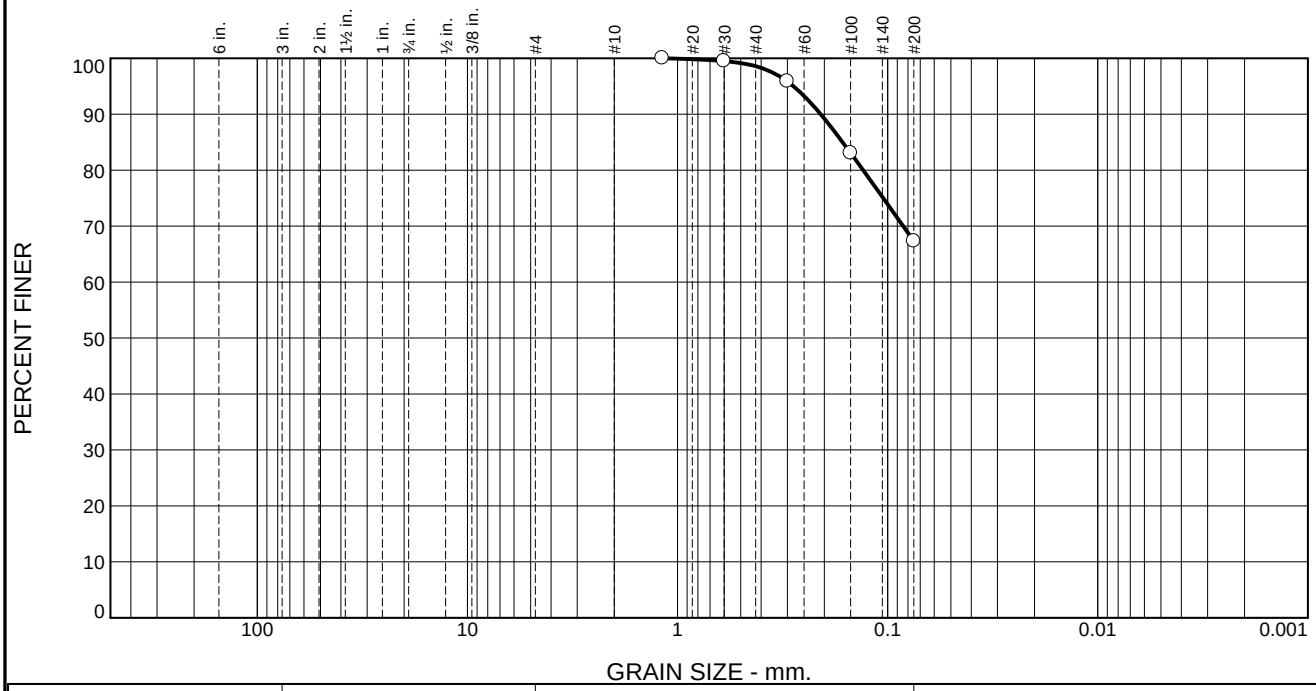
Location: Split Spoon: B-2 **Date Sampled:** -
Sample Number: 42764 **Depth:** 13.0'-14.0'

GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.
Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	32	67

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100		
#30	99		
#50	96		
#100	83		
#200	67		

* (no specification provided)

Material Description

Brown sandy lean clay

Atterberg Limits (ASTM D 4318)

PL= 23 **LL=** 32 **PI=** 9

Classification

USCS (D 2487)= CL **AASHTO (M 145)=** A-4(5)

Coefficients

D_{90}= 0.2083 D_{85}= 0.1638 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.22

Date Received: 4/19/19 **Date Tested:** 5/17/19

Tested By: JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42765 **Depth:** 15.5'-16.5'

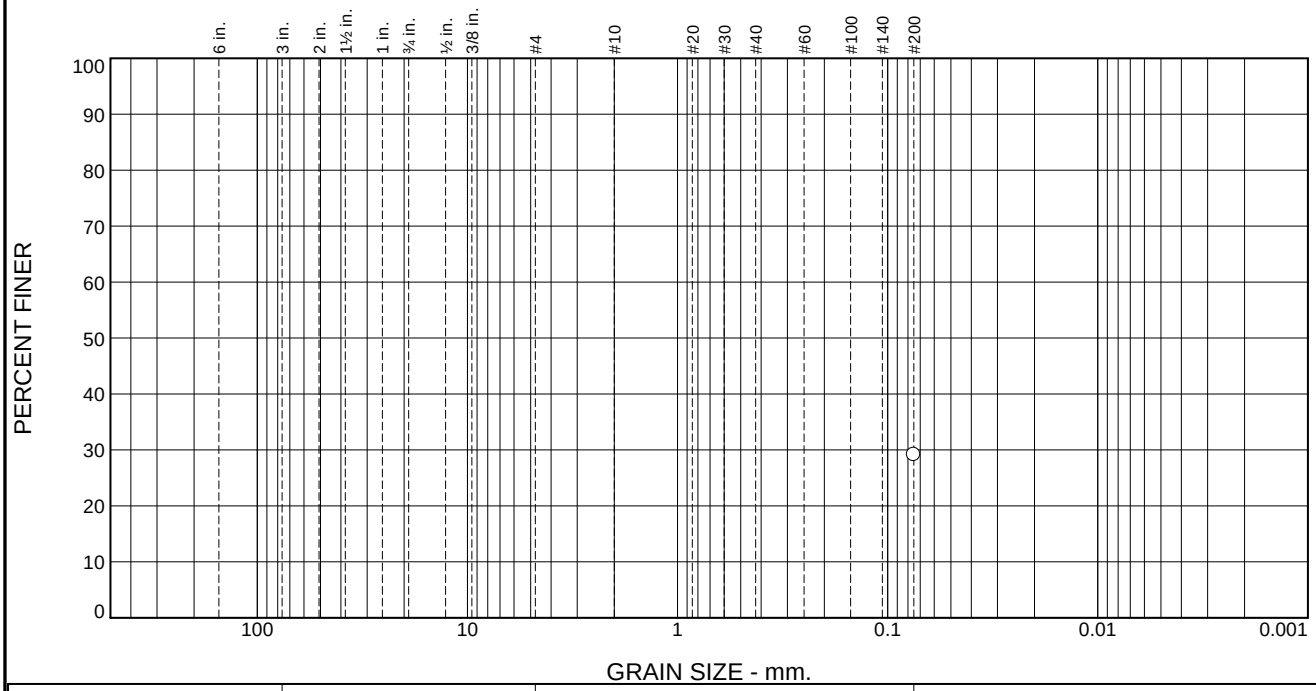
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						29

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	29		

* (no specification provided)

Material Description

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 4/19/19 **Date Tested:** 5/17/19

Tested By: BM/JM

Checked By: JML

Title: PM

Location: Split Spoon: B-2 **Date Sampled:** -

Sample Number: 42769 **Depth:** 20.5'-21.5'

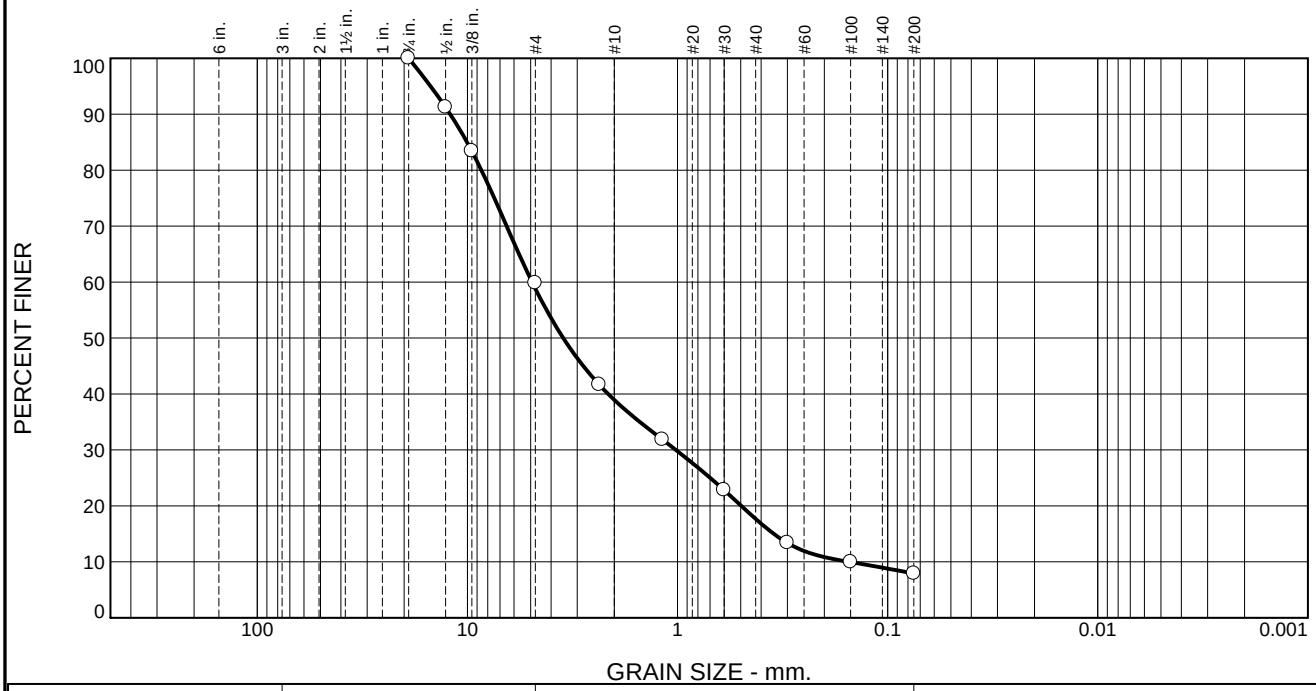
GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.

Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	41	20	21	10	8

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4 Inch	100		
1/2 Inch	91		
3/8 Inch	83		
#4	59		
#8	42		
#16	32		
#30	23		
#50	13		
#100	10		
#200	7.9		

* (no specification provided)

Material Description

Brown well-graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SW-SM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 12.0639 D_{85}= 10.0355 D_{60}= 4.9237
D_{50}= 3.4987 D_{30}= 1.0189 D_{15}= 0.3483
D_{10}= 0.1529 C_u= 32.19 C_c= 1.38

Remarks

F.M.=4.38

Date Received: 4/19/19 **Date Tested:** 5/17/19

Tested By: BM/JM

Checked By: JML

Title: PM

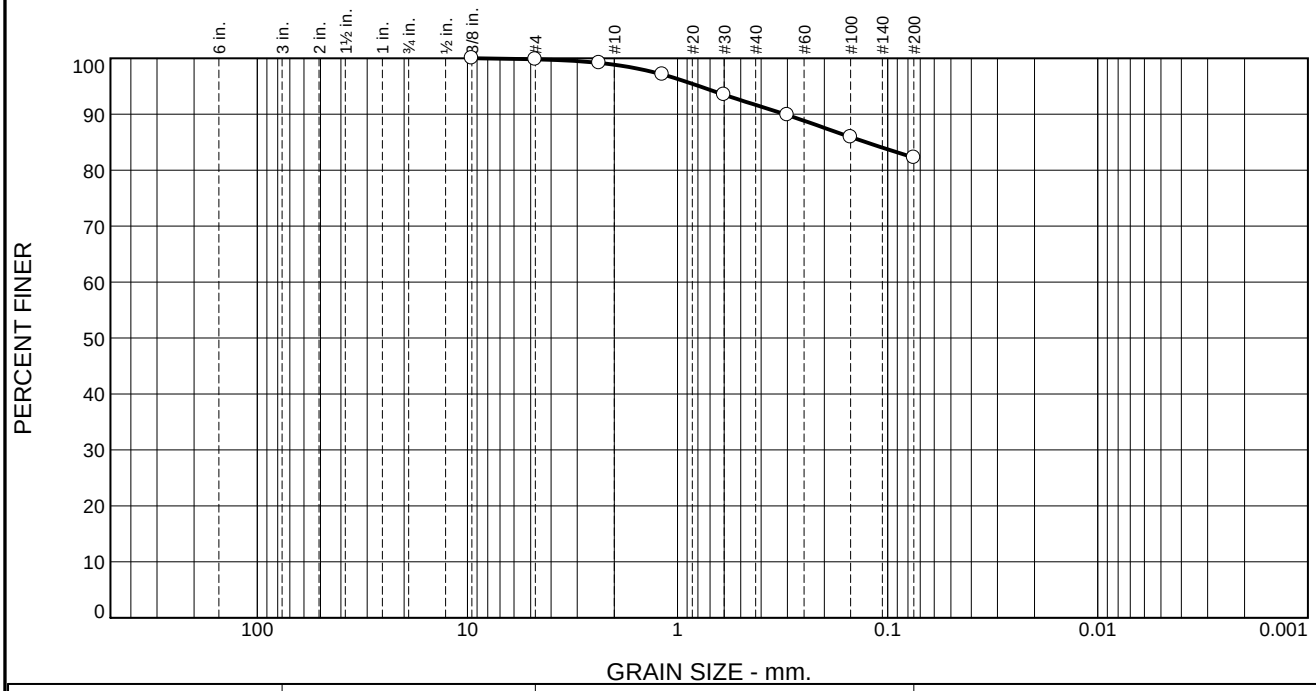
Location: Split Spoon: B-2 **Date Sampled:** -
Sample Number: 42766 **Depth:** 23.0'-24.0'

GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.
Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	1	7	10	82

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8 Inch	100		
#4	100		
#8	99		
#16	97		
#30	93		
#50	90		
#100	86		
#200	82		

* (no specification provided)

Material Description

Brown

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 0.3089 D_{85}= 0.1268 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.35

Date Received: 4/19/19 **Date Tested:** 4/30/19

Tested By: JM

Checked By: JML

Title: PM

Location: MOD CAL: B-2
Sample Number: 42771 **Depth:** 35.0'-36.5'

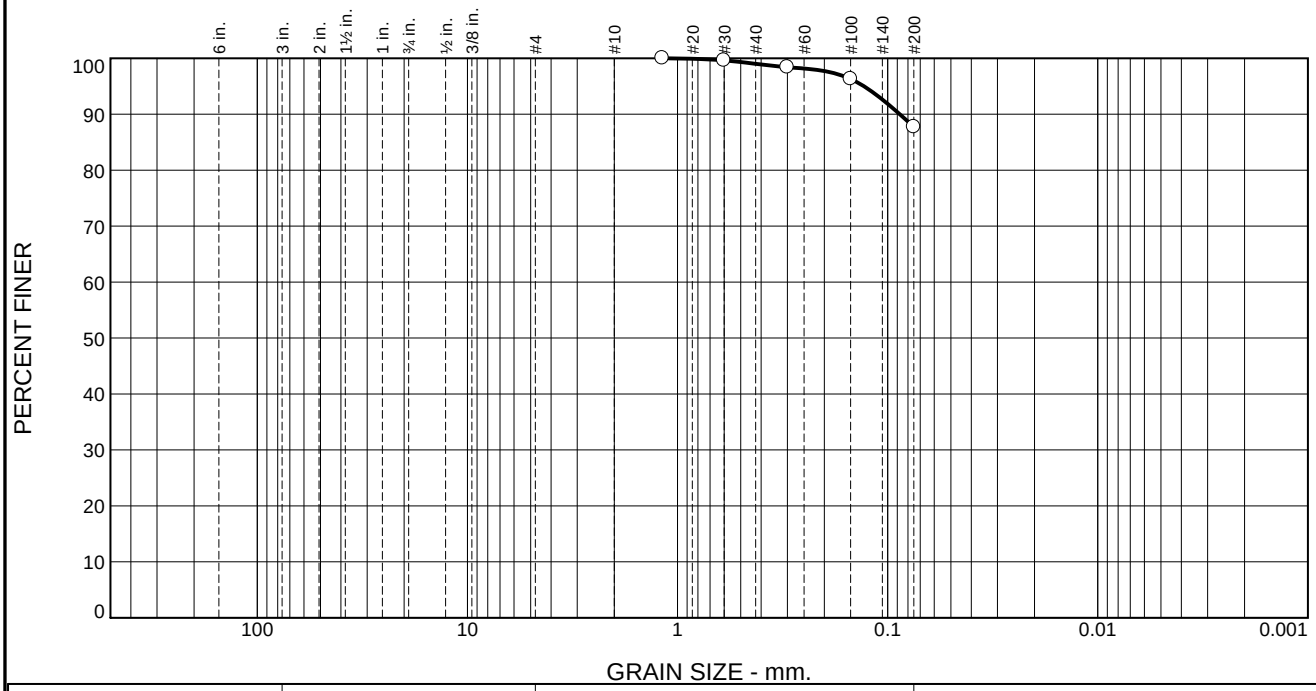
Date Sampled: -

GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.
Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0	0	0	0	1	11	88

Test Results (ASTM D6913 & ASTM D1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100		
#30	100		
#50	98		
#100	96		
#200	88		

* (no specification provided)

Material Description

Brown silt

Atterberg Limits (ASTM D 4318)

PL= 27 **LL=** 35 **PI=** 8

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(8)

Coefficients

D_{90}= 0.0876 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

F.M.=0.06

Date Received: 4/19/19 **Date Tested:** 5/20/19

Tested By: CJ

Checked By: JML

Title: PM

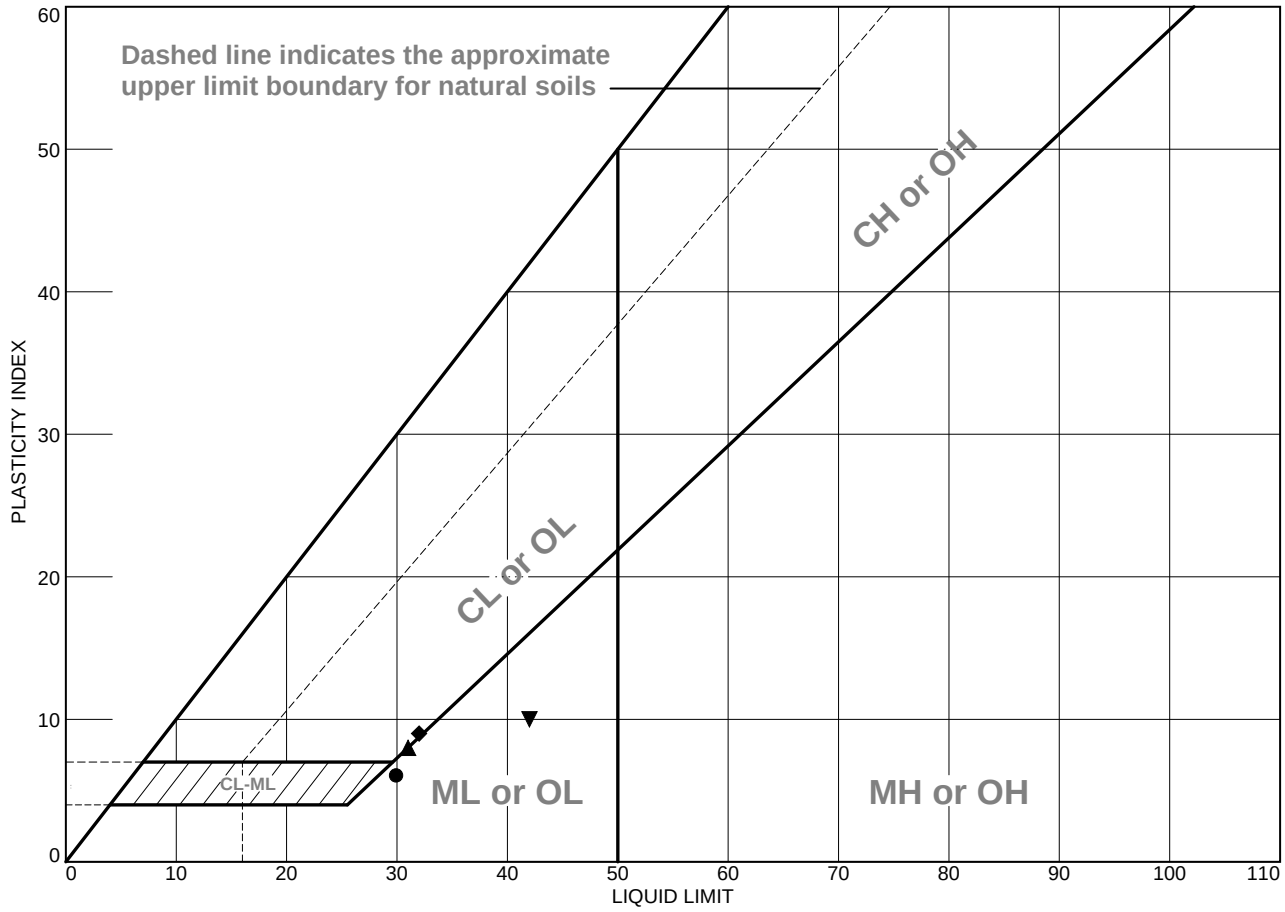
Location: Split Spoon: B-2 **Date Sampled:** -
Sample Number: 42768 **Depth:** 50.5'-51.5'

GULF SHORE EXPLORATION AND TESTING

Client: HDR, Inc.
Project: Small Communities - Rio Oso

Project No: 19-147 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy silt	30	24	6	94	66	ML
■	Brown well-graded sand with silt and gravel	NV	NP	NP	18	7.9	SW-SM
▲	Brown sandy lean clay	31	23	8	97	64	CL
◆	Brown sandy lean clay	32	23	9	99	67	CL
▼		42	32	10			

Project No. 19-147 **Client:** HDR, Inc.

Project: Small Communities - Rio Oso

Remarks:

● **Location:** Split Spoon: B-2 **Depth:** 10.5'-11.5' **Sample Number:** 42763

■ **Location:** Split Spoon: B-2 **Depth:** 23.0'-24.0' **Sample Number:** 42766

▲ **Location:** Split Spoon: B-2 **Depth:** 13.0'-14.0' **Sample Number:** 42764

◆ **Location:** Split Spoon: B-2 **Depth:** 15.5'-16.5' **Sample Number:** 42765

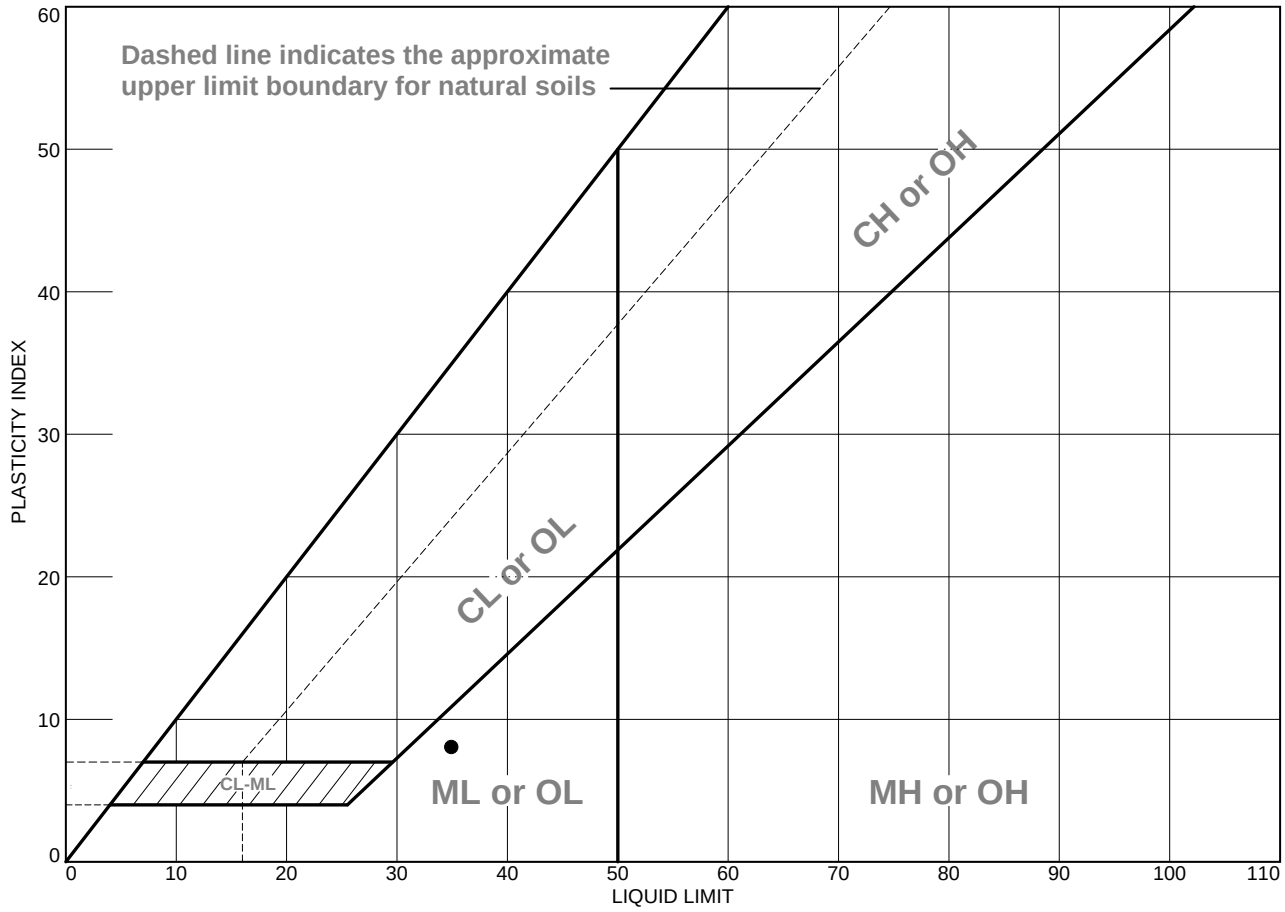
▼ **Location:** Split Spoon: B-2 **Depth:** 25.5'-26.5' **Sample Number:** 42767

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: ○ SL □ BM △ SL ◇ SL ▽ SL **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown silt	35	27	8	99	88	ML

Project No. 19-147 **Client:** HDR, Inc.

Project: Small Communities - Rio Oso

●**Location:** Split Spoon: B-2 **Depth:** 50.5'-51.5' **Sample Number:** 42768

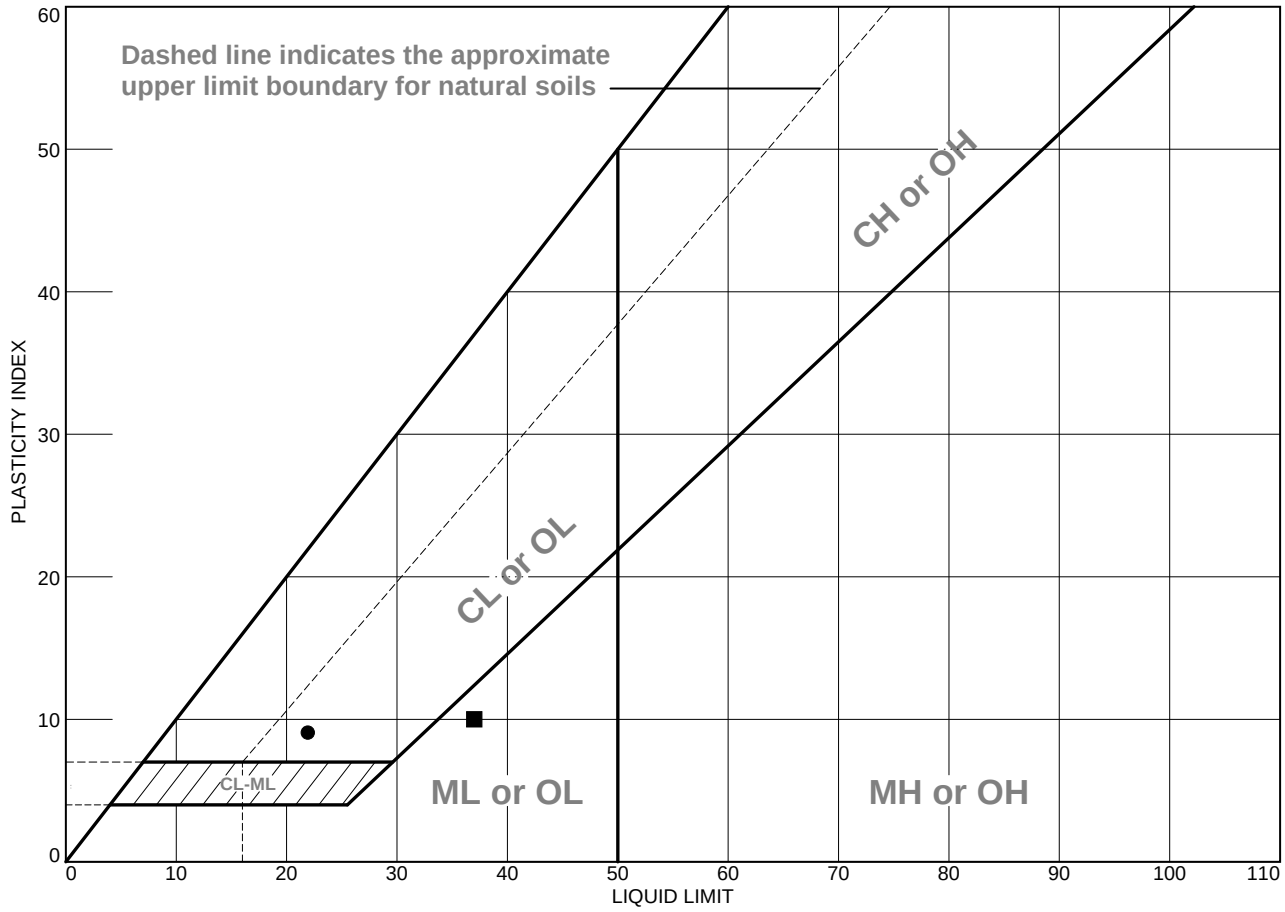
Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: AS **Checked By:** JML

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark red-brown sandy lean clay	22	13	9	99	59	CL
■	Brown silt with sand	37	27	10	92	82	ML

Project No. 19-147 **Client:** HDR, Inc.

Project: Small Communities - Rio Oso

●**Location:** MOD CAL: B-2 **Depth:** 5.5'-6.5' **Sample Number:** 42770

■**Location:** MOD CAL: B-2 **Depth:** 35.0'-36.5' **Sample Number:** 42771

Remarks:

GULF SHORE EXPLORATION AND TESTING

Figure

Tested By: SL **Checked By:** JML

MOISTURE CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Moisture Content, %
Split Spoon B-2	10.5'-11.5'	26.4
Split Spoon B-2	13.0'-14.0'	15.5
Split Spoon B-2	15.5'-16.5'	17.6
Split Spoon B-2	23.0'-24.0'	12.2
Split Spoon B-2	25.5'-26.5'	41.5
Split Spoon B-2	50.5'-51.5'	38.6
Split Spoon B-2	20.5'-21.5'	24.2

Test Method: ASTM D2216

PROJECT NUMBER:	19-147	May 20, 2019	Small Communities - Rio Oso

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

Sample Identification	Depth, ft.	Wet Unit Weight, lb/ft.^{3}	Dry Unit Weight, lb/ft.^{3}	Moisture Content, %
MOD CAL: B-2	5.5'-6.5'	108.6	99.0	9.7
MOD CAL: B-2	35.0'-36.5'	113.8	80.1	42.1

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: **19-147** April 26, 2019

Small Communities - Rio Oso

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

SOIL SPECIFIC GRAVITY

Sample Identification	Specific Gravity
MOD CAL B-2 (5.5'-6.5')	2.67
MOD CAL B-2 (35.0'-36.5')	2.58

Test Method: ASTM D854

PROJECT NUMBER:	19-147	May 28, 2019	

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

Small Communities - Rio Oso

SOIL SPECIFIC GRAVITY

Sample Identification	Specific Gravity
Split Spoon B-2 (23.0'-24.0')	2.72

Test Method: ASTM D854

PROJECT NUMBER:	19-147	May 16, 2019	

GULF SHORE EXPLORATION AND TESTING
3362 Fitzgerald Road
Rancho Cordova, CA 95742
Phone: (916) 939-4117
FAX: (916) 635-4315

Small Community - Rio Oso

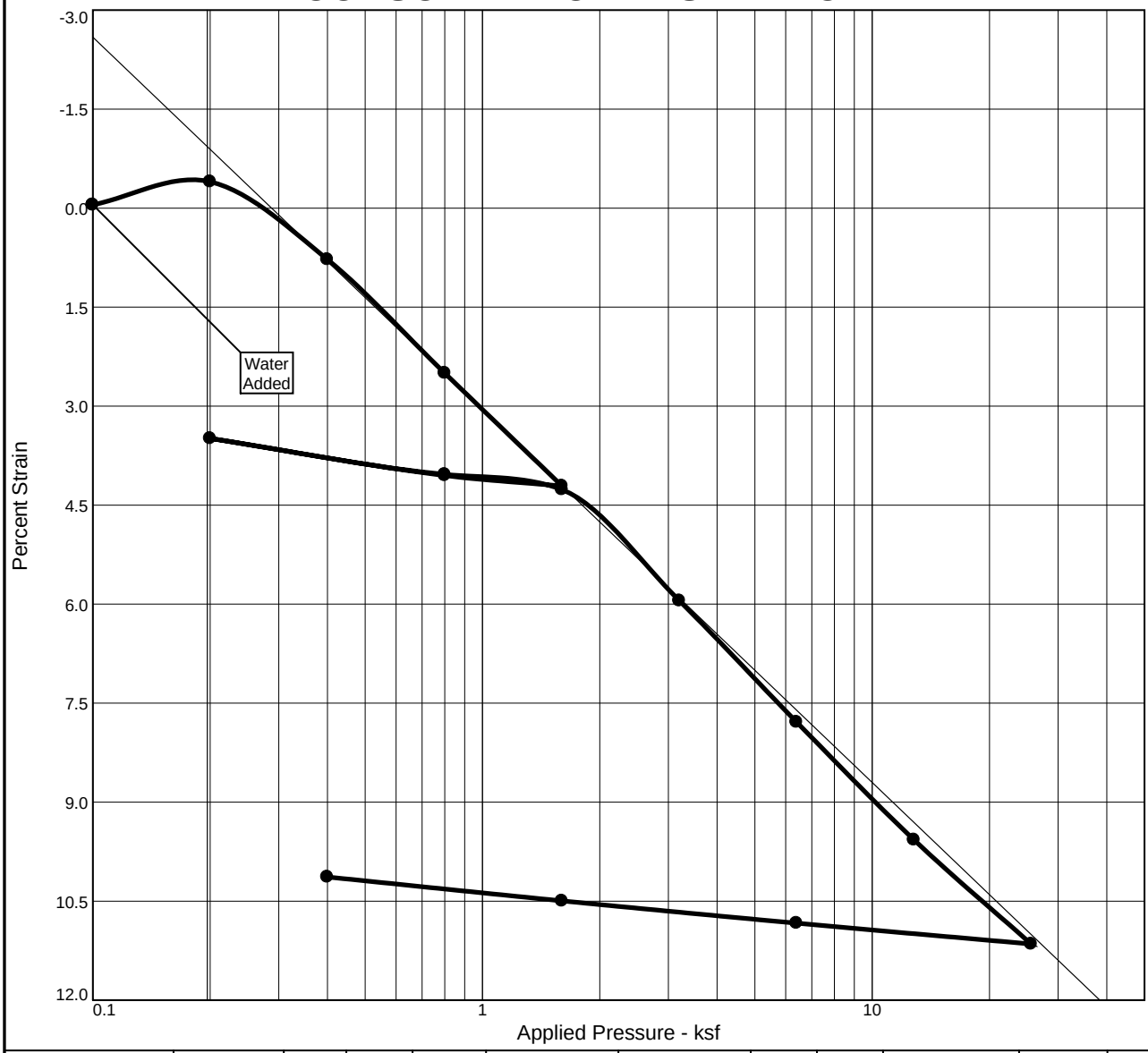
MOISTURE AND ORGANIC CONTENT TEST RESULTS

Sample Identification	Depth, ft.	Organic Content, %	Moisture Content, %
MOD CAL: B-2	5.5'-6.5'	3.3	9.7
MOD CAL: B-2	35.0'-36.5'	4.8	42.1

Test Method: ASTM D2974

PROJECT NUMBER:	19-147	April 30, 2019	
GULF SHORE EXPLORATION AND TESTING	3362 Fitzgerald Road Rancho Cordova, CA 95742 Phone: (916) 939-4117 FAX: (916) 635-4315		**Small Communities - Rio Oso**

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Swell %	e_o
48.2 %	17.1 %	85.7	22	9	2.67	0	0.2	0.11	0.01		0.0	0.945

MATERIAL DESCRIPTION	USCS	AASHTO
Dark red-brown sandy lean clay	CL	A-4(2)

Project No. 19-147 **Client:** HDR, Inc.

Project: Small Communities - Rio Oso

Location: MOD CAL: B-2 **Depth:** 5.5'-6.5' **Sample Number:** 42770

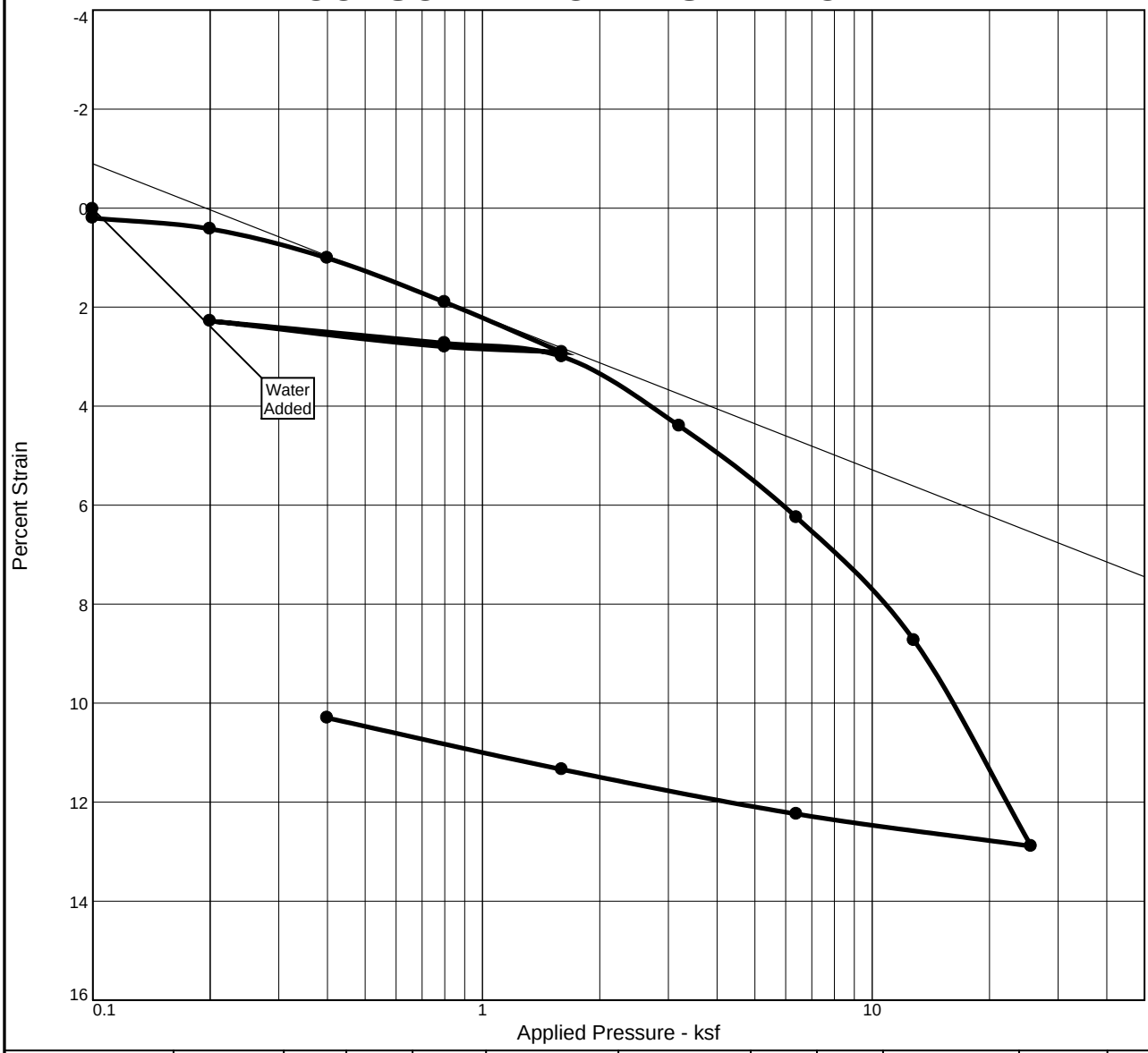
GULF SHORE EXPLORATION AND TESTING

Remarks:

Figure

Tested By: MPW **Checked By:** JML

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_s	Swell Press. (ksf)	Clpse. %	e_o
99.8 %	40.7 %	78.4	37	10	2.58	0	0.3	0.06	0.02		0.2	1.053

MATERIAL DESCRIPTION	USCS	AASHTO
Brown silt with sand	ML	A-4(9)

Project No. 19-147 **Client:** HDR, Inc.

Project: Small Communities - Rio Oso

Location: MOD CAL: B-2 **Depth:** 35.0'-36.5' **Sample Number:** 42771

GULF SHORE EXPLORATION AND TESTING

Remarks:

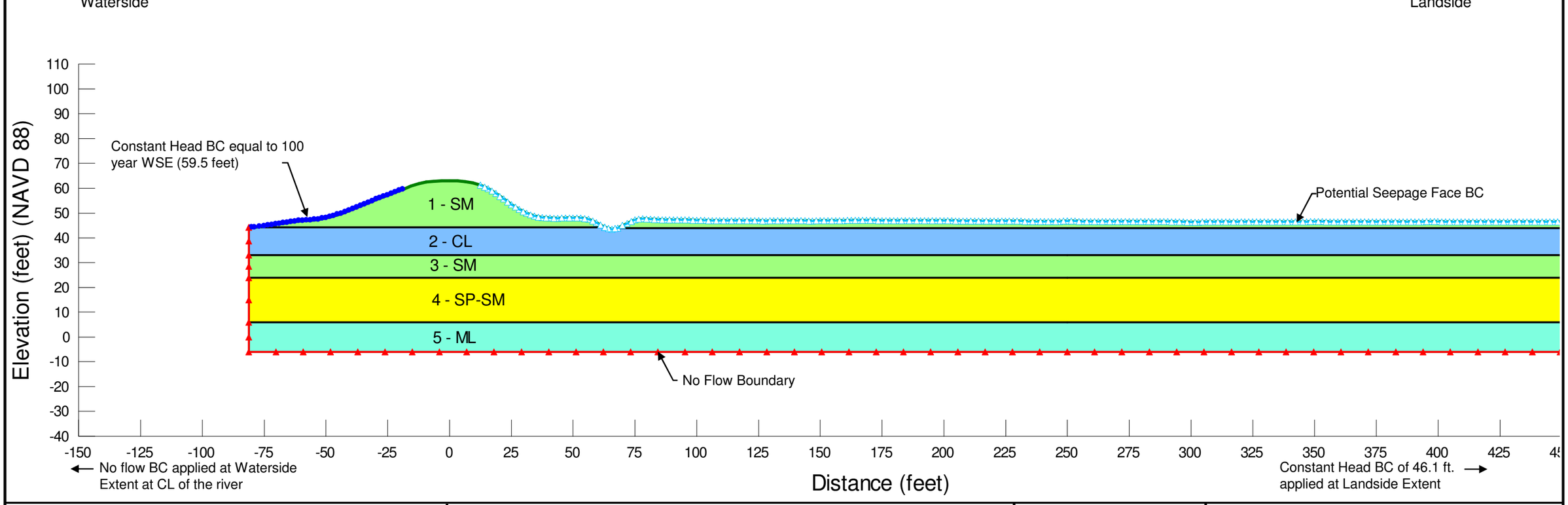
Figure

Tested By: MPW **Checked By:** JML

Appendix D – Seepage Analysis

Reach A (YS-L 1030+60)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**SP-SM**	11.336	4.0E-3	0.25
5	**ML**	0.028	1.0E-5	0.25



NOTES:

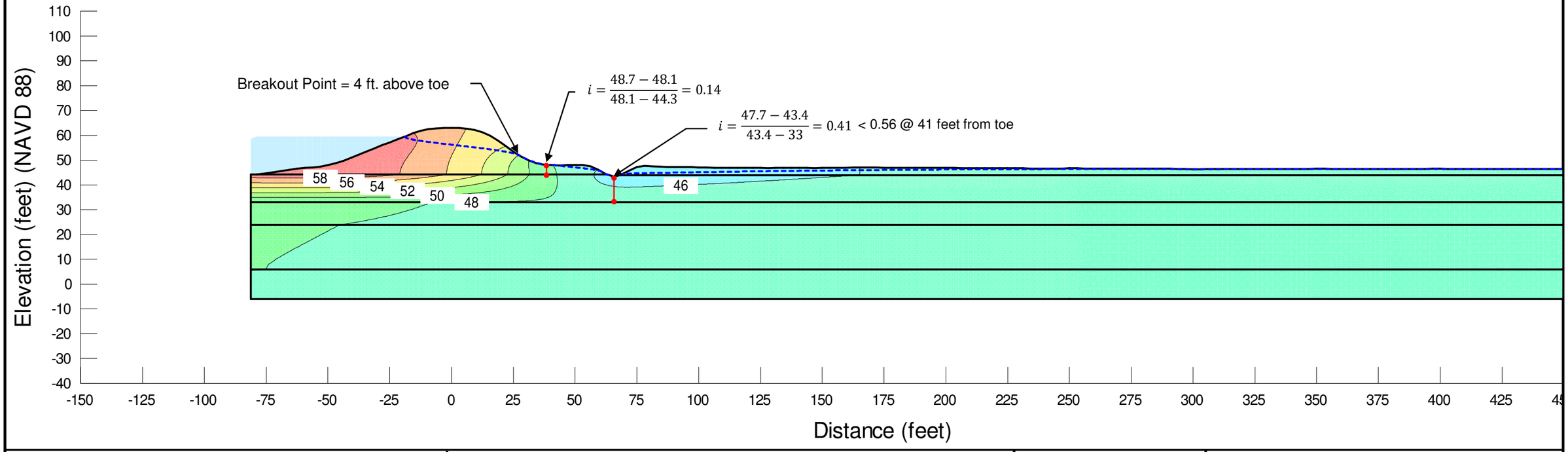
Rio Oso Flood Risk Reduction Feasibility Study

Reach A (YS-L 1030+60) Seepage Model-100 year WSE

July 2019 FIGURE D-1

Waterside

Landside



NOTES:

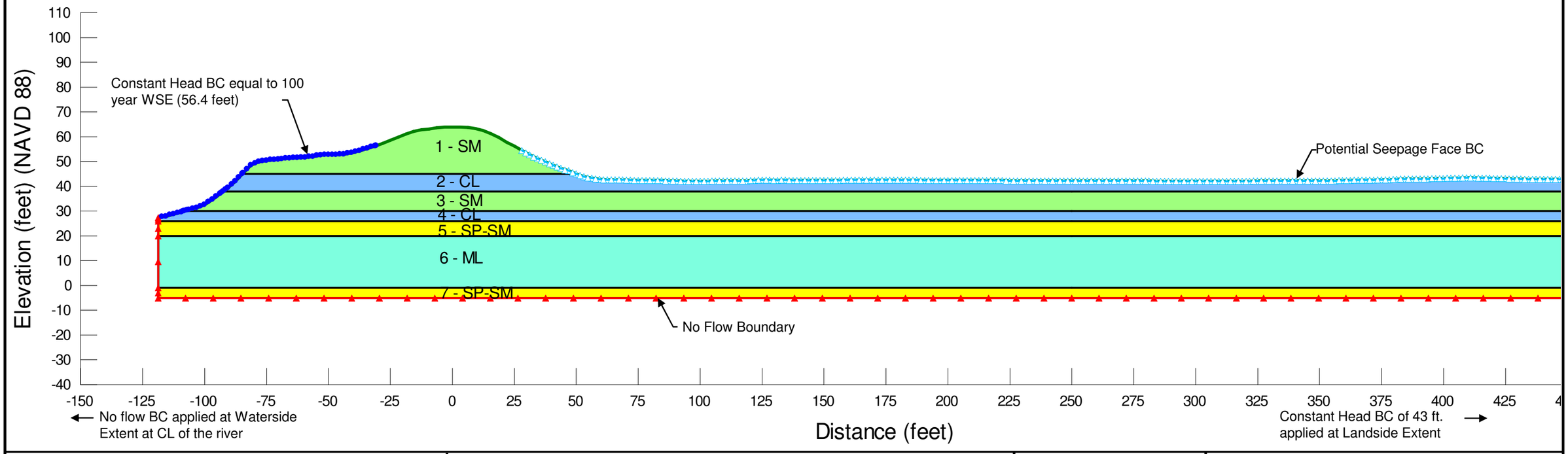
Rio Oso Flood Risk Reduction Feasibility Study

Reach A (YS-L 1030+60)
Seepage Result-100 year WSE

July 2019 FIGURE D-2

Reach B (BR-L 1106+12)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	SM	2.834	1.0E-3	0.25
2	CL	0.028	1.0E-5	0.25
3	SM	2.834	1.0E-3	0.25
4	CL	0.028	1.0E-5	0.25
5	SP-SM	11.336	4.0E-3	0.25
6	ML	0.028	1.0E-5	0.25
7	SP-SM	11.336	4.0E-3	0.25

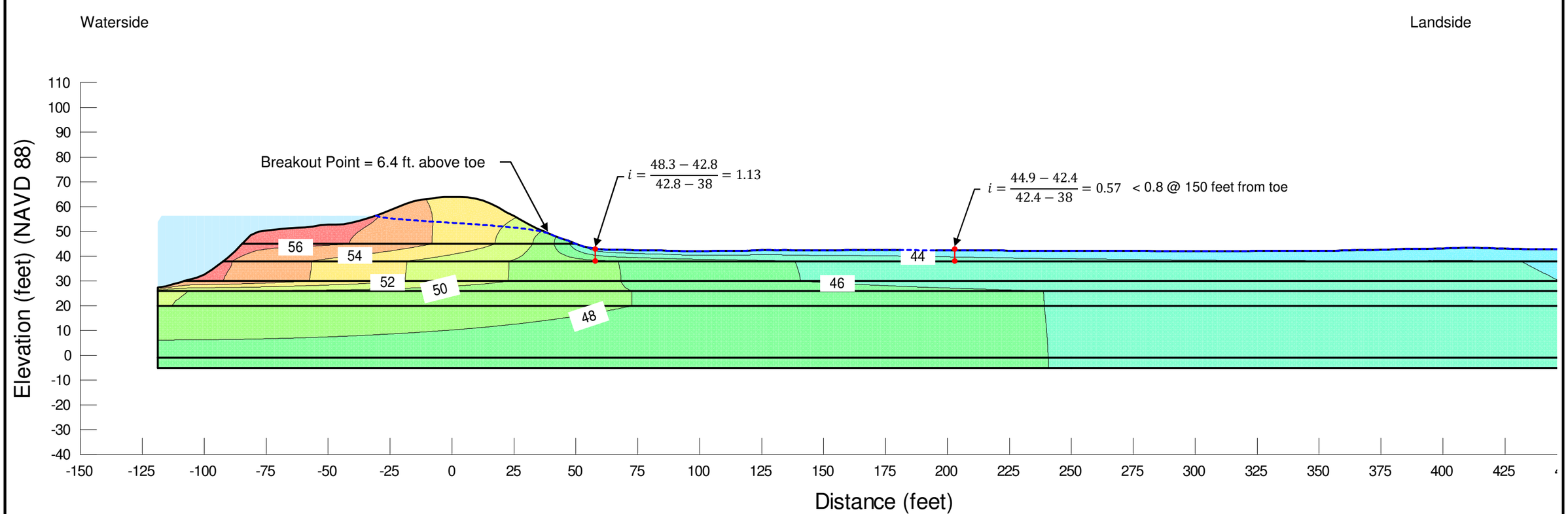


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach B (BR-L 1106+12) Seepage Model-100 year WSE

July 2019 FIGURE D-3



NOTES:

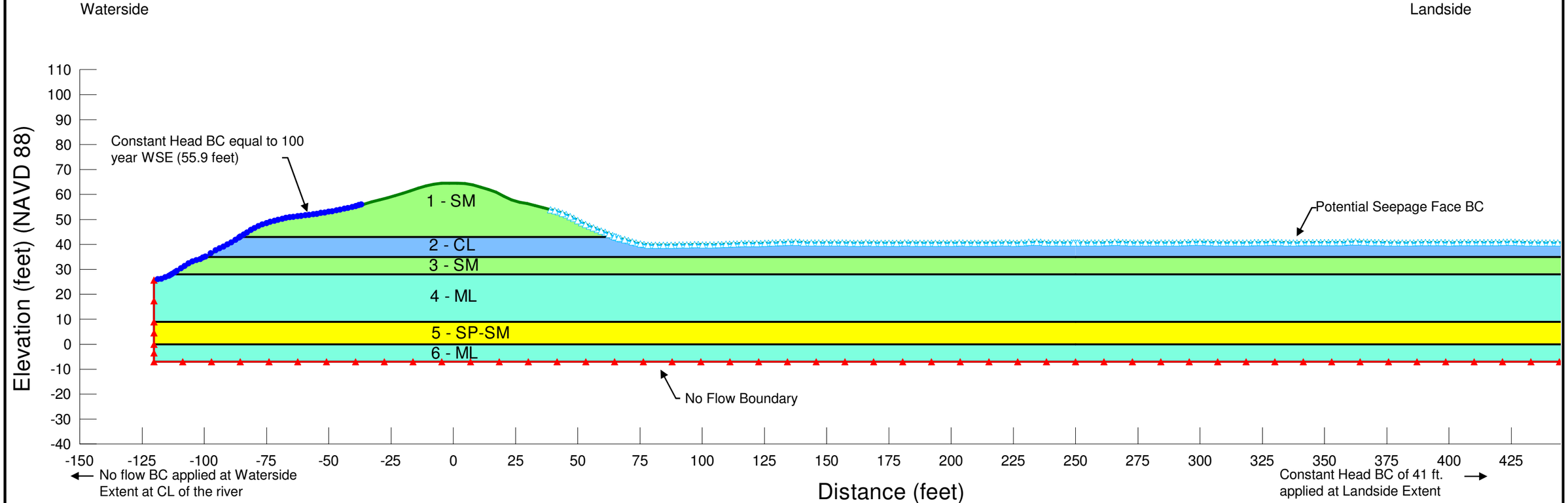
Rio Oso Flood Risk Reduction Feasibility Study

Reach B (BR-L 1106+12)
Seepage Result-100 year WSE

July 2019 FIGURE D-4

Reach C (BR-L 1080+27)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**ML**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25

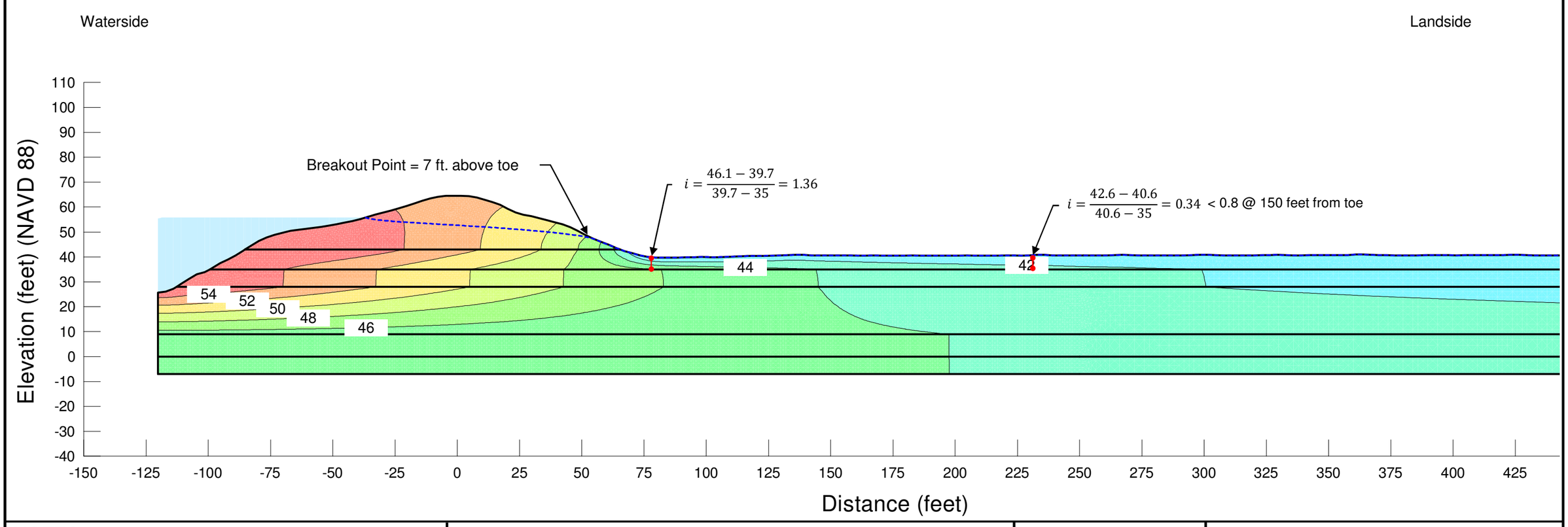


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach C (BR-L 1080+27) Seepage Model-100 year WSE

July 2019 FIGURE D-5



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

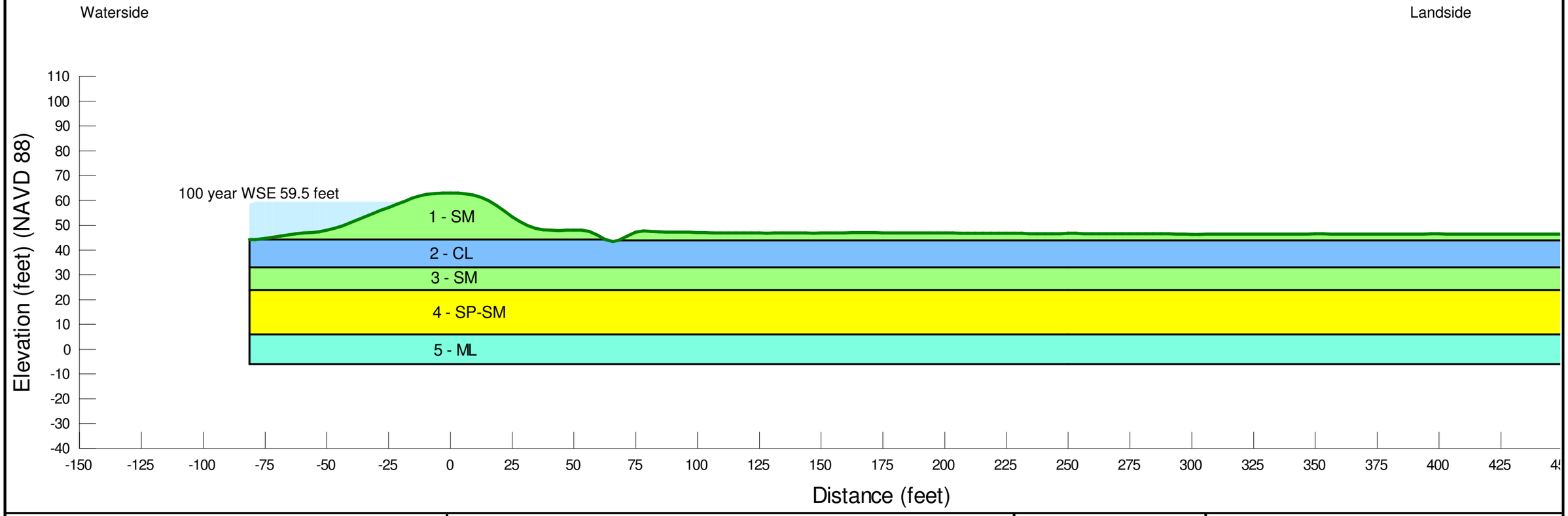
Reach C (BR-L 1080+27)
Seepage Result-100 year WSE

July 2019 FIGURE D-6

Appendix E – Stability Analysis

Reach A (YS-L 1030+60)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	SM	125	0	33	-	-
2	CL	120	100	31	360	4
3	SM	125	0	32	-	-
4	SP-SM	125	0	34	-	-
5	ML	120	50	31	360	4

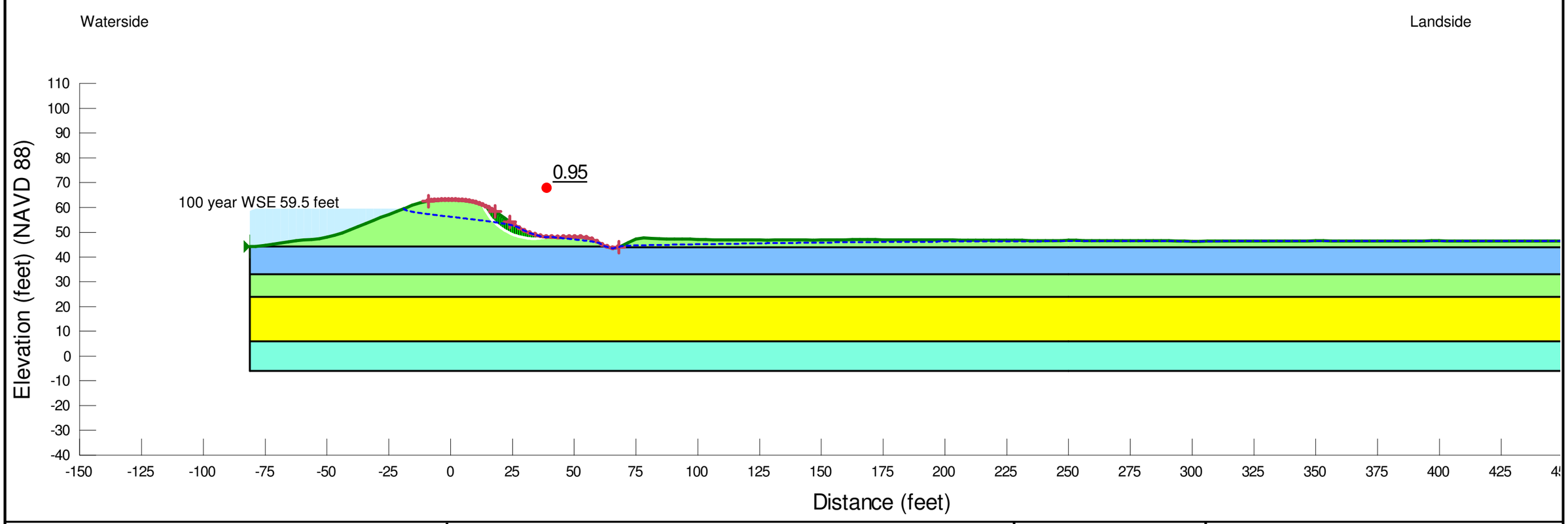


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach A (YS-L 1030+60)
Slope Stability Model

July 2019 FIGURE E-1

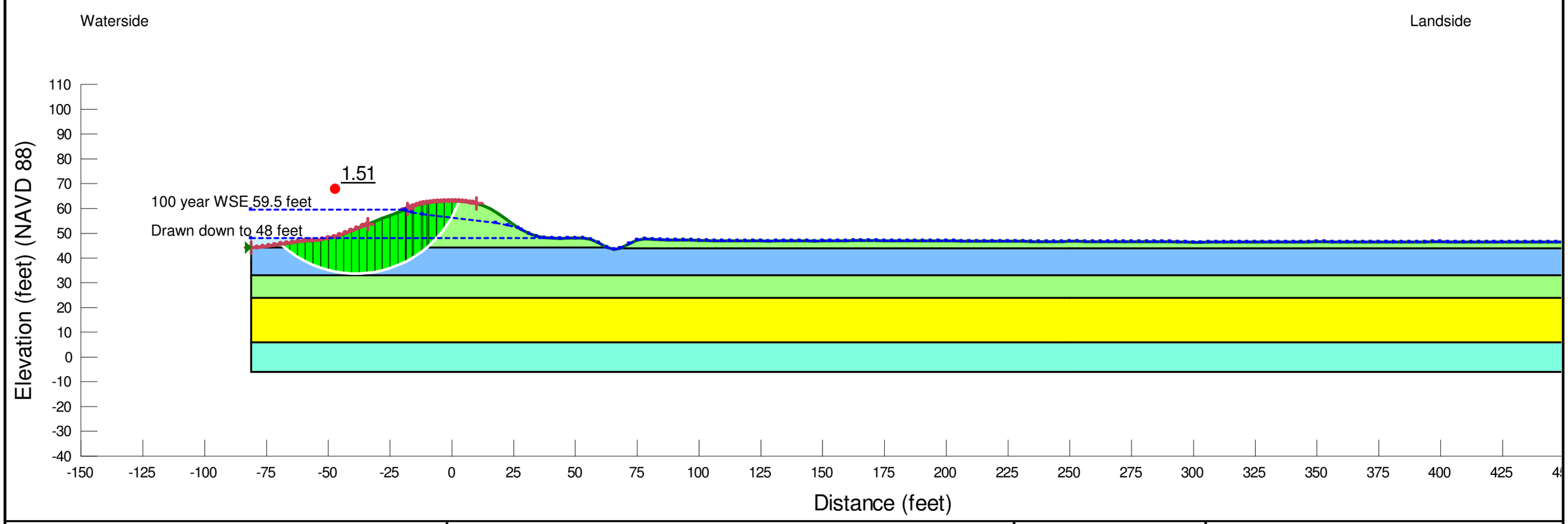


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach A (YS-L 1030+60)
Slope Stability Result-Steady State Landside-100 year WSE

July 2019 FIGURE E-2



NOTES:

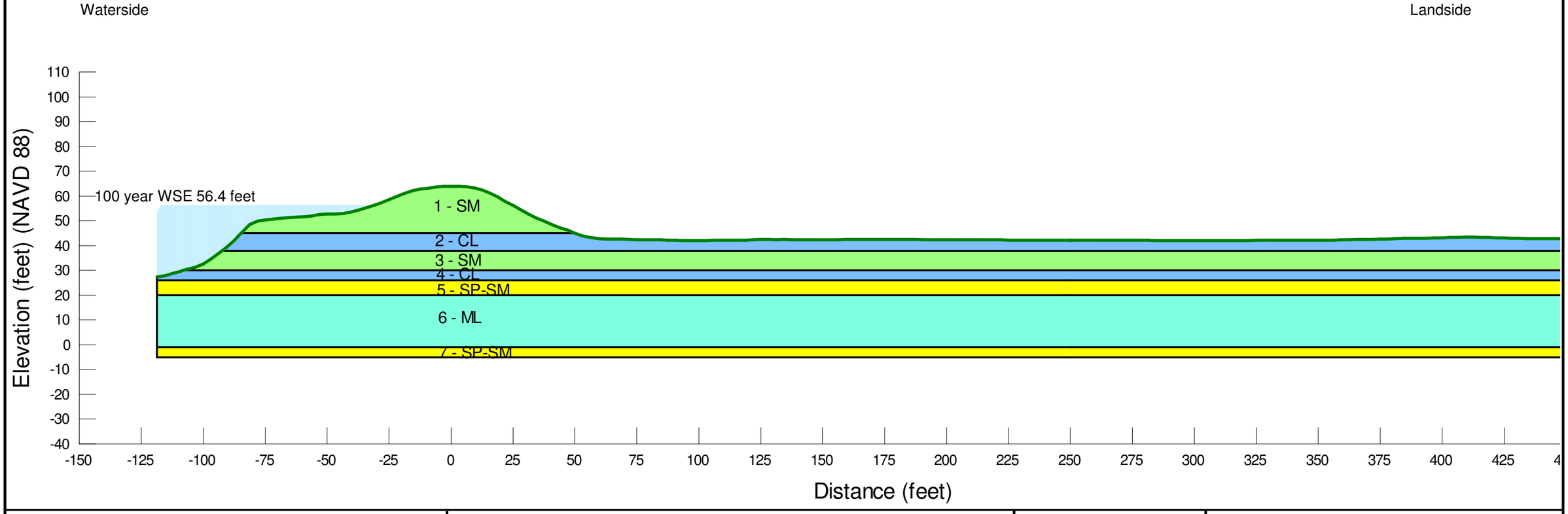
Rio Oso Flood Risk Reduction Feasibility Study

Reach A (YS-L 1030+60)
Slope Stability Result-
Waterside RDD-100 year WSE

July 2019 FIGURE E-3

Reach B (BR-L 1106+12)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**CL**	120	100	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
7	**SP-SM**	125	0	34	-	-

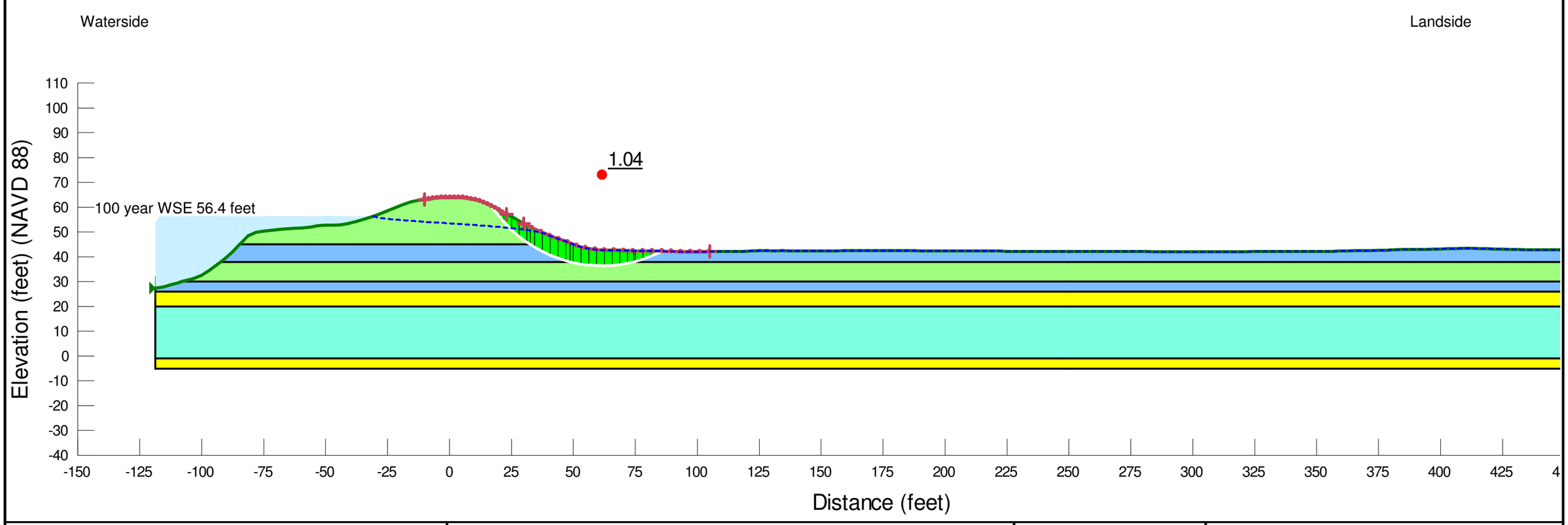


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach B (BR-L 1106+12)
Slope Stability Model

July 2019 FIGURE E-4

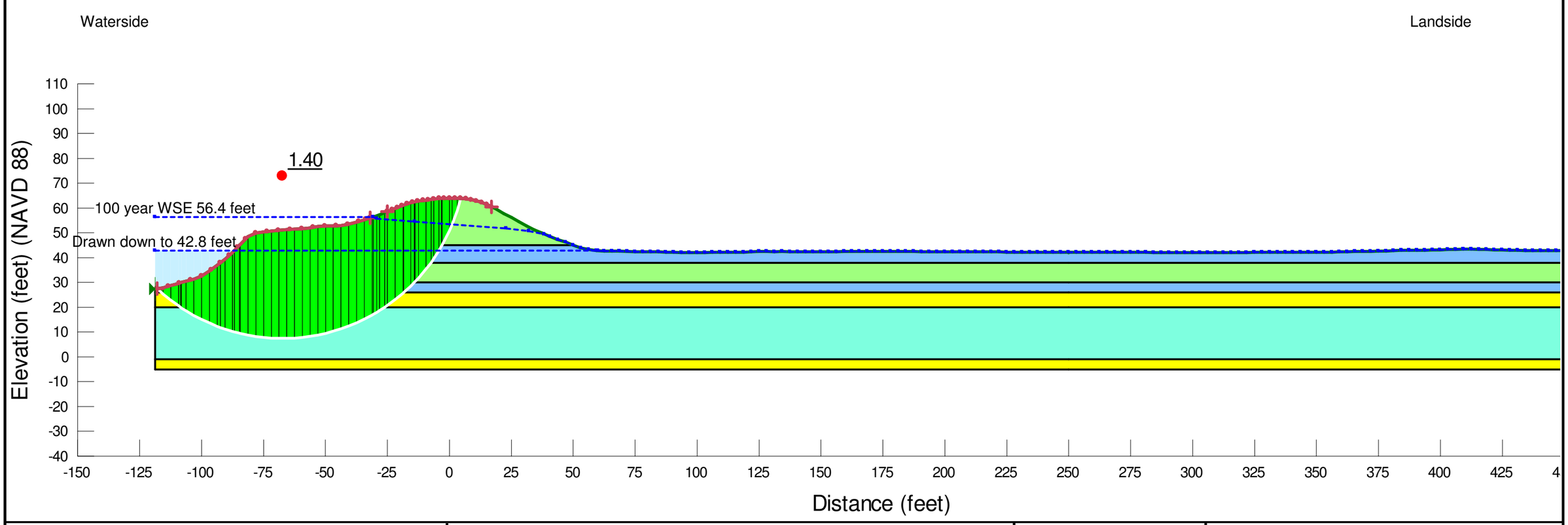


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach B (BR-L 1106+12)
Slope Stability Result-Steady State Landside-100 year WSE

July 2019 FIGURE E-5



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach B (BR-L 1106+12)
Slope Stability Result-
Waterside RDD-100 year WSE

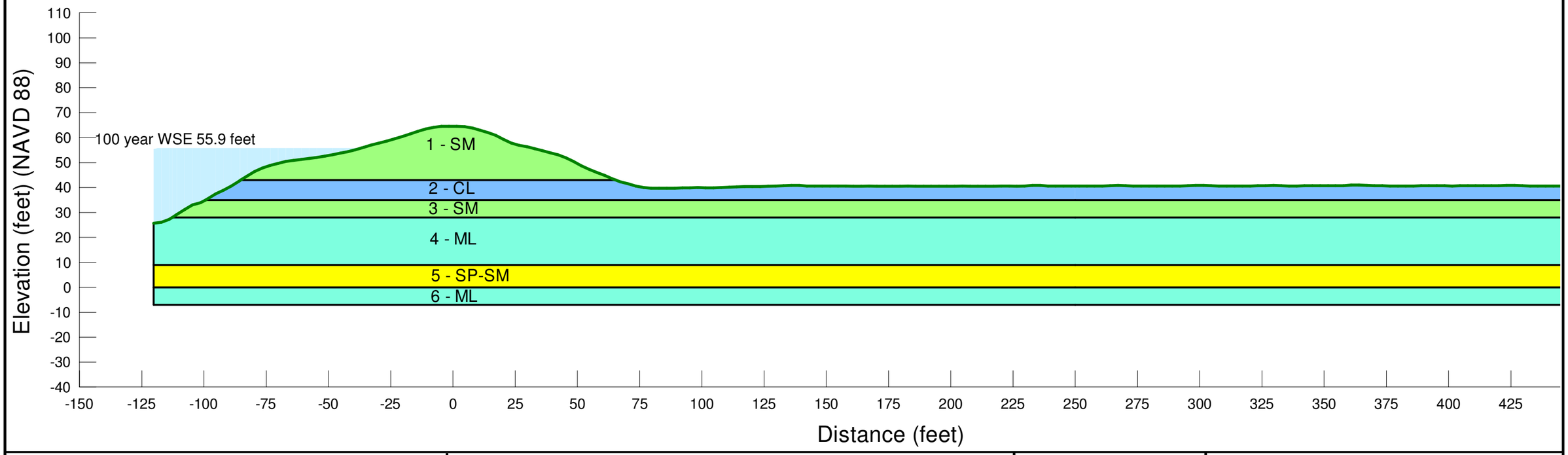
July 2019 FIGURE E-6

Reach C (BR-L 1080+27)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**ML**	120	50	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4

Waterside

Landside

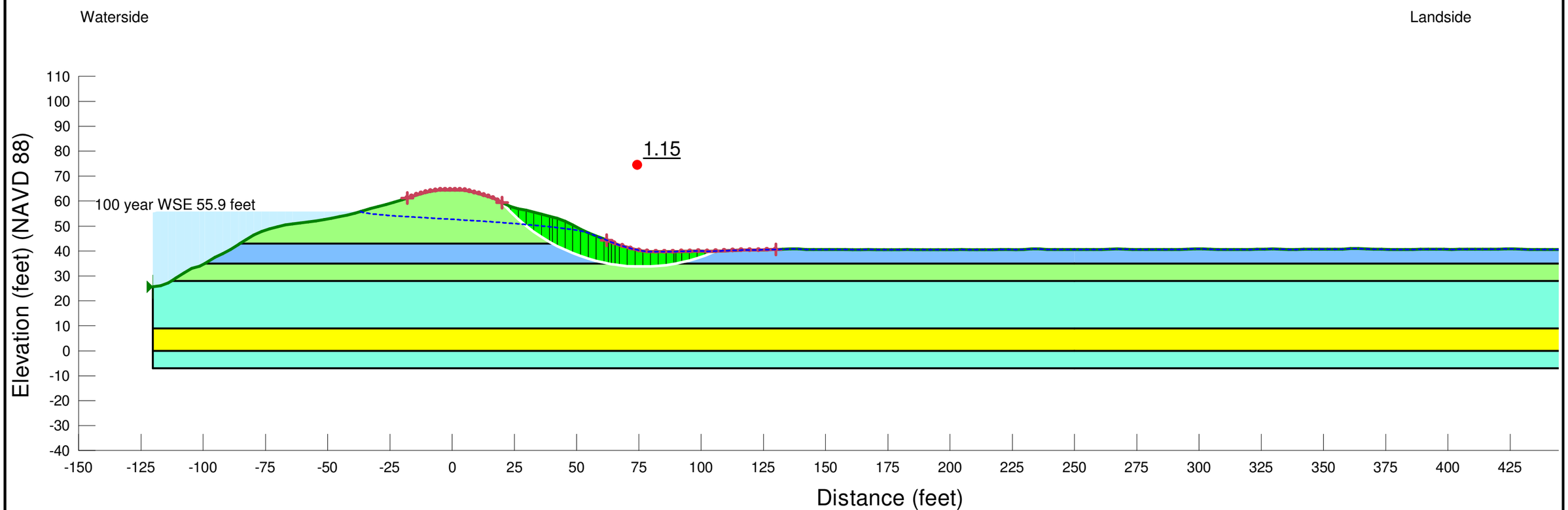


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach C (BR-L 1080+27)
Slope Stability Model

July 2019 FIGURE E-7

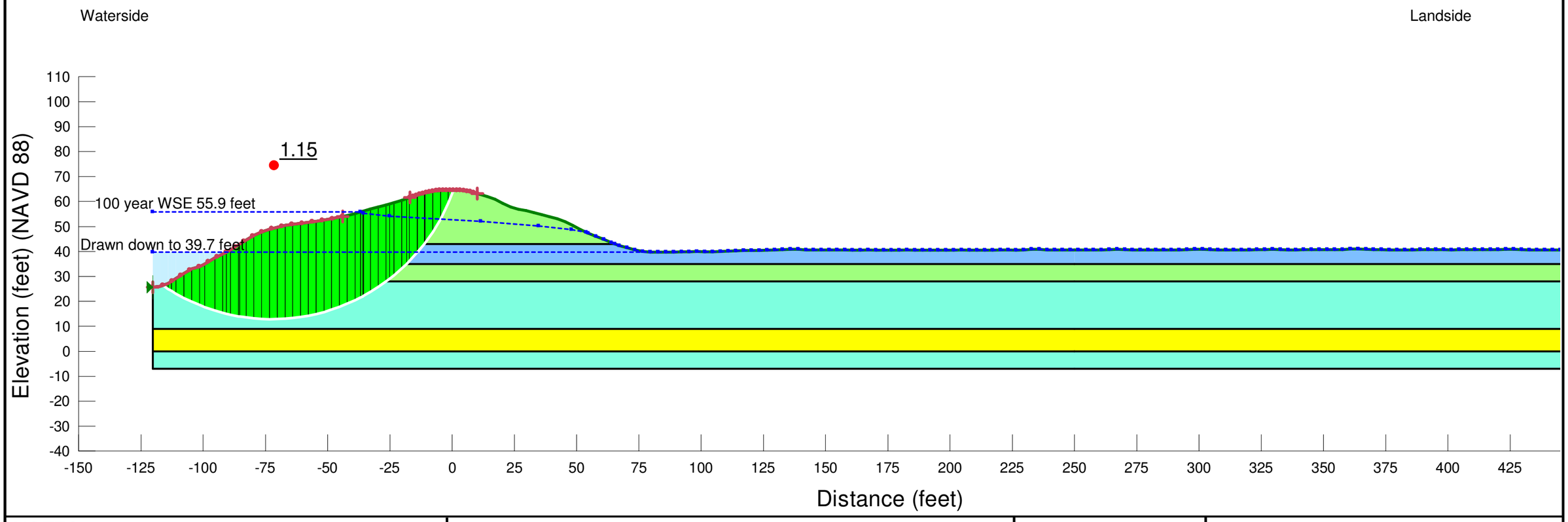


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Reach C (BR-L 1080+27)
Slope Stability Result-Steady State Landside-100 year WSE

July 2019 FIGURE E-8



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

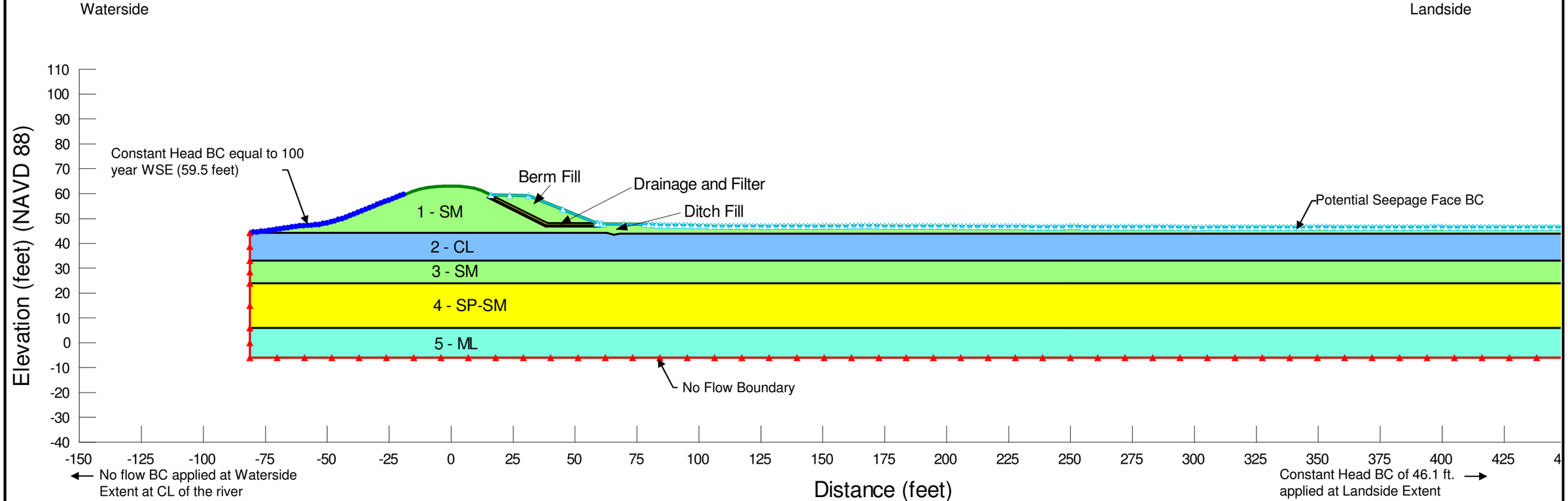
Reach C (BR-L 1080+27)
Slope Stability Result-
Waterside RDD-100 year WSE

July 2019 FIGURE E-9

Appendix F – Remediation Alternatives Analysis

Reach A (YS-L 1030+60)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**SP-SM**	11.336	4.0E-3	0.25
5	**ML**	0.028	1.0E-5	0.25
Berm Fill	**SM**	2.834	1.0E-3	0.25
Drain	**SP**	141.696	5.0E-2	1
Filter	**SP**	2.834	1.0E-3	1

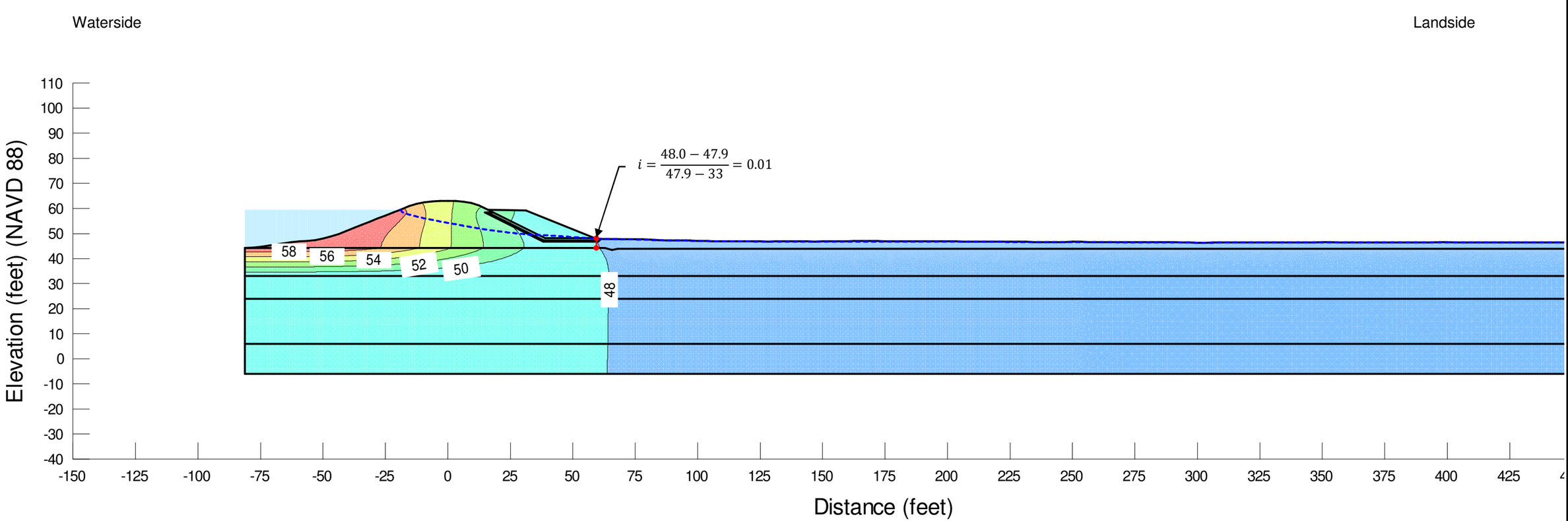


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Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Stability Berm Seepage Model-100 year WSE

Aug 2019 FIGURE F-1



NOTES:

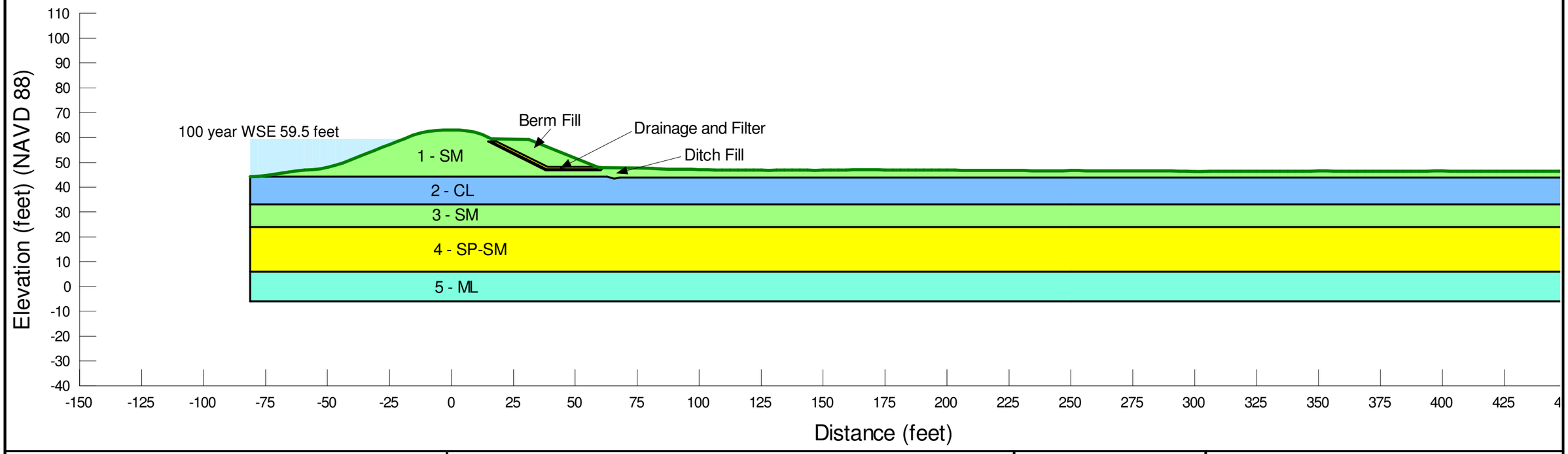
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Stability Berm Seepage Result-100 year WSE

Aug 2019 FIGURE F-2

Reach A (YS-L 1030+60)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	SM	125	0	33	-	-
2	CL	120	100	31	360	4
3	SM	125	0	32	-	-
4	SP-SM	125	0	34	-	-
5	ML	120	50	31	360	4
Berm Fill	SM	120	0	34	-	-
Drain	SP	130	0	34	-	-
Filter	SP	130	0	32	-	-

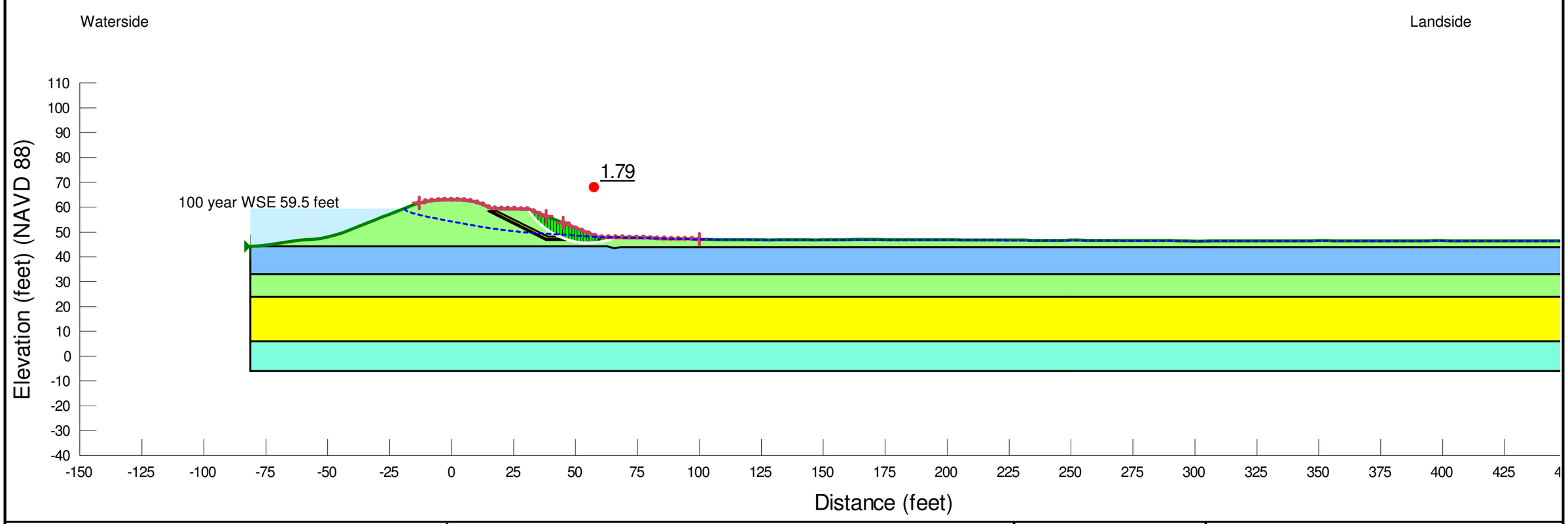


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Stability Berm Slope Stability Model

Aug 2019 FIGURE F-3

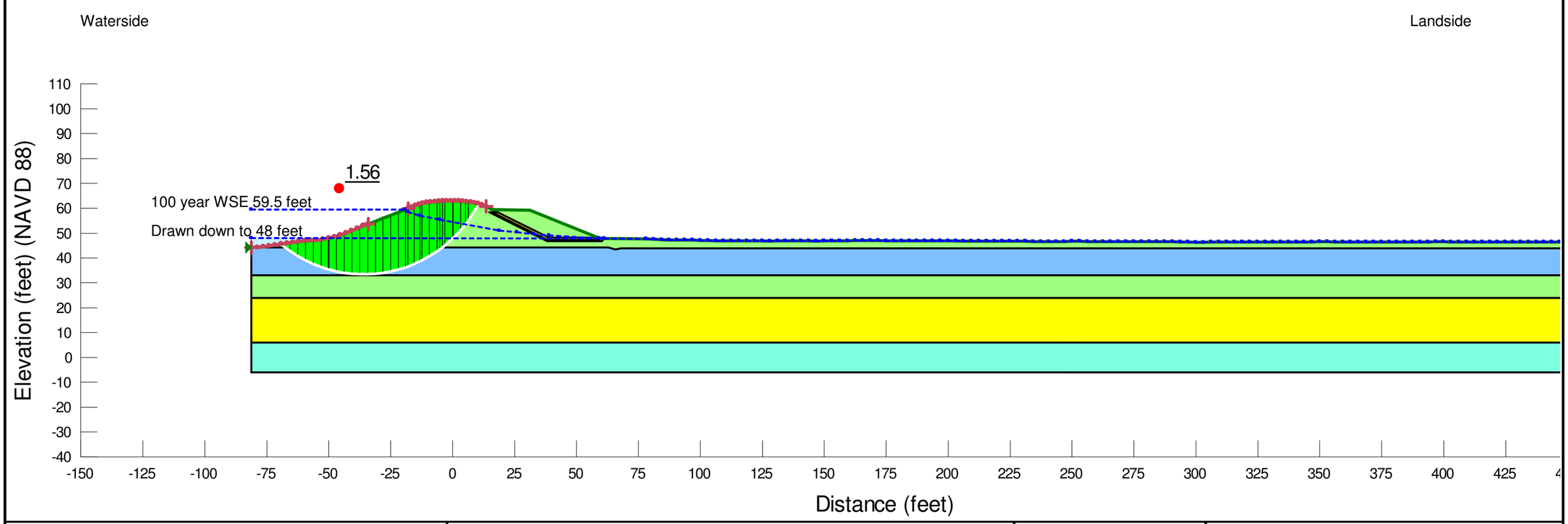


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Stability Berm Slope Stability Result- Steady State Landside-100 year WSE

Aug 2019 FIGURE F-4



NOTES:

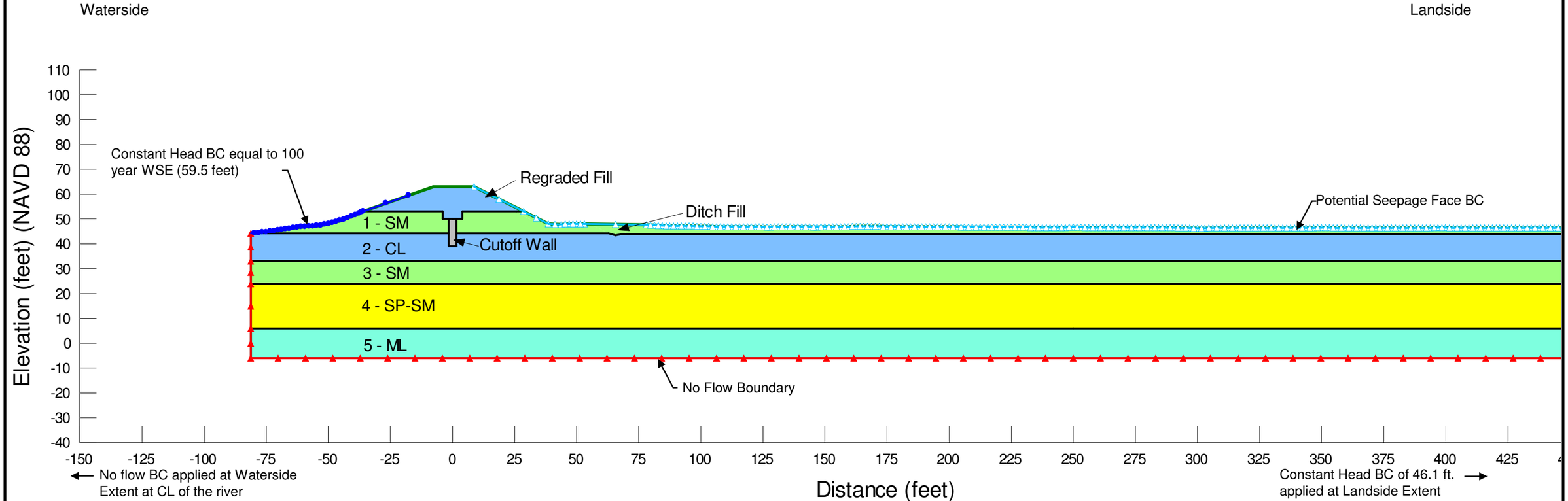
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Stability Berm Slope Stability Result- Waterside RDD-100 year WSE

Aug 2019 FIGURE F-5

Reach A (YS-L 1030+60)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**SP-SM**	11.336	4.0E-3	0.25
5	**ML**	0.028	1.0E-5	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1



NOTES:

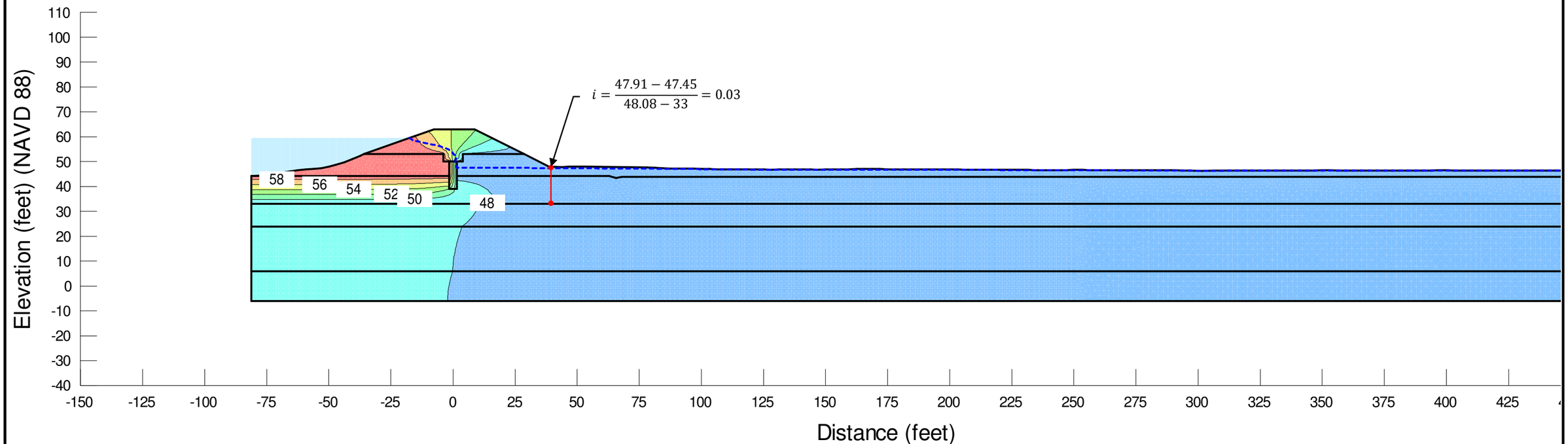
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Half Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-6

Waterside

Landside



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

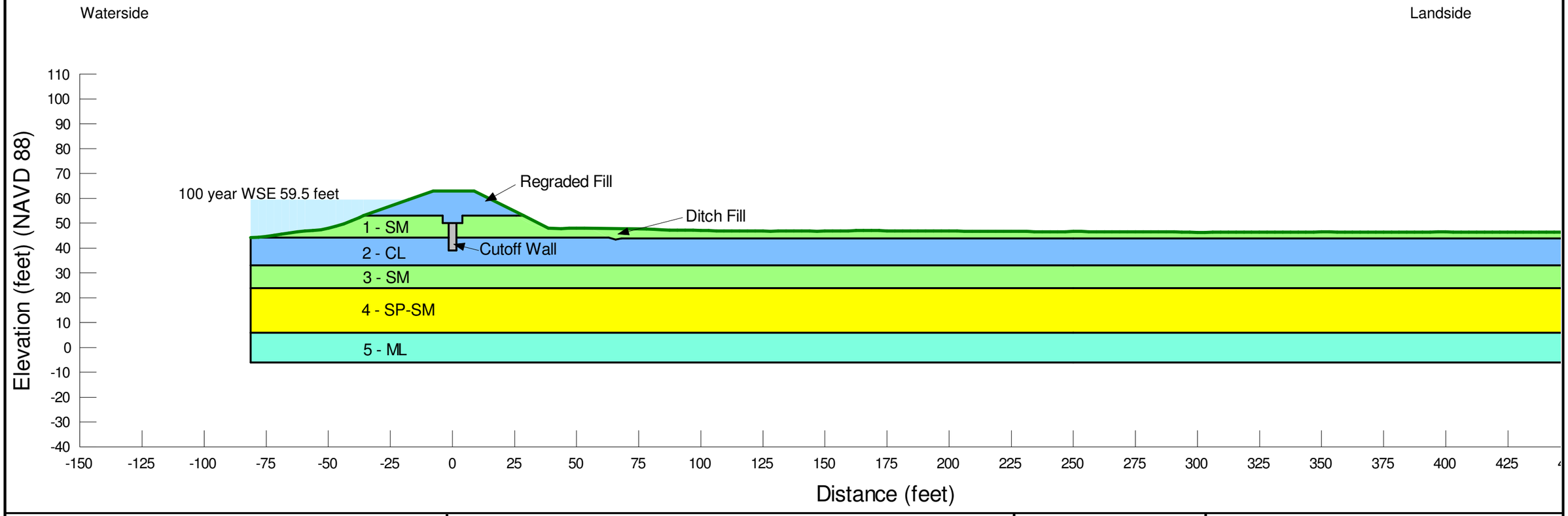
Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Half Levee Degrade Seepage Result-100 year WSE

Aug 2019

FIGURE F-7

Reach A (YS-L 1030+60)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**SP-SM**	125	0	34	-	-
5	**ML**	120	50	31	360	4
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

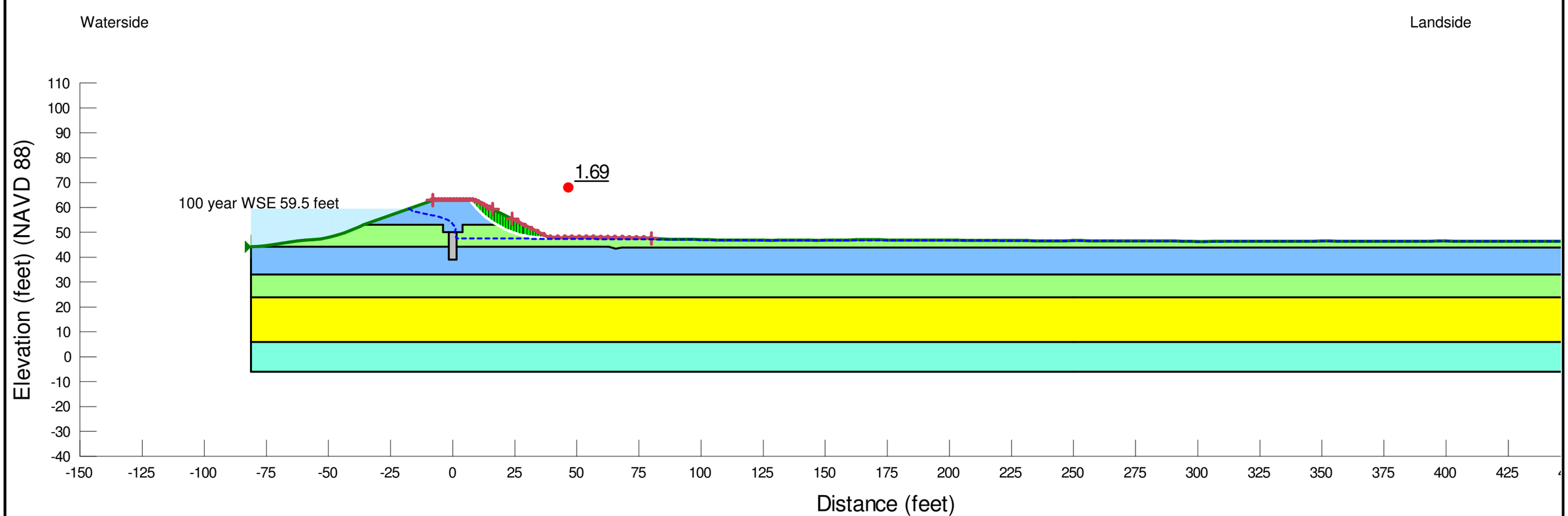


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Half Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-8

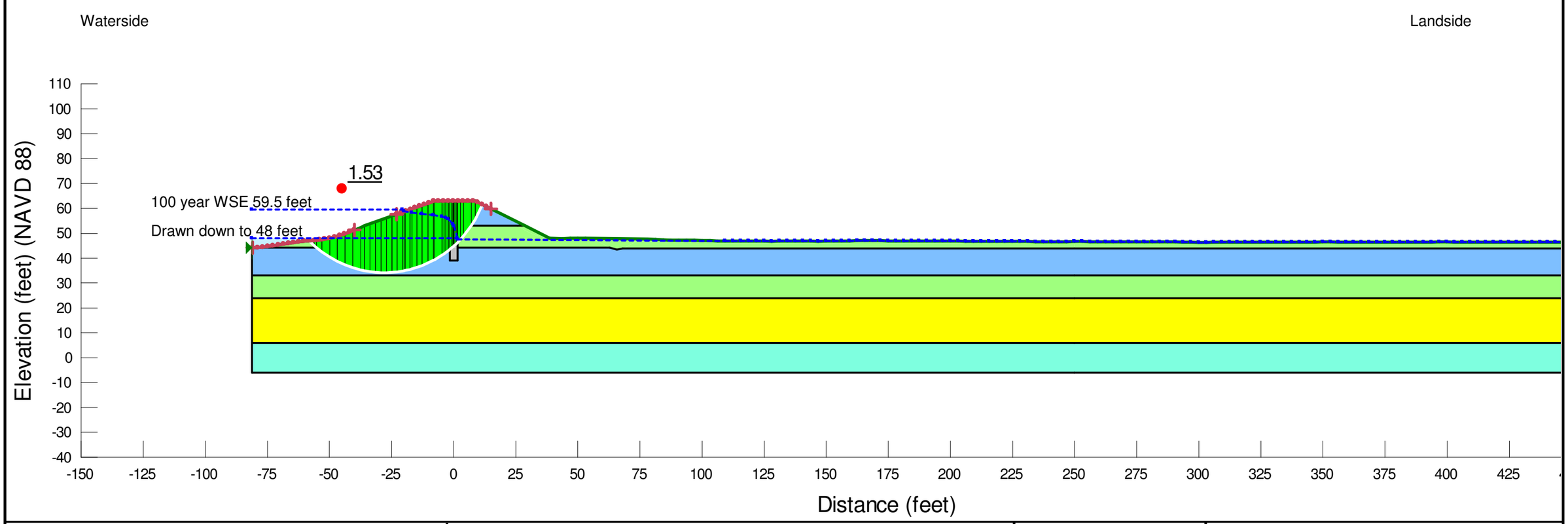


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Half Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-9



NOTES:

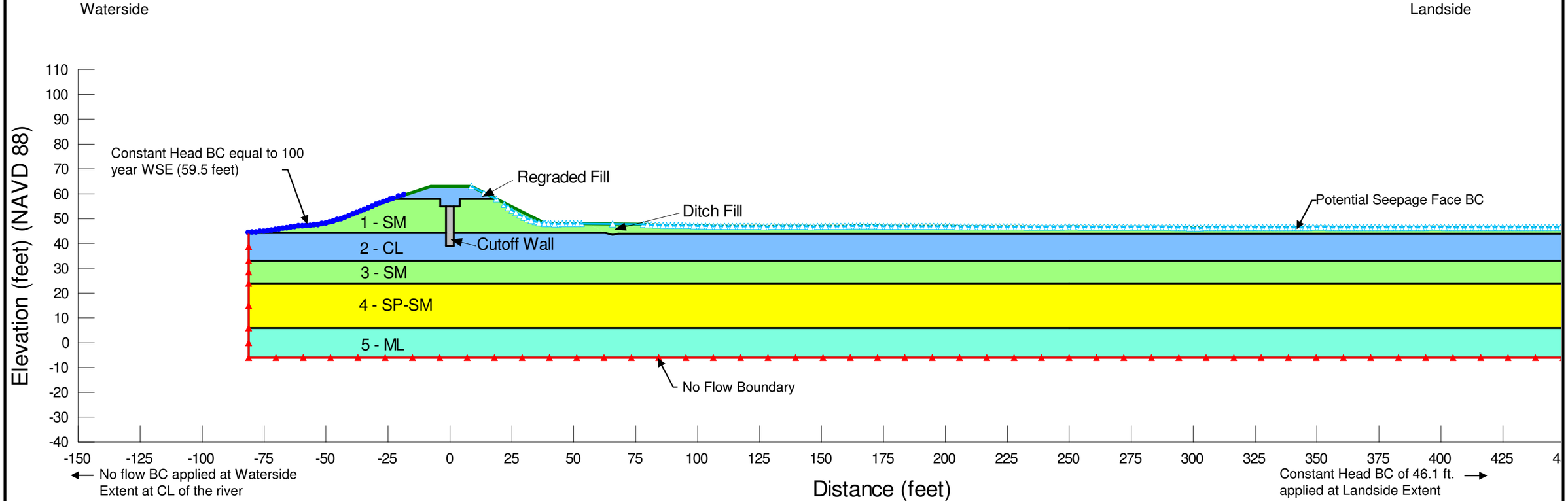
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Half Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-10

Reach A (YS-L 1030+60)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**SP-SM**	11.336	4.0E-3	0.25
5	**ML**	0.028	1.0E-5	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1

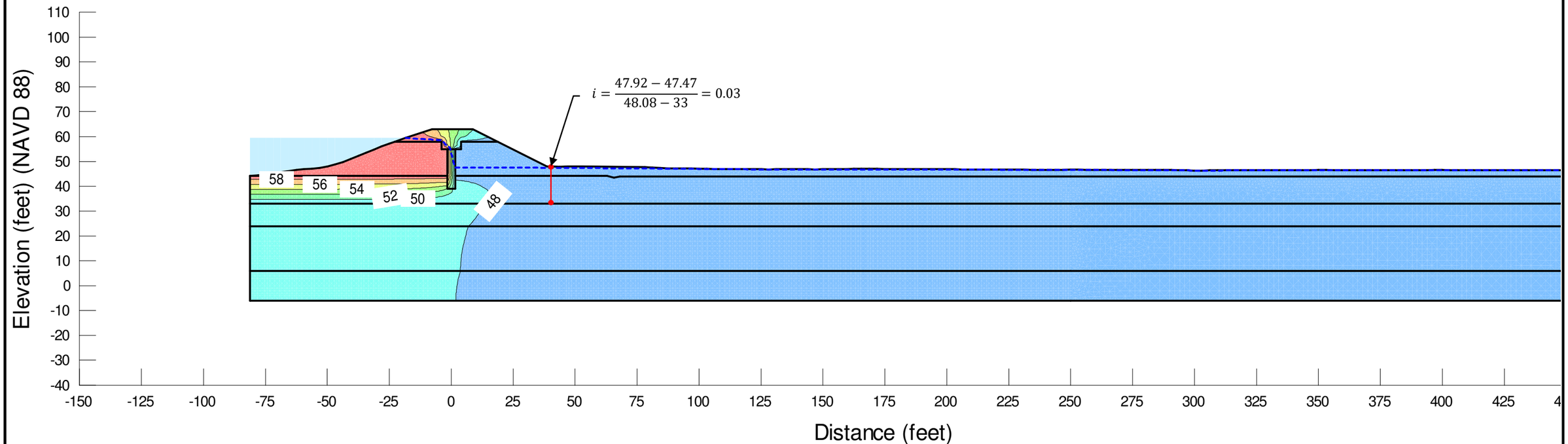


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Third Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-11



NOTES:

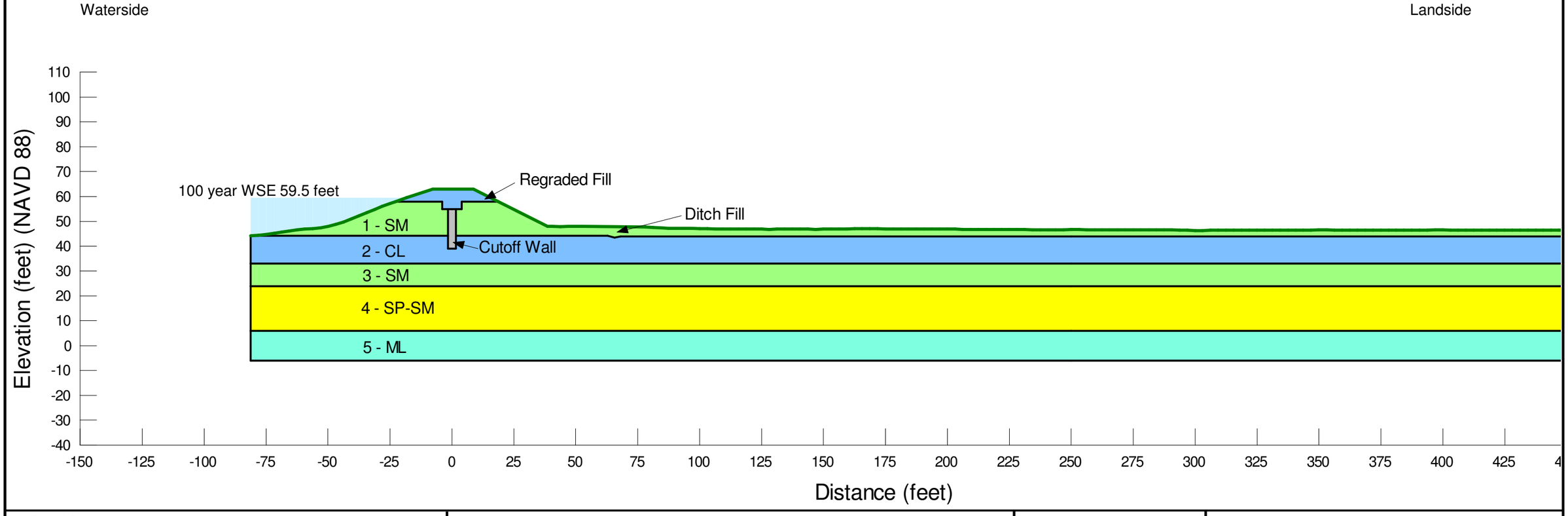
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Third Levee Degrade Seepage Result-100 year WSE

Aug 2019 FIGURE F-12

Reach A (YS-L 1030+60)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**SP-SM**	125	0	34	-	-
5	**ML**	120	50	31	360	4
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

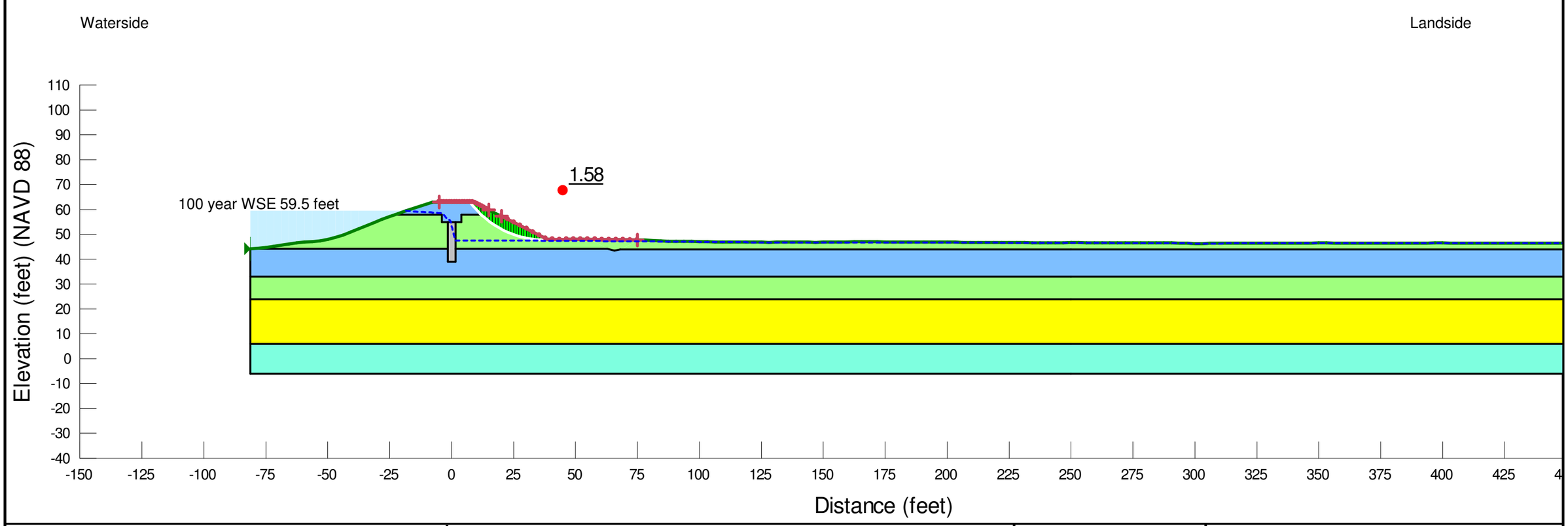


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Third Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-13

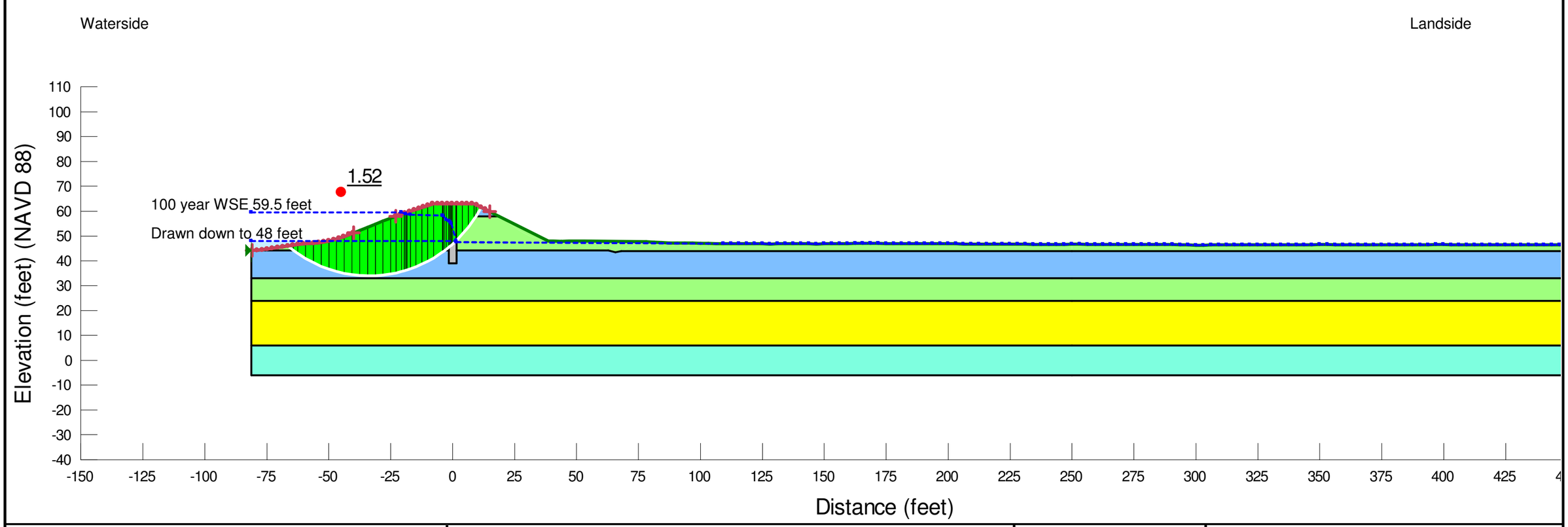


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Third Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-14



NOTES:

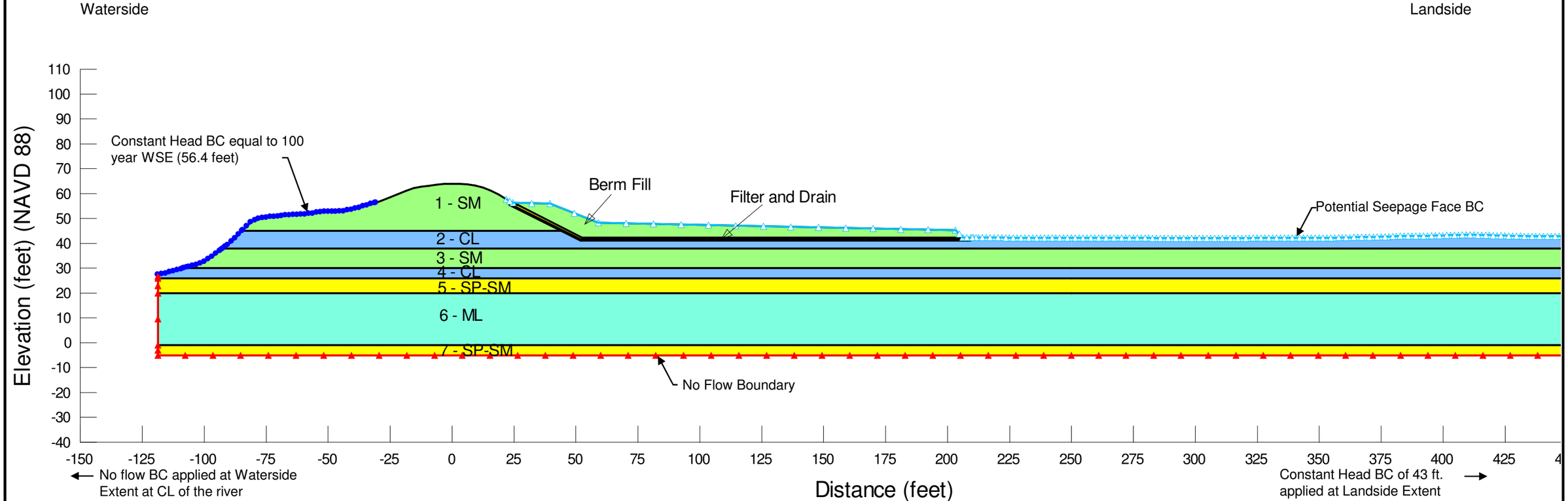
Rio Oso Flood Risk Reduction Feasibility Study

Segment 145 Reach A (YS-L 1030+60) Cutoff Wall Third Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-15

Reach B (BR-L 1106+12)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**CL**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
7	**SP-SM**	11.336	4.0E-3	0.25
Berm Fill	**SM**	2.834	1.0E-3	0.25
Drain	**SP**	141.696	5.0E-2	1
Filter	**SP**	2.834	1.0E-3	1

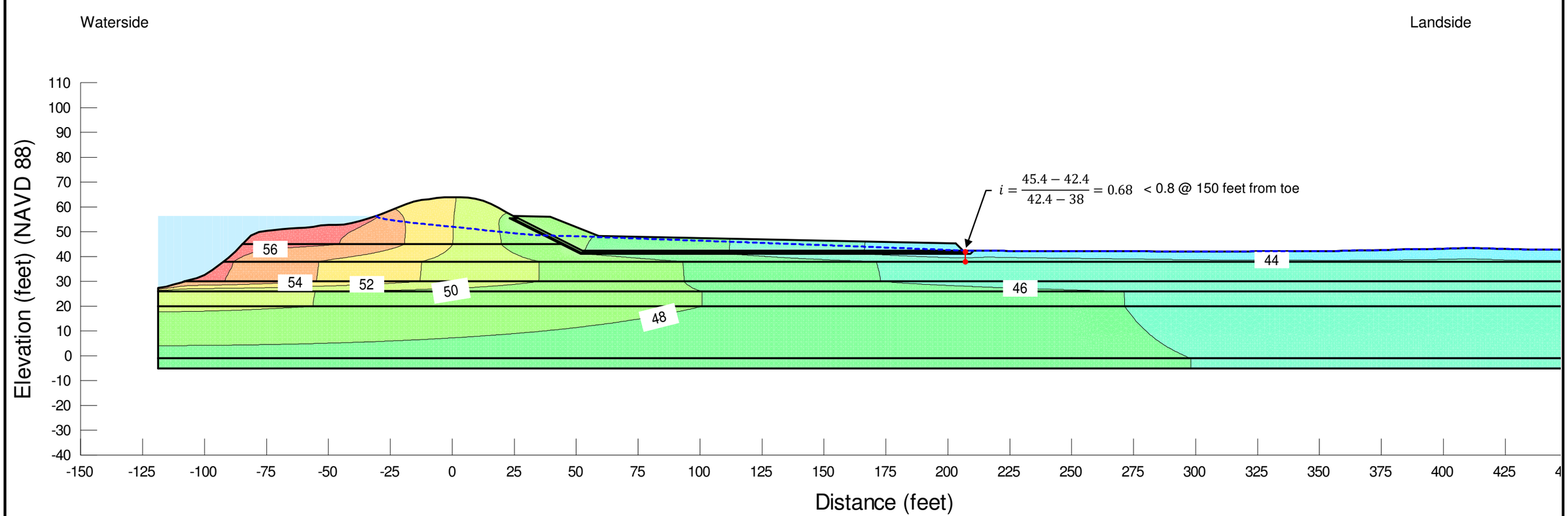


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Combined Berm Seepage Model-100 year WSE

Aug 2019 FIGURE F-16



NOTES:

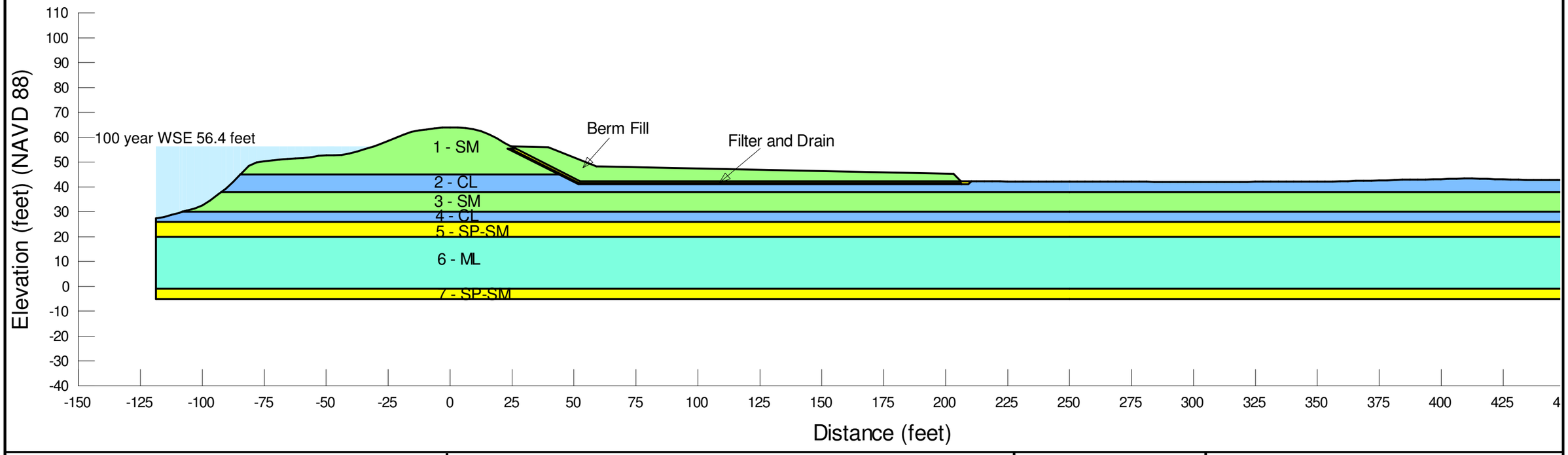
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Combined Berm Seepage Result-100 year WSE

Aug 2019 FIGURE F-17

Reach B (BR-L 1106+12)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**CL**	120	100	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
7	**SP-SM**	125	0	34	-	-
Berm Fill	**SM**	120	0	34	-	-
Drain	**SP**	130	0	34	-	-
Filter	**SP**	130	0	32	-	-

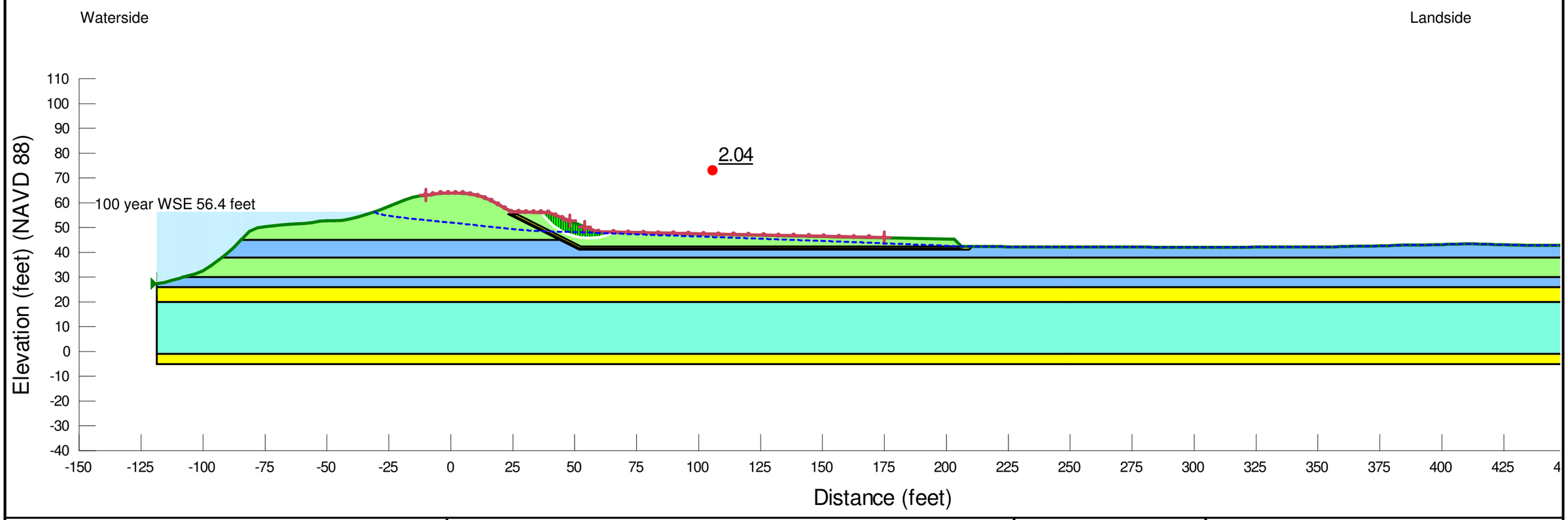


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12)
Combined Berm Slope Stability Model

Aug 2019 FIGURE F-18

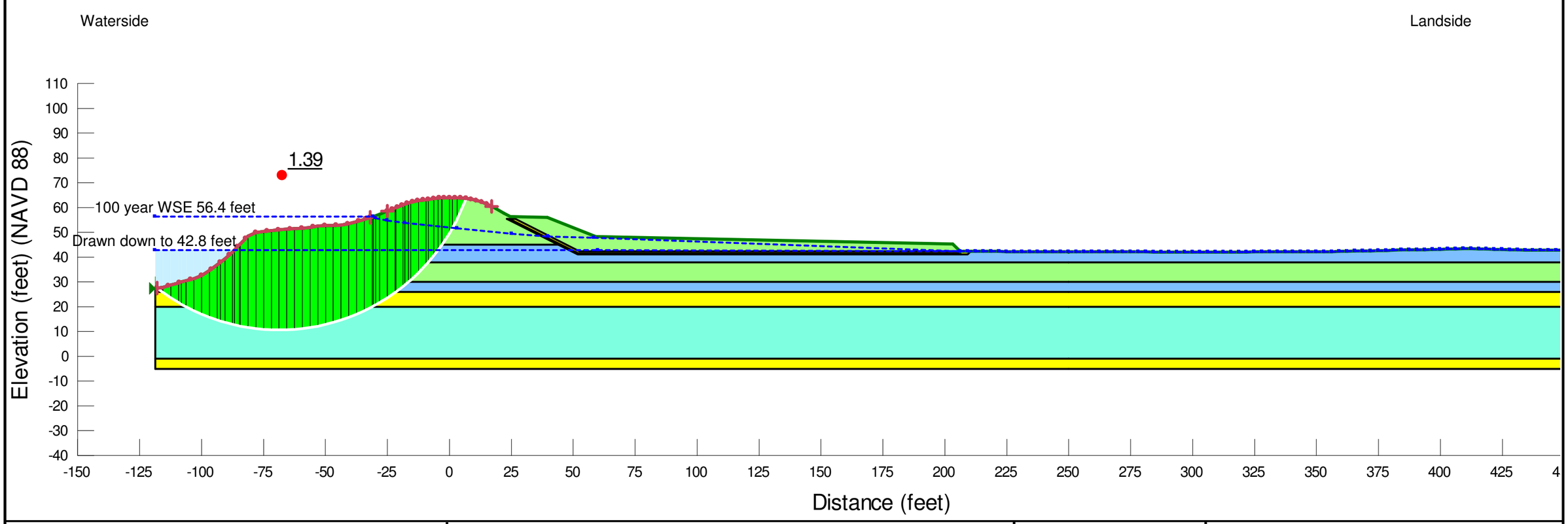


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Combined Berm Slope Stability Result- Steady State Landside-100 year WSE

Aug 2019 FIGURE F-19



NOTES:

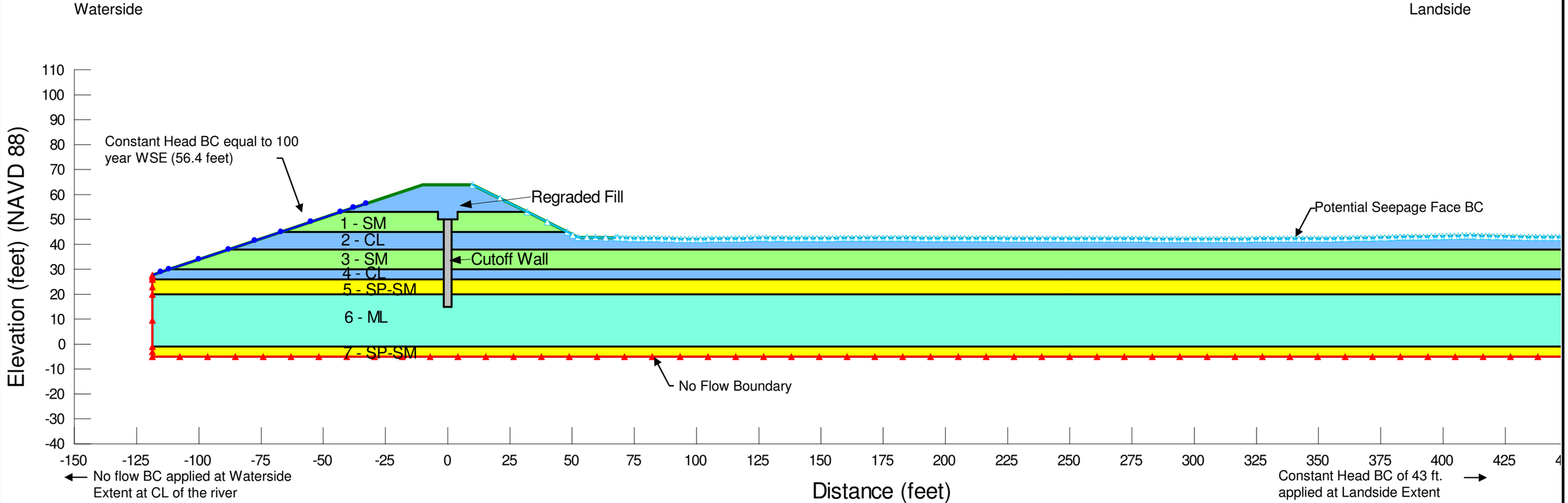
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Combined Berm Slope Stability Result- Waterside RDD-100 year WSE

Aug 2019 FIGURE F-20

Reach B (BR-L 1106+12)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**CL**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
7	**SP-SM**	11.336	4.0E-3	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1

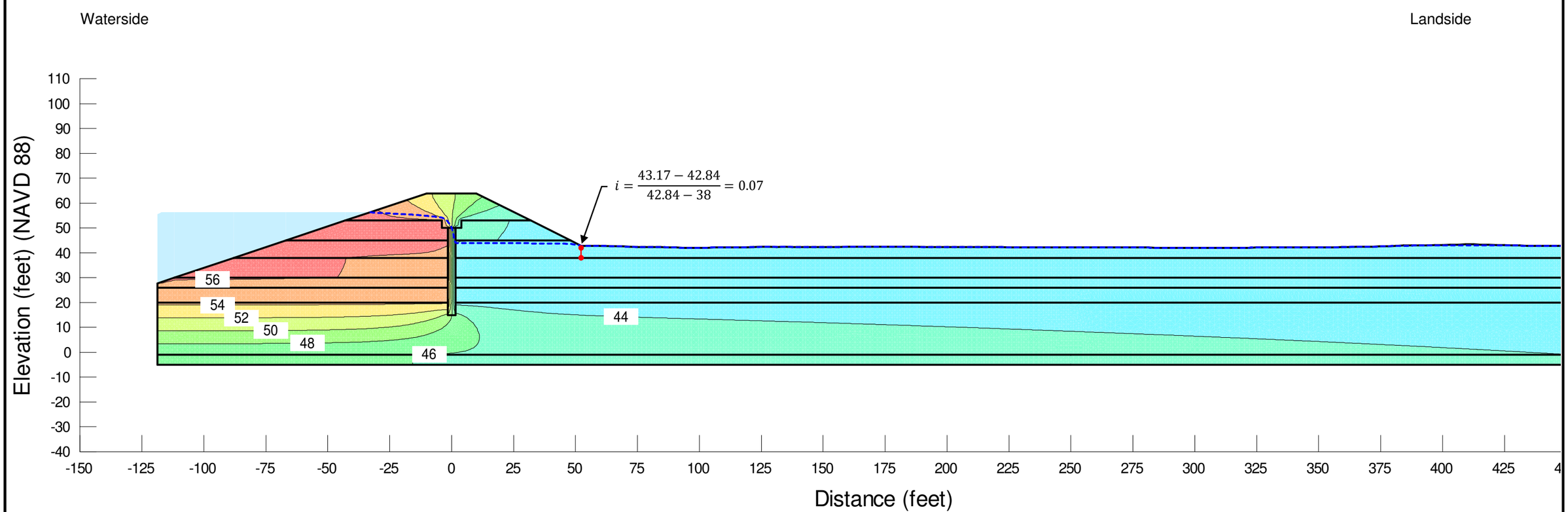


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Half Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-21



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Half Levee Degrade Seepage Result-100 year WSE

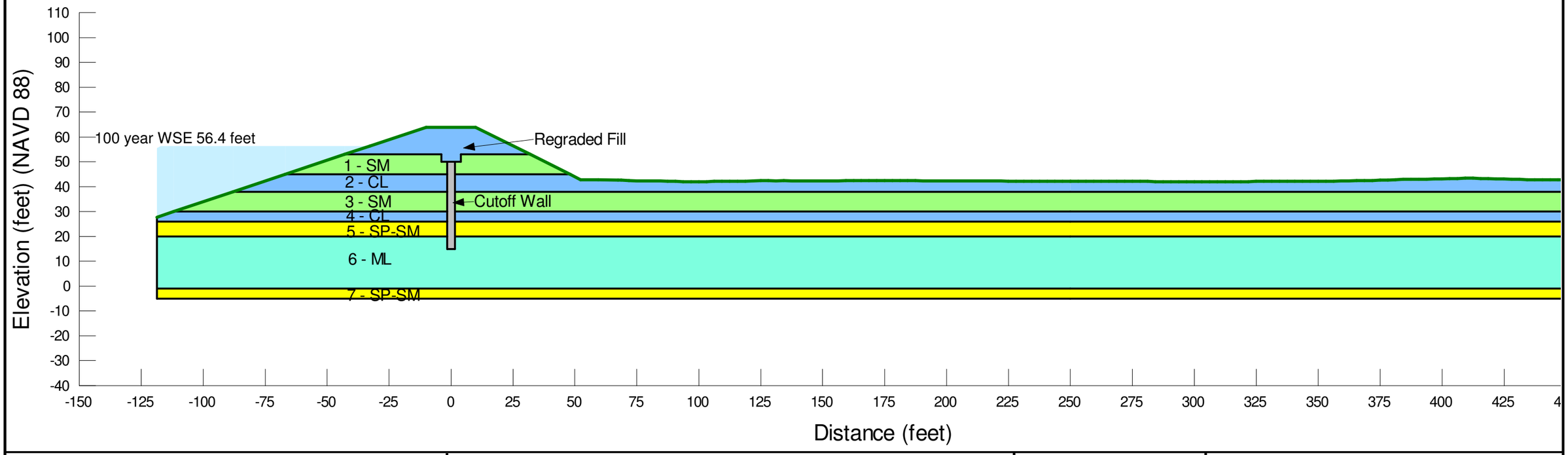
Aug 2019 FIGURE F-22

Reach B (BR-L 1106+12)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**CL**	120	100	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
7	**SP-SM**	125	0	34	-	-
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

Waterside

Landside

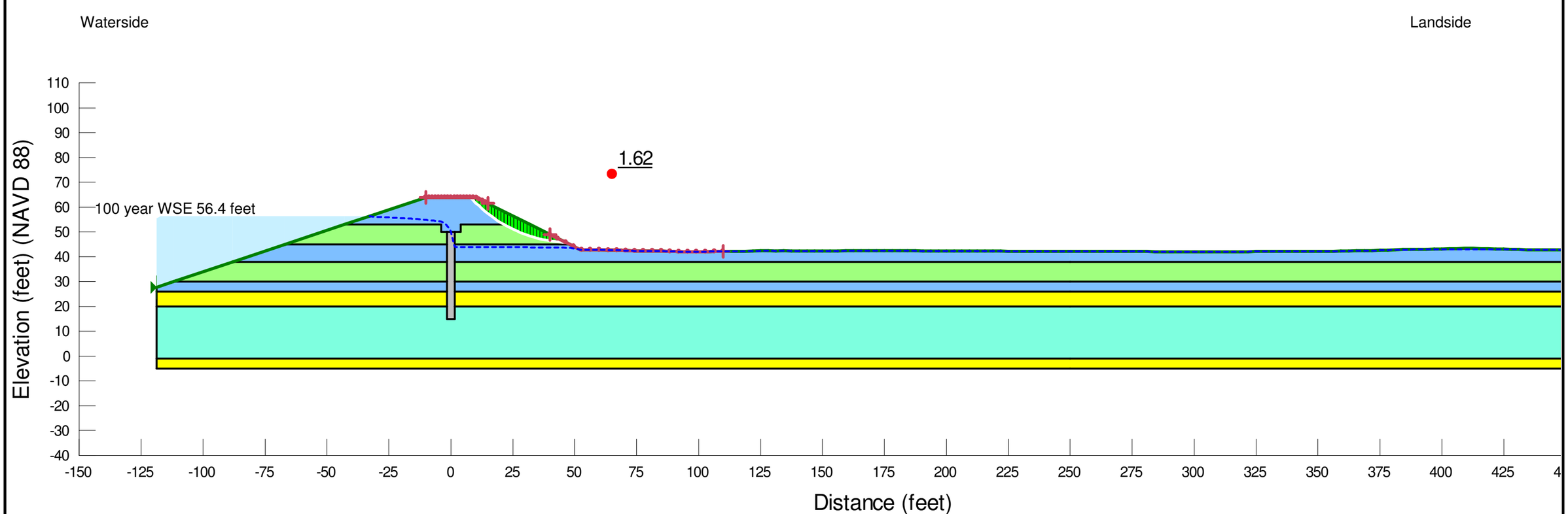


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Half Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-23

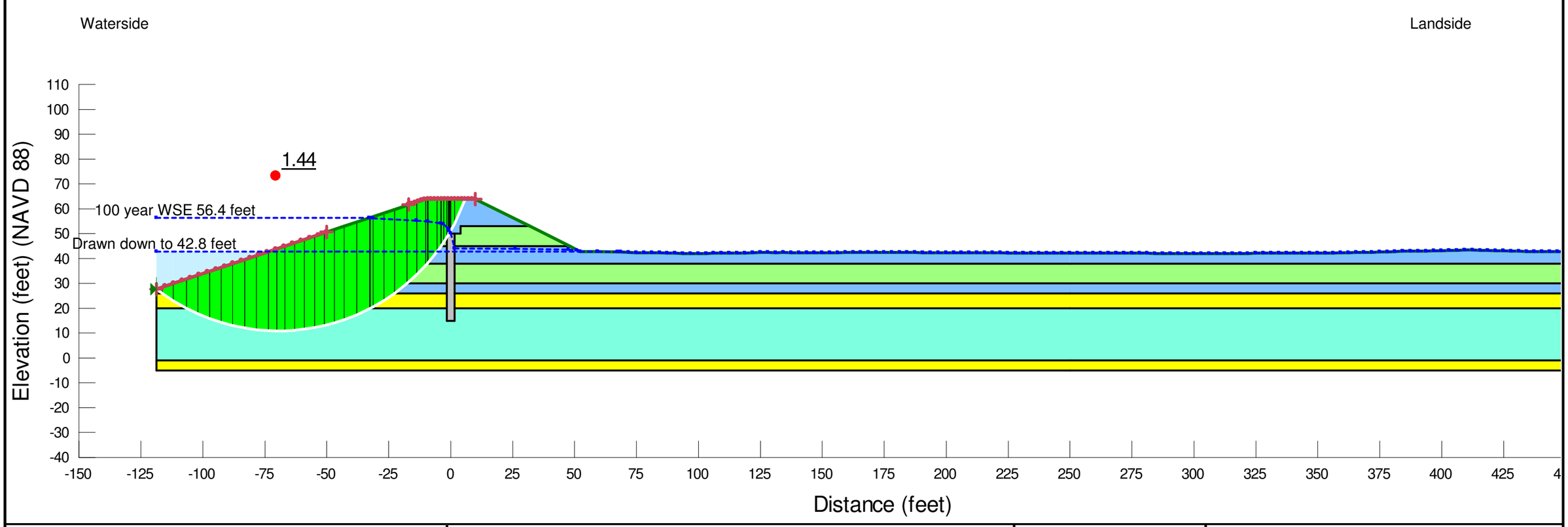


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Half Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-24



NOTES:

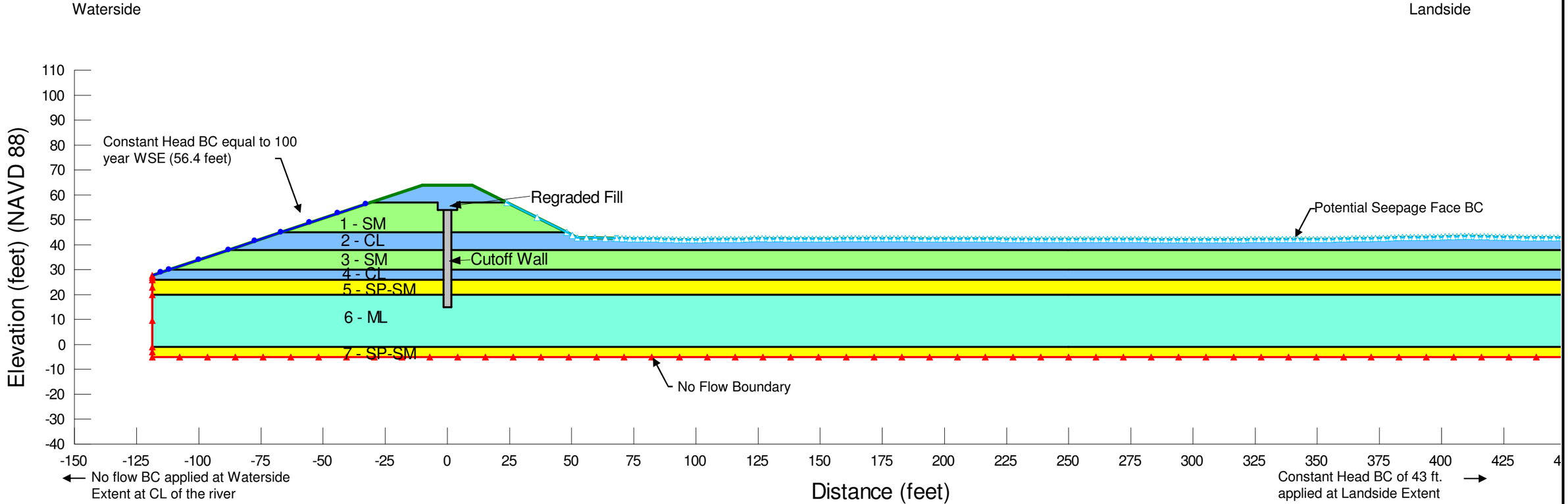
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Half Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-25

Reach B (BR-L 1106+12)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**CL**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
7	**SP-SM**	11.336	4.0E-3	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1

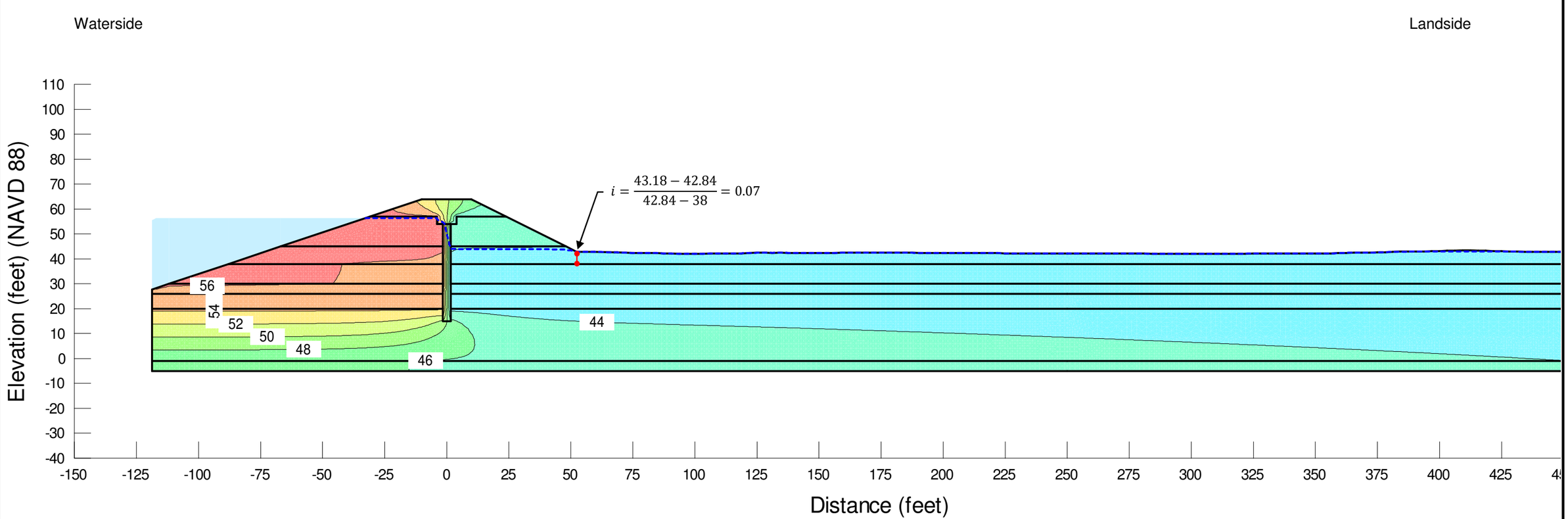


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Third Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-26



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Third Levee Degrade Seepage Result-100 year WSE

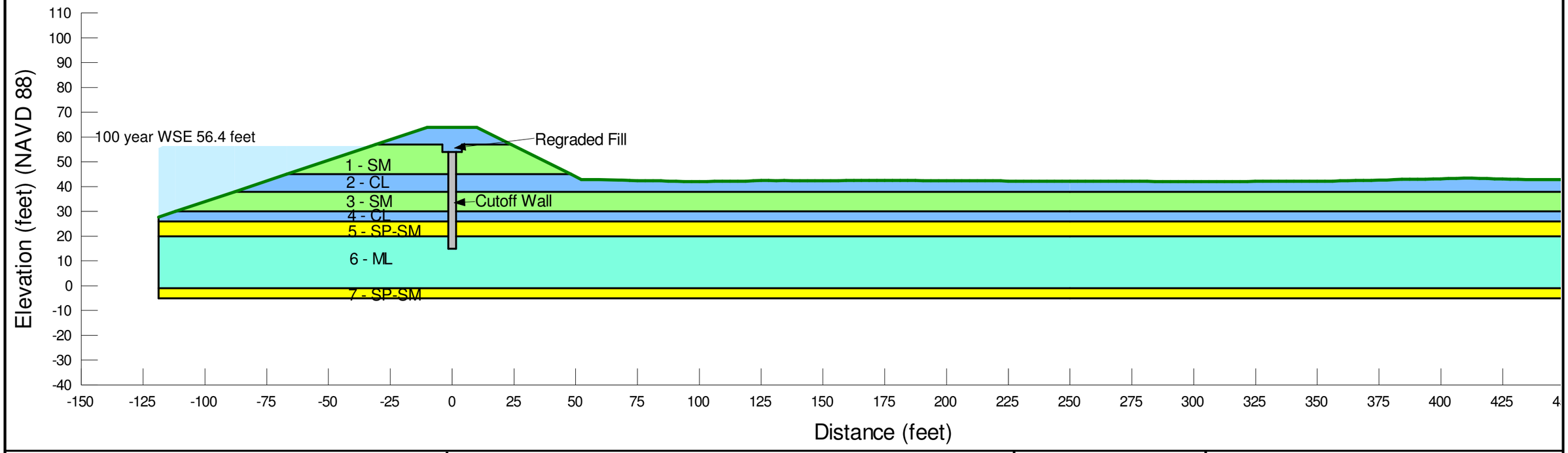
Aug 2019 FIGURE F-27

Reach B (BR-L 1106+12)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**CL**	120	100	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
7	**SP-SM**	125	0	34	-	-
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

Waterside

Landside

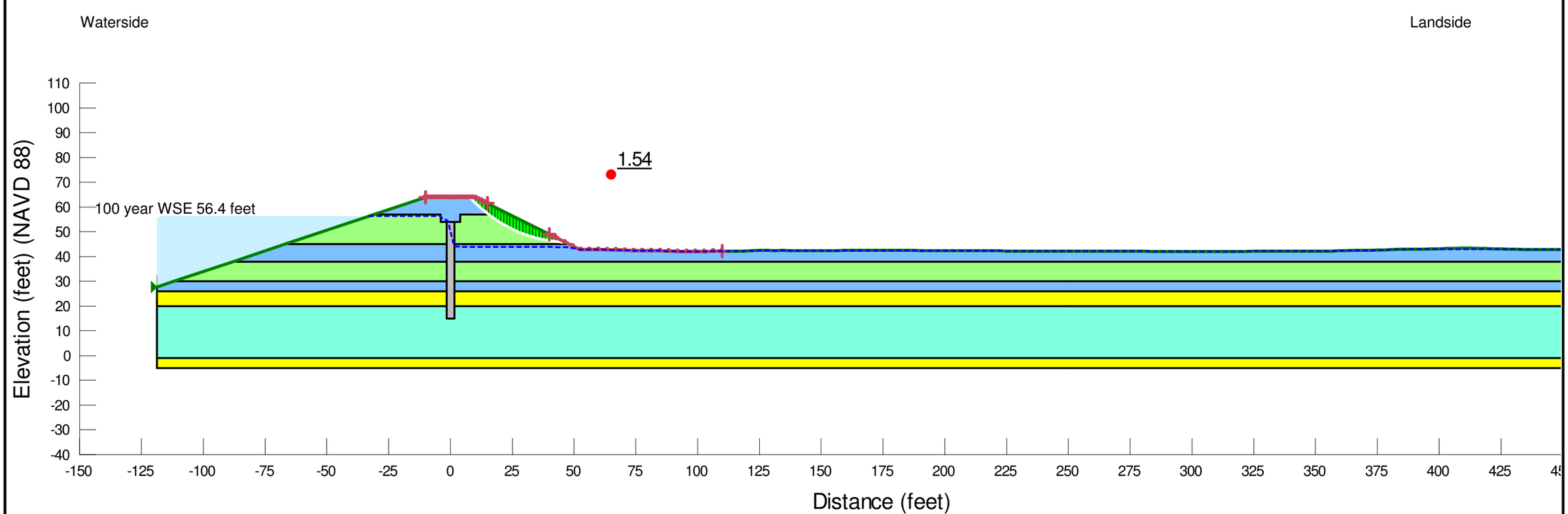


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Third Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-28

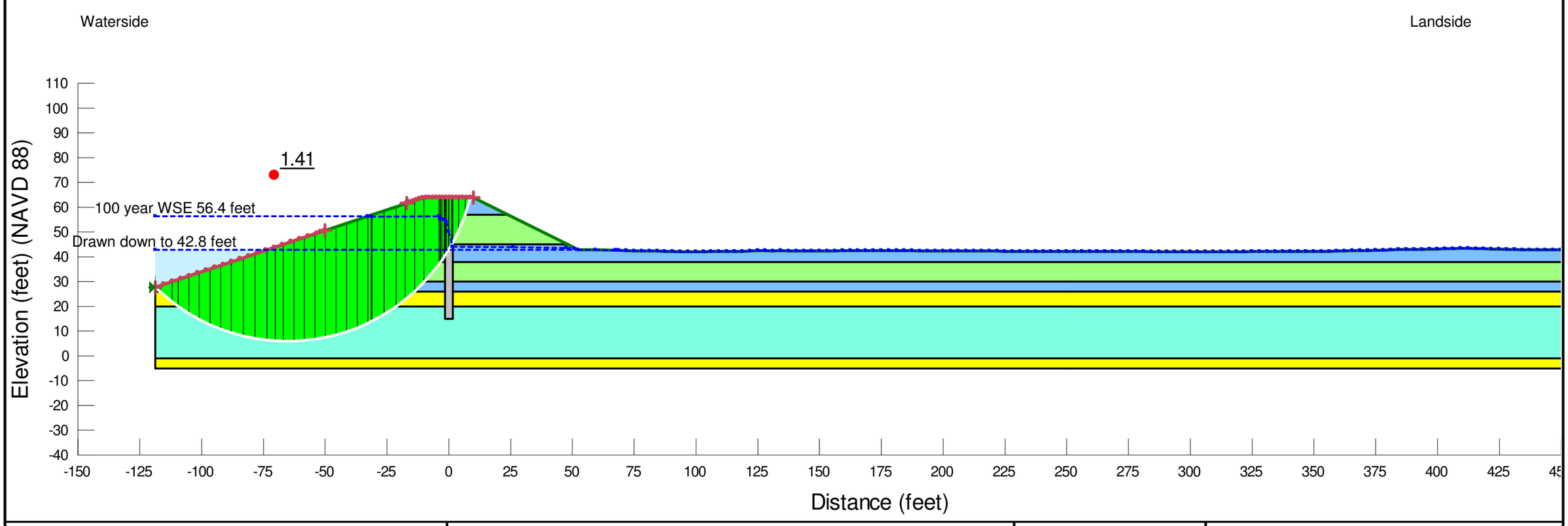


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Third Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-29



NOTES:

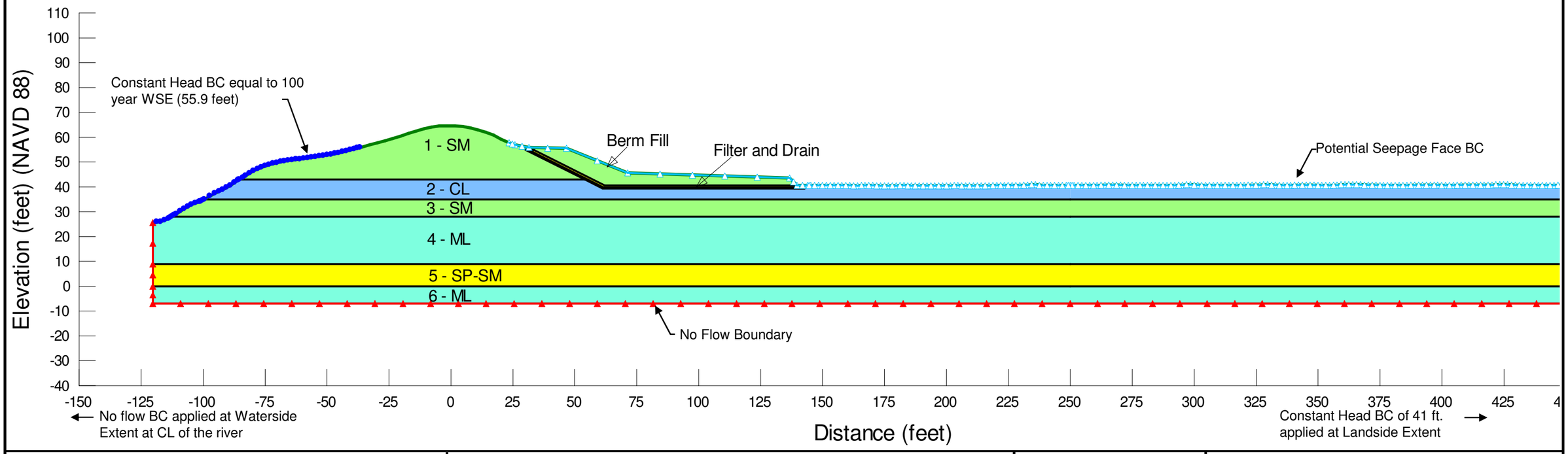
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach B (BR-L 1106+12) Cutoff Wall Third Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-30

Reach C (BR-L 1080+27)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**ML**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
Berm Fill	**SM**	2.834	1.0E-3	0.25
Drain	**SP**	141.696	5.0E-2	1
Filter	**SP**	2.834	1.0E-3	1

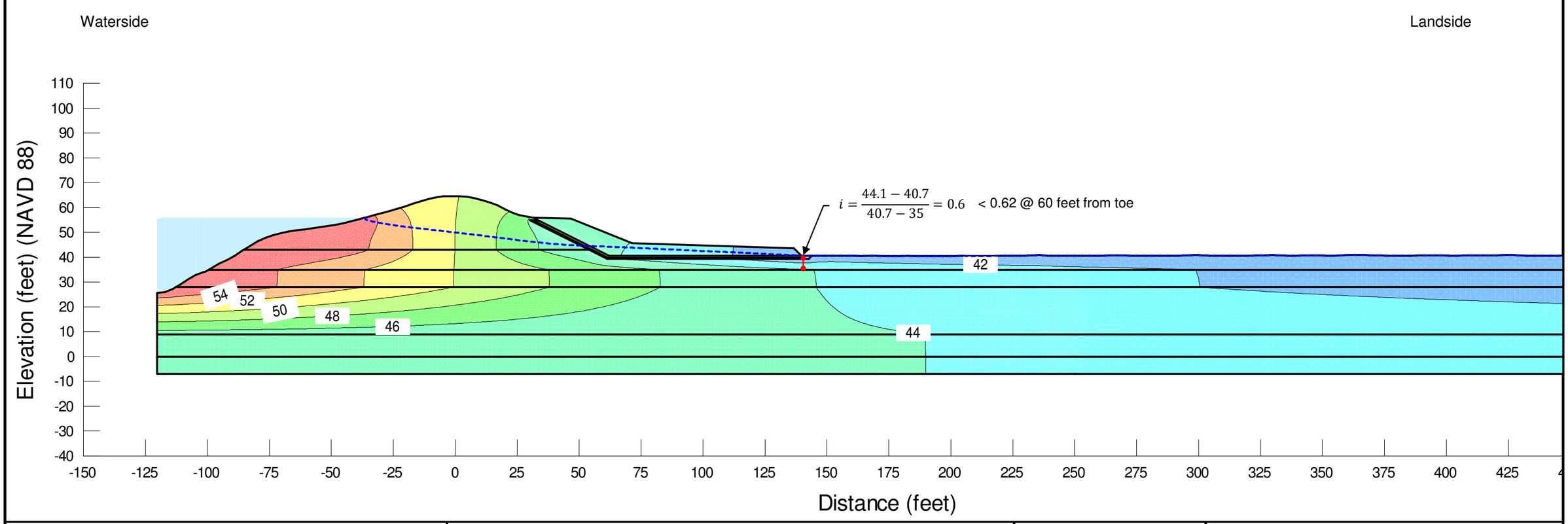


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Combined Berm Seepage Model-100 year WSE

Aug 2019 FIGURE F-31



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Combined Berm Seepage Result-100 year WSE

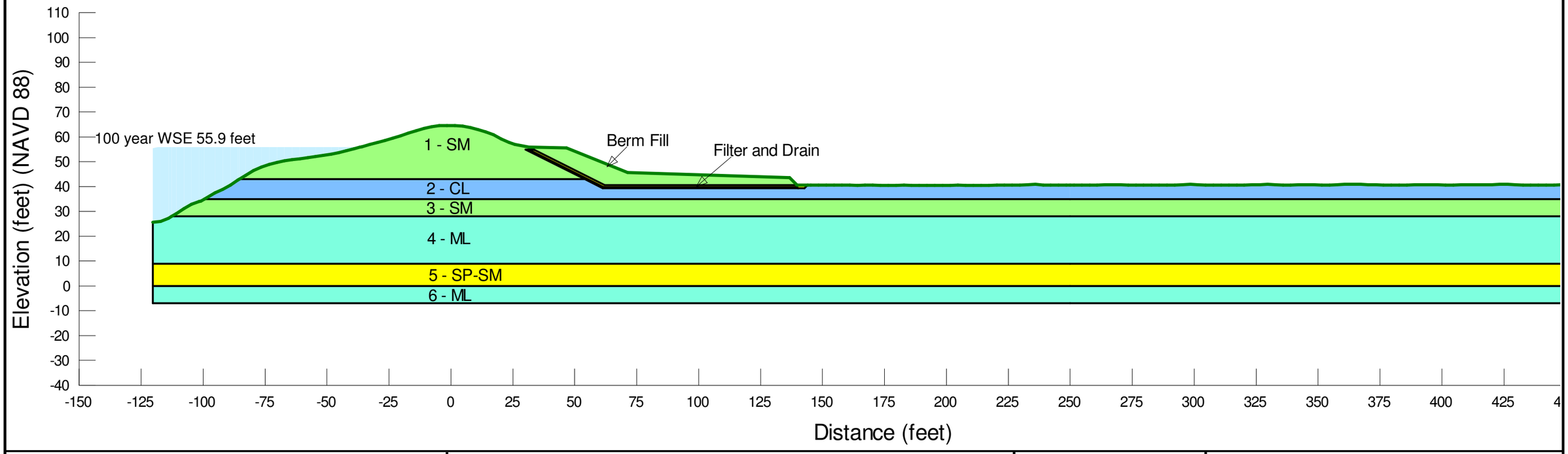
Aug 2019 FIGURE F-32

Reach C (BR-L 1080+27)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**ML**	120	50	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
Berm Fill	**SM**	120	0	34	-	-
Drain	**SP**	130	0	34	-	-
Filter	**SP**	130	0	32	-	-

Waterside

Landside

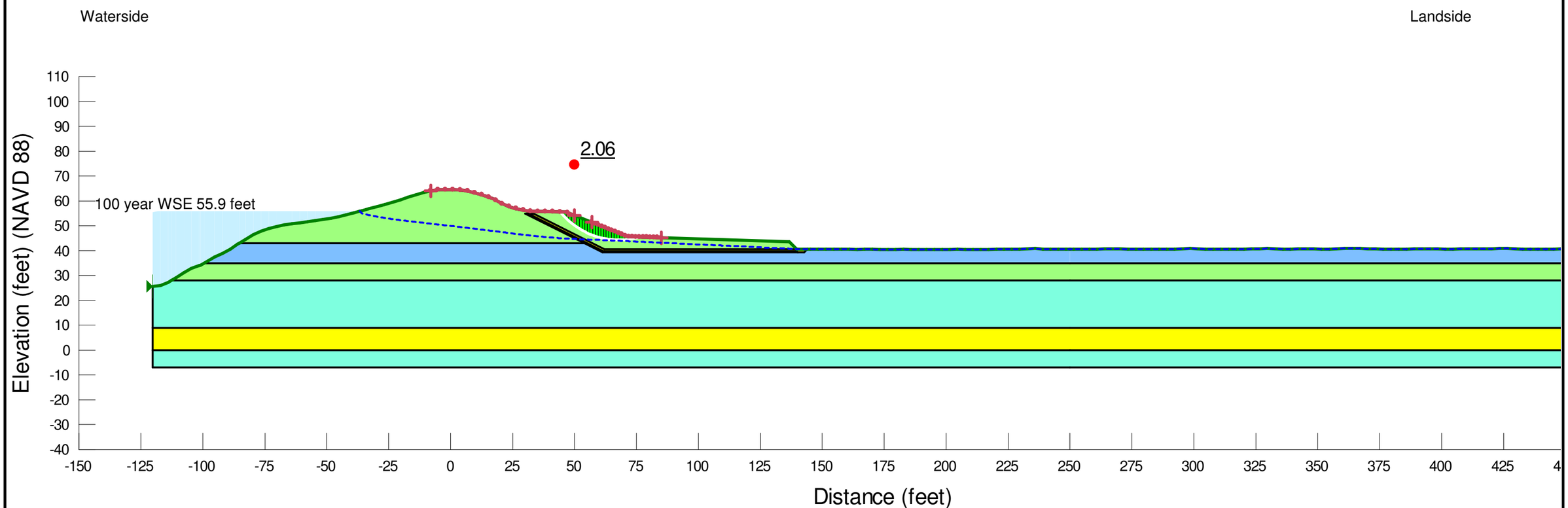


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27)
Combined Berm Slope Stability Model

Aug 2019 FIGURE F-33

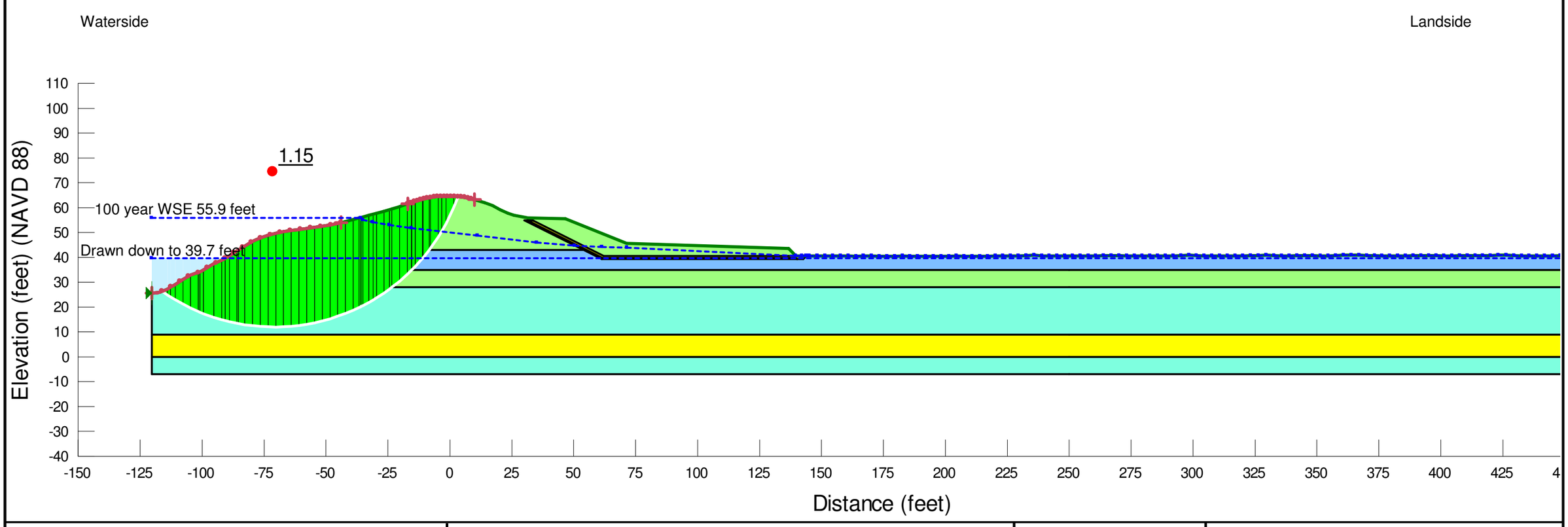


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Combined Berm Slope Stability Result- Steady State Landside-100 year WSE

Aug 2019 FIGURE F-34



NOTES:

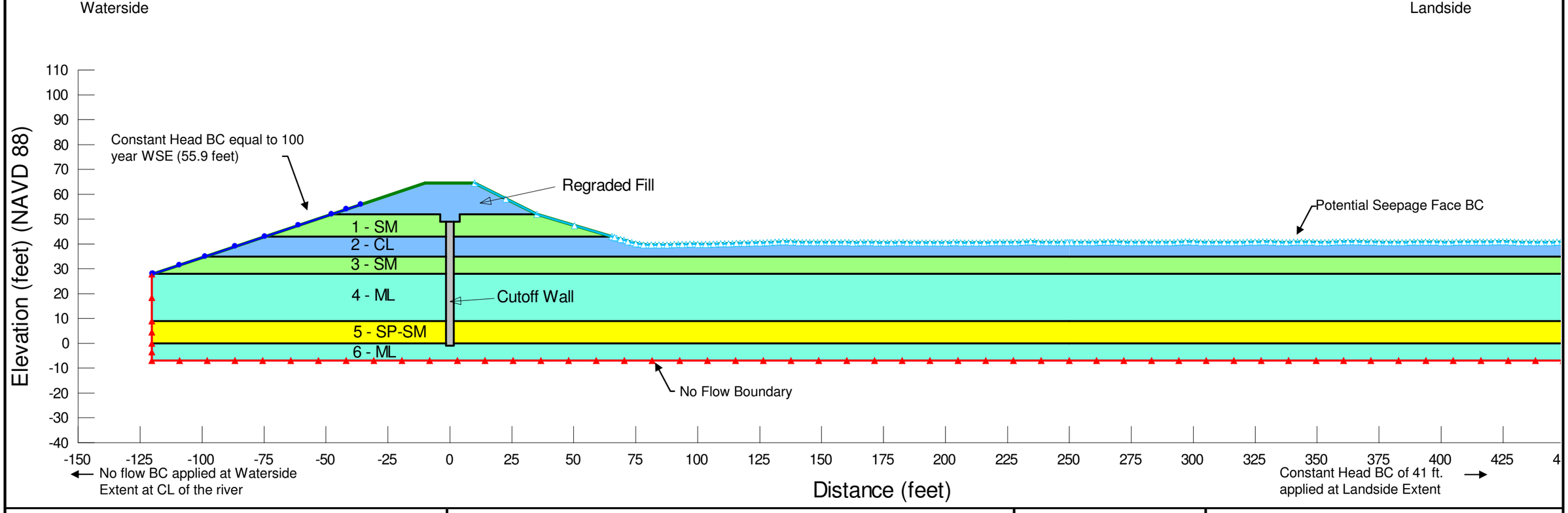
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Combined Berm Slope Stability Result- Waterside RDD-100 year WSE

Aug 2019 FIGURE F-35

Reach C (BR-L 1080+27)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**ML**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1

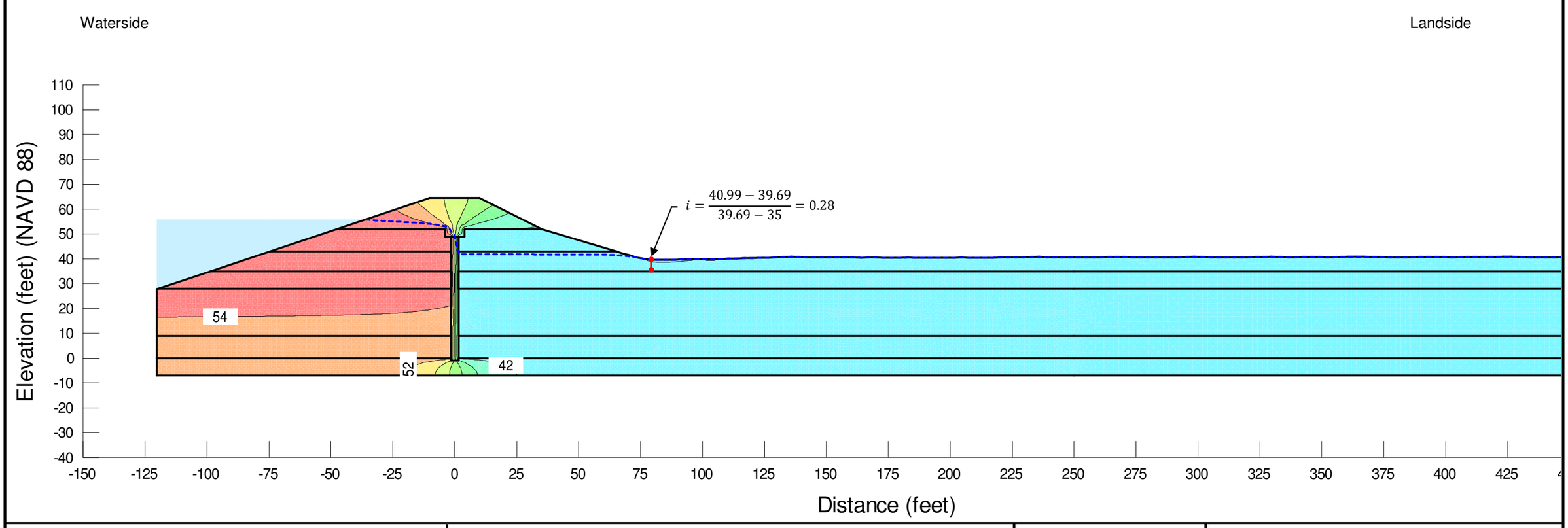


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Half Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-36



NOTES:

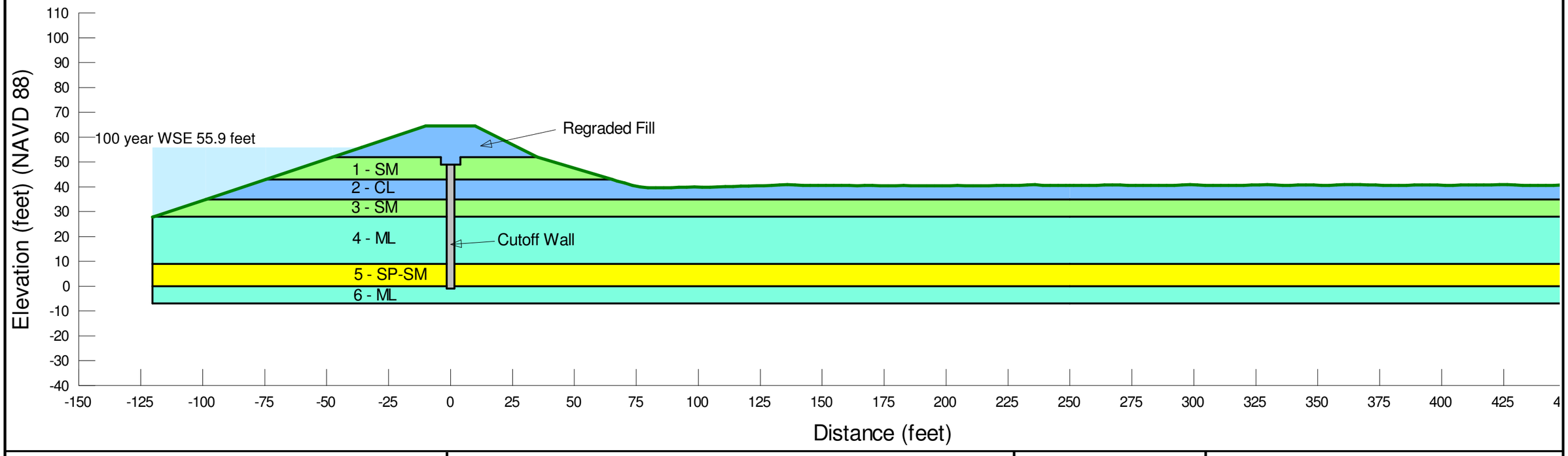
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Half Levee Degrade Seepage Result-100 year WSE

Aug 2019 FIGURE F-37

Reach C (BR-L 1080+27)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**ML**	120	50	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

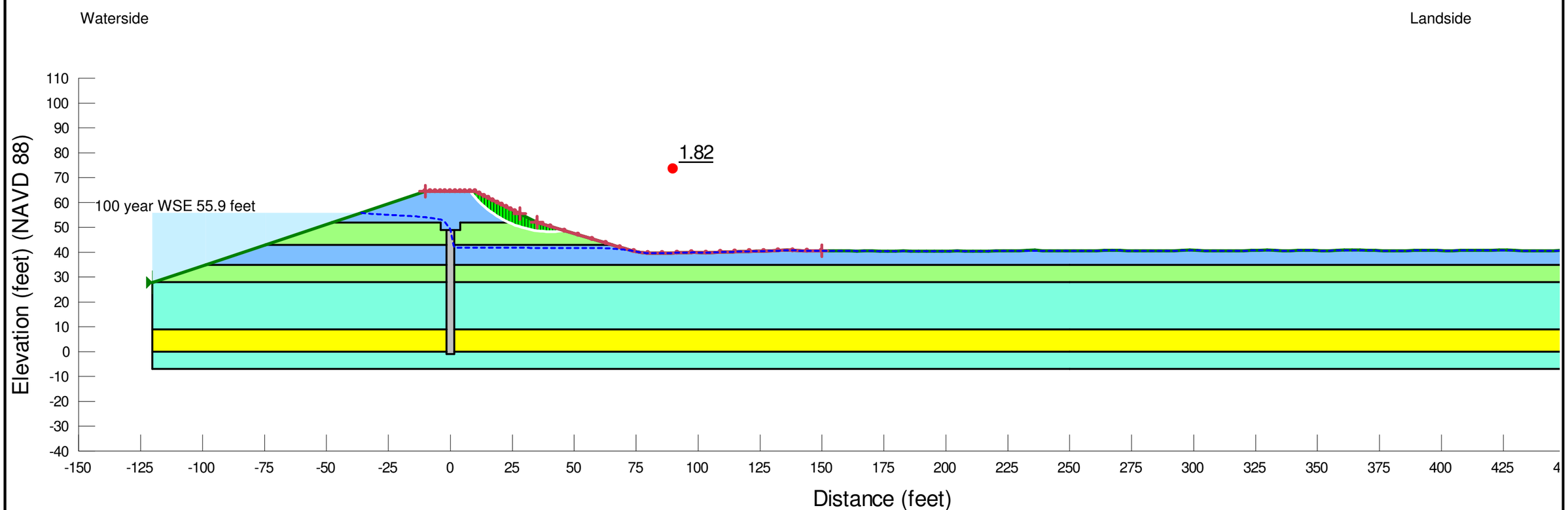


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Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Half Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-38

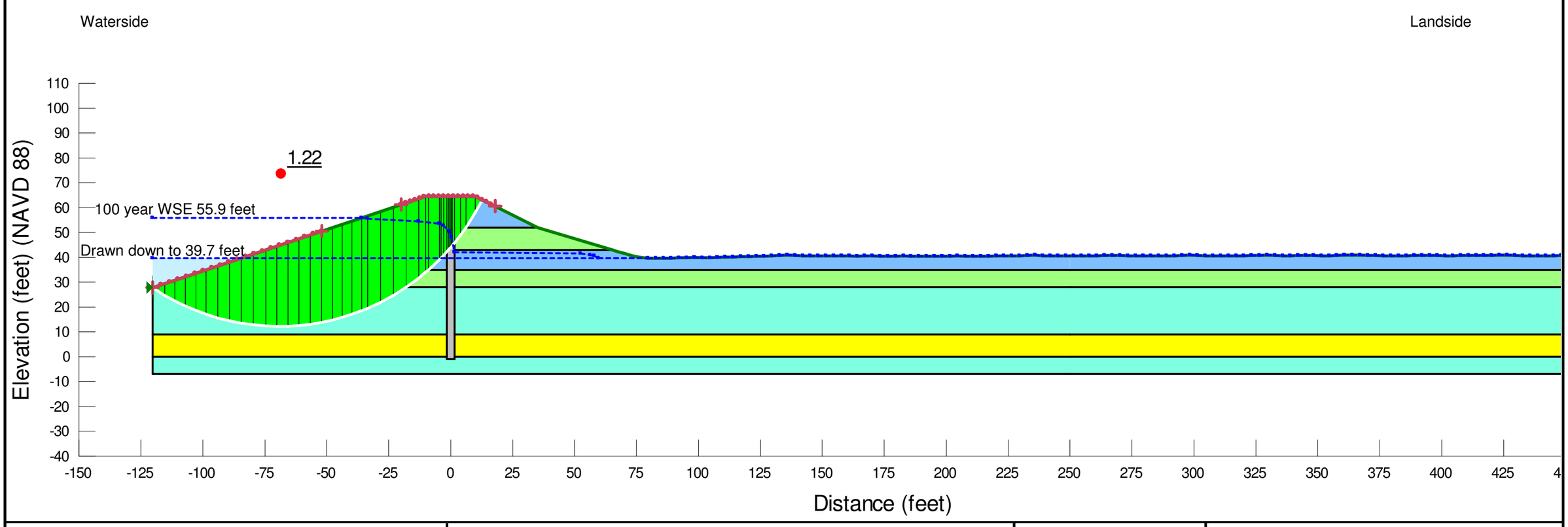


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Half Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-39



NOTES:

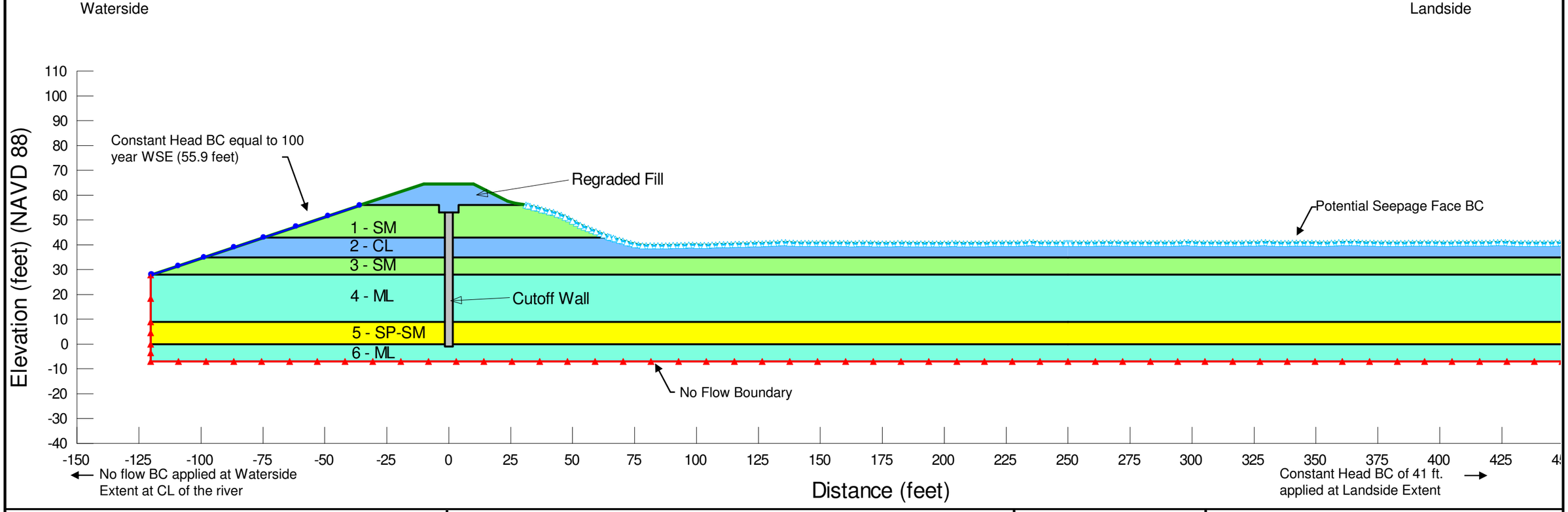
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Half Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-40

Reach C (BR-L 1080+27)

Layer	Material	Hydraulic Conductivity		
		k_h (ft/days)	k_h (cm/sec)	k_v/k_h
1	**SM**	2.834	1.0E-3	0.25
2	**CL**	0.028	1.0E-5	0.25
3	**SM**	2.834	1.0E-3	0.25
4	**ML**	0.028	1.0E-5	0.25
5	**SP-SM**	11.336	4.0E-3	0.25
6	**ML**	0.028	1.0E-5	0.25
Regraded Fill	**CL**	0.00283	1.0E-6	0.25
Cutoff Wall	**SCB**	0.000283	1.0E-7	1

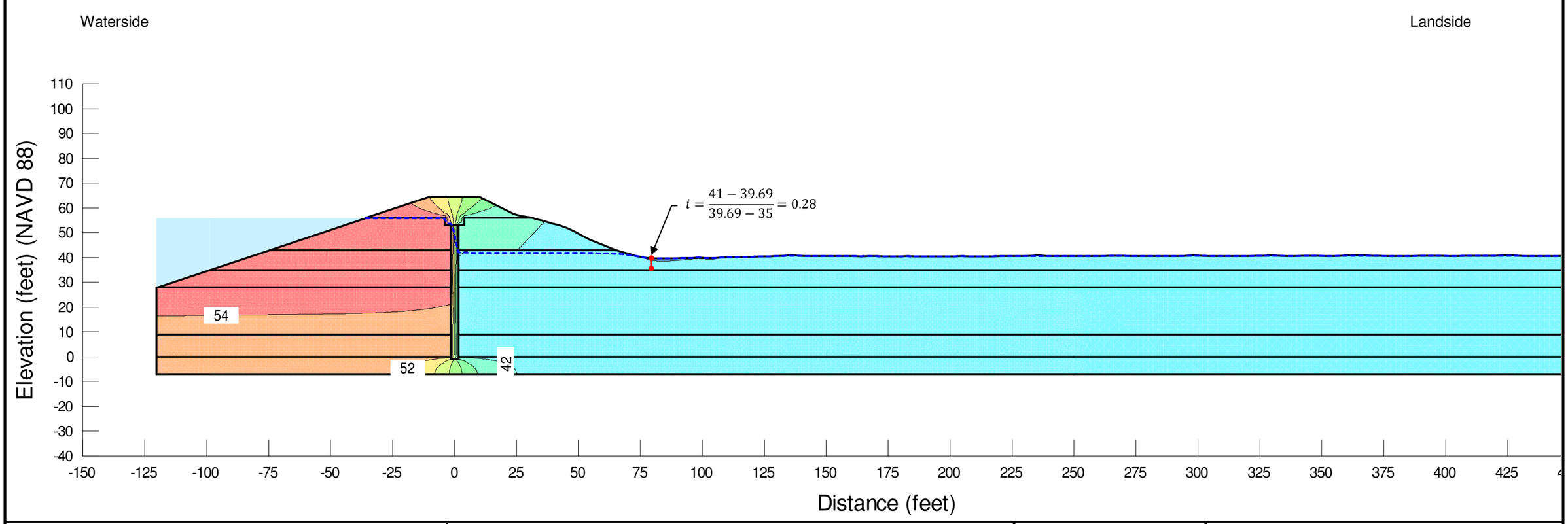


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Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Third Levee Degrade Seepage Model-100 year WSE

Aug 2019 FIGURE F-41



NOTES:

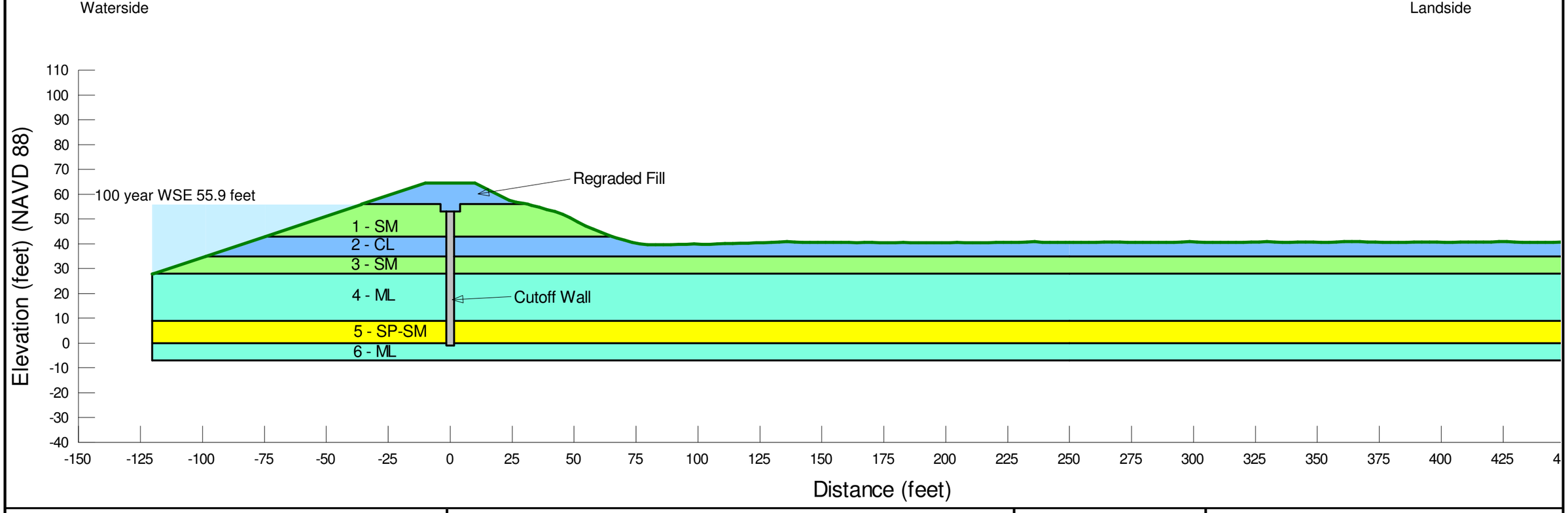
Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Third Levee Degrade Seepage Result-100 year WSE

Aug 2019 FIGURE F-42

Reach C (BR-L 1080+27)

Layer	Material	Total Unit Weight (pcf)	Shear Strength			
			C' (psf)	Φ' (deg)	C (psf)	Φ (deg)
1	**SM**	125	0	33	-	-
2	**CL**	120	100	31	360	4
3	**SM**	125	0	32	-	-
4	**ML**	120	50	31	360	4
5	**SP-SM**	125	0	34	-	-
6	**ML**	120	50	31	360	4
Regraded Fill	**CL**	125	100	31	360	4
Cutoff Wall	**SCB**	120	500	0	500	0

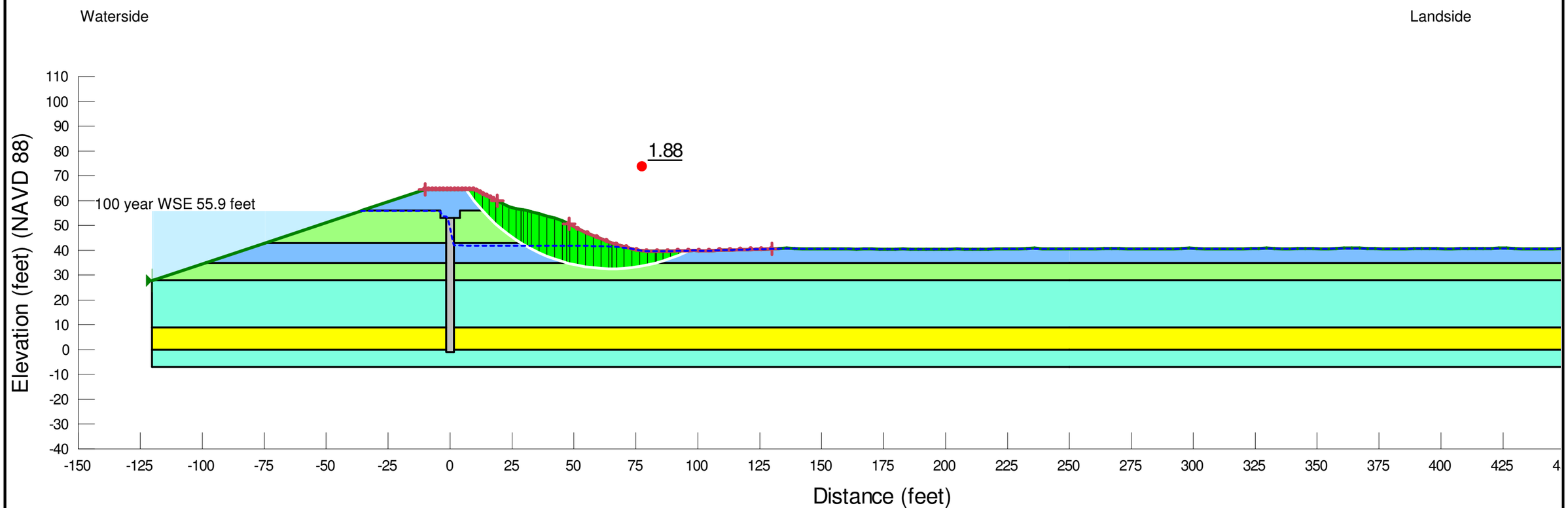


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Third Levee Degrade Slope Stability Model

Aug 2019 FIGURE F-43

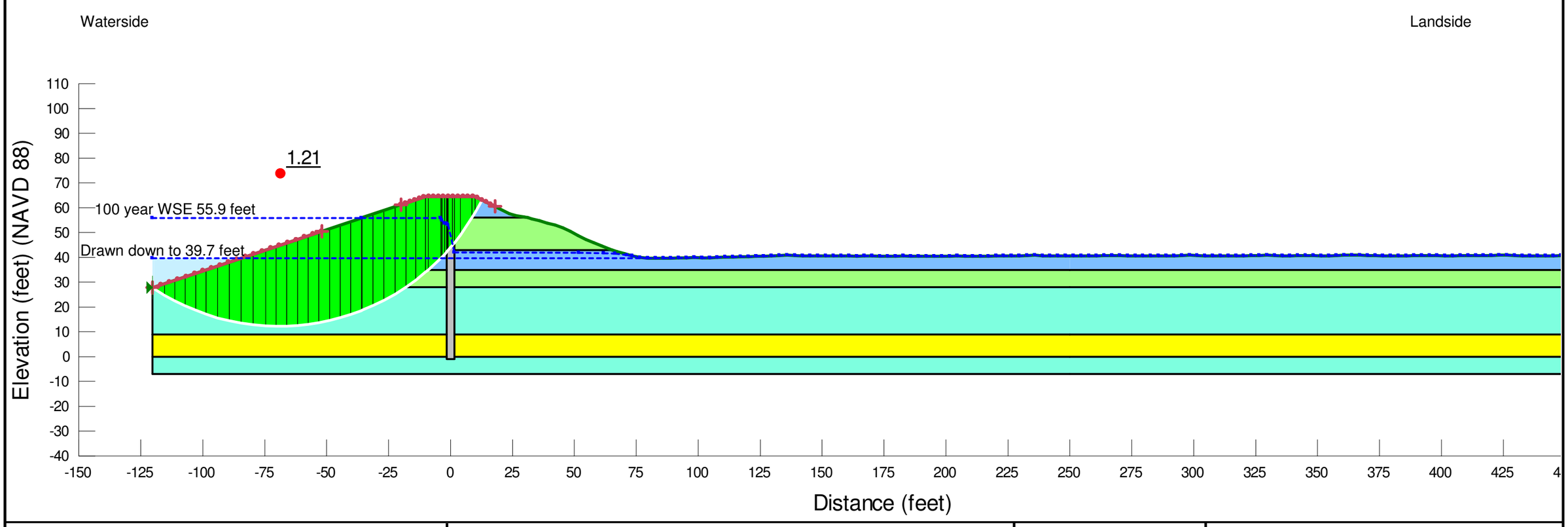


NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Third Levee Degrade Slope Stability Result-Steady State Landside-100 year WSE

Aug 2019 FIGURE F-44



NOTES:

Rio Oso Flood Risk Reduction Feasibility Study

Segment 283 Reach C (BR-L 1080+27) Cutoff Wall Third Levee Degrade Slope Stability Result-Waterside RDD-100 year WSE

Aug 2019 FIGURE F-45

ATTACHMENT B

Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus

MBK ENGINEERS

Water Resources ◆ Flood Control ◆ Water Rights

GILBERT COSIO, JR., P.E.
MARC VAN CAMP, P.E.
WALTER BOUREZ, III, P.E.
RIC REINHARDT, P.E.
GARY KIENLEN, P.E.
DON TRIEU, P.E.
DARREN CORDOVA, P.E.
NATHAN HERSHEY, P.E., P.L.S.
LEE BERGFELD, P.E.
BEN TUSTISON, P.E.

ANGUS NORMAN MURRAY
1913-1985

CONSULTANTS:
JOSEPH I. BURNS, P.E.
DONALD E. KIENLEN, P.E.

M E M O R A N D U M

DATE: August 30, 2019

TO: SCFRR Rio Oso & Nicolaus Study Team

FROM: Don Trieu, P.E., Patrick Ho, P.E. MBK Engineers

SUBJECT: Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus

1. PURPOSE

The purpose of the Small Community Flood Risk Reduction (SCFRR) Program is to invest in qualifying projects that would reduce flood risk for small communities. Rio Oso and Nicolaus are in process of identifying structural and nonstructural flood risk reduction projects that would qualify for SCFRR program funding.

The project team requested that MBK Engineers (MBK) analyze potential flood risks to these communities using best available data at the time of this study. Historically, the Feather River south levees near Nicolaus breached during the flood of December 1955 and there remains potential risk at this location. As part of this study, flood control levees protecting these communities were hypothetically breached and flood depth maps are attached to inform the project team on characterizing existing risk and developing potential flood risk reduction alternatives.

2. HYDRAULIC MODEL

Flood risk to Rio Oso and Nicolaus could potentially be derived from levee breaches along the Bear and Feather River. After levees are breached, floodwater flows overland and fills the basin. This dynamic is better captured and understood using a two-dimensional (2D) model. The Central Valley Floodplain Evaluation Delineation (CVFED) Sacramento River basin, HEC-RAS model is an integrated one-dimensional (1D) and two-dimensional (2D) hydraulic model. This model simulates the Sacramento River and tributaries such as the Feather and Bear Rivers. This model was modified to include a 2D flow area in the basin around Rio Oso and Nicolaus. This will provide more informative flood depth calculations. The hydraulic model was developed

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using HEC-RAS version 5.06. The basins with improved spatial representation for this study is shown in Figure 1. The model is simulated using a representative 1-in-100 year flood event. This hydrology is from a Central Valley Hydrology Study (CVHS) selection prepared for the Sacramento General Re-evaluation Report.

3. CHARACTERIZING EXISTING FLOOD RISK

3.1 Hydraulic Analysis

Using best available data and techniques, flood depths are calculated and mapped by following guidelines from Federal Emergency Management Agency (FEMA) levee analysis and mapping procedures. Levees protecting Rio Oso and Nicolaus are non-accredited levees and flood mapping of areas protected by these levees will require a comprehensive critical section-by-section breach analysis per FEMA guidelines. In this analysis, two locations were selected as critical sections that may produce the largest floodplain and greatest flood depths. These are a levee section along the south Feather River at Highway 99 and a levee section along the south Bear River levees above Highway 70.

During the December 1955 flood, the levees along the south Feather River at Highway 99 breached and flooded the basin. This breach is revisited in this analysis because the location potentially draws the largest flood volume as it brings flows from the Feather and the Bear Rivers. The breach on the south Bear River levees at Highway 70 is a point of higher elevation in the basin. This location has the potential to generate higher water surface elevations provided that flood volume is sufficient, and it also would affect more properties along the path of a breached flood wave. Both these scenarios will provide a representative baseline for formulating flood risk reduction alternatives.

Levee breaches are assumed to occur as the water surface elevation (WSE) reaches a height against where the Federal/State project levee design criteria would be exceeded. This height is measured from the top-of-levee to a vertical distance downwards identified as the levee reduction height (URS, 2011). The levee reduction height is determined through geotechnical assessment and is a concept derived from the Non-Urban Levee Evaluation (NULE) program. Once the levees fail, the levee structure is assumed to completely wash out the levee towards the dry-side toe elevation. This breach is assumed to fully form in two hours. Table 1 shows the parameters selected for each levee breach.

Table 1. Levee Breach Parameters

Location	Width (ft.)	Dry-Side Levee Toe Elevation	Formation Time (hrs)	Breach Trigger Elevation (NAVD 88-FT)
Feather River above Highway 99	600	33.0	2	45.0
Bear River above Highway 70	525	38.5	2	49.0

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3.2 Discussion and Results

Flood protection structures and facilities protecting the communities of Rio Oso and Nicolaus are managed and maintained by Reclamation District (RD) 1001. RD 1001 maintains 6 levee units. Floodwaters resulting from breaches on the Bear or Feather River will overland flow southwesterly and impound behind Levee Units 4, 5, and 6 (Figure 2). Major features within the basin that can impede flows include embankments supporting the Highway 99 and Highway 70 infrastructures. Maximum flood depths as a result of these scenarios are mapped in Figure 3 and Figure 4.

3.2.a Feather River Levee Breach above Highway 99

In the event of the Feather River above Highway 99 breach scenario, floodwater flows southwesterly and fills Reclamation District (RD) 1001. Once flood depth in the basin exceeds crown elevations of Highway 99, floodwater back northeasterly towards Highway 70 towards Rio Oso. Flood depths in this scenario reaches greater than 20 feet in lower lying areas and floodwaters overtop the north Natomas Cross Canal levees, which then flows back into the Sacramento River from the Natomas Cross Canal.

3.2.b Bear River Levee Breach above Highway 70

In the event of the Bear River above Highway 70 breach, floodwaters overtop Highway 70 and flows southwesterly towards RD 1001. Similar to the Feather River levee breach, floodwater fills RD 1001 to portions of the floodplain bounded by Highway 99 to the northeast. The flood source from this breach is not solely from the Bear River watershed. The breach opening size has the potential to divert most of the Bear River and in addition, draw water from the Feather River and into this basin.

Another pertinent feature to point out is public infrastructure development within the basin that can affect flow dynamics. The hydraulic model uses CVFED topography. In this model, floodwater overtops at a depressed location at Highway 70 and Rio Oso Road. The topographic survey used in the hydraulic model was collected before construction of the Highway 70 Bypass Project. The Highway 70 Bypass Project raised the Highway crown elevation between 0.5 and 1.4 feet (DOT, 2011) at Rio Oso Road. Per the As-Built Plans, Highway 70 crown elevations between from Cornelius Avenue to about Kempton Road were largely matched, therefore it is likely a similar flow pattern overtopping Highway 70 still exists today. However, it is pertinent that future analyses requiring FEMA mapping consider a topographic model that includes Highway 70, as it exists today.

4. NON-STRUCTURAL FLOOD RISK REDUCTION

4.1 Hydraulic Analysis

Based on the analysis in Section 3, the largest flood damage to properties in the basin could be caused by a breach on the Feather River levees at Highway 99. As part of a non-structural flood risk reduction alternative, relief cuts were analyzed at a levee location on the Feather River near Verona (Figure 5) to explore flood-fighting the breach on the Feather River at Highway 99. Excavation depths at the relief cut location will be limited by the water surface

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elevation on the Feather River, which is the receiving water. In the breach analysis at Highway 99, the stage reached approximately 40 feet on the water side of the relief cut location. The top-of-levee elevations at this location is approximately 50 feet. Therefore, relief-cut depth dimensions with 10 feet (50 feet – 40 feet) of depth is simulated on our relief-cut scenarios. Three relief-cuts were explored, and their parameters are tabulated as follows:

Table 2. Assumptions of Relief-Cuts Analyzed

Location	Width x Depth (ft x ft)	Final Relief Cut Crest Elevation (NAVD 88)	Approximate Time Available to Construct Cut After Breach Occurs (hours)
Feather River near Verona	100	40	24
	500	40	24
	1,000	40	24

4.2 Discussion and Results

By performing relief-cuts, lower portions of the RD 1001 basin will observe reductions in maximum stage while the upper portions near Rio Oso and Nicolaus will observe reduction in inundated lands. The flood stage reductions in the lower portions of the basin provided by each relief-cut is tabulated in **Table *3***. The flood stage reduction is outflow constrained as the inflow from the breach at Highway 99 far exceeds outflow capacity at the relief-cut. While relief-cuts are outflow constrained, there are reductions in the acres of lands as a result of performing relief-cuts. **Table *3*** quantifies and Figure 5 illustrates the reduction in flooded lands as a result of each relief cut.

Table 3. Reduction in Stage and Inundated Lands Provided by Relief Cuts

Location	Width x Depth (ft x ft)	Approximate Stage Reduction (feet)	Reduction in Inundated Lands (acres)
No Relief Cut	0 x 0	0	0
Feather River near Verona	100 x 10	0.1’	757
	500 x 10	0.3’	1,767
	1,000 x 10	0.6’	2,779

REFERENCES

1. (URS, 2011). Geotechnical Assessment Report North NULE Project Study Area Volume 4 of 6: Appendix E, URS 2011.
2. (MBK, 2018). *Sacramento General Re-evaluation Report CVHS Selection.* MBK Engineers. December 2018.
3. (DOT, 2011). State of California, Department of Transportation, Project Plans for Construction on State Highway in Sutter and Yuba Counties near Nicolaus from 70/99 Separation to 1.0 KM North of Feather River Blvd., Caltrans 2011.

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Olivehurst
Reeds Creek
Yuba County
Dry Creek
Wheatland
2066
0784
2103
0817
0823
0803
1500
1000
1600
Bear River
Feather River
Coon Creek
Sutter County
Placer County
Pleasant Grove Creek
Curry Creek
Steelhead Creek
Sacramento River
Sacramento River
Yolo County
Sacramento County
N
65
70
99
113

Legend

Project Levee

2D Model Extents

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

MBK ENGINEERS
455 University Avenue, Suite 100
Sacramento, California 95825-6579
(916) 456-4400

Rio Oso & Nicolaus 2D Model Extents
Figure 1

0 5,280
Scale in Feet

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Olivehurst
Reeds Creek
Yuba County
Dry Creek
Wheatland
2066
0784
0817
2103
0823
0803
1500
1001
1000
1600
Bear River
Feather River
Coon Creek
Sutter County
Placer County
Yolo County
Sacramento County
Pleasant Grove Creek
Curry Creek
Steelhead Creek
Sacramento River
Sacramento River
Dry Creek
SMF

Levee Unit 3
Levee Unit 4
Levee Unit 5
Levee Unit 6

N

65 70 99 113

Legend
Project Levee
Levee Unit Demarcation

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Sacramento, California 95825-6579
(916) 456-4400

Reclamation District 1001 - Levee Units
Figure 2

0 5,280
Scale in Feet

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Legend

Project Levee

Flood Depth (ft.)

0 - 3

3 - 5

5 - 10

10 - 15

15 - 20

>20

N

2066

Feather River

0784

Yuba County

Dry Creek

0817

Bear River

70

99

0823

0803

1500

Feather River at HWY 99 Breach

Sutter County

Coon Creek

1001

1000

Pleasant Grove Creek

Curry Creek

Sacramento River

Yolo County

1600

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Sacramento, California 95825-6579
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Figure 3 - Maximum Flood Depth Map from Breach on Feather River at Highway 99

0 5,280
Scale in Feet

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Legend

Hypothetical Levee Failure Location

Project Levee

Flood Depth (ft.)

0 - 3

3 - 5

5 - 10

10 - 15

15 - 20

>20

N

Bear River at HWY 70 Breach

Yuba County

Sutter County

Yolo County

0784

0817

0803

1500

1001

1000

1600

Dry Creek

Bear River

Feather River

Coon Creek

Pleasant Grove Creek

Curry Creek

Steamboat Creek

Sacramento River

Sacramento River

70

99

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Sacramento, California 95825-6579
(916) 456-4400

Figure 4 - Maximum Flood Depth Map from Breach on Bear River at Highway 70

0 5,280

Scale in Feet

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Legend

Relief-Cut Location

Project Levee

Flood Extent

1000' Relief-Cut

500' Relief-Cut

100' Relief-Cut

Without-Relief Cut

N

Feather River at Highway 99 Breach

Relief-Cut Location

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

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(916) 456-4400

Figure 5 - Reduction of Inundated Areas as a Result of Relief Cuts

0 5,280
Scale in Feet

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ATTACHMENT C

Draft Environmental Constraints Analysis, Rio Oso Flood Risk Reduction Feasibility Study

Environmental Constraints Analysis

Sutter County

Rio Oso Flood Risk Reduction Feasibility Study

Rio Oso, Sutter County, California
April 21, 2020

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Appendix D. Cultural Resources Analysis D-1

Acronyms and Abbreviations

APE	Area of Potential Effects
BMP	Best Management Practice
Cal Fire	California Department of Forestry and Fire Protection
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
County	Sutter County
CVFPP	Central Valley Flood Protection Plan
CWA	Clean Water Act
DWR	California Department of Water Resources
EIR	Environmental Impact Report
ESA	Endangered Species Act
Feasibility Study	Rio Oso Flood Risk Reduction Feasibility Study
FEMA	Federal Emergency Management Agency
FRRFMP	Feather River Regional Flood Management Plan
GHG	Greenhouse Gas
HCP	Habitat Conservation Plan
iPaC	Information Planning and Consultation
MND	Mitigated Negative Declaration
NAHC	California Native American Heritage Commission
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NULE	Non-Urban Levee Evaluation
project	Rio Oso Flood Risk Reduction Project
quad	quadrangle
RCD	Resource Conservation District
RWQCB	Regional Water Quality Control Board
SHPO	State Historic Preservation Officer
SPFC	California State Plan of Flood Control
USACE	U.S. Army Corps of Engineers

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1 Introduction

Sutter County (County), as lead agency, is initiating the Community of Rio Oso (Rio Oso) Flood Risk Reduction Feasibility Study (Feasibility Study). The County is studying the feasibility of providing flood damage reduction for the unincorporated and census-designated community of Rio Oso (project).

Generally, a feasibility study is conducted by a lead agency to identify preferred structural and nonstructural elements, multi-benefits, and constraints. The Feasibility Study to assess alternatives for reducing flood risk in Rio Oso also compares implementation costs and schedules, and identifies local funding requirements to assess options which will reduce the flood risk to the community of Rio Oso. The alternative chosen is also intended to sustain agriculture and the regional economy, provide safe public access to the river, and improve the riverine habitat viability and regional levee maintenance governance.

1.1 Purpose and Scope of a Feasibility Study

During the planning phase of a project, a feasibility study is often prepared to provide a description of the existing conditions and associated deficiencies, as well as an evaluation of alternative solutions to correct identified problems. A feasibility study typically includes a framing of the feasibility study objectives, a discussion of the project area and background, an identification of problems and opportunities, and definition of potential environmental constraints. Environmental constraints are restrictions that limit the planning process, such as resource constraints (i.e. biological, cultural, etc.); legal and policy constraints (i.e. laws, applicable policies, regulations, etc.); and permit requirements. The purpose of including an environmental constraints analysis within the feasibility study is to assist with the identification of key environmental issues that should be given due consideration during the planning and design phase of the project.

The analysis of environmental constraints is intended to facilitate the project planning process, assist with the evaluation of various alternatives, support definition of a preferred project, and identify potential permitting and mitigation requirements. This environmental constraints analysis focuses on one preferred structural alternative, described in Section 1.5, since this alternative has been developed to the point that a useful evaluation of environmental constraints is viable and can be informative for planning purposes. Specifically, this environmental constraints analysis identifies potential constraints based on the anticipated presence or absence of environmental resources; describes the consistency and/or compliance with existing policies; and identifies potential environmental mitigation costs that could be attributable to this alternative. Finally, this report also provides basic permit information. For comparison, nonstructural measures are also described in Section 1.6 of this document; however, these concepts have not been developed to the point to allow for a useful evaluation of environmental constraints, thus this report does not describe the potential environmental constraints related to nonstructural measures.

The California Environmental Quality Act (CEQA) Guidelines Section 15262 states that “a project involving only feasibility or planning studies for possible future actions which an

agency, board, or commission has not approved, adopted, or funded does not require the preparation of an Environmental Impact Report or a Negative Declaration". Section 15262 of the CEQA Guidelines further defines that it does not apply to the adoption of a plan that will have a legally binding effect on later activities. Since the Feasibility Study is not legally binding to future activities, no documentation under CEQA has been prepared for the Feasibility Study. In addition, the ecosystem concepts and multi-benefit concepts identified in the Feasibility Study and summarized in this report are presented solely for planning purposes at this time. Their inclusion herein does not commit the County to any specific future actions and has no legally binding effect.

1.2 Project Area Location and Information

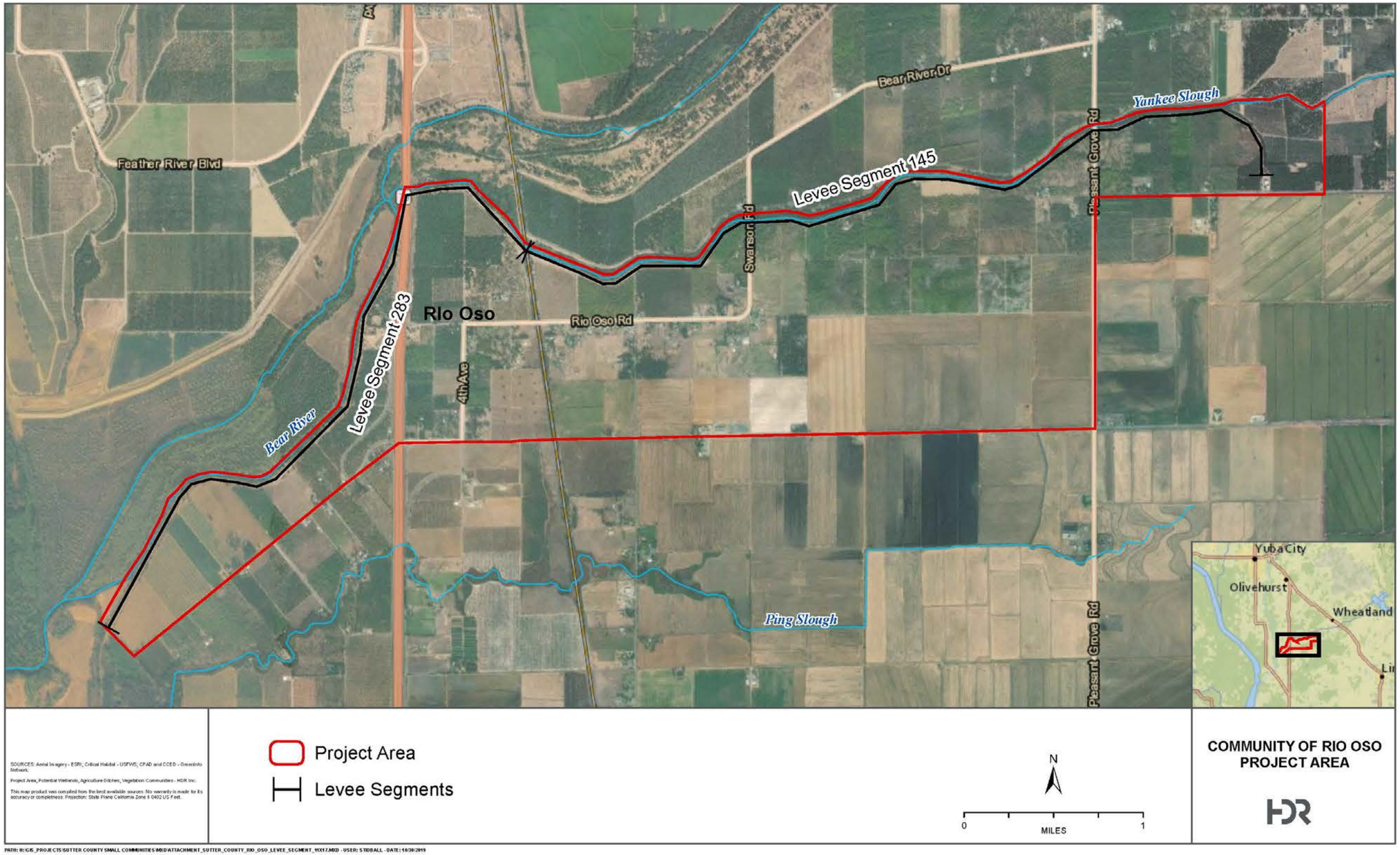
The project is located in the community of Rio Oso, a census-designated place in Sutter County, California. **Figure 1-1** provides an overview of the project area. Rio Oso is situated along State Highway 70 east of State Highway 99 along the south bank levee of the Bear River and Yankee Slough. Rio Oso is approximately 30 miles north of Sacramento, California and approximately 15 miles south of Yuba City, California along State Route 99 in the southern portion of Sutter County. Rio Oso occupies approximately 6.5 square miles of land (**Figure 1-1**). The community is at an elevation of approximately 52 feet and receives an average annual precipitation of 21 inches (Best Places 2019).

Reclamation District (RD) 1001 maintains the levees surrounding Rio Oso. Rio Oso is protected from flooding by State Plan of Flood Control (SPFC) levees along the left (south) bank of Yankee Slough, the left (south) bank of Bear River, and the left (east) bank of the Feather River. The levee segments protecting Rio Oso are shown on **Figure 1-1**. The project area for this flood risk reduction feasibility study includes Segment 283 and Segment 145 (a similar feasibility study carried out for the community of Nicolaus covers Segment 247).

There are approximately 124 housing units in Rio Oso, no hospitals and one school, Browns Elementary School. According to the 2010 census, the population of Rio Oso was approximately 356 people. The 5-year estimate for the U.S. Census Bureau American Community Survey projected the population of Rio Oso to be 421 people in 2017, which is an approximately 18% increase from 2010. (U.S. Census Bureau 2019).

According to the Sutter County General Plan Land Use Map, predominant land uses in Rio Oso include agriculture, agricultural rural community, open space, park and recreation, and public (Sutter County 2014). Lands immediately adjacent to the project area are all designated for either open space or agricultural purposes (Sutter County 2014).

Figure 1-1. Community of Rio Oso Project Area



1.3 Objectives of the Proposed Project

The objectives of the project are to:

- Reduce the risks of flooding to life, property, and critical infrastructure
- Improve flood system resiliency and facilitate adaptation to future climate variability
- If feasible, attain a 100-year level of flood protection for the community of Rio Oso and surrounding areas in accordance with Federal Emergency Management Agency's (FEMA) guidelines pursuant to Code of Federal Regulations (CFR) Section 65.10.
- Increase and improve the quantity, diversity, quality, and connectivity of riverine aquatic and floodplain habitats
- Contribute to the recovery and sustainability of native species populations and overall biotic community diversity
- Promote multi-benefit projects/provide recreational benefits
- Improve operations and maintenance
- Improve institutional support

1.4 Need for the Proposed Project

The project is located in the Central Valley of California which faces significant flood risk. According to the Department of Water Resources (DWR), "approximately 1 million Californians live and work in the floodplains of the valley, which contain approximately $80 billion worth of infrastructure, buildings, homes, and prime agricultural land" (DWR 2018). As a result, a major flood in the Central Valley could result in devastating loses, both financially and otherwise (DWR 2018). According to DWR, the Central Valley is home to more than 1,600 miles of State-Federal levees, and since 1983 these project levees have been breached or overtopped more than 70 times (DWR 2019). The Central Valley Flood Protection Plan (CVFPP) 2017 Update indicates that future floods are expected to result in greater damage due to such factors as climate change, subsistence, sea-level rise, and future population growth and development within floodplains (DWR 2017). Therefore, the project is being studied to address the need for flood protection in this high flood risk community of California.

Rio Oso is located in the southern portion of the Feather River Regional Flood Management Plan (FRRFMP) area. Many Levee Maintaining Agencies (LMAs) in the noted FRRFMP area face challenges from encroachments, levee penetrations, slope instability and erosion, and maintenance issues (FRRFMP 2014).

In 2008, Rio Oso and the surrounding areas were remapped by FEMA as Zone A on Flood Insurance Rate Maps (FIRM), meaning they are in the identified 100-year floodplain and those living within the zone must have flood insurance. According to the FEMA Flood Insurance Study for Sutter County, the existing levees, segment 283 along the Bear River and 145 along Yankee Slough are not in compliance with the requirements set forth in the National Flood Insurance Program (NFIP), and would likely

fail in a larger event (FEMA 2015). Therefore, the project is needed to provide increased flood protection for Rio Oso and the surrounding areas and would help meet DWR's Central Valley Flood Protection Plan (CVFPP) Conservation Strategy goals. The goals of the CVFPP Conservation Strategy include: improved flood risk management, the promotion of multi-benefit projects, increased operational and regulatory efficiency, and the promotion and restoration of ecosystem function in the Central Valley (DWR 2016). Specifically, the project is needed because:

1. Rio Oso and the surrounding areas are threatened from flooding from the Feather River, Bear River, and Yankee Slough.
2. Previous and current geotechnical investigations, showed that levees protecting Rio Oso and surrounding areas suffer from underseepage, through seepage, and levee slope stability issues and that the anticipated hazard level is low to moderate likelihood of either levee failure or the need to flood-fight to prevent levee failure. (HDR 2019)

1.5 Preferred Remediation Alternative

Based on the goals and objectives of the project to improve flood risk management, enhance habitat restoration, provide recreational benefits, and support agricultural sustainability in Rio Oso, a wide array of preliminary flood risk reduction alternatives were scoped for the community of Rio Oso through the Small Communities Flood Risk Reduction grant program administered by DWR. Several alternatives were formulated and screened during the Feasibility Study scoping process. Nonstructural, multi-benefit and ecosystem measures are described in Section 1.6. The two remediation/structural alternatives were formulated and evaluated during the Feasibility Study scoping process.

Segments 145 and 283 were divided into remediation reaches for the geotechnical evaluation. **Figure 1-2** shows the identified remediation reaches on segment 145 and 283. The reaches of segments 145 and 283 that did not meet the criteria for a 100-year flood were evaluated for one or more remediation alternatives. In general, the remediation alternatives considered consist of cutoff wall, drained stability berm, combined drained stability and seepage berm, erosion remediation-rock slope revetment, and geometry mitigation. Remediation Alternative 1 generally met the criteria established in the Feasibility Study for the 100 year water surface elevation and is the only alternative evaluated further in this analysis. This alternative is summarized below in **Table 1**.

For the preferred remediation alternative, the regulatory setting and regulatory consistency analysis are provided for each resource area in **Appendix A**. An analysis of environmental resources, which includes the existing conditions, such as the anticipated presence or absence of environmental resources, and the key environmental constraints, is provided in **Appendix B**.

A summary of the proposed remediation measures and construction techniques is provided below by remediation type. Borrow areas for the remediation measures are also described below.

Figure 1-2. Preferred Remediation Alternative Reaches

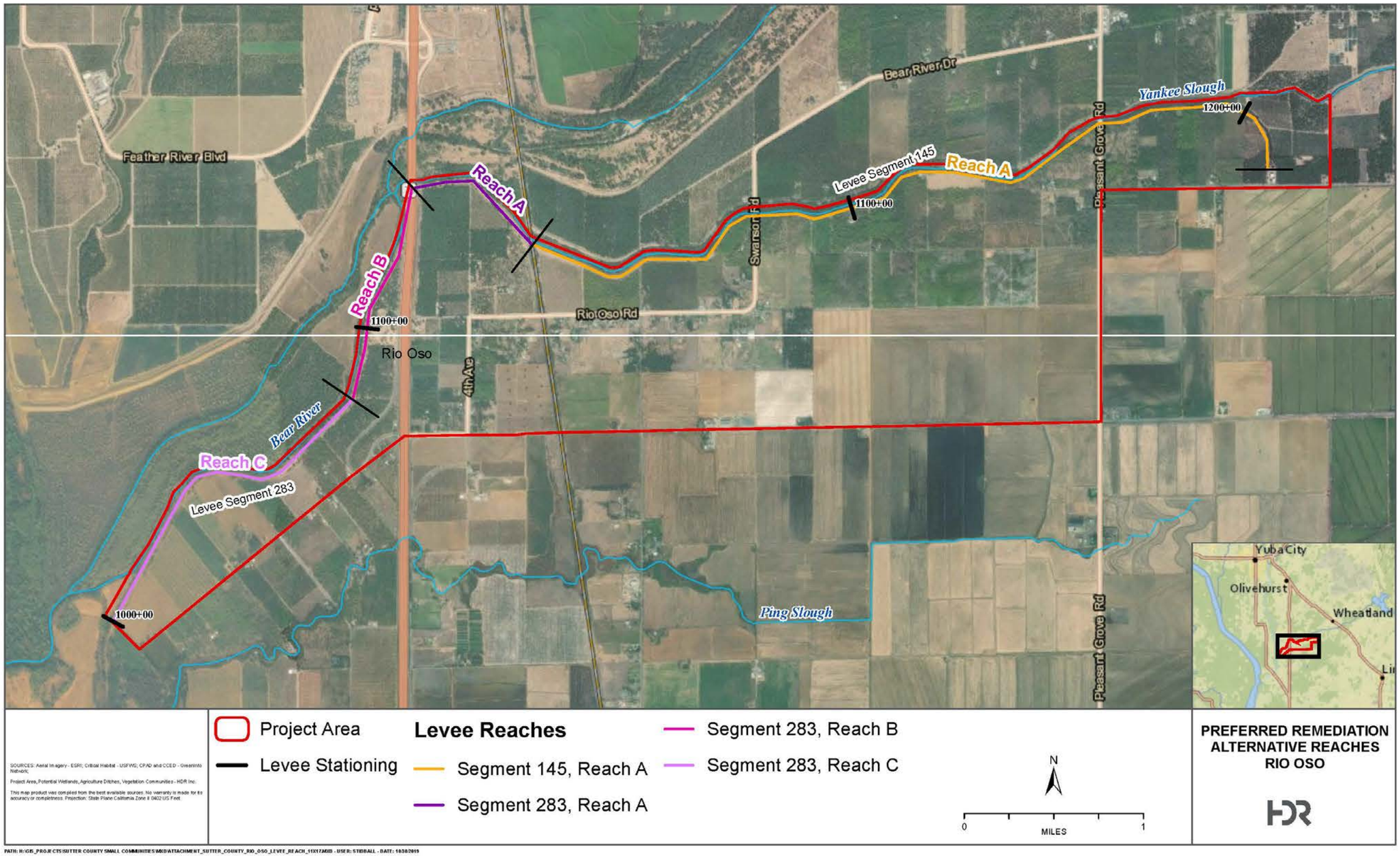


Table 1. 100 year Water Surface Remediation Alternative

Segment	Reach	Project Stationing	Remediation Alternative 1
145	A	YS 231+17 to YS 38+30	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials
283	A	YS 38+30 to YS 4+64	Drained Stability Berm - 15 feet wide and backfill landside depression with locally available materials
283	B	YS 4+64 to YS 0+00 and BR 130+72 to BR 85+00	Combined Drained Stability and Seepage Berm - 150 feet wide
283	C	BR 85+00 to BR 0+00	Waterside Slope - Rock Slope Protection; Landside - Combined Drained Stability and Seepage Berm - 60 feet wide

1.5.1 Drained Stability Berm

Drained stability berms will mitigate landside slope stability and/or through seepage. In the case of mitigating landside stability, the drained stability berm will provide additional weight at the toe to resist forces that develop along a slip surface. In the case of mitigating through seepage, filter material will retain existing embankment material in place and allow seepage to safely flow from the embankment. Drained stability berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing filter material, placing drain material, and then placing a protected layer of embankment soil. For the purposes of assessing project feasibility, it is assumed that the drained stability berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

1.5.2 Combined Drained Stability and Seepage Berm

Combined drained stability and seepage berms can be used to remediate underseepage, through seepage, and landside levee embankment slope instability. The berm includes a drainage layer on the foundation and levee landside slope that is comprised of drain rock over a sand filter layer placed on the foundation. A geotextile fabric separates the drain rock from the overlying berm fill. Berms are constructed by stripping approximately 1 foot of soil from the existing ground surface, placing geotextile filter material, placing drain material, and then placing a protected layer of embankment soil. The berm fill should be more pervious than the existing levee and shallow foundation layer. For the purposes of assessing project feasibility, assume that combined drained stability and seepage berms extend a minimum of 40 feet (two times the levee height) beyond the ends of the levee segment needing improvement. The extended improvement area is intended to address end-around effects. The drained seepage berm will discharge captured water at the berm toe and grading to provide positive drainage away from the levee will be required.

1.5.3 Erosion Remediation – Rock Slope Revetment

Rock slope revetment can be used to remediate erosion and generally consists of 6 inches of sand bedding overlain by 2 feet of rip-rap. Earthwork should be performed before placing sand bedding to backfill eroded areas and reshape the surface. Rock slope revetment generally extends from the waterside toe to the 100 water surface elevation.

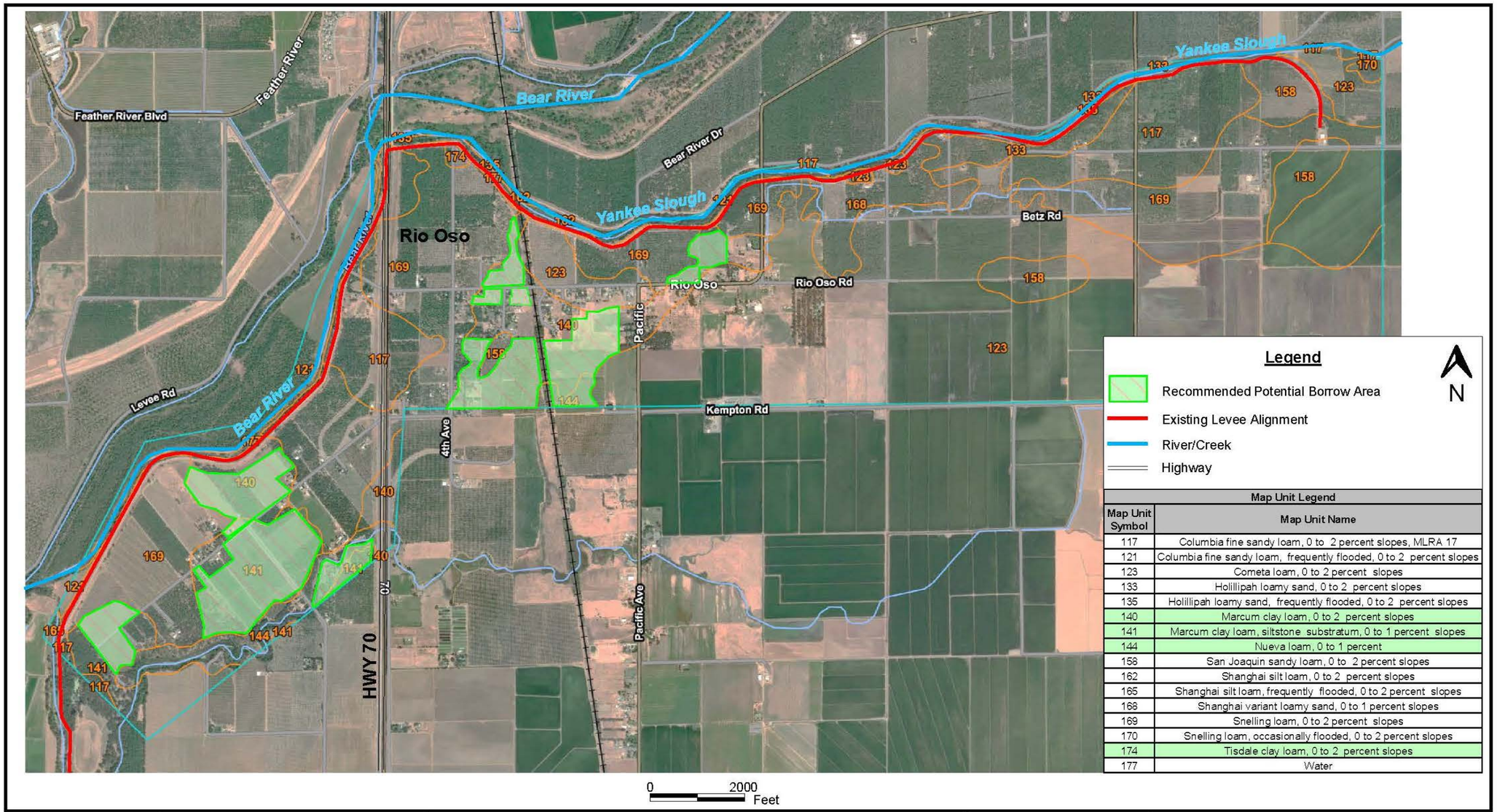
1.5.4 Geometry Mitigation

Geometry mitigation can be used to remediate the existing levee embankment prism to the standard levee dimensions. Remediation should be performed by landside widening and crest raising. The minimum width of the landside widening is at least 8 feet to ensure that the new fill section is wide enough to facilitate placement and compaction of the material by construction equipment. This landside remediation method eliminates significant work on the waterside of the levee thus minimizing environmental impact.

1.5.5 Borrow Area Recommendations

Potential borrow areas for the study area were identified based on soil types and a range of engineering properties for each soil unit. Comparing the typical engineering properties of each soil unit with the typical engineering properties of levee fill materials, potential borrow areas were identified and marked. In general, soil units identified as majority lean clay (CL) were selected as potential borrow areas. From these potential borrow areas, the locations closest to the levees were selected and marked. These potential borrow areas are shown in **Figure 1-3**.

Figure 1-3. Proposed Borrow Areas



Map Unit Legend	
Map Unit Symbol	Map Unit Name
117	Columbia fine sandy loam, 0 to 2 percent slopes, MLRA 17
121	Columbia fine sandy loam, frequently flooded, 0 to 2 percent slopes
123	Cometa loam, 0 to 2 percent slopes
133	Holillipah loamy sand, 0 to 2 percent slopes
135	Holillipah loamy sand, frequently flooded, 0 to 2 percent slopes
140	Marcum clay loam, 0 to 2 percent slopes
141	Marcum clay loam, siltstone substratum, 0 to 1 percent slopes
144	Nueva loam, 0 to 1 percent
158	San Joaquin sandy loam, 0 to 2 percent slopes
162	Shanghai silt loam, 0 to 2 percent slopes
165	Shanghai silt loam, frequently flooded, 0 to 2 percent slopes
168	Shanghai variant loamy sand, 0 to 1 percent slopes
169	Snelling loam, 0 to 2 percent slopes
170	Snelling loam, occasionally flooded, 0 to 2 percent slopes
174	Tisdale clay loam, 0 to 2 percent slopes
177	Water

NOTES: Source: USDA Web Soil Survey
https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Map Units selected for borrow are highlighted with green color

Rio Oso Flood Risk Reduction Feasibility Study

Potential Borrow Area

1.6 Nonstructural Measures, Ecosystem and Multi-Benefit Concepts

As discussed in Section 1.1, the nonstructural measures, ecosystem and multi-benefit concepts identified in the Feasibility Study have been developed to a conceptual level only; therefore, they do not meet the definition of a "project" as defined by CEQA (PRC, Division 13, Section 21000 et seq.). The CEQA Guidelines define a project as the whole of an action, which has a potential for resulting in either the direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment (California Code of Regulations [CCR], Chapter 14, Section 15378). Further, as described in Section 1.1, the CEQA Guidelines Section 15262 states that a project involving only feasibility or planning studies for possible future actions which an agency, board, or commission has not approved, adopted, or funded does not require the preparation of an Environmental Impact Report or a Negative Declaration. Section 15262 does not apply to the adoption of a plan that will have a legally binding effect on later activities. Therefore, the nonstructural measures, ecosystem and multi-benefit concepts are presented solely for planning purposes. These concepts have not been developed to the point to allow for a useful evaluation of environmental constraints, thus this report does not describe the potential environmental constraints related to the nonstructural measures, ecosystem and multi-benefit concepts.

1.6.1 Nonstructural Measures

Residual risk is defined as the product of (1) the chance of damage or other adverse consequence and (2) the amount of that damage or other adverse consequence, after flood management actions have been taken. Therefore, even after implementing the preferred remediation alternative, Rio Oso would still face residual risk from flooding.

Although it is not possible to completely eliminate residual risk, it can be mitigated with the implementation of nonstructural measures that improve flood system performance of existing facilities and/or reduce exposure, vulnerability, and consequences of flooding by adapting to the natural floodplain or inherent features of the floodplain.

For the Feasibility Study, several nonstructural measures were considered and evaluated for future consideration by Rio Oso. The measures are presented in order of feasibility and potential benefit to Rio Oso:

- Flood Emergency Evacuation Plan
- Flood Evacuation Warning System
- Emergency Flood Fight Plan
- Levee Relief Cuts
- Voluntary Structure Elevation & Flood-proofing
- Changes to National Flood Insurance Program (NFIP)
- Agricultural Conservation Easements

1.6.2 Ecosystem and Multi-Benefit Concepts

The FRRFMP identified several ecosystem problems facing the region, including the Rio Oso area. These problems included erosion, flow constrictions, invasive vegetation, and overgrown vegetation from lack of proper maintenance. To potentially address these problems, several concepts were identified for improved habitat, restoring natural dynamic process that support agricultural and terrestrial floodplain ecosystems, planting of riparian vegetation, sediment removal, creating shaded riverine aquatic habitat, and some recreation improvements. These concepts are still under evaluation and could be implemented in the future in addition to the preferred remediation alternative.

2 Research Methods

2.1 Environmental Constraints Analysis Methodology

A desktop analysis was performed in order to determine potential environmental constraints associated with the implementation of the preferred structural alternative. Criteria from Appendix G of the California Environmental Quality Act (CEQA) Guidelines was used as a framework to determine potentially significant impacts on different resource areas, and was also used as a means to determine if CEQA documentation would be required for the preferred alternative. The resource areas evaluated include the following:

- Aesthetics
- Agriculture and Forestry Resources
- Air Quality and Green House Gas (GHG) Emissions
- Biological Resources
- Cultural and Tribal Cultural Resources
- Energy
- Geology and Soils
- Mineral Resources
- Hazards and Hazardous Materials
- Hydrology and Water Quality
- Land Use and Planning
- Noise
- Public Services
- Recreation
- Transportation
- Utilities and Service Systems
- Wildfire

The results of that analysis are provided in **Appendix B** of this report, and a summary of potential environmental constraints is provided in **Section 3.2**. A regulatory consistency analysis was also performed for the project to determine the preferred alternative's conformance to relevant federal, state, and local regulations under each of the evaluated resource areas **(Appendix A).** Primary data sources used during the desktop analysis include the following:

- Sutter County General Plan
- California Department of Conservation Farmland Mapping and Monitoring Program
- California Department of Conservation Williamson Act Maps
- California Department of Forestry and Fire Protection (Cal Fire) Hazard Severity Zone Maps
- California Department of Transportation Scenic Highway Maps
- California State Water Resources Control Board GeoTracker Database
- Department of Toxic Substances Control (DTSC) EnviroStor Database
- Feather River Air Quality Management District
- U.S. Fish and Wildlife Service Critical Habitat Maps
- California Energy Commission
- Sutter County Climate Action Plan

In addition to the environmental constraints and regulatory consistency analyses, separate in-depth biological resources and cultural resources analyses were conducted to support the environmental constraints analysis, as described in further detail below. The Biological Resources Analysis is provided in **Appendix C** and the Cultural Resources Analysis is located in **Appendix D**.

2.2 Biological Resources Analysis Methodology

The Biological Resources Analysis is provided in **Appendix C**. The methodology is described below.

2.2.1 Desktop Review

A desktop review was undertaken to assess potential biological constraints in the Rio Oso project area (**Appendix C, Exhibit 1**), which included two steps to collect data on special-status species, vegetation communities, sensitive communities, protected lands, and federally-protected aquatic resources with the potential to occur in the project area. First, preliminary database searches were performed to identify aquatic resources and special-status species with the potential to occur in the project area. Second, a preliminary review of recent aerial imagery and land use maps was conducted to collect site-specific data regarding habitat suitability for special-status species, and to see if any protected lands overlap with the project area.

Database searches were performed on the following websites:

- U.S. Fish and Wildlife Service's (USFWS) Information Planning and Consultation (IPaC) System (2019a);
- USFWS Critical Habitat Portal (2019b);
- National Marine Fisheries Service (NMFS) (2016)
- California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB) in BIOS 5 (2019);
- California Native Plant Society (CNPS) California Rare Plant Rank (CRPR) (2019);
- USFWS National Wetland Inventory (2019c); and,
- U.S. Geological Survey (USGS) topographical map.
- Google Earth Pro (2019)

A query of the USFWS's IPaC system was performed to identify federally listed species that may occur in or adjacent to the project area. A review of the USFWS's Critical Habitat portal was also conducted to identify designated critical habitat units that fall within the project area. A query of the CNDDB provided a list of processed and unprocessed special-status species occurrences within the Nicolaus and Sheridan USGS 7.5 minute quadrangles (quads), as well as all adjacent quads. The CNDDB was also used to analyze land ownership data in the vicinity of the project area. Additionally, the CNPS database was queried to identify special-status plant species with the potential to occur in the aforementioned quads. Finally, USFWS National Wetland Inventory data and USGS topographical maps were used to aid in the digitization of vegetation communities and potential aquatic resources within the project area. The raw data returned from the database queries is provided in **Appendix A.** Reconnaissance Survey

A reconnaissance level survey was conducted on February 12, 2019 to verify the results of the desktop review. HDR biologists drove on publically accessible roads throughout the project area in order to record existing vegetation communities, aquatic resources, and species observed. A summary of the results of the site visit are included in **Section 3.2**.

2.3 Cultural Resources Analysis Methodology

2.3.1 Records Search and Historic Map Review

Records search requests for the Project area were submitted on February 14, 2019 to the North Central Information Center (NCIC) at California State University, Sacramento and the Northeastern Information Center (NEIC) at California State University, Chico of the California Historical Resources Information System. The search area for which data was requested included all alternatives for the project footprint, plus a 0.25-mile buffer. Search results were received from the NCIC on February 20, 2019 and from the NEIC on March 13, 2019. The information requests included a search of previous cultural resources investigations, and previously recorded archaeological sites and built

environment resources. To gather these data the records searches reviewed the following including the:

- NCIC and NEIC Resource Databases,
- NCIC and NEIC Report Databases,
- Office of Historic Preservation (OHP) Historic Properties Directory for Sutter County,
- OHP Archaeological Determinations of Eligibility for Sutter County,
- California Inventory of Historical Resources (1976), and
- General Land Office (GLO) and/or Rancho Plat Maps.

Information was also requested on the Caltrans Bridge Survey, ethnographic information, and local inventories, where present. Historic United States Geological Service (USGS) topographic maps were also reviewed in order to track land-use and historic-era development. An additional data review was performed in November, 2019 due a revision on the project area. The APE map and summary of the results of the records search and desktop investigation are provided in a technical memorandum attached as **Appendix D**. The technical memorandum includes the technical data review and discussion of cultural resources and their potential for sensitivity. The findings of the technical memorandum have been incorporated into Section 3.2.

2.3.2 Reconnaissance Survey

A field reconnaissance of the project area was conducted on April 2, 2019 by John “Jay” Lloyd, M.A. Linguistics, who meets the Secretary of the Interior’s Qualification Standards for archaeology and is a Registered Professional Archaeologist (RPA). Methods included reviewing the results of the records search, confirming the absence/presence of previously recorded (and accessible) resources, generally driving across the breadth of the project area on publicly accessible roads, and assessing major topographical differences between the historic and modern landscape using historic-era maps for comparison.

3 Results

3.1 Regulatory Consistency Analysis

The results of the Regulatory Consistency Analysis, provided in **Appendix A**, are summarized below. Based on the results of the analysis, potential regulatory conflicts could exist for agricultural resources, biological resources, cultural resources, air quality and greenhouse gas emissions and noise. Other resources would comply with applicable federal, state and local regulations.

Agricultural Resources

The project would have the potential to disturb lands designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance during construction activities

(DOC 2016). This results in the potential to conflict with the Farmland Mapping and Monitoring Program and Sutter County General Plan Land Use and Agricultural Resources Elements.

The project is not located adjacent to Williamson Act Contract properties and none would be disturbed as a result of project activities. Therefore the project would not conflict with the Williamson Act Program.

Biological Resources

The project could conflict with biological resource regulations. Based on a preliminary review of biological resources databases and a site reconnaissance, the project area appears to contain suitable habitat for several special-status species and includes protected aquatic resources. Project activities have the potential to impact any of the biological resources listed in **Appendix C, Table 1**, should they be present in the vicinity of the proposed work area. Prior to project implementation, consultation with resource agencies and acquisition of permits would be necessary.

Cultural Resources

Based on a review of the records search results, historic map review, and the site reconnaissance provided in **Appendix D**, 23 archaeological sites and historical built environment resources were identified, both within and outside the project area. Project activities have the potential to impact these cultural resources, should they be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site(s) which cannot be avoided by the project would also require evaluation for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation could be required if significant impacts/adverse effects could not be avoided.

Air Quality, GHG Emissions, and Noise

During construction, the preferred alternative would require the use of construction vehicles and equipment on a temporary basis. Significant air quality impacts could result on a short-term basis from particulate matter generated during construction activities, such as dust and equipment exhaust. The project would also generate GHG emissions during the operation of construction vehicles and equipment. The project would adhere to Best Management Practices to minimize air quality and GHG emissions impacts, but there remains potential that the project would not conform to the Clean Air Act and relevant GHG regulations.

The project would generate increased noise conditions during proposed project construction activities. With noise sensitive receptors in close proximity (schools, residents, etc.), there is a potential that the project would not adhere to noise thresholds outlined in the Sutter County General Plan.

Other Resources

Based on the Regulatory Consistency Analysis provided in **Appendix A**, and following the resource categories outlined in CEQA Guidelines Appendix G, the project would conform to all federal, state and local regulations under aesthetics; energy; geology and soils; hazards and hazardous materials; hydrology and water quality; land use and

planning; mineral resources; public services; utilities and service systems; recreation; transportation; and wildfire. In many cases, regulatory compliance is contingent upon implementation of appropriate Best Management Practices (BMPs), such as those required to protect water quality, and proper permitting. Those permits and approvals that could be required prior to implementation of the project are provided in **Table 3.**

3.2 Summary of Potential Environmental Constraints

Resources with No Impacts

Based on the Existing Conditions and Environmental Constraints Analysis, environmental constraints would not occur under the following resources:

- Aesthetics
- Energy
- Land Use and Planning
- Mineral Resources
- Public Services
- Recreation
- Wildfire

Table 2 presents a summary of potential environmental constraints under the preferred structural alternative. Only those resource areas with potential constraints are included in **Table 2**. The full analysis is provided in **Appendix B,** Existing Conditions and Environmental Constraints.

Table 2. Summary of Potential Environmental Constraints under the Preferred Structural Alternative

Potential Environmental Constraints	Structural Preferred Alternative
Agriculture and Forestry Resources	
Would the project result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance?	✓
Air Quality and GHG Emissions	
Would project result in substantial emissions?	✓
Would the project expose sensitive receptors to substantial pollutant concentrations?	✓
Would the project generate GHG emissions either directly or indirectly?	✓
Biological Resources	
Is the project located adjacent to terrestrial or aquatic habitat areas for state or federally listed endangered, threatened, or candidate species?	✓
Would the project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	✓

Potential Environmental Constraints	Structural Preferred Alternative
Would the project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	✓
Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	✓
Would the project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	✓
Cultural and Tribal Cultural Resources	
Do known historical, archaeological, or tribal sites or resources occur in the project area?	✓
Does the project require excavations or ground disturbance that could inadvertently impact known or unknown cultural, historical, or archaeological resources?	✓
Would the project disturb human remains, including those encountered outside of dedicated cemeteries?	✓
Geology, Soils and Mineral Resources	
Would the project require excavations, grading, or other ground disturbing activities capable of causing erosion or loss of topsoil?	✓
Do known paleontological resources exist in the project area?	✓
Hazards and Hazardous Materials	
Does the project require the use or routine transport of hazardous materials?	✓
Hydrology and Water Quality	
Would the project alter the drainage pattern of the site or area in a manner which would result in substantial erosion or siltation?	✓
Would the project alter the drainage pattern of the site or area or result in an increase in surface runoff in a manner which would result in flooding on- or off-site?	✓
Is the project located within a 100-year flood hazard area?	✓
Noise	
Would the project generate noise in excess of thresholds outlined in the county noise ordinance or general plan?	✓
Would the project generate excessive ground borne vibration or ground borne noise levels?	✓
Transportation	
Would the project result in disruptions to traffic or the circulatory system?	✓
Utilities and Service Systems	
Would the project require or result in the relocation or construction of new or expanded water, or wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities or expansion of existing facilities, the construction or relocation of which could cause significant environmental effects?	✓

As shown in **Table 2**, the preferred structural alternative (described in Section 1.5) could result in impacts on agriculture and forestry resources; air quality and GHG emissions; biological resources; cultural and tribal cultural resources; geology and soils; hazards

and hazardous materials; hydrology and water quality; noise, transportation, and utilities and service systems.

4 Environmental Documentation, Permits and Approvals

4.1 California Environmental Quality Act

Based on the results of the environmental constraints analysis, it is likely that the preferred alternative would result in an impact on the environment and therefore, CEQA documentation would be required. CEQA requires that all state and local government agencies consider the environmental consequences of projects they propose to carry out, or over which they have discretionary authority, before implementing or approving those projects. As specified in Section 15367 of the State CEQA Guidelines, the public agency that has the principal responsibility for carrying out or approving a project, as defined above and as described in more detail below, is the lead agency for purposes of CEQA. As specified in Section 15064(a) of the state CEQA Guidelines, if there is substantial evidence (such as the results of an Initial Study (IS)) that a project, either individually or cumulatively, could have a significant effect on the environment that cannot effectively be mitigated to a less-than-significant level, the lead agency must prepare an EIR. The lead agency may instead prepare an IS if it determined that there is no substantial evidence that the project could cause a significant impact to the environment. The lead agency may prepare a Mitigated Negative Declaration (MND), if in the course of the IS analysis, the agency finds that the project would have no significant environmental impacts or could have a significant impact to the environment but that implementing specific mitigation measures would reduce any such impacts to a less-than-significant level (state CEQA Guidelines, Section 15064[f]). The level of CEQA documentation that would be required for the project would be determined after the Feasibility Study is completed and once the project moves into the design phase.

4.2 National Environmental Policy Act

Based on the results of the Environmental Constraints Analysis (ECA), it is likely that the project would require compliance with federal regulations, such as the Clean Water Act, Section 404; National Historic Preservation Act, Section 106; and Endangered Species Act (ESA), Section 7, as described in **Section 4.3, Permits**. Because these federal permits and consultations would likely be required, compliance with the National Environmental Policy Act (NEPA) could be triggered. In addition, all of the Rio Oso Levee System levees are part of the California State Plan of Flood Control (SPFC) and thus are identified as state/federal facilities; therefore, any modifications to the levees could also trigger the need for NEPA compliance, as well as a Rivers and Harbors Act, Section 408 permit. The level of NEPA documentation that would be required for the project would be determined during the permitting process.

4.3 Permits and Approvals

Several Federal, state, and local permits and/or authorizations are anticipated for the project. **Table 3** summarizes the potential permits and approvals that may be associated with the project. The regulations and ordinances listed below represent a preliminary assessment of permitting requirements, which would be refined through subsequent project design and preparation of a detailed project description.

The preferred alternative would directly and indirectly affect sensitive natural resources, including waters of the U.S. All potential waters of the U.S., including wetlands, identified within the project area may be regulated by the U.S. Army Corps of Engineers (USACE) through section 404 of the Clean Water Act (CWA) and by the Regional Water Quality Control Board (RWQCB) as waters of the State through Section 401. All ecological systems associated with drainages (i.e. potential waters of the U.S.), and drainage features with bed and bank topography may also be regulated by Sections 1600-1616 of the California Fish and Game Code. In conjunction with the USACE Section 404 permit, impacts on wetlands and waters would require a Section 401 Water Quality Certification or Waste Discharge Requirement from RWQCB and CDFW Section 1602 Streambed Alteration Agreement. Also, the project has the potential to affect more than 1.0 acre of soil, triggering the requirement of a National Pollutant Discharge Elimination System (NPDES) General Permit from the RWQCB.

Finally, the project has the potential to adversely affect special-status species. Direct and/or indirect impact to federal and state listed species and their habitat would require formal consultation with the USFWS (Biological Opinion/Take Statement for Federal-listed species) and CDFW (2081 Incidental Take Permit for State-listed species) to determine the levels of take.

Table 3. Potential Environmental Permits and Approvals

Agency	Type of Permit or Approval	Regulated Activity
Federal		
U.S. Army Corps of Engineers	Clean Water Act, Section 404 Permit	Discharges of dredged or fill material into waters of the U.S., including wetlands
State Historic Preservation Officer (SHPO)	National Historic Preservation Act, Section 106 Consultation	Potential effects on properties listed in, or eligible for listing in the National Register of Historic Places
U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS)	Endangered Species Act (ESA), Section 7 Consultation	Potential effects on federally-listed species
State		
California Department of Fish and Wildlife (CDFW)	California ESA Take Authorization, California Fish and Game Code, Section 2081 Consultation	Potential for take of state-listed species
CDFW	California Fish and Game Code, Section 1602 Streambed Alteration Agreement	Alteration of bed, bank, or associated riparian areas
California Native American Heritage Commission (NAHC)	Assembly Bill 52 (CEQA), NAHC Consultation	Potential effects on Native American burials or artifacts

Agency	Type of Permit or Approval	Regulated Activity
Local		
Regional Water Quality Control Board (RWQCB)	CWA, Section 402 National Pollutant Discharge Elimination System (NPDES) Construction General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities and/or Waste Discharge Requirements for Dewatering and Other Low Threat Discharges to Surface Waters	Discharge of pollutants into Waters of the U.S.
RWQCB	CWA, Section 401 Water Quality Certification	Discharge of dredged or fill material into Waters of the U.S. and State
Air Pollution Control District	Authority to Construct/ Permit to Operate	Local construction emissions. Construction emissions and equipment must comply with applicable rules and regulations and will not interfere with air quality standards.

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Appendix A. Regulatory Consistency Analysis

Regulatory Consistency Analysis

Introduction

The Regulatory Consistency Analysis provides an overview of the federal, state and local regulations, policies and plans applicable to the project and includes a discussion of whether project activities, at this conceptual stage of development, would be anticipated to conflict with these regulations, policies and plans. **Table A-1** includes a summary of potential consistency conflicts by regulatory area.

Table A-1. Regulatory Consistency Conflicts

Regulatory Area	Potential Consistency Conflict? Yes/No (Y/N)
Aesthetics	N
Agricultural Resources	Y
Air Quality	Y
Biological Resources	Y
Cultural Resources	Y
Energy	N
Geology and Soils	N
Hazards and Hazardous Materials	N
Hydrology and Water Quality	N
Land Use and Planning	N
Noise	Y
Public Services and Utilities	N
Recreation	N
Transportation	N

The sections below describe the relevant regulatory setting and regulatory consistency analysis for each resource area.

Aesthetics

State

California Scenic Highway Program. California's Scenic Highway Program was created by the Legislature in 1963 to preserve and protect scenic highway corridors from change, which would diminish the aesthetic value of lands adjacent to highways (Caltrans 2017). The state laws governing the Scenic Highway Program are found in the Streets and Highways Code (Section 260, et seq.).

Local

***Sutter County General Plan*.** According to the Sutter County General Plan Land Use Element and Environmental Resources Element, goals and policies strive to preserve and enhance

Sutter County's natural resources, and promote development that visually complements the natural environment, topography and aesthetic viewsheds (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The preferred remediation alternative would not conflict with the California Scenic Highway Program. There are no officially designated state or county highways in Sutter County or in the vicinity of the project. The project would conform to policies outlined in the Sutter County General Plan. The project area is located in rural Sutter County and is primarily dominated by lands under agricultural use (Sutter County 2011). Project activities would be consistent with the current uses and visual quality of the project area, and would not impact visual resources in Sutter County.

Agricultural Resources

State

***Farmland Mapping and Monitoring Program*.** The California Department of Conservation, Division of Land Resource Protection works with landowners, local governments, and researchers to conserve the state's farmland and open space, and maintains a statewide inventory of farmlands. These lands are mapped as part of the Farmland Mapping and Monitoring Program (FMMP), which is based on a classification system that rates agricultural land according to soil quality and irrigation status. Agricultural lands are divided and mapped into the following eight categories:

- *Prime Farmland*—Farmland with the best combination of physical and chemical features able to sustain long-term agricultural production. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for irrigated agricultural production at some time during the 4 years before the mapping date.
- *Farmland of Statewide Importance*—Farmland similar to Prime Farmland but with minor shortcomings, such as greater slopes or less ability to store soil moisture. Land must have been used for irrigated agricultural production at some time during the 4 years before the mapping date.
- *Unique Farmland*—Farmland of lesser quality soils used for the production of the state's leading agricultural crops. This land is usually irrigated, but may include non-irrigated orchards or vineyards as found in some climatic zones in California. Land must have been cropped at some time during the 4 years before the mapping date.
- *Farmland of Local Importance*—Land of importance to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee.
- *Grazing Land*—Land on which the existing vegetation is suited to the grazing of livestock.
- *Urban and Built-up Land*—Land occupied by structures with a building density of at least one unit to 1.5 acres, or approximately six structures to a 10-acre parcel.
- *Other Land*—Land not included in any other mapping category. Common examples include low-density rural developments; brush, timber, wetland, and riparian areas not suitable for livestock grazing; confined livestock, poultry, or aquaculture facilities; strip

mines; borrow pits; and water bodies smaller than 40 acres. Vacant and nonagricultural land surrounded on all sides by urban development and greater than 40 acres is mapped as Other Land.
- *Water*—Perennial water bodies with an extent of at least 40 acres.

Williamson Act Program. The California Land Conservation Act of 1965, commonly referred to as the Williamson Act, enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In return, landowners receive reduced property tax assessments. Williamson Act categories include:

- Williamson Act – Non-Prime Agricultural Land: Land which is enrolled under California Land Conservation Act contract and does not meet any of the criteria for classification as Prime Agricultural Land.
- Williamson Act – Farmland Security Zone: Enrolled parcels containing either Prime or Non-Prime agricultural land restricted by a 20 year contract pursuant to Government Code Section 51296.

Local

Sutter County General Plan. The Agricultural Resources Element and Land Use Element of the Sutter County General Plan include goals and policies geared towards the preservation of agricultural lands during economic growth and improvement of the County's productive capabilities (Sutter County 2011).

CONSISTENCY ANALYSIS

Potential conflict. The preferred remediation alternative would potentially conflict with the Farmland Mapping and Monitoring Program and the Sutter County General Plan Land Use Element and Agricultural Resources Element. The project area includes Prime Farmland, Unique Farmland, Farmland of Statewide Importance, and has the potential to disturb or convert such land uses during construction and ground disturbing activities (DOC 2016; Sutter County 2011). To the extent possible, these areas would be avoided and BMPs would be employed to reduce impacts on agricultural lands. While Williamson Act Contract properties are in the vicinity of the project area, none are adjacent to the proposed levee improvements. Therefore, the project would not conflict with the Williamson Act Program.

Air Quality

Federal

Clean Air Act. The Clean Air Act (CAA) was first enacted in 1963 and has since been amended (1965, 1967, 1970, 1977, and 1990). Under the CAA, the U.S. Environmental Protection Agency (USEPA) developed the National Ambient Air Quality Standards (NAAQS), or numerical concentration-based standards, for six criteria pollutants that have been determined to affect human health and the environment. The NAAQS represent the maximum allowable concentrations for O3 - measured as either volatile organic compounds (VOCs) or total oxides of nitrogen (NOx), carbon monoxide (CO), nitrogen dioxide (NO2), sulfur oxides (SOx), respirable particulate matter (including PM10 and PM2.5), and lead (Pb).

USEPA classifies the air quality in an Air Quality Control Region (AQCR), or in subareas of an AQCR, according to whether the concentrations of criteria pollutants in ambient air exceed the NAAQS. Areas within each AQCR are therefore designated as either "attainment," "nonattainment," "maintenance," or "unclassified" for each of the six criteria pollutants. Attainment means that the air quality within an AQCR is better than the NAAQS; nonattainment indicates that criteria pollutant levels exceed NAAQS; maintenance indicates that an area was previously designated nonattainment but is now attainment; and an unclassified air quality designation by USEPA means that there is not enough information to appropriately classify an AQCR, so the area is considered attainment. The CAA also mandates that each state implement a State Implementation Plan (SIP) for local areas not meeting those standards, and the SIP must include pollution control measures outlining how the standards will be met.

State

California Clean Air Act. The CAA gives the authority to states to establish air quality rules and regulations. Air quality in California is governed by the California Clean Air Act (CCAA). The State of California has adopted the NAAQS and promulgated additional California Ambient Air Quality Standards (CAAQS) for criteria pollutants. The CAAQS are more stringent than the Federal primary standards. The CCAA requires all air districts in the state to endeavor to meet the CAAQS by the earliest practical date.

In California, the USEPA has delegated the authority for ensuring compliance with the NAAQS to the California Air Resources Board (CARB). CARB has delegated responsibility for implementation of the CAA and CCAA to local air pollution control agencies.

Greenhouse Gas Regulation. California has adopted statewide legislation addressing various aspects of climate change and mitigation for greenhouse gas (GHG) emissions. This legislation establishes a broad framework for meeting the state's long-term GHG reduction goals. The Governor of California has also issued several orders related to the state's evolving climate change policy. Of particular importance is the Global Warming Solutions Act of 2006, also commonly referred to as Assembly Bill (AB) 32, which establishes a statewide GHG reduction goal of achieving 1990 emissions levels by 2020.

Local

Feather River Air Quality Management District (FRAQMD). The project area is located within the jurisdictional boundaries of the FRAQMD and is subject to the rules and regulations developed by the FRAQMD. FRAQMD is responsible for administering local, State and federal air quality management programs for Yuba and Sutter Counties (SVAQEEP 2018).

Sutter County General Plan. The Mobility Element and Environmental Resources Element of the Sutter County General Plan include updated goals and policies intended for the conservation, protection, and enhancements of the County's air quality, including the minimization of air pollutant emissions (Sutter County 2011).

CONSISTENCY ANALYSIS

Potential conflict. The project would require the use of construction vehicles and equipment on a temporary basis during construction. Air quality impacts could result from particulate matter

generated during construction activities, such as dust and equipment exhaust. Operation of construction vehicles and equipment could generate GHG emissions on a short term, intermittent basis. The project would implement BMPs during construction in an effort to minimize air quality and GHG impacts, but there is potential that the Project would not conform to CAA, GHG regulations and the FRAQMD's rules and regulations.

Biological Resources

Federal

Endangered Species Act of 1973. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) enforce the provisions stipulated within the Federal Endangered Species Act of 1973 (hereafter, "FESA," 16 United States Code [USC] §1531 et seq.). Threatened and Endangered species on the Federal list (50 Code of Federal Regulations [CFR] § 17.11 and 17.12) are protected from take, defined as direct or indirect harm or harassment, unless a Section 10 permit is granted to an entity other than a Federal agency, or a Biological Opinion with incidental take provisions is rendered to a Federal lead agency via a Section 7 consultation. Pursuant to the requirements of FESA, an agency reviewing a Proposed Project within its jurisdiction must determine whether any federally listed or proposed species may be present in the study area and determine whether the Proposed Project is likely to jeopardize the continued existence of the species, or result in the adverse modification or destruction of habitat for said species. Under FESA, habitat loss is considered to be an impact to a species, thus related impacts to these species or their habitats would be considered significant and would require mitigation.

Migratory Bird Treaty Act. Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703–711). As interpreted in a 2018 regulation, the MBTA makes it unlawful to non-incidentally take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 CFR 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 CFR 21).

Wetlands and Other Waters of the U.S. Any person, firm, or agency planning to perform work that involves the discharge of dredged or fill material into "waters of the U.S.", must first obtain authorization from the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (33 USC §1344). Permits, licenses, variances, or similar authorizations may also be required by other Federal, State, and local statutes. Waters of the U.S. are defined as: all waters used in interstate or foreign commerce; all interstate waters including interstate wetlands; all other waters such as intrastate lakes, rivers, streams (including intermittent and ephemeral streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes or natural ponds, where the use, degradation, or destruction of which could affect interstate commerce; impoundments of these waters; tributaries of these waters; or wetlands adjacent to these waters (33 CFR Part 328). With non-tidal waters, in the absence of adjacent wetlands, the extent of USACE jurisdiction extends to the ordinary high water mark (OHWM) – the line on the shore established by fluctuations of water and indicated by a clear, natural line impressed on the bank, shelving, changes in soil character, destruction of terrestrial vegetation, or the presence of litter and debris. Wetlands are defined as: "… those areas that are inundated

or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".

In addition, the Regional Water Quality Control Board (RWQCB) may require a State Water Quality Certification (CWA, Section 401 permit) before other permits are issued.

State

California Fish and Game Code. The California Fish and Game Code includes various statutes that protect biological resources, including the Native Plant Protection Act of 1977 (NPPA), fully protected species, and requirements for notification of lake or streambed alteration.

The NPPA (Fish and Game Code Sections 1900–1913) authorizes the Fish and Game Commission to designate plants as endangered or rare and prohibits take of any such plants, except as authorized under limited circumstances.

Fish and Game Code Sections 3503, 3513, and 3800 protect raptors and native and migratory birds, including their active or inactive nests and eggs, from all forms of take. In addition, species that are "fully protected" from all forms of take are listed in Section 3511 (birds), Section 5515 (fish), Section 4700 (mammals), and Section 5050 (amphibians). No permit is available to take these species.

CDFW regulates activities that will interfere with the natural flow of, or substantially alter, the channel, bed, or bank of a lake, river, or stream. Section 1602 of the Fish and Game Code requires that CDFW be notified of lake or streambed alteration activities. If CDFW subsequently determines that such an activity might adversely affect an existing fish and wildlife resource, the agency has the authority to issue a streambed alteration agreement, including requirements to protect biological resources and water quality.

CNPS has developed a set of lists of native plants in California according to rarity. Plants on List 1A, List 1B, and List 2 meet the definitions of Section 1901, Chapter 10 (NPPA) or Sections 2060 and 2067 (CESA) of the Fish and Game Code (Section 1900–1913) as rare or endangered species.

California Endangered Species Act (CESA). The California Endangered Species Act (CESA) is similar to the FESA in that it contains a process for listing species and regulating potential impacts to listed species. Section 2081 of the CESA authorizes the California Department of Fish and Wildlife (CDFW) to enter into a memorandum of agreement for take of listed species for scientific, educational or management purposes.

CDFW also requires notification prior to commencement, and may require a Streambed Alteration Agreement, pursuant to California Fish and Game Code (Subsections 1601-1603), if a proposed project would result in the alteration or degradation of a stream, river, or lake in California.

Local

Yuba and Sutter County Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP). Yuba and Sutter Counties are currently in the process of developing a Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP) that incorporates valley floor communities for both counties. The project area falls completely within the proposed boundary for the NCCP/HCP. Under the NCCP/HCP, specific habitats that are recommended to be protected include vernal pools and their watersheds, emergent wetlands, confluences of riparian/riverine systems, valley oak woodlands, mature riparian forests, wide riparian areas of more than 100 meters, and functional or potentially restorable floodplain areas. Additionally, the proposed plan calls out the confluence of the Bear and Feather Rivers and the Coon Creek watershed as areas of high biological potential. The plan also outlines guidelines for riparian conservation and restoration, establishing wetland buffers, maintaining and restoring hydrological connectivity including minimizing barriers to fish passage, and general levee maintenance. It is anticipated that the project activities would comply with the conditions set forth in the NCCP/HCP.

***Sutter County General Plan*.** The Environmental Resources Element of the Sutter County General Plan includes goals and policies intended for the conservation and protection of the County's ecosystem, habitats, and special status species (Sutter County 2011).

CONSISTENCY ANALYSIS

Potential conflict. Based on a preliminary review of biological resources databases and a site reconnaissance, the project area appears to contain suitable habitat for several special-status species and also includes aquatic resources. Project activities have the potential to impact biological resources listed in **Appendix C, Table 1**, should they be present in the vicinity of the proposed work area, and may therefore conflict with such regulations as MBTA, the California Fish and Game Code and CESA. Prior to project implementation, consultation with resource agencies and acquisition of permits would likely be necessary.

Cultural and Tribal Cultural Resources

Federal

Section 106 of the National Historic Preservation Act (NHPA). Section 106 of the National Historic Preservation Act (NHPA) requires that, before beginning any undertaking, a federal agency must take into account the potential for effects on historic properties and offer the Advisory Council on Historic Preservation (ACHP) and other interested parties an opportunity to comment on the Proposed Project. Specific regulations regarding compliance with Section 106 state that, although the tasks necessary to comply with Section 106 may be delegated to others, the federal agency is ultimately responsible for ensuring that the Section 106 process is completed. Upon initiation of the Section 106 process, the lead federal agency is required to invite the appropriate State Historic Preservation Office (SHPO) or appropriate Tribal Historic Preservation Office (required only if the undertaking would occur on land owned by a federally recognized Indian tribe) to participate in the process.

Section 106 also requires federal agencies, or those they fund or permit, to consider the effects of their actions on properties that are determined eligible for listing or are listed in the National

Register of Historic Places (NRHP). To determine whether an undertaking could affect NRHP-eligible properties, cultural resources (archaeological, historical, architectural, and traditional cultural properties) must be inventoried and evaluated for the NRHP. To be listed in the NRHP, a property must be at least 50 years old (or be of exceptional historic significance if less than 50 years old) and meet one or more of the NRHP criteria. To qualify for listing, a historic property must represent a significant theme or pattern in history, architecture, archaeology, engineering, or culture at the local, state, or national level, and must meet specific significance criteria.

Antiquities Act of 1906. This act provides for fines or imprisonment of any person convicted of appropriating, excavating, injuring, or destroying any historic or prehistoric ruin or monument or other object of antiquity that falls under the jurisdiction of the federal government.

Archaeological Resources Protection Act of 1979. This act amended the Antiquities Act, set a broad policy stating that archaeological resources are important to the nation and should be protected, and required special permits before the excavation or removal of archaeological resources from public or Indian lands.

State

PRC Section 5024.1: California Register of Historical Resources. The State of California implements the NHPA through its statewide comprehensive cultural resource preservation programs. The California Office of Historic Preservation (OHP), an office of the California Department of Parks and Recreation, implements the policies of the NHPA on a statewide level. The OHP also maintains the California Register of Historical Resources (CRHR). The SHPO is an appointed official who implements historic preservation programs within the State's jurisdiction.

The CRHR includes resources that are listed in or formally determined eligible for listing in the NRHP, as well as some designated California State Landmarks and Points of Historical Interest. Properties of local significance that have been designated under a local preservation ordinance (local landmarks or landmark districts) or that have been identified in a local historical resources inventory may be eligible for listing in the CRHR.

PRC Sections 5097.91 through 5097.98: California Native American Heritage Commission (NAHC) The California Native American Heritage Commission (NAHC) identifies and catalogs cultural resources (i.e., places of special religious or social significance to Native Americans, and known graves and cemeteries of Native Americans on private lands) in California. The NAHC is charged with preserving and ensuring accessibility of sacred sites and burials, the disposition of Native American human remains and burial items, maintain an inventory of Native American sacred sites located on public lands, and review current administrative and statutory protections related to these sacred sites.

Assembly Bill 52. Assembly Bill (AB) 52 (Chapter 532, Statutes of 2014) applies to all projects that file a Notice of Preparation (NOP) or notice of a Negative Declaration on or after July 1, 2015. The bill requires that a lead agency begin consultation with a California Native American tribe if that tribe has requested, in writing, to be kept informed of proposed projects by the lead agency, prior to the determination whether a Negative Declaration, or EIR will be prepared. The

bill also specifies mitigation measures that may be considered to avoid or minimize impacts on tribal cultural resources.

Local

Sutter County General Plan. The Environmental Resources Element of the Sutter County General Plan includes goals and policies intended to conserve and protect cultural and historical resources (Sutter County 2011).

CONSISTENCY ANALYSIS

Potential conflict. The records search indicated 23 archaeological sites and historical built environment resources, both within and outside the project area. Project activities have the potential to impact these cultural resources, should they be identified within, or potentially in the vicinity of, a proposed work area, resulting in conflicts to such regulations as Archaeological Resources Protection Act of 1979 and Antiquities Act of 1906. Any newly discovered archaeological site which cannot be avoided by the project must be evaluated for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided. If tribal cultural resources are identified in the project area, the project would conform to regulations established under Assembly Bill 52.

Energy

State

Senate Bill 350. SB 350 (Chapter 547, Statutes of 2015) was signed into law in September 2015. SB 350 establishes tiered increases to the Renewables Portfolio Standard of 40 percent by 2024, 45 percent by 2027, and 50 percent by 2030. The former target was 33 percent by 2020. SB 350 also set a new goal to double the electricity and natural gas savings for existing buildings through energy efficiency and conservation measures.

CONSISTENCY ANALYSIS

No conflict. The preferred remediation alternative would conform to Senate Bill 350. The project would use limited amounts of energy during construction during the operation of construction equipment. Regular energy usage would not be required during operation of the project.

Geology and Soils

Federal

Paleontological Resources Preservation Act. The Paleontological Resources Preservation Act (PRPA; Public Law 111-11, Title VI, Subtitle D; 16 USC Sections 470aaa – 470aaa 11) was passed on March 30, 2009. The PRPA is intended to preserve, manage, and protect paleontological resources on lands administered by the Bureau of Land Management, the Bureau of Reclamation, the National Parks Service, and the U.S. Fish and Wildlife Service. The PRPA addresses the management, collection, and curation of paleontological resources from federal lands and authorizes civil and criminal penalties for illegally collecting, damaging, defacing, or selling paleontological resources.

State

Alquist-Priolo Earthquake Fault Zoning Act. California's Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) (Public Resources Code [PRC] Section 2621 et seq.) is intended to reduce risks to life and property from surface fault rupture during earthquakes. Under the Alquist-Priolo Act, faults are zoned, and construction along or across them is strictly regulated if they are "sufficiently active" and "well defined." A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface, or in the shallow subsurface using standard professional techniques, criteria, and judgment.

Seismic Hazards Mapping Act. Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sections 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other seismic hazards, including strong ground shaking, liquefaction, and seismically induced landslides, and cities and counties are required to regulate development within mapped seismic hazard zones.

Construction General Permit. The State of California adopted the Construction General Permit, Order No. 2012-0006-DWQ amending Order No. 2009-0009-DWQ, effective on July 17, 2012. The State Water Resources Control Board (SWRCB) Water Quality Order 2012-0006-DWQ (Construction General Permit) regulates construction site storm water management. Dischargers whose projects disturb 1 or more acres of soil, or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the general permit for discharges of storm water associated with construction activity. This requirement includes linear projects that disturb 1 or more acres. Construction activity subject to this permit includes clearing, grading, and disturbances to the ground, such as stockpiling or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility.

Permit applicants are required to submit a Notice of Intent to the SWRCB and to prepare a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP identifies BMPs that must be implemented to reduce construction effects on receiving water quality based on pollutants. The BMPs identified are directed at implementing both sediment and erosion control measures and other measures to control chemical contaminants. The SWPPP must also include descriptions of the BMPs to reduce pollutants in storm water discharges after all construction phases have been completed at the site (post-construction BMPs). The SWPPP must contain a visual monitoring program, a chemical monitoring program for "nonvisible" pollutants to be implemented if there is a failure of BMPs, and a sediment monitoring plan if the site discharges directly to a waterbody listed on the Clean Water Act 303(d) list for sediment.

Local

***Sutter County General Plan*.** The Sutter County General Plan Public Health and Safety Element identifies goals and policies relating to geologic and seismic hazards in Sutter County (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The project area is in a region of California characterized as having relatively low seismic activity. No Alquist-Priolo Earthquake Fault Zones and no Seismic Hazard Zones are identified within the County. Therefore, the project would conform to the Alquist-Priolo Earthquake Fault Zoning Act and Seismic Hazards Mapping Act. The project would adhere to the Construction General Permit to manage storm water and discharges during construction, and would conform to PRPA in the event that paleontological resources are inadvertently discovered in the project area. Additionally, the project would adhere to grading and erosion control measures during ground disturbing activities and would not conflict with local regulations and policies.

Hazards and Hazardous Materials

State

California Environmental Protection Agency (Cal/EPA) and the State Office of Emergency Services. The California Environmental Protection Agency (Cal/EPA) and the State Office of Emergency Services establish rules governing the use of hazardous substances. The SWRCB has primary responsibility to protect water quality and supply. The Cal/EPA was created to better coordinate state environmental programs, reduce administrative duplication, and address the greatest environmental and health risks. The agency also unifies the California's environmental authority under a single Cabinet-level agency. The Secretary for Environmental Protection oversees the following agencies: CARB, Integrated Waste Management Board, Department of Pesticide Regulation, SWRCB, Department of Toxic Substances Control (DTSC), and the Office of Environmental Health Hazard Assessment.

Hazardous Waste Control Law. California requirements and statutory responsibilities are outlined in the statute implemented by the California DTSC in Health and Safety Code, Division 20, Chapter 6.5, Hazardous Waste Control Law. Regulations adopted from the Statute are found in Title 22 of the California Code of Regulations. The Hazardous Waste Control Law is similar to RCRA in that it regulates the identification, generation, transportation, storage, and disposal of materials deemed hazardous by the State.

Local

Sutter County General Plan. The Public Health and Safety Element of the Sutter County General Plan addresses a range of natural and human-caused hazards that may pose a risk to life and property, and includes goals and policies intended to protect residents and land from hazards and hazardous materials (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The project would conform to federal, state and local hazardous waste regulations. Construction vehicles and equipment containing grease and oils would be utilized during the

construction phase. Implementation of spill prevention measures to address the accidental or inadvertent release of oil, grease, or fuel into adjacent waterways would further help minimize potential construction-related water quality impacts. No hazardous materials would be used during operations and no hazardous waste would be generated. In the event that hazardous materials are identified in fill being removed while degrading the existing levee, they would be transported to a permitted hazardous waste and materials facility

Hydrology and Water Quality

Federal

The Clean Water Act: Section 401—Water Quality Certification. Section 401 of the CWA requires that an applicant pursuing a federal permit to conduct an activity that may result in a discharge of a pollutant obtain a Water Quality Certification. A Water Quality Certification requires the evaluation of water quality considerations associated with dredging or placement of fill materials into waters of the U.S. and State. Water Quality Certifications are issued by one of the nine geographically separated Regional Water Quality Control Boards (Regional Boards) in California. Under the CWA, the relevant Regional Board must issue a Section 401 Water Quality Certification for a project to be permitted under CWA Section 404.

The Clean Water Act: Section 402—NPDES Permit Program. NPDES Permit Program: CWA Section 402 establishes the NPDES, a permitting system for the discharge of any pollutant (except for dredged or fill material) into waters of the U.S. The Central Valley Regional Water Quality Control Board (Central Valley Water Board) is delegated with the responsibility of protecting the quality of surface and ground waters of the state in the project area.

The Clean Water Act: Section 404—Dredge/Fill Permitting. The discharge of dredged or fill material into waters of the U.S. is subject to permitting specified under Title IV (Permits and Licenses) of the CWA and specifically under Section 404 (Discharges of Dredge or Fill Material) of the CWA. Section 404 of the CWA regulates placement of fill materials into the waters of the U.S. Section 404 permits are administered by the USACE.

State

Porter-Cologne Act. The Porter-Cologne Act authorizes the state to implement the provisions of the CWA and establishes a regulatory program to protect the water quality and beneficial uses of waters of the state. The act requires projects that are discharging, or proposing to discharge, wastes that could affect the quality of the state's waters to file a report of waste discharge with the appropriate Regional Board.

Local

***Sutter County General Plan*.** The Environmental Resources Element of the Sutter County General Plan includes goals and policies intended for the protection of the County's water resources (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The preferred remediation alternative would involve work along various water bodies, such as Bear River and Yankee Slough. However, the project would conform to all

federal, state and local water quality, waste discharge, and reporting requirements. Further, the project would obtain all necessary permits issued under CWA, including Section 401, Section 404, and NPDES permitting, and would implement a project SWPPP and grading and erosion control BMPs, as required, to reduce water quality impacts.

Land Use and Planning

Local

***Sutter County General Plan*.** Land use designations and zoning districts for the County are outlined in the General Plan Land Use Element (Sutter County 2011). The Land Use Element includes a discussion of zoning classifications, allowed uses, and development standards (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. Land use zoning would not change or be impacted by the implementation of the preferred remediation alternative. The project would not require the development of new roads or structures that have the potential to divide an established community and would adhere to the land use designations in the Sutter County General Plan.

Noise

Local

***Sutter County General Plan*.** The Noise Element of the Sutter County General Plan includes goals and policies that seek to reduce community exposure to excessive noise levels through the establishment of noise level standards for a variety of land uses (Sutter County 2011). Noise standards specific to construction are also included in the Noise Element (Sutter County 2011).

CONSISTENCY ANALYSIS

Potential conflict. The preferred remediation alternative would generate altered noise conditions only during project construction activities. With noise sensitive receptors in close proximity (schools, residents, etc.), there is a potential that the project would temporarily not adhere to noise constraints outlined in the Sutter County General Plan.

Public Services and Utilities

Local

Sutter County General Plan. The Sutter County General Plan Public Services Element includes goals and policies intended to address the following public services and facilities: law enforcement, fire protection, schools, libraries, parks and recreation, recreational trails, and civic and cultural facilities (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The project would not result in an increase in population that could result in an increased demand on public services, levels of service or service ratios. Therefore, the

preferred remediation alternative would adhere to public service guidelines outlined in the Sutter County General Plan.

Recreation

Local

***Sutter County General Plan*.** The Public Services Element of the Sutter County General Plan includes goals and policies intended to govern the preservation of open space and the maintenance, expansion, and creation of recreational resources and amenities to maintain a high quality of life for the County's citizens (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. The preferred remediation alternative would adhere to recreation guidelines outlined in the Sutter County General Plan. The project would not permanently disturb recreational facilities and the project would not result in increased population growth resulting in the need for additional recreational facilities.

Transportation

Local

Sutter County General Plan. The Mobility Element of the Sutter County General Plan provides the framework for decisions concerning the countywide transportation system, and includes goals and policies intended to provide an efficient multi-modal road and highway system that meets the needs of its users (Sutter County 2011).

CONSISTENCY ANALYSIS

No conflict. During construction, the project would involve work within roadways and highways which would result in temporary disruptions to traffic and the circulation system. Prior to construction activities, a traffic management plan and a traffic safety plan would be developed in coordination with Sutter County. Upon completion of construction, vehicle traffic would return to pre-construction levels. Therefore, the preferred remediation alternative would adhere to traffic guidelines outlined in the Sutter County General Plan.

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Appendix B. Existing Conditions and Environmental Constraints

Impact Criteria and Existing Conditions	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Aesthetics		
Existing Conditions: According to the California Department of Transportation and the Sutter County General Plan Environmental Impact Report, there are no officially designated scenic highways in Sutter County and none in the vicinity of the project (Caltrans 2017; Sutter County 2011b). According to the Sutter County General Pan Land Use Map for Rio Oso, the project area is located in rural Sutter County and is primarily dominated by lands under agricultural use (Sutter County 2011a). Approximately 83 percent of the land in Sutter County is designated for agricultural purposes, while 11 percent is designated as open space, accounting for 95 percent of the county's total land use. Scenic resources in Sutter County include the Sutter Buttes; the Sutter, Sacramento, and Bear rivers; and the valley's orchards and agricultural landscape (Sutter County 2011b). The County is also home to 16,000 acres of wildlife areas that contribute to the scenic beauty and quality of life (Sutter County 2011b).		
Would the project create a substantial source of light or glare?	No. The project does not include any permanent stationary sources of light. Light would be associated with the operation of construction vehicles and equipment. However, use of construction vehicles and equipment would occur on a temporary basis, primarily during daylight hours and would not substantially impact surrounding communities.	No
Is the project located near a scenic highway?	No. There are no officially designated state or county highways in Sutter County or in the vicinity of the project.	No
Would the project interfere with public views in the area?	No. The preferred remediation alternative includes implementation of drained stability berms and waterside rock slope protection. These improvements would not substantially interfere with public views and would be consistent with the visual character of the area given that the project area is predominantly agricultural. Construction equipment would be used on a temporary basis and would be staged when not in use.	No
Would the project damage scenic resources?	No. The project involves levee improvements and the implementation of ancillary flood control features. These activities would be consistent with the current uses and visual quality of the project area, and would not impact visual resources in Sutter County.	No
Agriculture and Forestry Resources		
Existing Conditions: Approximately 83 percent of Sutter County is designated for agricultural land use (Sutter County 2011b).According to the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP), the project area contains Prime Farmland, Unique Farmland, and Farmland of Statewide Importance (California Department of Conservation 2016). The majority of the land near the levee improvements is designated as Prime Farmland (California Department of Conservation 2016 Sutter County 2011). Williamson Act lands are located in the vicinity of the project, however, none are located adjacent to Rio Oso levee segments 283 and 145 (Sutter County 2011b). According to the Sutter County Countywide Land Use Diagram, there are is no forest land in the project area (Sutter County 2011a).		

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance?	Yes. According the DOC FMMP, the project area contains Prime Farmland, Unique Farmland, and Farmland of Statewide Importance and has the potential to disturb or convert such land uses during construction and ground disturbing activities (DOC 2016).	Yes
Is the project located on a Williamson Act Contract property, or would it disturb a property under the Williamson Act Contract?	No. No Williamson Act lands are located adjacent to the project and none would be disturbed as a result of project activities.	No
Would the Project result in the loss of forest land or conversion of forest land to non-forest use?	No. According to the Sutter County Countywide Land Use Diagram, there is no forest land in the project area. Ground disturbing activities would not extend to areas designated as forest land. As a result, no impact to forest land would occur.	No
Air Quality and GHG Emissions		
Existing Conditions: Sutter County is located within the Sacramento Valley Air Basin. The SVAB is a broad, flat valley bounded by the Coastal Range to the west, the Sierra Nevada to the east, the Cascade Range to the north, and the San Joaquin Valley Air Basin to the south. The SVAB consists of 13 counties and is split into two planning sections based on the degree of pollutant transport and the level of emissions. The project area is located within the jurisdictional boundaries of the Feather River Air Quality Management District (FRAQMD) and is subject to the rules and regulations developed by the FRAQMD. FRAQMD is responsible for administering local, State and federal air quality management programs for Yuba and Sutter Counties.FRAQMD is a part of the Northern Sacramento Valley Planning Area (NSVPA). The NSVPA Districts were designated as nonattainment for the ozone California Ambient Air Quality Standards (CAAQS) and agreed to jointly prepare an Air Quality Management Plan (SVAQEEP 2018). **Sensitive Receptors** Sensitive receptors in the vicinity of the project area include residences and schools. There is one school in Rio Oso (Browns Elementary School), located within 1.2 mile of the project area. No hospitals are located in the vicinity of the project area.		
Would project result in substantial emissions?	Yes. The project would not create emissions post construction and no new stationary emissions sources are proposed. However, during construction the project would require the use of construction vehicles and equipment on a temporary basis. Air quality impacts could result from particulate matter generated during construction activities, such as dust and equipment exhaust.	Yes
Would the project create objectionable odors?	No. The project includes implementation of flood protection and remediation measures and does not include activities that involve the long term creation of objectionable odors during construction or post construction.	No

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project expose sensitive receptors to substantial pollutant concentrations?	Yes. Sensitive receptors in the vicinity of the project area include residences and a school. There are no hospitals in the vicinity of the project area. Operation of construction vehicles and equipment under the preferred remediation alternative could result in increased emissions on a short term basis and impacts on sensitive receptors would not be substantial.	Yes
Would the project generate GHG emissions either directly or indirectly?	Yes. Operation of construction vehicles and equipment could generate GHG emissions on a short term, intermittent basis.	Yes
Biological Resources		
Existing Conditions: See Appendix C, Biological Resources Analysis, for existing conditions and detailed analysis.		
Is the project located adjacent to terrestrial or aquatic habitat areas for state or federally listed endangered, threatened, or candidate species?	Yes. Database query results returned a large number of special-status species with a potential to occur in the vicinity of the project area (Appendix C, Database Results). Through review of these results, many species were determined to not have the potential to occur in the project area due to absence of suitable habitat or the project area being located outside of known species ranges. Appendix C, Table 1 provides a description of the special-status species that have the potential to occur in each of the delineated vegetation communities. A few of the species included in this table are associated with riparian habitat located adjacent to the project area. Project work may require vegetation removal which could impact associated special-status species, should they be present, and these species should be considered when consulting with the appropriate agencies.	Yes
Would the project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	Yes. There are no critical habitat units within the project area. However, final designated critical habitat for steelhead and Chinook salmon occurs along the Bear River, to the west and north of the project area. Appendix C, Table 1 provides a description of the special-status species that have the potential to occur in each of the delineated vegetation communities. A few of the species included in this table are associated with riparian habitat located immediately adjacent to the project area. Project work may require vegetation removal which could impact associated special-status species, should they be present, and these species should be considered when consulting with the appropriate agencies. Other communities in the project area that provide suitable habitat for special-status species include agricultural ditches, open water, and various aquatic resources.	Yes

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	Yes. Several aquatic resources and vegetation communities in the project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. Project work may require removal of riparian vegetation. It is recommended that a formal delineation of aquatic resource be completed prior to any project work in order to determine the level of impact to sensitive communities. Consultation and permitting through the appropriate agencies would need to occur where appropriate.	Yes
Does the project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	No. Yuba and Sutter Counties are currently in the process of developing a Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP) that incorporates valley floor communities for both counties. The project area falls completely within the proposed boundary for the NCCP/HCP. However, it is anticipated that project activities would comply with the conditions set forth in the HCP.	No
Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	Yes. There are no protected areas or easements within the project area. However, there are numerous protected areas and easements on the lands surrounding the project area. There are several aquatic resources and vegetation communities in the project area, and these may act as movement corridors for both special-status and common species. Although substantial interference with movement is unlikely to result from project activities, levee improvements may act as barriers.	Yes
Would the Project have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	Yes. Aquatic resources were mapped in the project area and have the potential to be categorized as vernal pools or wetlands. It is recommended that a formal delineation of aquatic resources be completed prior to any project work to verify the jurisdiction of these features.	Yes
Cultural and Tribal Cultural Resources		
Existing Conditions: Existing Conditions: See Appendix D, Cultural Resources Analysis, for existing conditions and detailed analysis.		
Do known historical, archaeological, or tribal sites or resources occur in the project area?	Yes. The records search identified 23 archaeological sites and historical built environment resources, both within and outside the project area. The NEIC and NCIC databases indicate that there have been nine cultural resources recorded within the project area and 0.25 mile search radius – two prehistoric sites, one historical site, and six built environment resources. Resource CA-YUB-001911H, a segment of the Western Pacific Railroad (WPRR), was determined ineligible for listing on the NRHP; all other sites are considered unevaluated.	Yes

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Does the project require excavations or ground disturbance that could inadvertently impact known or unknown cultural, historical, or archaeological resources?	Yes. Construction of the project would require ground disturbance and use of heavy equipment. These activities have the potential to result in impacts to the cultural resources listed in Appendix D, should the resources be identified within, or potentially in the vicinity of, a proposed work area. Any newly discovered archaeological site which cannot be avoided by the project must be evaluated for eligibility to the CRHR and/or NRHP. If eligible, additional mitigation may be required if significant impacts/adverse effects cannot be avoided.	Yes
Would the project disturb human remains, including those encountered outside of dedicated cemeteries?	Yes. No human remains, cemeteries, or burial sites were identified by the cultural resources analysis. In the event that human remains are inadvertently discovered outside of dedicated cemeteries, work would stop immediately and the County Coroner would be contacted for consultation.	Yes
Energy		
Existing Conditions: Pacific Gas and Electric (PG&E) provides energy services to Sutter County. The following is a breakdown of PG&E's primary energy sources (PG&E 2019): • Renewable (39 percent) • Large hydroelectric facilities (13 percent) • Nuclear (34 percent). •Natural gas (15 percent) According to the California Energy Commission, Sutter County consumed approximately 635 GWh of electricity and 20 million therms of natural gas in 2018 (California Energy Commission 2016).		
Would the project result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy, or wasteful use of energy resources, during project construction or operation?	No. The project would use limited amounts of energy during construction through the operation of construction equipment. Regular energy usage would not be required once construction is completed. PG&E would have the capacity to support the project's energy needs. Therefore, impacts on energy resources would not be substantial.	No
Would the project conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	No. The project would comply with state and local plans for renewable energy and energy efficiency.	No
Geology, Soils and Mineral Resources		

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Existing Conditions: According to the Sutter County General Plan, Sutter County is located in the Great Valley Geomorphic province. The Great Valley is a 50 mile wide and 400 mile long alluvial plan that is characterized by alluvial sediments derived primarily from erosion of the mountains of the Sierra Nevada to the east and the Klamath Mountains and Cascade Range to the north (Sutter County 2011a). Materials underlying the northern portion of the Sacramento Valley consist primarily of Holocene alluvial deposits from the Sacramento River and its east-flowing tributaries that drain the Coast Ranges located west of the project area. These Holocene materials consist of stream and basin deposits from clay to boulder size and overlie older alluvial formations. The predominant soils in Sutter County include Capay, Clearlake, Conejo, Oswald, and Olashes soils. Approximately 34 percent of the soils in Sutter County have a high shrink-swell potential. Landsides are rare in the area given the flat topography of Sutter County (Sutter County 2011a). The Sacramento area has a relatively low seismic hazard when compared to other parts of California. The most active faults, such as the San Andreas, Hayward, Calaveras, and others, are at least 6 miles away from the project area. According to the California Geological Survey, the project area is located outside of areas designated as earthquake fault zones, liquefaction zones, landslide zones (CGS 2016). According to the USGS Mineral Resources On-Line Spatial Data Map and the Sutter County General Plan, there are no significant mineral resources in the vicinity of the project area (USGS 2019; Sutter County 2011a). University of California Museum of Paleontology (UCMP) has identified paleontological resources in the county and includes records of numerous vertebrate fossil localities (Sutter County 2011a).		
Would the project require excavations, grading, or other ground disturbing activities capable of causing erosion or loss of topsoil?	Yes. The project would require ground disturbance and use of heavy construction equipment during installation of the levee improvement features. These activities would result in erosion and loss of topsoil. However, the preferred remediation alternative also involves rock slope protection, which would help to minimize erosion. The project would adhere to erosion and grading control ordinances within Sutter County and therefore, impacts would not be substantial.	Yes
Is the project located in a seismically active area?	No. The project area is in a region of California characterized as having relatively low seismic activity. According to the California Geological Survey, the project area is located outside of areas designated as earthquake fault zones (CGS 2016).	No
Are new permanent structures proposed that could expose people to seismic related hazards such as landslides, liquefaction, ground failure, strong seismic ground shaking?	No. The project area is in a region of California characterized as having relatively low seismic activity. Although the project would involve the construction of levee repairs and improvements, no impacts would occur because seismic hazards are lacking in the project area (CGS 2016).	No
Is the project located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	No. The project area is not located on a geologic unit or soil(s) that are unstable, or that would become unstable as a result of the project, thereby resulting in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. Approximately 34 percent of the soils in Sutter County have a high shrink-swell potential, however, these considerations would be factored into the project design.	No
Are mineral resources present in the project area?	No. According to the USGS Mineral Resources On-Line Spatial Data Map and the Sutter County General Plan, there are no significant mineral resources in the vicinity of the project area (USGS 2019; Sutter County 2011a).	No

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Do known paleontological resources exist in the project area?	Yes. University of California Museum of Paleontology (UCMP) has identified paleontological resources in the county and includes records of numerous vertebrate fossil localities (Sutter County 2011a). If paleontological resources were identified in the project area during construction, the project would follow policies outlined in the Sutter County General Plan Environmental Resources Element and the Society of Vertebrate Paleontology's standard procedures for the assessment and mitigation of adverse impacts on paleontological resources. With these measures in place, impacts on paleontological resources would not be substantial.	Yes
Hazards and Hazardous Materials		
Existing Conditions: According to Cal/EPA, the provisions in Government Code Section 65962.5 are commonly referred to as the "Cortese List." A site's presence on the list has bearing on the local permitting process. The Cortese list, which includes the resources listed below, was reviewed for references to the project area and vicinity: • List of Hazardous Waste and Substances sites from the DTSC EnviroStor database; • List of Leaking Underground Storage Tank Sites from the SWRCB GeoTracker database; • List of solid waste disposal sites identified by SWRCB with waste constituents above hazardous waste levels outside the waste management unit; • List of "active" Cease and Desist Orders and Cleanup and Abatement Orders from SWRCB; and • List of hazardous waste facilities subject to corrective action identified by DTSC. According to the DTSC EnviroStor Database and the SWRCB GeoTracker Database, one hazardous materials database listing is located less than 1 mile from the project area. Plumas Ranch Elementary School, located at Feather River Boulevard and River Oaks Boulevard is listed as a School Cleanup Site with an Inactive - Withdrawn status as of 10/21/2013. The potential contaminants of concern include metals and organochlorine pesticides; soil is the potential media affected (DTSC 2019). There are no airports within 2 miles of the project. According to the Cal Fire, Fire Hazard Severity Zone Map for Sutter County, portions of the project are located within Local Responsibility Area (LRA) Unzoned areas, and some are located within LRA Moderate fire hazard severity zones (CAL FIRE 2007). No schools are located within a quarter mile radius of the project.		
Would the project be located on a site which is included on a list of hazardous materials sites compiles pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	No. One hazardous materials database listing is located within one mile of the project area, outside of the project's proposed area of disturbance. Further, this site has an Inactive - Withdrawn status as of 10/21/2013 and contamination did not reach the groundwater, making impacts during ground disturbing activities less likely. There would be no impact.	No
Would the project impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	No. Implementation of the project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities.	No
Does the project require the use or routine transport of hazardous materials?	Yes. Construction vehicles and equipment containing grease and oils would be utilized during the construction phase. Implementation of spill prevention measures to address the accidental or inadvertent release of oil, grease, or fuel into adjacent waterways would further help minimize potential construction-related water quality impacts. Impacts would not be substantial with the implementation of BMPs.	Yes

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	No. No schools are located within one-quarter mile of the an existing or proposed schools. Additionally, to the extent possible, emissions would be controlled and contained through the implementation of BMPs.	No
For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	No. No airports are located within two miles of the project area, and the project is not located within an airport land use plan.	No
Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?	No. According to the Cal Fire, Fire Hazard Severity Zone Map for Sutter County, the project is located in an areas designated as Local Responsibility Area (LRA) unzoned and moderate fire hazard severity zone, outside of high and very high fire hazard severity zones. Therefore, it is unlikely that the project would lead to a significant risk of loss, injury or death involving wildland fires.	No
Hydrology and Water Quality		
Existing Conditions: The project area is located within a Special Flood Hazard Area. Portions of the project area are located in FEMA Flood Zone A, indicating that they are within the 100-year zone (Sutter County 2019). <u>Groundwater</u> The project area is located in the Sacramento Valley Groundwater Basin, a large basin which covers over 5,900 square miles and 10 counties. This basin is divided into several smaller subbasins. The project area is located within the Sutter subbasin. <u>Surface Water</u> The Sutter subbasin is considered part of the Sacramento River Hydrologic Region. North of the Sutter subbasin is the confluence of Butte Creek, Sacramento River and Sutter Buttes; west of the subbasin is the Sacramento River; south of the subbasin is the confluence of the Sacramento River and Sutter Bypass; and east of the subbasin is Feather River. The most notable hydrologic features in the Sutter subbasin are the Sacramento and Feather Rivers (DWR 2006).		
Would the project alter the drainage pattern of the site or area in a manner which would result in substantial erosion or siltation?	Yes. Ground disturbance and use of heavy construction equipment during installation of the levee improvement features could potentially cause or result in erosion and/or sedimentation. Erosion of onsite soils can lead to increased levels of suspended sediments and turbidity in receiving waters, and could potentially impact water quality and result in a violation of water quality standards during construction. Impacts would be temporary and increased erosion and sedimentation is not anticipated once construction is completed. Post construction, installation of rock slope protection proposed under the preferred remediation alternative would improve conditions of erosion in the project area.	Yes

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project alter the drainage pattern of the site or area or result in an increase in surface runoff in a manner which would result in flooding on- or off-site?	Yes. Installation of the drained stability berm and rock slope protection could alter the drainage pattern of the site or area; however, the project is intended to provide flood damage reduction and would therefore result in beneficial impacts on flooding.	Yes
Would the project conform to water quality standards and waste discharge requirements?	Yes. During construction, the project has the potential to result in erosion, which could lead to increased levels of suspended sediments and turbidity in receiving waters. However, the project would conform to water quality standards during construction through the implementation of BMPs, such as grading and erosion control measures, as well as the implementation of a project SWPPP to reduce polluted storm water runoff.	No
Is the project located within a 100-year flood hazard area?	Yes. According to FEMA floodplain maps, the project area is located within the 100-year flood zone and the project has the potential to temporarily increase flood risk during construction. However, post construction flood risks in the project area are not considered a restraint to project implementation, as the purpose of the project is to provide flood damage reduction.	Yes
Would the project require the use of groundwater or hinder groundwater recharge?	No. The project would not require the use of groundwater and would not involve the implementation of impervious surfaces to the extent that groundwater recharge would be hindered. Therefore, impacts on groundwater would not be substantial.	No
Would the project create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?	No. Construction, ground disturbing activities and work along the existing levees have the potential to contribute to increased runoff on a temporary basis. However, the project would include a Stormwater Pollution Prevention Plan (SWPPP) and would not exceed the capacity of existing or planned storm water drainage or provide substantial additional sources of polluted runoff.	No
Land Use and Planning		
Existing Conditions: According the Rio Oso and Sutter County General Plan Land Use Maps, the project area is almost entirely designated for agricultural purposes. Open space land uses are also located along the levee alignment (Sutter County 2011a). Established residential neighborhoods are lacking in the project area.		
Is the project consistent with the predominant character of the existing built or natural landscape?	Yes. Agricultural zonings are predominant in the project area (Sutter County 2011a). Flood improvement measures under the project are consistent with these zonings and would not preclude current land uses.	No

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Is the project permitted under zoning regulations?	Yes. Agricultural zonings are predominant in the project area (Sutter County 2011a). Flood improvement measures under the project are consistent with these zonings and would not preclude current land uses.	No
Would the project physically divide an established community?	No. The project would not require the development of new roads or structures that have the potential to divide an established community. Flood control measures would be installed along the existing levee and would not divide communities within Rio Oso, as established communities are lacking the project area. Therefore, no impact would occur.	No
Noise		
Existing Conditions: Land uses typically considered sensitive to noise include hospitals, parks, churches, schools, libraries, and other uses where low interior noise levels are essential. According to the Sutter County General Plan Noise Element, sensitive receptors in Sutter County include residences, schools, child-care centers, hospitals, long-term health facilities, convalescent centers, and retirement homes. The primary source of noise in the county is motor vehicle traffic. Other significant noise occurs from airplane traffic and railroads (Sutter County 2011a). Noise standards specific to construction are included in the Sutter County General Plan Noise Element. The Sutter County General Plan states that for residential, commercial and agricultural land uses the exterior noise level standards for outdoor activity areas may range between 60 and 75 Ldn/CNEL, db (Sutter County 2011a).		
Would the project generate noise in excess of thresholds outlined in the county noise ordinance or general plan?	Yes. Sensitive receptors in Sutter County include residences, schools, child-care centers, hospitals, long-term health facilities, convalescent centers, and retirement homes. The project has the potential to generate noise in excess of local thresholds during the operation of construction vehicles and equipment. Construction activities, such as installation of the stability berm and use of heavy construction equipment, could result in increased noise levels. Generally, construction activities would not occur in the direct vicinity of sensitive resources. Construction would occur on a temporary and intermittent basis and thus, noise levels would return to pre-construction levels once construction is completed.	Yes
Would the project generate excessive ground borne vibration or ground borne noise levels?	Yes. Operation of construction equipment and ground disturbing activities would result in ground borne vibration and ground borne noise. However, ground borne noise and vibration impacts would occur on a short term, intermittent basis and would not be substantial.	Yes
Public Services and Recreation		
Existing Conditions: Police services in the unincorporated areas of Sutter County are provided by the Sutter County Sheriff's Department. The Sheriff's Department is responsible for law enforcement patrol services. California Highway Patrol (CHP) provides traffic enforcement on all highways in the county and all roadways in the unincorporated areas of Sutter County. Fire protection services in the project area are provided by four county service areas (CSA) and two independent fire protection districts. The project area is predominantly located in CSA-C. Parks and recreational areas within a 1.5 mile radius of the project area include Bear River Park and Constitution Splashpad Park. Browns Elementary School is the only school in Rio Oso.		

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project result in an increase in response times for public services such as police and fire protection?	No. The project would not result in an increase in population that could result in an increased demand on public services or response times. Further, the project would not interfere with emergency routes and would implement a traffic safety plan. As a result there would be no impact on public services response times.	No
Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: Fire protection, police protection, schools, parks, other public facilities?	No. The project would not result in an increase in population that could result in an increased demand on public services, levels of service or service ratios. As it relates to emergency response times, the project would not interfere with emergency routes and would implement a traffic safety plan. As a result, there would be no impact on public services.	No
Would the project damage parks or other public facilities?	No. There are parks and public facilities within the vicinity of the project area. However, these facilities are outside of the area of disturbance for the project as work would be concentrated on existing levees. Further, construction vehicles and equipment would not be staged within park grounds or public facilities. Therefore, no impact would occur.	No
Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	No. The project does not include recreational facilities and would not require expansion of recreational facilities. Further, the project would not result in increased population growth resulting in the need for additional recreational facilities. Therefore, there would be no impact.	No
Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	No. The project would not result in increased population growth resulting in the increased use of parks and recreational facilities. Therefore, there would be no impact.	No
Traffic and Transportation		
Existing Conditions: Sutter County has a comprehensive transportation system consisting of State highways, local roads, urban arterials, rural highways, and streets, bus transit services, freight rail and airports. Major highways in Sutter County include 20, 113, 99, and 70 (Sutter County 2011a). Union Pacific Railroad Sacramento Subdivision is located east of the project area and intersects Levee Segment 145. Levee improvements along Segment 283 intersect with Highway 70.		
Would the project result in a substantial increase in traffic above present levels?	No. The project has the potential to temporarily increase the volume of traffic present on local roads and highways during construction. However, upon completion of construction, traffic would return to pre-project conditions.	No

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project conflict with a plan, ordinance or policy addressing the circulation system, including transit, roadways, bicycle lanes and pedestrian paths?	No. The project would conform to relevant plans, ordinances and policies addressing the circulation system. Construction vehicles and equipment would utilize local roads and highways on a temporary basis. Construction equipment would be staged to the extent possible when not in use. Prior to project activities, a Traffic Management Plan would be developed in coordination with Sutter County and Rio Oso. Additionally, implementation of the project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities.	No
Would the project substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment)?	No. The project involves the construction of levee improvements. These activities would be consistent with the current uses and would not create traffic or transportation hazards due to a geometric design feature.	No
Would the project result in inadequate emergency access?	No. Implementation of the project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities. The project would adhere to the traffic safety plan and would not interfere with emergency access routes.	No
Would the project result in disruptions to traffic or the circulation system?	Yes. The project would involve work within roadways and highways which would result in temporary disruptions to traffic and the circulation system. Improvements along Segment 145 intersect with Union Pacific Railroad Sacramento Subdivision, and improvements along Segment 283 intersect with Highway 70. Roads, highways, lanes and railroads through which the alignment passes could be blocked on a temporary basis. Construction equipment would be staged to the extent possible when not in use. Prior to project activities, a Traffic Management Plan would be developed in coordination with Sutter County and Rio Oso. Additionally, implementation of the project is anticipated to include advanced construction traffic planning and development of a traffic safety plan, which would ensure the continuation of emergency response services during construction activities. However, temporary disruptions to traffic would still occur.	Yes
Utilities and Service Systems		
Existing Conditions: Potable water in Sutter County is supplied primarily from groundwater sources. Most of the groundwater is pumped by privately owned wells in the rural areas of the county. Municipal and community potable water systems which rely on water supplies from Feather River and groundwater are also common in the county. Wastewater in the unincorporated areas of the county is treated and disposed of through on-site wastewater treatment systems (OWTS) or septic systems (Sutter County 2011a). Yuba-Sutter Regional Waste Management Authority operates a Joint Powers agreement between Sutter and Yuba Counties and the Cities of Live Oak, Marysville, Wheatland and Yuba City. Yuba-Sutter Regional Waste Management Authority is responsible for solid waste management in the area. Recology Yuba-Sutter has an agreement with Sutter and Yuba Counties and the Cities of Live Oak, Marysville, Wheatland and Yuba City to be solely responsible for collection, recycling, and disposal of solid waste from each jurisdiction. Their facilities include, Marysville Integrated Waste Recovery Facility, Ponderosa Transfer Station, Ostrom Road Landfill, and Yuba-Sutter Household Hazardous Waste Facility (Yuba Sutter Recycles 2019).		

	Preferred Remediation Alternative Impact Analysis	Potential for Environmental Constraints (Yes/No)
Impact Criteria and Existing Conditions		
Would the project connect to an existing public/private water supply?	No. The project would not require connection to an existing public or private water supply.	No
Would the project result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	No. The project would not generate wastewater that would need to be treated by a local wastewater treatment provider.	No
Would the project have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	Yes. Limited amounts of water would be used during construction; however no water would be required post construction. Therefore, no impacts on water supply would result from the project.	No
Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	Yes. The project would generate limited amounts of solid waste during construction. No solid waste would be generated once construction is completed. The project would comply with federal, state and local regulations on solid waste.	No
Would the project generate solid waste in excess of State or local standards or in excess of the capacity of local infrastructure?	No. Limited amounts of solid waste such as construction debris, municipal waste and green waste would be generated during construction. Solid waste would not be generated once construction is completed. The project would not generate waste in excess of state or local standards and could be accommodated by local infrastructure.	No
Would the project require or result in the relocation or construction of new or expanded water, or wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities or expansion of existing facilities, the construction or relocation of which could cause significant environmental effects?	Yes. The project would not increase demand for solid waste disposal, water service, wastewater treatment, electric power, natural gas or telecommunications facilities, and would not require service by local utility providers. However, overhead utility lines are present along surface streets and highways in the project area, and there is potential that unseen underground utility infrastructure exists in the project area.	Yes

Appendix C. Biological Resources Analysis

Memo

Date:	April 2020
Project:	Rio Oso Flood Risk Reduction Feasibility Study
To:	Sutter County
From:	Scott Tidball, Biologist (HDR)
Reviewed:	Leslie Parker, Associate Biologist (HDR)
Subject:	Rio Oso – Biological Constraints Analysis

Introduction

This memo presents a preliminary review of potential biological constraints for the Rio Oso Flood Risk Reduction Feasibility Study project. Potential constraints are described below.

Methodology

Desktop Review

A desktop review was undertaken to assess potential biological constraints in the Rio Oso project area (Exhibit 1), which included two steps to collect data on special-status species, vegetation communities, sensitive communities, protected lands, and federally-protected aquatic resources with the potential to occur in the project area. First, preliminary database searches were performed to identify aquatic resources and special-status species with the potential to occur in the project area. Second, a preliminary review of recent aerial imagery and land ownership maps was conducted to collect site-specific data regarding habitat suitability for special-status species and to see if any protected lands overlap with the project area.

Database searches were performed on the following websites:

- U.S. Fish and Wildlife Service's (USFWS) Information Planning and Consultation (IPaC) System (2019a);
- USFWS Critical Habitat Portal (2019b);
- National Marine Fisheries Service (NMFS) (2016)
- California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB) in BIOS 5 (2019);
- California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants of California (2019);
- USFWS National Wetland Inventory (2019c);
- U.S. Geological Survey (USGS) topographical map; and,
- Google Earth Pro (2019).

A query of the USFWS's IPaC system was performed to identify federally listed species that may occur in or adjacent to the project area. A review of the USFWS's Critical Habitat portal was also conducted to identify designated critical habitat units that fall within the project area. A query of the CNDDB provided a list of processed and unprocessed special-status species occurrences within the Nicolaus and Sheridan USGS 7.5 minute quadrangles (quads), as well as all adjacent quads. The CNDDB was also used to analyze land ownership data in the vicinity of the project area. Additionally, the CNPS database was queried to identify special-status plant species with the potential to occur in the aforementioned quads. Finally, USFWS National Wetland Inventory data and USGS topographical maps were used to aid in the digitization of vegetation communities and potential aquatic resources within the project area. The raw data returned from the database queries is provided in Appendix 1.

Reconnaissance Survey

A reconnaissance level survey was conducted on February 12, 2019 to verify the results of the desktop review. HDR biologists drove on publically accessible roads throughout the project area in order to record existing vegetation communities, aquatic resources, and species observed.

Results

The desktop and reconnaissance survey mapped seven vegetation communities in the project area including irrigated agriculture, oak woodland, orchard, pasture, rice, riparian, and urban. Agricultural ditches and potential aquatic resources were also recorded in the project area. These resources are described in detail below and are shown on Exhibit 1. The review of the project area also evaluated the potential for special-status species to occur in the project area. Table 1 provides a summary of special-status species with the potential to occur and their associated vegetation communities. Several special-status species included in the database query results were ruled-out due to absence of suitable habitat in the project area or being located outside of known species ranges. These species are not included in Table 1 but can be referenced in Appendix 1. Additionally, USFWS designated critical habitat units, conservation easements, and other protected areas located in or adjacent to the project area are described in greater detail below.

Vegetation Communities

IRRIGATED AGRICULTURE

Irrigated agriculture in the project area includes field and row crops. These are dryland crops that are irrigated throughout the growing season and can often have multiple harvests during the year. No crops were planted during the February 12, 2019 site visit, however typical agriculture crops in this part of the Sacramento Valley include corn (*Zea mays*), tomatoes (*Solanum lycopersicum*), and other grain and vegetable crops. While grape (*Vitis* spp.) vineyards are another abundant Central Valley crop, none were observed within the project area. Irrigated agriculture is found throughout the project area.

OAK WOODLAND

An area of oak woodland occurs adjacent to the Union Pacific rail line that bisects the western part of the project area. Oak woodland communities in the project area have a canopy of valley oak (*Quercus lobata*) with some unidentified trees of the *Prunus* genus. The understory consisted of non-native annual grasses similar to those species described in the pasture vegetation community below.

OPEN WATER

Open water consists of small, permanent water features that support little to no vegetation. Areas of open water include the linear water feature of the Bear River.

ORCHARD

Orchard crops consist of various tree grown agriculture products. Species observed during the February 12, 2019 survey included walnut (*Juglans regia*), and almond (*Prunus dulcis*). It is possible that additional nut and fruit crops could be grown in the project area. Orchards are the dominant vegetation community within the project area and are located throughout.

PASTURE

Pastures within the project area include undeveloped areas vegetated with herbaceous plants and primarily nonnative grasses that are regularly grazed or mowed. A site-specific list of plant species found in pastures was not compiled during the site visit due to lack of access; however, common species associated with pasture communities typically include annual grasses such as wild oat, ripgut brome, medusahead (*Elymus caput-medusae*), as well as herbaceous species such as filaree (*Erodium* spp.), blue dicks (*Dichelostemma capitatum*), clover (*Trifolium* spp.), and lupines (*Lupinus* spp.). Pastures are scattered throughout the project area.

RICE

Rice (*Oryza* spp.) is a seed producing annual grass that is grown as a flood irrigated crop. Rice is usually grown in leveed fields that are flooded much of the growing period, and dried out to mature and to facilitate harvesting. Rice fields typically produce 100 percent canopy closure as they mature. Crop rotation systems are common with rice fields in California, and they may be planted in rotation with other irrigated agriculture crops such as winter wheat or barley. Additionally some acres may be fallowed for a year or more or planted with legumes to fix nitrogen in the soil (CDFW 2018). For the purposes of this study, areas were designated as “rice” if they appeared to have been used primarily for rice production in the last ten years, using Google Earth historic imagery as a reference. Rice fields are found in the southern portion of the project area.

RIPARIAN

Riparian communities in the project area consists of multilayered woodlands with a tree overstory and a diverse shrub layer. During the February 12, 2019 field visit, it was observed that riparian areas consisted of an overstory of cottonwood (*Populus fremontii*), valley oak, and willows (*Salix* spp.). The understory consisted of California grape (*Vitis californica*), Himalayan blackberry (*Rubus armeniacus*), poison oak (*Toxicodendron diversilobum*), mustard (*Brassica* spp.), cattails (*Typha* spp.), coyote brush (*Baccharis pilularis*), filaree (*Erodium* sp.), and numerous other annual grassland species. A stretch of riparian habitat is found on the levee for the Bear River, along the western border of the project area, and on the levee for Yankee Slough, running along the northern border of the project area. There is also a small isolated patch of riparian habitat found within an orchard.

URBAN

Urban areas mapped in the project area include small semi-rural residential areas, in addition to State Route 70. Urban cover is also associated with paved roads and rural residences scattered throughout the project area; however, these were not mapped in detail on Exhibit 1. Vegetation is characterized as either landscaped areas or non-native herbaceous species growing in and around paved and developed features.

AGRICULTURAL DITCHES

Agricultural ditches are narrow, freshwater, linear features that can be either channelized natural features or anthropologically created. These features are typically unvegetated or support emergent, hydrophytic plants that are adapted to regular inundation. Agricultural ditches have the potential to fall under state or federal jurisdiction; however a formal aquatic resources delineation would need to be conducted to verify the jurisdiction of these features. Agriculture ditches are typically found adjacent to irrigated agriculture fields or orchards. In addition to multiple unnamed ditches, Yankee Slough has been classified as an agricultural ditch.

POTENTIAL AQUATIC RESOURCES

Aquatic resources mapped in the project area are areas that were identified as having the potential to be categorized as vernal pools or wetlands, including areas prone to seasonal flooding or topographic depressions. These features are typically seasonally pooled or saturated areas fed by precipitation or flooding from adjacent rivers and can be either natural or anthropologically created. Aquatic resources typically consist of hydrophytic plants that are adapted to regular inundation and have the potential to fall under state and/or federal jurisdiction; however, a formal wetland delineation would need to occur to verify jurisdiction. Aquatic resources shown on Exhibit 1 were identified by a combination of aerial review, National Wetlands Inventory, and field verification. Not all features were field verified in which case the mapped extent of potential aquatic resources is based on aerial interpretation and their presence, location, or extent should not be considered final.

Wildlife Observed

Wildlife observed during the February 12, 2019 site visit included numerous bird species such as red-winged blackbird (*Agelaius phoeniceus*), yellow-billed magpie (*Pica nuttalli*), California scrub jay (*Aphelocoma californica*), Brewer's blackbird (*Euphagus cyanocephalus*), great egret (*Ardea albus*), and other water fowl, in addition to raptors such as red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*Buteo lineatus*). Numerous domestic sheep and chickens were also observed within pasture and urban areas. No special-status species or elderberry shrubs were observed during the survey, but they still have the potential to occur in the project area (Table 1) and are discussed in more detail below.

Special-Status Species

Database query results returned a large number of special-status species with a potential to occur in the vicinity of the project area (Appendix 1). Through review of these results, many species were determined to not have the potential to occur in the project area due to absence of suitable habitat or the project area being located outside of known species ranges. Table 1 provides a description of the special-status species that have the potential to occur in each of the delineated vegetation communities.

Any potential project related effects on these species or their habitats would require compliance with the California Environmental Quality Act as well as permits/authorizations from the appropriate state or federal agencies; as a result, a site-specific biological resources assessment would need to be conducted prior to project implementation to assess impacts on special-status species and their habitats.

Critical Habitat

There are no critical habitat units within the project area. However, final designated critical habitat for steelhead and Chinook salmon occurs along the Bear River, to the west and north of the project

area. The critical habitat unit for Chinook salmon (V08) ends approximately 2 miles upstream from the State Route 99 crossing, however the critical habitat unit for steelhead (V01) extends upstream to the outlet of Camp Far West Reservoir (USFWS 2019b).

Sensitive Habitats and Aquatic Resources

Sensitive habitats included are those that are of special concern to resource agencies or those that are protected under various state or federal regulations. Aquatic resources provide a variety of functions for plants and wildlife including habitat, foraging, cover, migration, and movement corridors. In addition to habitat functions, these features provide physical conveyance of surface water flows capable of handling large stormwater events.

Several aquatic resources and vegetation communities in the project area would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. These areas include the following communities: riparian, agricultural ditches, open water, and other potential aquatic resources. It is recommended that a formal delineation of aquatic resources be completed prior to any work in order to determine the level of impact on sensitive communities.

Depending on the project alternative chosen and the biological resources that may be affected, there are numerous agencies that may need to be consulted with and/or permits completed. It is likely that the project would require consultation with or completion of some or all of the following:

- US Army Corps of Engineers (USACE) Section 404 consultation – covers any impacts to waters of the U.S.
- USACE Section 408 consultation – covers any project work in or around federally managed levees.
- USFWS Section 7 consultation – covers any potential impacts to federally listed species managed by the USFWS.
- National Marine Fisheries Service (NMFS) Section 7 consultation – covers any potential impacts to federally listed species managed by the NMFS.
- CDFW Section 1602 permit – covers any alteration below the top-of-bank of a river channel or within the riparian corridor.
- CDFW Incidental Take Permit (ITP) – covers any potential impacts to state listed species.
- RWQCB Section 401 permit – covers any discharge of dredge or fill into waters of the State.

Protected Areas, Conservation Easements, and Wildlife Movement Corridors

There are no protected areas or easements within the project area. However, there are numerous protected areas and easements on the lands surrounding the project area.

There are six protected areas that are located within two miles of the project area, including one area owned by the Central Valley Flood Protection Board, four areas owned by the Olivehurst Public Utilities District, and one area owned by the Sacramento and San Joaquin Drainage District (CPAD 2018). There are five land parcels with conservation easements within two miles of the project area, including two areas operated by CDFW, one area operated by the Wildlife Heritage Foundation, and two areas operated by the United States Natural Resources Conservation Service (CCED 2018).

The Sutter Bypass is located approximately 6 miles southwest of the project area. The bypass is part of a large engineered floodway that runs adjacent to the Sacramento River from north of the Sutter Buttes, south to the Sacramento-San Joaquin Delta and acts as a wildlife movement corridor for numerous terrestrial and aquatic species.

Local Ordinances
There are no county or local ordinances that affect this project area.

Yuba and Sutter County NCCP/HCP

Yuba and Sutter Counties are currently in the process of developing a Natural Community Conservation Plan/Habitat Conservation Plan (NCCP/HCP) that incorporates valley floor communities for both counties. The project area falls completely within the proposed boundary for the NCCP/HCP. In 2006, a Report of Independent Science Advisors for the Yuba and Sutter County NCCP/HCP (Sutter County 2006) was prepared that summarizes recommendations for the continued development of the plan from a group of independent science advisors. Additionally, in 2011, the pertinent parties, local agencies, and wildlife agencies signed a planning agreement that worked to define goals and commitments for the NCCP/HCP (Yuba County 2011).

The Science Advisors report makes numerous recommendations for habitat areas that should have special protections as well as best practices for a variety of activities that are pertinent to this feasibility study. Specific habitats that are recommended to be protected include vernal pools and their watersheds, emergent wetlands, confluences of riparian/riverine systems, valley oak woodlands, mature riparian forests, wide riparian areas of more than 100 meters, and functional or potentially restorable floodplain areas. Additionally, the report calls out the confluence of the Bear and Feather Rivers and the Coon Creek watershed as areas of high biological potential. The report also outlines guidelines for riparian conservation and restoration, establishing wetland buffers, maintain and restoring hydrological connectivity including minimizing barriers to fish passage, and general levee maintenance.

The list of special-status species that are currently proposed for inclusion in the NCCP/HCP include:

- Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*)
- bald eagle (*Haliaeetus leucocephalus*)
- bank swallow (*Riparia riparia*)
- Boggs Lake hedge-hyssop (*Gratiola heterosephala*)
- burrowing owl (*Athene cunicularia*)
- California black rail (*Laterallus jamaicensis coturniculus*)
- dwarf downingia (*Doningia pusilla*)
- giant garter snake (*Thamnophis gigas*)
- greater sandhill crane (*Grus canadensis tabida*)
- legenere (*Legenere limosa*)
- steelhead – Central Valley ESU (*Oncorhynchus mykiss irideus*)
- Swainson's hawk (*Buteo swainsoni*)
- tricolored blackbird (*Agelaius tricolor*)
- valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)
- vernal pool fairy shrimp (*Lepidurus packardi*)

- western pond turtle (*Emys marmorata*)
- western spadefoot toad (*Spea hammondii*)
- western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)

Out of these 18 species that are proposed to be included in the NCCP/HCP, eight were determined to have very limited potential to occur within the project area, including Ahart's dwarf rush, bald eagle, Boggs Lake hedge, dwarf downingia, greater sandhill crane, legenere, steelhead, and western spadefoot toad. The remaining ten species have the potential to occur somewhere in the project area and are shown in Table 1.

Table 1. Special-Status Species with the Potential to Occur in the Project Area[1]

Scientific Name	Common Name	Federal Listing[2]	State Listing[3]/CRPR[4]	Vegetation Community Description
Plants				
Astragalus tener var. *ferrisiae*	Ferris' milk-vetch	--	1B.1	potential aquatic resources
Delphinium recurvatum	Recurved larkspur	--	1B.2	pasture
Downingia pusilla	dwarf downingia	--	2B.2	potential aquatic resources
Hibiscus lasiocarpos var. *occidentalis*	woolly rose-mallow	--	1B.2	riparian, potential aquatic resources
Monardella venosa	veiny monardella	--	1B.1	pasture
Pseudobahia bahiifolia	Hartweg's golden sunburst	--	1B.2	pasture
Sagittaria sanfordii	Sanford's arrowhead	--	1B.2	riparian, agricultural ditches, potential aquatic resources
Invertebrates				
Branchinecta conservatio	Conservancy fairy shrimp	FE	--	potential aquatic resources
Branchinecta lynchi	vernal pool fairy shrimp	FT	--	potential aquatic resources
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	--	throughout the project area wherever elderberry host plant occurs, but most likely to occur in riparian areas
Lepidurus packardi	vernal pool tadpole shrimp	FE	--	potential aquatic resources
Fish				
Lavinia exilicauda	Sacramento hitch	--	SSC	Yankee Slough

[1] This list was compiled based on a preliminary habitat assessment, and should not be considered a final list of all species with potential to occur in the project area.
[2] FT = Federally Threatened, FE = Federally Endangered
[3] SSC = Species of Special Concern, ST = State Threatened, SE = State Endangered, FP = Fully Protected, CE = Candidate for Endangered
[4] CRPR (California Rare Plant Ranking); 1B.1 = Seriously rare, threatened, or endangered in CA and elsewhere, 1B.2 = Moderately rare, threatened, or endangered in CA and elsewhere, 2B.2 = Moderately rare, threatened, or endangered in CA but more common elsewhere

Scientific Name	Common Name	Federal Listing[2]	State Listing[3]/CRPR[4]	Vegetation Community Description
Pogonichthys macrolepidotus	Sacramento splittail	--	SSC	Yankee Slough
Reptiles				
Emys marmorata	western pond turtle	--	SSC	Yankee Slough, agricultural ditches
Thamnophis gigas	giant garter snake	FT	ST	rice, riparian, Yankee Slough, agricultural ditches
Birds				
Agelauis tricolor	tricolored blackbird	--	ST/SSC	irrigated agriculture, rice, riparian, Yankee Slough, agricultural ditches
Athene cunicularia	burrowing owl	--	SSC	pasture, urban
Buteo swainsoni	Swainson's hawk	--	ST	foraging: irrigated agriculture, orchard, pasture nesting: riparian and other large trees throughout project area
Circus hudsonius	northern harrier	--	SSC	foraging: irrigated agriculture, orchard, pasture, rice
Coccyzus americanus occidentalis	western yellow-billed cuckoo	FT	SE	riparian
Elanus leucurus	white-tailed kite	--	FP	foraging: irrigated agriculture, pasture, rice nesting: riparian and other large trees throughout project area
Icteria virens	yellow-breasted chat	--	SSC	riparian
Ixobrychus exilis	least bittern	--	SSC	riparian
Lanius ludovicianus	loggerhead shrike	--	SSC	foraging: irrigated agriculture, pasture, rice nesting: shrubs and trees throughout project area
Laterallus jamaicensis coturniculus	California black rail	--	ST/FP	Yankee Slough, potential aquatic resources
Riparia	bank swallow	--	ST	riparian
Mammals				
Antrozous pallidus	pallid bat	--	SSC	orchard, urban
Lasiurus blossevillii	western red bat	--	SSC	orchard, riparian

Conclusion

The findings in this memo represent a preliminary, high-level review of potential biological constraints in the project area and should not be considered final and all-encompassing. Based on this preliminary review of biological resources databases and the site reconnaissance, the project area appears to contain suitable habitat for several special-status species and includes various sensitive communities and aquatic resources. Project activities have the potential to impact any of the aforementioned biological resources, should they be present in the vicinity of the proposed work area. Prior to project implementation, consultation with resource agencies and acquisition of permits may be necessary.

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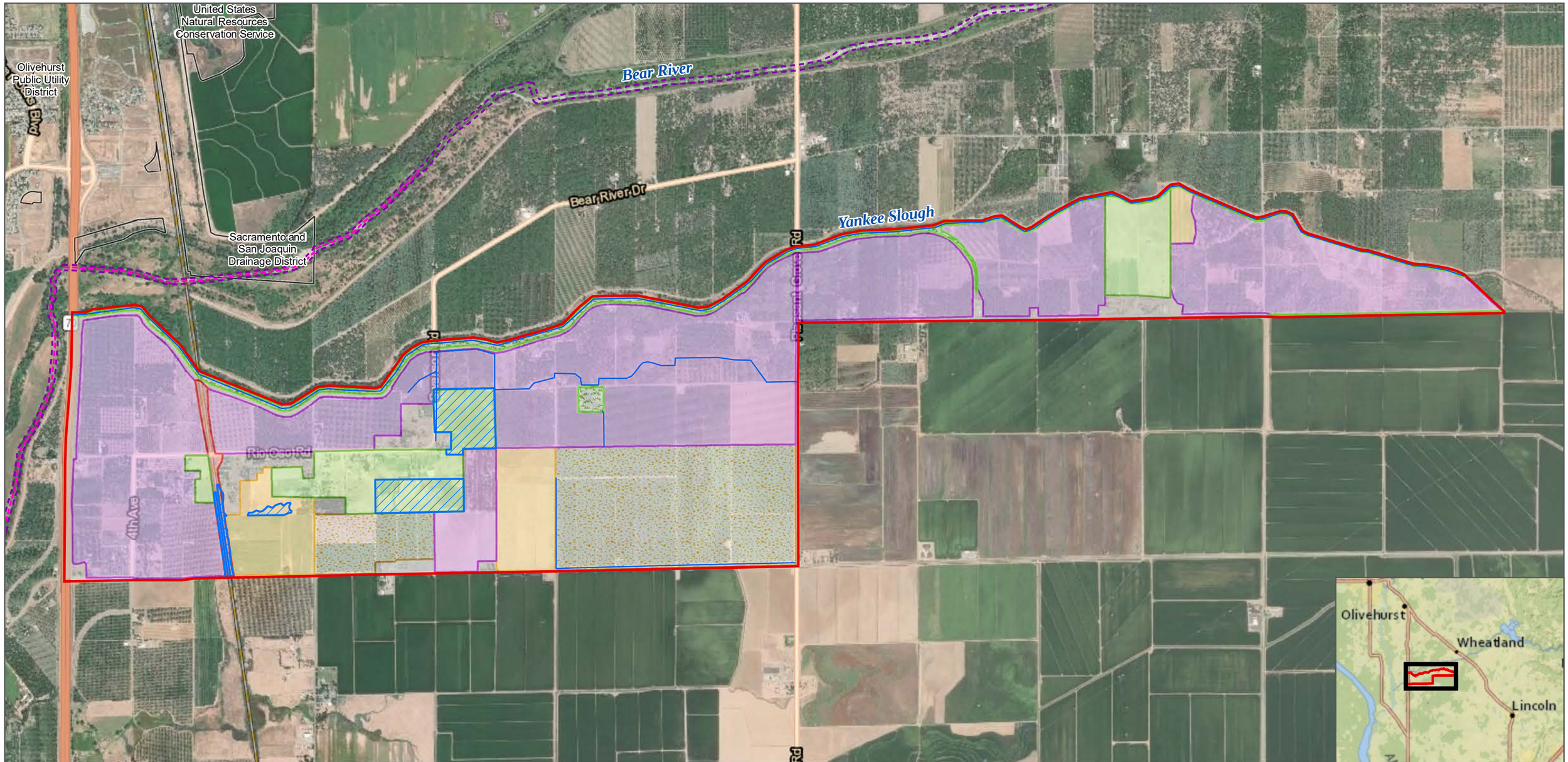
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0 MILES 1

SOURCES: Aerial Imagery - ESRI; Critical Habitat - USFWS; CPAD and CCED - GreenInfo Network;

Project Area, Potential Wetlands, Agriculture Ditches, Vegetation Communities - HDR Inc.

This map product was compiled from the best available sources. No warranty is made for its accuracy or completness. Projection: State Plane California Zone II 0402 US Feet.

- Project Area
- Agriculture Ditches
- Potential Wetlands
- Final Critical Habitat for Chinook Salmon *(Oncorhynchus tshawytscha)*
- Final Critical Habitat for Steelhead *(Oncorhynchus mykiss)*
- California Protected Areas Database (CPAD) and California Conservation Easement Database (CCED) Units

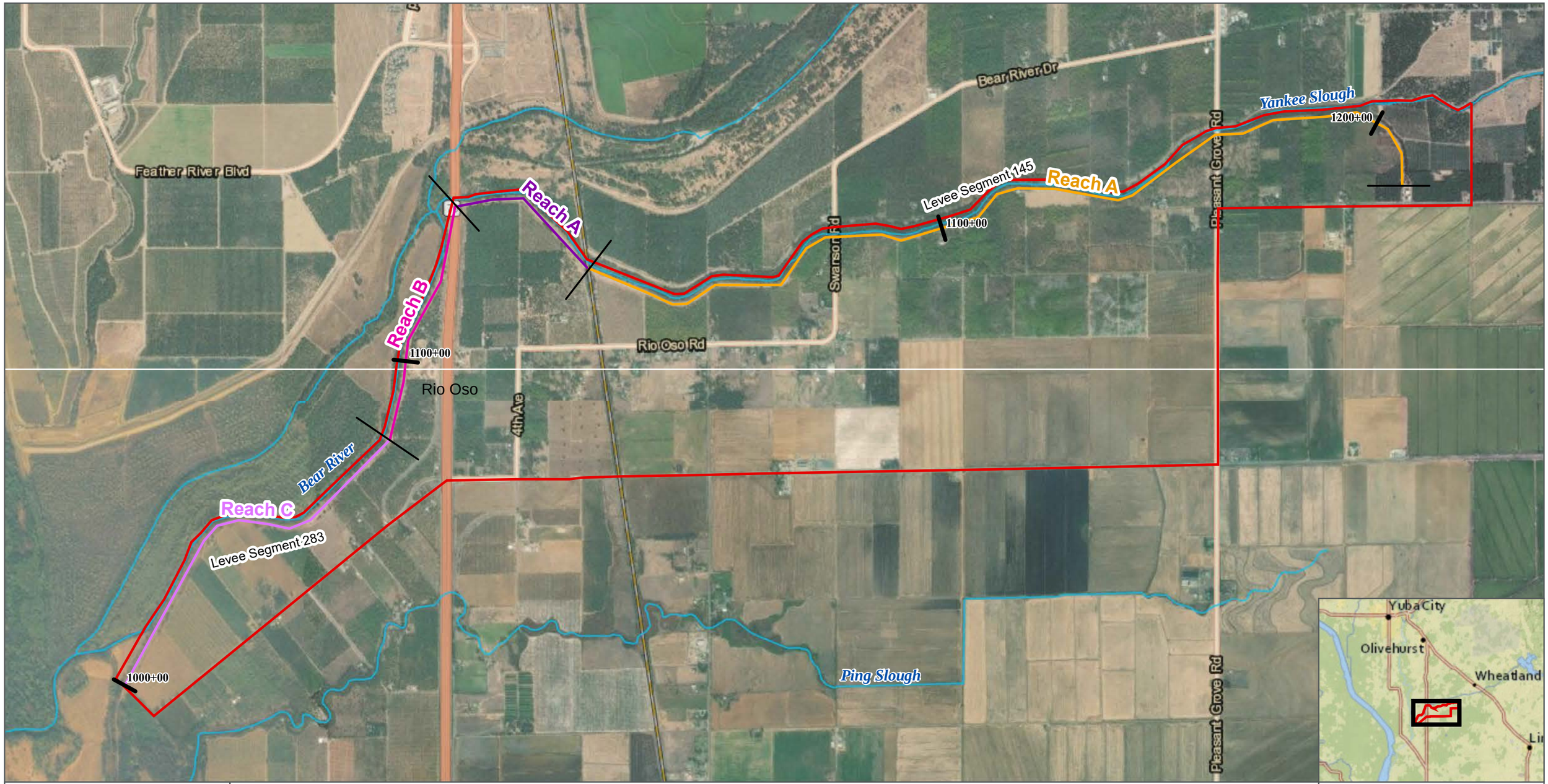
Vegetation Communities

- Irrigated Agriculture
- Oak Woodland
- Orchard
- Pasture
- Rice
- Riparian
- Urban

RIO OSO
FLOOD RISK REDUCTION
FEASIBILITY STUDY

FIGURE 1

PATH: H:\GIS_PROJECTS\SUTTER COUNTY SMALL COMMUNITIES\MXD\ATTACHMENT_SUTTER_COUNTY_RIO_OSO_11X17.MXD - USER: STIDBALL - DATE: 4/5/2019



SOURCES: Aerial Imagery - ESRI; Critical Habitat - USFWS; CPAD and CCED - GreenInfo Network;

Project Area, Potential Wetlands, Agriculture Ditches, Vegetation Communities - HDR Inc.

This map product was compiled from the best available sources. No warranty is made for its accuracy or completness. Projection: State Plane California Zone II 0402 US Feet.

Project Area

Levee Stationing

Levee Reaches

Segment 145, Reach A

Segment 283, Reach A

Segment 283, Reach B

Segment 283, Reach C

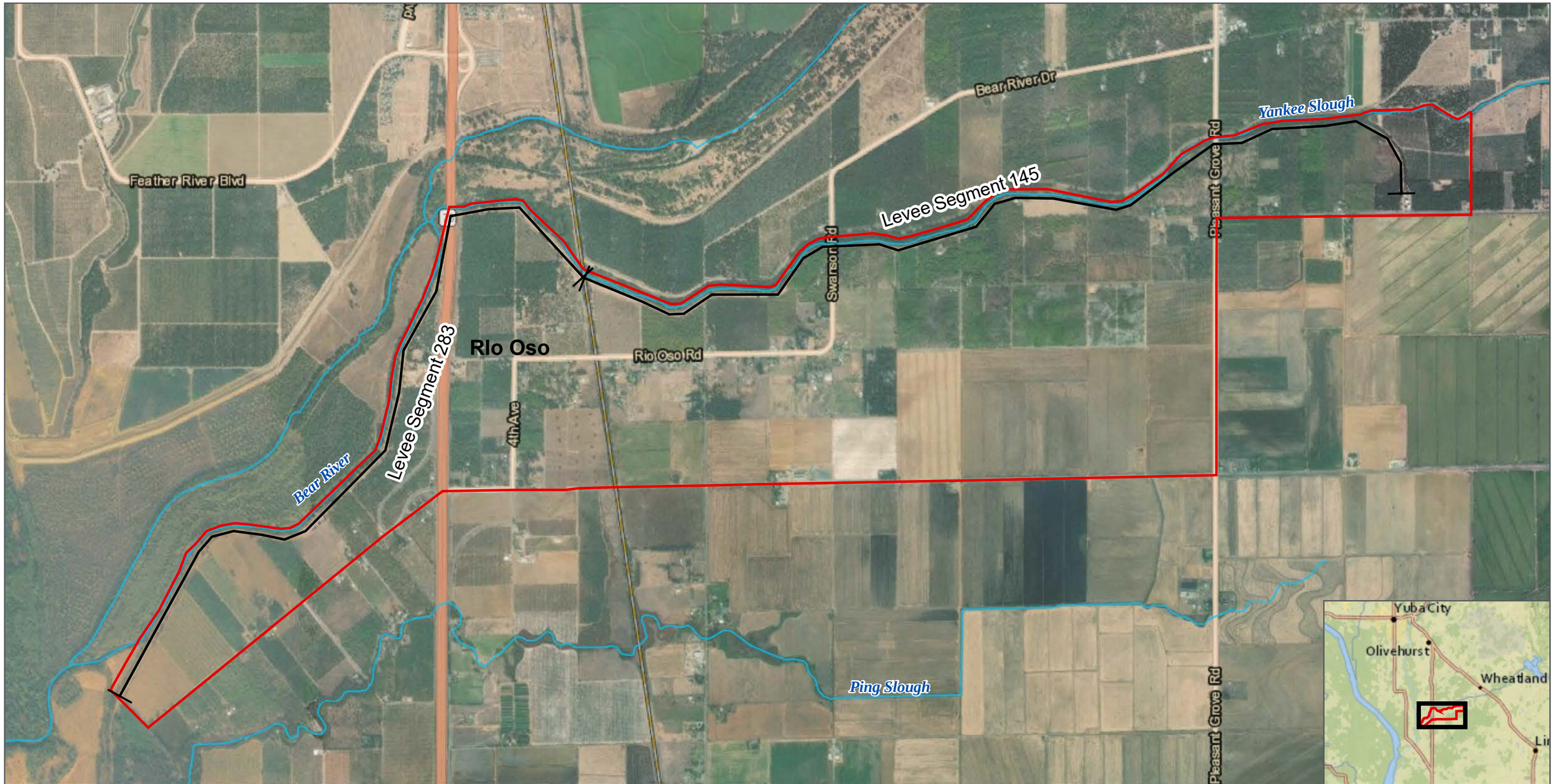
N

0 MILES 1

PREFERRED REMEDIATION ALTERNATIVE REACHES RIO OSO

HDR

PATH: H:\GIS_PROJECTS\SUTTER COUNTY SMALL COMMUNITIES\MXD\ATTACHMENT_SUTTER_COUNTY_RIO_OSO_LEVEE_REACH_11X17.MXD - USER: STIDBALL - DATE: 10/30/2019



SOURCES: Aerial Imagery - ESRI; Critical Habitat - USFWS; CPAD and CCED - GreenInfo Network;

Project Area, Potential Wetlands, Agriculture Ditches, Vegetation Communities - HDR Inc.

This map product was compiled from the best available sources. No warranty is made for its accuracy or completness. Projection: State Plane California Zone II 0402 US Feet.

Project Area

Levee Segments

N

0 MILES 1

COMMUNITY OF RIO OSO PROJECT AREA

PATH: H:\GIS_PROJECTS\SUTTER COUNTY SMALL COMMUNITIES\MXD\ATTACHMENT_SUTTER_COUNTY_RIO_OSO_LEVEE_SEGMENT_11X17.MXD - USER: STIDBALL - DATE: 10/30/2019

Appendix 1. Database Results

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To:
Consultation Code: 08ESMF00-2019-SLI-0819
Event Code: 08ESMF00-2019-E-02503
Project Name: Rio Oso

January 31, 2019

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

Project Summary

Consultation Code: 08ESMF00-2019-SLI-0819

Event Code: 08ESMF00-2019-E-02503

Project Name: Rio Oso

Project Type: LAND - FLOODING

Project Description: Flood reduction feasibility study

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/38.96558058170463N121.50342507586126W



Counties: Sutter, CA

Endangered Species Act Species

There is a total of 8 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Yellow-billed Cuckoo Coccyzus americanus Population: Western U.S. DPS There is proposed critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Giant Garter Snake Thamnophis gigas No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4482	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/321	Threatened

Insects

NAME	STATUS
Valley Elderberry Longhorn Beetle Desmocerus californicus dimorphus There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/7850 Habitat assessment guidelines: https://ecos.fws.gov/ipac/guideline/assessment/population/436/office/11420.pdf	Threatened

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp Branchinecta conservatio There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Fairy Shrimp Branchinecta lynchi There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/498	Threatened
Vernal Pool Tadpole Shrimp Lepidurus packardi There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2246	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Rio Oso Flood Risk Reduction Feasibility Study

Quad Name **Nicolaus**
Quad Number **38121-H5**

ESA Anadromous Fish

SONCC Coho ESU (T) -
CCC Coho ESU (E) -
CC Chinook Salmon ESU (T) -
CVSR Chinook Salmon ESU (T) - **X**
SRWR Chinook Salmon ESU (E) - **X**
NC Steelhead DPS (T) -
CCC Steelhead DPS (T) -
SCCC Steelhead DPS (T) -
SC Steelhead DPS (E) -
CCV Steelhead DPS (T) - **X**
Eulachon (T) -
sDPS Green Sturgeon (T) - **X**

ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -
CCC Coho Critical Habitat -
CC Chinook Salmon Critical Habitat -
CVSR Chinook Salmon Critical Habitat - **X**
SRWR Chinook Salmon Critical Habitat -
NC Steelhead Critical Habitat -
CCC Steelhead Critical Habitat -
SCCC Steelhead Critical Habitat -
SC Steelhead Critical Habitat -
CCV Steelhead Critical Habitat - **X**
Eulachon Critical Habitat -
sDPS Green Sturgeon Critical Habitat - **X**

ESA Marine Invertebrates

Range Black Abalone (E) -
Range White Abalone (E) -

ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

ESA Sea Turtles

East Pacific Green Sea Turtle (T) -
Olive Ridley Sea Turtle (T/E) -
Leatherback Sea Turtle (E) -
North Pacific Loggerhead Sea Turtle (E) -

ESA Whales

Blue Whale (E) -
Fin Whale (E) -
Humpback Whale (E) -
Southern Resident Killer Whale (E) -
North Pacific Right Whale (E) -
Sei Whale (E) -
Sperm Whale (E) -

ESA Pinnipeds

Guadalupe Fur Seal (T) -
Steller Sea Lion Critical Habitat -

Essential Fish Habitat

Coho EFH -
Chinook Salmon EFH - **X**
Groundfish EFH -
Coastal Pelagics EFH -
Highly Migratory Species EFH -

MMPA Species (See list at left)

ESA and MMPA Cetaceans/Pinnipeds

See list at left and consult the NMFS Long Beach office
562-980-4000

MMPA Cetaceans -
MMPA Pinnipeds -

Quad Name **Sheridan**
Quad Number **38121-H4**

ESA Anadromous Fish

SONCC Coho ESU (T) -
CCC Coho ESU (E) -
CC Chinook Salmon ESU (T) -
CVSR Chinook Salmon ESU (T) - **X**
SRWR Chinook Salmon ESU (E) -
NC Steelhead DPS (T) -
CCC Steelhead DPS (T) -
SCCC Steelhead DPS (T) -
SC Steelhead DPS (E) -
CCV Steelhead DPS (T) - **X**
Eulachon (T) -
sDPS Green Sturgeon (T) -

ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -
CCC Coho Critical Habitat -
CC Chinook Salmon Critical Habitat -
CVSR Chinook Salmon Critical Habitat -
SRWR Chinook Salmon Critical Habitat -
NC Steelhead Critical Habitat -
CCC Steelhead Critical Habitat -
SCCC Steelhead Critical Habitat -
SC Steelhead Critical Habitat -
CCV Steelhead Critical Habitat - **X**

Eulachon Critical Habitat -
sDPS Green Sturgeon Critical Habitat -

ESA Marine Invertebrates

Range Black Abalone (E) -
Range White Abalone (E) -

ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

ESA Sea Turtles

East Pacific Green Sea Turtle (T) -
Olive Ridley Sea Turtle (T/E) -
Leatherback Sea Turtle (E) -
North Pacific Loggerhead Sea Turtle (E) -

ESA Whales

Blue Whale (E) -
Fin Whale (E) -
Humpback Whale (E) -
Southern Resident Killer Whale (E) -
North Pacific Right Whale (E) -
Sei Whale (E) -
Sperm Whale (E) -

ESA Pinnipeds

Guadalupe Fur Seal (T) -
Steller Sea Lion Critical Habitat -

Essential Fish Habitat

Coho EFH -
Chinook Salmon EFH - **X**
Groundfish EFH -
Coastal Pelagics EFH -

Highly Migratory Species EFH -

MMPA Species (See list at left)

ESA and MMPA Cetaceans/Pinnipeds
See list at left and consult the NMFS Long Beach office 562-980-4000

MMPA Cetaceans -
MMPA Pinnipeds -

CNDDB 9-Quad Species List 173 records.

Element Type	Scientific Name	Common Name	Element Code	Federal Status	State Status	CDFW Status	CA Rare Plant Rank	Quad Code	Quad Name	Data Status	Taxonomic Sort
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3812174	Pleasant Grove	Mapped	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Birds	Aquila chrysaetos	golden eagle	ABNKC22010	None	None	FP , WL	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Accipitridae - Aquila chrysaetos
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812186	Sutter Causeway	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812184	Sheridan	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812185	Nicolaus	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912116	Gilsizer Slough	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3912114	Wheatland	Mapped	Animals - Birds - Accipitridae - Circus hudsonius
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3912115	Olivehurst	Mapped	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3812176	Knights Landing	Unprocessed	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Branta hutchinsii leucopareia	cackling (=Aleutian Canada) goose	ABNJB05035	Delisted	None	-	-	3912116	Gilsizer Slough	Mapped	Animals - Birds - Anatidae - Branta hutchinsii leucopareia
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912116	Gilsizer Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812186	Sutter Causeway	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Ardeidae - Ardea alba

Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812186	Sutter Causeway	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912116	Gilsizer Slough	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3812186	Sutter Causeway	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Ixobrychus exilis	least bittern	ABNGA02010	None	None	SSC	-	3912116	Gilsizer Slough	Unprocessed	Animals - Birds - Ardeidae - Ixobrychus exilis
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3812175	Verona	Mapped	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Charadrius montanus	mountain plover	ABNNB03100	None	None	SSC	-	3812176	Knights Landing	Mapped	Animals - Birds - Charadriidae - Charadrius montanus
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3812176	Knights Landing	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912115	Olivehurst	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3812185	Nicolaus	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3812185	Nicolaus	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3812175	Verona	Mapped	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812174	Pleasant Grove	Mapped	Animals - Birds - Icteridae - Agelaius tricolor

Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812175	Verona	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812176	Knights Landing	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912115	Olivehurst	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812186	Sutter Causeway	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912114	Wheatland	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812184	Sheridan	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812185	Nicolaus	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912116	Gilsizer Slough	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Lanius ludovicianus	loggerhead shrike	ABPBR01030	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Birds - Laniidae - Lanius ludovicianus
Animals - Birds	Baeolophus inornatus	oak titmouse	ABPAW01100	None	None	-	-	3812175	Verona	Unprocessed	Animals - Birds - Paridae - Baeolophus inornatus
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3812186	Sutter Causeway	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Phalacrocorax auritus	double-crested cormorant	ABNFD01020	None	None	WL	-	3812176	Knights Landing	Unprocessed	Animals - Birds - Phalacrocoracidae - Phalacrocorax auritus
Animals - Birds	Laterallus jamaicensis coturniculus	California black rail	ABNME03041	None	Threatened	FP	-	3912116	Gilsizer Slough	Mapped	Animals - Birds - Rallidae - Laterallus jamaicensis coturniculus
Animals - Birds	Asio otus	long-eared owl	ABNSB13010	None	None	SSC	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Strigidae - Asio otus
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812175	Verona	Mapped and Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3912114	Wheatland	Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Empidonax traillii	willow flycatcher	ABPAE33040	None	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Birds - Tyrannidae - Empidonax traillii

Animals - Crustaceans	Branchinecta conservatio	Conservancy fairy shrimp	ICBRA03010	Endangered	None	-	-	3812184	Sheridan	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta conservatio
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912115	Olivehurst	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912116	Gilsizer Slough	Mapped	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812185	Nicolaus	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi

Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser transmontanus	white sturgeon	AFCAA01050	None	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Fish - Acipenseridae - Acipenser transmontanus
Animals - Fish	Acipenser transmontanus	white sturgeon	AFCAA01050	None	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Acipenseridae - Acipenser transmontanus
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3812185	Nicolaus	Mapped	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus

Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3812175	Verona	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hypomesus transpacificus	Delta smelt	AFCHB01040	Threatened	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Fish - Osmeridae - Hypomesus transpacificus
Animals - Fish	Spirinchus thaleichthys	longfin smelt	AFCHB03010	Candidate	Threatened	SSC	-	3812176	Knights Landing	Mapped	Animals - Fish - Osmeridae - Spirinchus thaleichthys
Animals - Fish	Thaleichthys pacificus	eulachon	AFCHB04010	Threatened	None	-	-	3812176	Knights Landing	Mapped	Animals - Fish - Osmeridae - Thaleichthys pacificus
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812174	Pleasant Grove	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812185	Nicolaus	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 8	steelhead - central California coast DPS	AFCHA0209G	Threatened	None	-	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 8
Animals - Fish	Oncorhynchus mykiss irideus pop. 8	steelhead - central California coast DPS	AFCHA0209G	Threatened	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 8
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30

Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3812185	Nicolaus	Mapped	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3812176	Knights Landing	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Insects	Anthicus antiochensis	Antioch Dunes anthicid beetle	IICOL49020	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Anthicidae - Anthicus antiochensis
Animals - Insects	Anthicus sacramento	Sacramento anthicid beetle	IICOL49010	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Anthicidae - Anthicus sacramento
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3812176	Knights Landing	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812176	Knights Landing	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812175	Verona	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812184	Sheridan	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus

Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912114	Wheatland	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Erethizon dorsatum	North American porcupine	AMAFJ01010	None	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Mammals - Erethizontidae - Erethizon dorsatum
Animals - Mammals	Antrozous pallidus	pallid bat	AMACC10010	None	None	SSC	-	3812184	Sheridan	Mapped	Animals - Mammals - Vespertilionidae - Antrozous pallidus
Animals - Mammals	Lasiurus blossevillii	western red bat	AMACC05060	None	None	SSC	-	3812176	Knights Landing	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus blossevillii
Animals - Mammals	Lasiurus cinereus	hoary bat	AMACC05030	None	None	-	-	3812176	Knights Landing	Mapped	Animals - Mammals - Vespertilionidae - Lasiurus cinereus
Animals - Mollusks	Anodonta californiensis	California floater	IMBIV04020	None	None	-	-	3812176	Knights Landing	Unprocessed	Animals - Mollusks - Unionidae - Anodonta californiensis
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812174	Pleasant Grove	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812185	Nicolaus	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912114	Wheatland	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812186	Sutter Causeway	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912116	Gilsizer Slough	Mapped and Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3912116	Gilsizer Slough	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812186	Sutter Causeway	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812185	Nicolaus	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas

Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812176	Knights Landing	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3812186	Sutter Causeway	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	CTT52410CA	None	None	-	-	3912116	Gilsizer Slough	Mapped	Community - Terrestrial - Coastal and Valley Freshwater Marsh
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912115	Olivehurst	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912115	Olivehurst	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3812185	Nicolaus	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3812176	Knights Landing	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Northern Hardpan Vernal Pool	Northern Hardpan Vernal Pool	CTT44110CA	None	None	-	-	3912114	Wheatland	Mapped	Community - Terrestrial - Northern Hardpan Vernal Pool
Plants - Vascular	Sagittaria sanfordii	Sanford's arrowhead	PMALI040Q0	None	None	-	1B.2	3812185	Nicolaus	Mapped	Plants - Vascular - Alismataceae - Sagittaria sanfordii
Plants - Vascular	Sagittaria sanfordii	Sanford's arrowhead	PMALI040Q0	None	None	-	1B.2	3912115	Olivehurst	Mapped	Plants - Vascular - Alismataceae - Sagittaria sanfordii
Plants - Vascular	Pseudobahia bahiifolia	Hartweg's golden sunburst	PDAST7P010	Endangered	Endangered	-	1B.1	3912116	Gilsizer Slough	Mapped	Plants - Vascular - Asteraceae - Pseudobahia bahiifolia
Plants - Vascular	Pseudobahia bahiifolia	Hartweg's golden sunburst	PDAST7P010	Endangered	Endangered	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Asteraceae - Pseudobahia bahiifolia
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3912114	Wheatland	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812184	Sheridan	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812174	Pleasant Grove	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912115	Olivehurst	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3812185	Nicolaus	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3812176	Knights Landing	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912116	Gilsizer Slough	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii

Plants - Vascular	Monardella venosa	veiny monardella	PDLAM18082	None	None	-	1B.1	3912116	Gilsizer Slough	Mapped	Plants - Vascular - Lamiaceae - Monardella venosa
Plants - Vascular	Monardella venosa	veiny monardella	PDLAM18082	None	None	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Lamiaceae - Monardella venosa
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3812186	Sutter Causeway	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3812176	Knights Landing	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3812175	Verona	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3912116	Gilsizer Slough	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis
Plants - Vascular	Gratiola heterosepala	Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	-	1B.2	3812174	Pleasant Grove	Mapped	Plants - Vascular - Plantaginaceae - Gratiola heterosepala
Plants - Vascular	Delphinium recurvatum	recurved larkspur	PDRAN0B1J0	None	None	-	1B.2	3912115	Olivehurst	Mapped	Plants - Vascular - Ranunculaceae - Delphinium recurvatum

CNDDB 9-Quad Species List 203 records.

Element Type	Scientific Name	Common Name	Element Code	Federal Status	State Status	CDFW Status	CA Rare Plant Rank	Quad Code	Quad Name	Data Status	Taxonomic Sort
Animals - Amphibians	Rana draytonii	California red-legged frog	AAABH01022	Threatened	None	SSC	-	3912113	Camp Far West	Unprocessed	Animals - Amphibians - Ranidae - Rana draytonii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3812173	Roseville	Mapped	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Amphibians	Spea hammondii	western spadefoot	AAABF02020	None	None	SSC	-	3812174	Pleasant Grove	Mapped	Animals - Amphibians - Scaphiopodidae - Spea hammondii
Animals - Birds	Accipiter cooperii	Cooper's hawk	ABNKC12040	None	None	WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Accipiter cooperii
Animals - Birds	Aquila chrysaetos	golden eagle	ABNKC22010	None	None	FP , WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Aquila chrysaetos
Animals - Birds	Aquila chrysaetos	golden eagle	ABNKC22010	None	None	FP , WL	-	3812173	Roseville	Unprocessed	Animals - Birds - Accipitridae - Aquila chrysaetos
Animals - Birds	Aquila chrysaetos	golden eagle	ABNKC22010	None	None	FP , WL	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Accipitridae - Aquila chrysaetos
Animals - Birds	Buteo regalis	ferruginous hawk	ABNKC19120	None	None	WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Buteo regalis
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812183	Lincoln	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812184	Sheridan	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812185	Nicolaus	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812173	Roseville	Mapped	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Buteo swainsoni	Swainson's hawk	ABNKC19070	None	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Birds - Accipitridae - Buteo swainsoni
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3912114	Wheatland	Mapped	Animals - Birds - Accipitridae - Circus hudsonius
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3912113	Camp Far West	Mapped	Animals - Birds - Accipitridae - Circus hudsonius
Animals - Birds	Circus hudsonius	northern harrier	ABNKC11011	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Circus hudsonius

Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3812173	Roseville	Mapped	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Elanus leucurus	white-tailed kite	ABNKC06010	None	None	FP	-	3912115	Olivehurst	Mapped	Animals - Birds - Accipitridae - Elanus leucurus
Animals - Birds	Haliaeetus leucocephalus	bald eagle	ABNKC10010	Delisted	Endangered	FP	-	3912113	Camp Far West	Unprocessed	Animals - Birds - Accipitridae - Haliaeetus leucocephalus
Animals - Birds	Haliaeetus leucocephalus	bald eagle	ABNKC10010	Delisted	Endangered	FP	-	3812183	Lincoln	Unprocessed	Animals - Birds - Accipitridae - Haliaeetus leucocephalus
Animals - Birds	Eremophila alpestris actia	California horned lark	ABPAT02011	None	None	WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Alaudidae - Eremophila alpestris actia
Animals - Birds	Aythya americana	redhead	ABNJB11030	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Anatidae - Aythya americana
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea alba	great egret	ABNGA04040	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Ardea alba
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3912113	Camp Far West	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Ardea herodias	great blue heron	ABNGA04010	None	None	-	-	3812183	Lincoln	Mapped and Unprocessed	Animals - Birds - Ardeidae - Ardea herodias
Animals - Birds	Botaurus lentiginosus	American bittern	ABNGA01020	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Ardeidae - Botaurus lentiginosus
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Egretta thula	snowy egret	ABNGA06030	None	None	-	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Ardeidae - Egretta thula
Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Ardeidae - Nycticorax nycticorax

Animals - Birds	Nycticorax nycticorax	black-crowned night heron	ABNGA11010	None	None	-	-	3812175	Verona	Mapped	Animals - Birds - Ardeidae - Nycticorax nycticorax
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3812185	Nicolaus	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Coccyzus americanus occidentalis	western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	-	-	3912115	Olivehurst	Mapped	Animals - Birds - Cuculidae - Coccyzus americanus occidentalis
Animals - Birds	Falco mexicanus	prairie falcon	ABNKD06090	None	None	WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Falconidae - Falco mexicanus
Animals - Birds	Progne subis	purple martin	ABPAU01010	None	None	SSC	-	3812173	Roseville	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Progne subis
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3812175	Verona	Mapped	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3812185	Nicolaus	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Riparia riparia	bank swallow	ABPAU08010	None	Threatened	-	-	3912113	Camp Far West	Mapped	Animals - Birds - Hirundinidae - Riparia riparia
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912115	Olivehurst	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3912114	Wheatland	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812185	Nicolaus	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812184	Sheridan	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812183	Lincoln	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812174	Pleasant Grove	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812175	Verona	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Agelaius tricolor	tricolored blackbird	ABPBXB0020	None	Candidate Endangered	SSC	-	3812173	Roseville	Mapped	Animals - Birds - Icteridae - Agelaius tricolor
Animals - Birds	Xanthocephalus xanthocephalus	yellow-headed blackbird	ABPBXB3010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Icteridae - Xanthocephalus xanthocephalus
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Icteria virens	yellow-breasted chat	ABPBX24010	None	None	SSC	-	3912113	Camp Far West	Mapped	Animals - Birds - Icteriidae - Icteria virens
Animals - Birds	Lanius ludovicianus	loggerhead shrike	ABPBR01030	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Laniidae - Lanius ludovicianus

Animals - Birds	Lanius ludovicianus	loggerhead shrike	ABPBR01030	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Birds - Laniidae - Lanius ludovicianus
Animals - Birds	Chlidonias niger	black tern	ABNNM10020	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Laridae - Chlidonias niger
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3912113	Camp Far West	Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Pandion haliaetus	osprey	ABNKC01010	None	None	WL	-	3812183	Lincoln	Unprocessed	Animals - Birds - Pandionidae - Pandion haliaetus
Animals - Birds	Baeolophus inornatus	oak titmouse	ABPAW01100	None	None	-	-	3812175	Verona	Unprocessed	Animals - Birds - Paridae - Baeolophus inornatus
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Setophaga petechia	yellow warbler	ABPBX03010	None	None	SSC	-	3912113	Camp Far West	Mapped	Animals - Birds - Parulidae - Setophaga petechia
Animals - Birds	Ammodramus savannarum	grasshopper sparrow	ABPBXA0020	None	None	SSC	-	3912113	Camp Far West	Mapped	Animals - Birds - Passerellidae - Ammodramus savannarum
Animals - Birds	Ammodramus savannarum	grasshopper sparrow	ABPBXA0020	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Passerellidae - Ammodramus savannarum
Animals - Birds	Ammodramus savannarum	grasshopper sparrow	ABPBXA0020	None	None	SSC	-	3812173	Roseville	Mapped	Animals - Birds - Passerellidae - Ammodramus savannarum
Animals - Birds	Melospiza melodia	song sparrow (-inModesto-in population)	ABPBXA3010	None	None	SSC	-	3812183	Lincoln	Mapped	Animals - Birds - Passerellidae - Melospiza melodia
Animals - Birds	Pelecanus erythrorhynchos	American white pelican	ABNFC01010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Pelecanidae - Pelecanus erythrorhynchos
Animals - Birds	Melanerpes lewis	Lewis' woodpecker	ABNYF04010	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Picidae - Melanerpes lewis
Animals - Birds	Laterallus jamaicensis coturniculus	California black rail	ABNME03041	None	Threatened	FP	-	3812183	Lincoln	Mapped	Animals - Birds - Rallidae - Laterallus jamaicensis coturniculus
Animals - Birds	Laterallus jamaicensis coturniculus	California black rail	ABNME03041	None	Threatened	FP	-	3912113	Camp Far West	Mapped	Animals - Birds - Rallidae - Laterallus jamaicensis coturniculus
Animals - Birds	Asio otus	long-eared owl	ABNSB13010	None	None	SSC	-	3812174	Pleasant Grove	Unprocessed	Animals - Birds - Strigidae - Asio otus
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812175	Verona	Mapped and Unprocessed	Animals - Birds - Strigidae - Athene cunicularia

Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812173	Roseville	Mapped	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3812183	Lincoln	Mapped and Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Athene cunicularia	burrowing owl	ABNSB10010	None	None	SSC	-	3912114	Wheatland	Unprocessed	Animals - Birds - Strigidae - Athene cunicularia
Animals - Birds	Plegadis chihi	white-faced ibis	ABNGE02020	None	None	WL	-	3912115	Olivehurst	Unprocessed	Animals - Birds - Threskiornithidae - Plegadis chihi
Animals - Birds	Contopus cooperi	olive-sided flycatcher	ABPAE32010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Birds - Tyrannidae - Contopus cooperi
Animals - Birds	Empidonax traillii	willow flycatcher	ABPAE33040	None	Endangered	-	-	3812183	Lincoln	Unprocessed	Animals - Birds - Tyrannidae - Empidonax traillii
Animals - Birds	Empidonax traillii	willow flycatcher	ABPAE33040	None	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Birds - Tyrannidae - Empidonax traillii
Animals - Crustaceans	Branchinecta conservatio	Conservancy fairy shrimp	ICBRA03010	Endangered	None	-	-	3812184	Sheridan	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta conservatio
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812183	Lincoln	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3812173	Roseville	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912113	Camp Far West	Mapped and Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi
Animals - Crustaceans	Branchinecta lynchi	vernal pool fairy shrimp	ICBRA03030	Threatened	None	-	-	3912115	Olivehurst	Mapped	Animals - Crustaceans - Branchinectidae - Branchinecta lynchi

Animals - Crustaceans	Branchinecta mesovallensis	midvalley fairy shrimp	ICBRA03150	None	None	-	-	3812183	Lincoln	Unprocessed	Animals - Crustaceans - Branchinectidae - Branchinecta mesovallensis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812183	Lincoln	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812173	Roseville	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912113	Camp Far West	Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Linderiella occidentalis	California linderiella	ICBRA06010	None	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Linderiellidae - Linderiella occidentalis
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912114	Wheatland	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812175	Verona	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812174	Pleasant Grove	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812173	Roseville	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi

Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812185	Nicolaus	Mapped	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812184	Sheridan	Mapped and Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Crustaceans	Lepidurus packardi	vernal pool tadpole shrimp	ICBRA10010	Endangered	None	-	-	3812183	Lincoln	Unprocessed	Animals - Crustaceans - Triopsidae - Lepidurus packardi
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3812185	Nicolaus	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser medirostris	green sturgeon	AFCAA01030	Threatened	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Fish - Acipenseridae - Acipenser medirostris
Animals - Fish	Acipenser transmontanus	white sturgeon	AFCAA01050	None	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Fish - Acipenseridae - Acipenser transmontanus
Animals - Fish	Lavinia exilicauda exilicauda	Sacramento hitch	AFCJB19012	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Cyprinidae - Lavinia exilicauda exilicauda
Animals - Fish	Mylopharodon conocephalus	hardhead	AFCJB25010	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Cyprinidae - Mylopharodon conocephalus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Pogonichthys macrolepidotus	Sacramento splittail	AFCJB34020	None	None	SSC	-	3812185	Nicolaus	Mapped	Animals - Fish - Cyprinidae - Pogonichthys macrolepidotus
Animals - Fish	Hysterocarpus traskii traskii	Sacramento-San Joaquin tule perch	AFCQK02012	None	None	-	-	3812175	Verona	Unprocessed	Animals - Fish - Embiotocidae - Hysterocarpus traskii traskii
Animals - Fish	Hypomesus transpacificus	Delta smelt	AFCHB01040	Threatened	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Fish - Osmeridae - Hypomesus transpacificus
Animals - Fish	Lampetra ayresii	river lamprey	AFBAA02030	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Fish - Petromyzontidae - Lampetra ayresii
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812183	Lincoln	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812185	Nicolaus	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11

Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812174	Pleasant Grove	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3812173	Roseville	Mapped	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 11
Animals - Fish	Oncorhynchus mykiss irideus pop. 8	steelhead - central California coast DPS	AFCHA0209G	Threatened	None	-	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus mykiss irideus pop. 8
Animals - Fish	Oncorhynchus tshawytscha pop. 13	chinook salmon - Central Valley fall / late fall-run ESU	AFCHA0205N	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 13
Animals - Fish	Oncorhynchus tshawytscha pop. 30	chinook salmon - upper Klamath and Trinity Rivers ESU	AFCHA02056	None	None	SSC	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 30
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3812185	Nicolaus	Mapped	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 6	chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 6
Animals - Fish	Oncorhynchus tshawytscha pop. 7	chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	-	-	3812175	Verona	Unprocessed	Animals - Fish - Salmonidae - Oncorhynchus tshawytscha pop. 7
Animals - Insects	Andrena subapasta	An andrenid bee	IIHYM35210	None	None	-	-	3812173	Roseville	Mapped	Animals - Insects - Andrenidae - Andrena subapasta
Animals - Insects	Anthicus antiochensis	Antioch Dunes anthicid beetle	IICOL49020	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Anthicidae - Anthicus antiochensis
Animals - Insects	Anthicus sacramento	Sacramento anthicid beetle	IICOL49010	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Anthicidae - Anthicus sacramento
Animals - Insects	Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	IICOL02106	None	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Carabidae - Cicindela hirticollis abrupta
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812185	Nicolaus	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus

Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812184	Sheridan	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3812175	Verona	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912114	Wheatland	Mapped	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	IICOL48011	Threatened	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Insects - Cerambycidae - Desmocerus californicus dimorphus
Animals - Insects	Hydrochara rickseckeri	Ricksecker's water scavenger beetle	IICOL5V010	None	None	-	-	3812173	Roseville	Mapped	Animals - Insects - Hydrophilidae - Hydrochara rickseckeri
Animals - Mammals	Vulpes vulpes patwin	Sacramento Valley red fox	AMAJA03015	None	None	-	-	3812184	Sheridan	Unprocessed	Animals - Mammals - Canidae - Vulpes vulpes patwin
Animals - Mammals	Erethizon dorsatum	North American porcupine	AMAFJ01010	None	None	-	-	3912115	Olivehurst	Mapped and Unprocessed	Animals - Mammals - Erethizontidae - Erethizon dorsatum
Animals - Mammals	Taxidea taxus	American badger	AMAJF04010	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Mammals - Mustelidae - Taxidea taxus
Animals - Mammals	Antrozous pallidus	pallid bat	AMACC10010	None	None	SSC	-	3812184	Sheridan	Mapped	Animals - Mammals - Vespertilionidae - Antrozous pallidus
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812185	Nicolaus	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812183	Lincoln	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812173	Roseville	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3812174	Pleasant Grove	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912115	Olivehurst	Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912114	Wheatland	Mapped	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Emys marmorata	western pond turtle	ARAAD02030	None	None	SSC	-	3912113	Camp Far West	Mapped and Unprocessed	Animals - Reptiles - Emydidae - Emys marmorata
Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812175	Verona	Mapped and Unprocessed	Animals - Reptiles - Natricidae - Thamnophis gigas

Animals - Reptiles	Thamnophis gigas	giant gartersnake	ARADB36150	Threatened	Threatened	-	-	3812185	Nicolaus	Mapped	Animals - Reptiles - Natricidae - Thamnophis gigas
Community - Terrestrial	Alkali Meadow	Alkali Meadow	CTT45310CA	None	None	-	-	3812173	Roseville	Mapped	Community - Terrestrial - Alkali Meadow
Community - Terrestrial	Alkali Seep	Alkali Seep	CTT45320CA	None	None	-	-	3812173	Roseville	Mapped	Community - Terrestrial - Alkali Seep
Community - Terrestrial	Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	-	-	3912115	Olivehurst	Mapped	Community - Terrestrial - Great Valley Cottonwood Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3912115	Olivehurst	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	CTT61420CA	None	None	-	-	3812185	Nicolaus	Mapped	Community - Terrestrial - Great Valley Mixed Riparian Forest
Community - Terrestrial	Northern Hardpan Vernal Pool	Northern Hardpan Vernal Pool	CTT44110CA	None	None	-	-	3812183	Lincoln	Mapped	Community - Terrestrial - Northern Hardpan Vernal Pool
Community - Terrestrial	Northern Hardpan Vernal Pool	Northern Hardpan Vernal Pool	CTT44110CA	None	None	-	-	3812173	Roseville	Mapped	Community - Terrestrial - Northern Hardpan Vernal Pool
Community - Terrestrial	Northern Hardpan Vernal Pool	Northern Hardpan Vernal Pool	CTT44110CA	None	None	-	-	3912114	Wheatland	Mapped	Community - Terrestrial - Northern Hardpan Vernal Pool
Community - Terrestrial	Northern Volcanic Mud Flow Vernal Pool	Northern Volcanic Mud Flow Vernal Pool	CTT44132CA	None	None	-	-	3812173	Roseville	Mapped	Community - Terrestrial - Northern Volcanic Mud Flow Vernal Pool
Plants - Vascular	Sagittaria sanfordii	Sanford's arrowhead	PMALI040Q0	None	None	-	1B.2	3812185	Nicolaus	Mapped	Plants - Vascular - Alismataceae - Sagittaria sanfordii
Plants - Vascular	Sagittaria sanfordii	Sanford's arrowhead	PMALI040Q0	None	None	-	1B.2	3912115	Olivehurst	Mapped	Plants - Vascular - Alismataceae - Sagittaria sanfordii
Plants - Vascular	Balsamorhiza macrolepis	big-scale balsamroot	PDAST11061	None	None	-	1B.2	3812183	Lincoln	Mapped	Plants - Vascular - Asteraceae - Balsamorhiza macrolepis
Plants - Vascular	Balsamorhiza macrolepis	big-scale balsamroot	PDAST11061	None	None	-	1B.2	3812173	Roseville	Mapped	Plants - Vascular - Asteraceae - Balsamorhiza macrolepis
Plants - Vascular	Pseudobahia bahiifolia	Hartweg's golden sunburst	PDAST7P010	Endangered	Endangered	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Asteraceae - Pseudobahia bahiifolia
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3912114	Wheatland	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla

Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3912113	Camp Far West	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812173	Roseville	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812174	Pleasant Grove	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812183	Lincoln	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Downingia pusilla	dwarf downingia	PDCAM060C0	None	None	-	2B.2	3812184	Sheridan	Mapped	Plants - Vascular - Campanulaceae - Downingia pusilla
Plants - Vascular	Legenere limosa	legenere	PDCAM0C010	None	None	-	1B.1	3812173	Roseville	Mapped	Plants - Vascular - Campanulaceae - Legenere limosa
Plants - Vascular	Astragalus tener var. ferrisiae	Ferris' milk-vetch	PDFAB0F8R3	None	None	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Fabaceae - Astragalus tener var. ferrisiae
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3912115	Olivehurst	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3812185	Nicolaus	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juglans hindsii	Northern California black walnut	PDJUG02040	None	None	-	1B.1	3812183	Lincoln	Unprocessed	Plants - Vascular - Juglandaceae - Juglans hindsii
Plants - Vascular	Juncus leiospermus var. ahartii	Ahart's dwarf rush	PMJUN011L1	None	None	-	1B.2	3812183	Lincoln	Mapped	Plants - Vascular - Juncaceae - Juncus leiospermus var. ahartii
Plants - Vascular	Juncus leiospermus var. leiospermus	Red Bluff dwarf rush	PMJUN011L2	None	None	-	1B.1	3812173	Roseville	Mapped	Plants - Vascular - Juncaceae - Juncus leiospermus var. leiospermus
Plants - Vascular	Monardella venosa	veiny monardella	PDLAM18082	None	None	-	1B.1	3912115	Olivehurst	Mapped	Plants - Vascular - Lamiaceae - Monardella venosa
Plants - Vascular	Wolffia brasiliensis	Brazilian watermeal	PMLEM03020	None	None	-	2B.3	3912113	Camp Far West	Mapped	Plants - Vascular - Lemnaceae - Wolffia brasiliensis
Plants - Vascular	Fritillaria agrestis	stinkbells	PMLIL0V010	None	None	-	4.2	3912113	Camp Far West	Unprocessed	Plants - Vascular - Liliaceae - Fritillaria agrestis
Plants - Vascular	Fritillaria agrestis	stinkbells	PMLIL0V010	None	None	-	4.2	3812173	Roseville	Unprocessed	Plants - Vascular - Liliaceae - Fritillaria agrestis
Plants - Vascular	Fritillaria agrestis	stinkbells	PMLIL0V010	None	None	-	4.2	3812183	Lincoln	Unprocessed	Plants - Vascular - Liliaceae - Fritillaria agrestis
Plants - Vascular	Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	PDMAL0H0R3	None	None	-	1B.2	3812175	Verona	Mapped	Plants - Vascular - Malvaceae - Hibiscus lasiocarpos var. occidentalis

Plants - Vascular	Clarkia biloba ssp. brandegeeae	Brandegee's clarkia	PDONA05053	None	None	-	4.2	3912113	Camp Far West	Mapped	Plants - Vascular - Onagraceae - Clarkia biloba ssp. brandegeeae
Plants - Vascular	Chloropyron molle ssp. hispidum	hispid salty bird's-beak	PDSCR0J0D1	None	None	-	1B.1	3812173	Roseville	Mapped	Plants - Vascular - Orobanchaceae - Chloropyron molle ssp. hispidum
Plants - Vascular	Gratiola heterosepala	Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	-	1B.2	3812173	Roseville	Mapped	Plants - Vascular - Plantaginaceae - Gratiola heterosepala
Plants - Vascular	Gratiola heterosepala	Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	-	1B.2	3812174	Pleasant Grove	Mapped	Plants - Vascular - Plantaginaceae - Gratiola heterosepala
Plants - Vascular	Gratiola heterosepala	Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	-	1B.2	3812183	Lincoln	Mapped	Plants - Vascular - Plantaginaceae - Gratiola heterosepala
Plants - Vascular	Navarretia myersii ssp. myersii	pincushion navarretia	PDPLM0C0X1	None	None	-	1B.1	3812183	Lincoln	Mapped	Plants - Vascular - Polemoniaceae - Navarretia myersii ssp. myersii
Plants - Vascular	Delphinium recurvatum	recurved larkspur	PDRAN0B1J0	None	None	-	1B.2	3912115	Olivehurst	Mapped	Plants - Vascular - Ranunculaceae - Delphinium recurvatum

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Found in Quads 3912116, 3912115, 3912114, 3812186, 3812185, 3812184, 3812176 3812175 and 3812174;

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Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Centromadia parryi ssp. rudis	Parry's rough tarplant	Asteraceae	annual herb	May-Oct	4.2	S3	G3T3
Downingia pusilla	dwarf downingia	Campanulaceae	annual herb	Mar-May	2B.2	S2	GU
Gratiola heterosepala	Boggs Lake hedge-hyssop	Plantaginaceae	annual herb	Apr-Aug	1B.2	S2	G2
Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	Malvaceae	perennial rhizomatous herb (emergent)	Jun-Sep	1B.2	S3	G5T3
Monardella venosa	veiny monardella	Lamiaceae	annual herb	May,Jul	1B.1	S1	G1
Sagittaria sanfordii	Sanford's arrowhead	Alismataceae	perennial rhizomatous herb (emergent)	May-Oct(Nov)	1B.2	S3	G3
Trichocoronis wrightii var. wrightii	Wright's trichocoronis	Asteraceae	annual herb	May-Sep	2B.1	S1	G4T3

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Found in Quads 3912115, 3912114, 3912113, 3812185, 3812184, 3812183, 3812175 3812174 and 3812173;

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Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Balsamorhiza macrolepis	big-scale balsamroot	Asteraceae	perennial herb	Mar-Jun	1B.2	S2	G2
Chloropyron molle ssp. hispidum	hispid bird's-beak	Orobanchaceae	annual herb (hemiparasitic)	Jun-Sep	1B.1	S1	G2T1
Clarkia biloba ssp. brandegeeae	Brandegee's clarkia	Onagraceae	annual herb	May-Jul	4.2	S4	G4G5T4
Downingia pusilla	dwarf downingia	Campanulaceae	annual herb	Mar-May	2B.2	S2	GU
Fritillaria agrestis	stinkbells	Liliaceae	perennial bulbiferous herb	Mar-Jun	4.2	S3	G3
Gratiola heterosepala	Boggs Lake hedge-hyssop	Plantaginaceae	annual herb	Apr-Aug	1B.2	S2	G2
Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	Malvaceae	perennial rhizomatous herb (emergent)	Jun-Sep	1B.2	S3	G5T3
Juncus leiospermus var. ahartii	Ahart's dwarf rush	Juncaceae	annual herb	Mar-May	1B.2	S1	G2T1
Juncus leiospermus var. leiospermus	Red Bluff dwarf rush	Juncaceae	annual herb	Mar-Jun	1B.1	S2	G2T2
Legenere limosa	legenere	Campanulaceae	annual herb	Apr-Jun	1B.1	S2	G2
Monardella venosa	veiny monardella	Lamiaceae	annual herb	May,Jul	1B.1	S1	G1
Navarretia myersii ssp. myersii	pincushion navarretia	Polemoniaceae	annual herb	Apr-May	1B.1	S2	G2T2
Navarretia nigelliformis ssp. nigelliformis	adobe navarretia	Polemoniaceae	annual herb	Apr-Jun	4.2	S3	G4T3
Sagittaria sanfordii	Sanford's arrowhead	Alismataceae	perennial rhizomatous herb (emergent)	May-Oct(Nov)	1B.2	S3	G3
Wolffia brasiliensis	Brazilian watermeal	Araceae	perennial herb (aquatic)	Apr,Dec	2B.3	S2	G5

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Appendix D. Cultural Resources Analysis

Memo

Date:	April 2020
Project:	Rio Oso Flood Risk Reduction Feasibility Study
To:	Sutter County
From:	John “Jay” Lloyd, Senior Archaeologist (HDR) Jonathan Schwartz, Cultural Resource Specialist I (HDR)
Reviewed:	Danielle Risse, Senior Archaeologist (HDR)
Subject:	Rio Oso – Cultural Resources Constraints Analysis

Introduction

This memo presents a preliminary review of potential cultural resources constraints for the Rio Oso Flood Risk Reduction Feasibility Study Project (project). Potential constraints are described below.

Methodology

Records Search and Historic Map Review

Records search requests for the project area were submitted on February 14, 2019 to the North Central Information Center (NCIC) at California State University, Sacramento and the Northeastern Information Center (NEIC) at California State University, Chico of the California Historical Resources Information System. The search area for which data was requested included all alternatives for the project footprint, plus a 0.25-mile buffer. Search results were received from the NCIC on February 20, 2019 and from the NEIC on March 13, 2019. The information requests included a search of previous cultural resources investigations, and previously recorded archaeological sites and built environment resources. To gather these data the records searches reviewed the following including the:

- NCIC and NEIC Resource Databases,
- NCIC and NEIC Report Databases,
- Office of Historic Preservation (OHP) Historic Properties Directory for Sutter County,
- OHP Archaeological Determinations of Eligibility for Sutter County,
- California Inventory of Historical Resources (1976), and
- General Land Office (GLO) and/or Rancho Plat Maps.

Information was also requested on the Caltrans Bridge Survey, ethnographic information, and local inventories, where present. Historic United States Geological Service (USGS) topographic maps were also reviewed in order to track land-use and historic-era development. An additional data review was performed in November 2019 due a revision on the project area.

Reconnaissance Survey

A field reconnaissance of the project area was conducted on April 2, 2019 by John “Jay” Lloyd, M.A. Linguistics, who meets the Secretary of the Interior’s Qualification Standards for archaeology and is a Registered Professional Archaeologist (RPA). Methods included reviewing the results of the

records search, confirming the absence/presence of previously recorded (and accessible) resources, generally driving across the breadth of the project area on publicly accessible roads, and assessing major topographical differences between the historic and modern landscape using historic-era maps for comparison.

Results

Records Search

There have been six cultural resources investigations intersecting the project footprint (**Table 1**). Previous investigations were primarily archaeological field studies, including investigations for transmission lines, fiber optics and other telecommunications infrastructure, academic research, and levee repairs, as well as a National Register of Historic Places (NRHP) evaluation of the Sacramento Northern Electric Railroad (SNERR). These studies recorded 23 archaeological sites and historical built environment resources, both within and outside the project area.

Table 1: Previous cultural resources investigations within the project area

Author(s)	Date	Report Title	Study Type	IC File No.	Results
Bouey, Paul	May 1990	Cultural Resource Inventory of the Cottonwood-Elverta #3 Transmission Line	Archaeological, Field study, Other research	001042	4 resources recorded
Grant, Joanne S.	Apr 2006	Cultural Resources Evaluation for the Emergency Levee-Banks Repairs of 16 Critical Erosion Sites	Archaeological, Field Study	008361	Negative survey
JRP Historical Consulting Services	Nov 1994	Historic Resource Evaluation Report of the Northern Electric (California Northern) Railroad	Architectural/ historical, Evaluation	007587	7 resources recorded
Nelson, Wendy J., Maureen Carpenter, and Kimberley L. Holanda	June 2000	Cultural Resource Inventory for the Level (3) Communications Long Haul Fiber Optics Project: Segment WPO4: Sacramento to Redding	Archaeological, Field study	004658	10 resources recorded
Peak, Melinda A.	Jan 2000	Archaeological Inventory Report for the Sprint PCS Site No. SF33XC042A, Rio Oso, Sutter County, California	Archaeological, Field Study	005363	Negative survey
Stoll, M. and S. Thompson	Jan 1961	Report on the Archaeological Survey of the Bear River	Archaeological, Field Study	007576	2 resources recorded

There have been an additional eight cultural resources investigations within 0.25 mile of the project footprint (**Table 2).** Projects included flood control, highway projects, levee repairs/improvements, and academic field research. Details provided by the information centers indicate that three of the projects consist of negative surveys, with the other five projects recording a total of 20 resources. A total of five reports were prepared for the California Department of Transportation's (Caltrans) State Route 70 Highway/Expressway Project (Information Center File No. 008351).

Table 2: Previous Cultural Resources Investigations within the 0.25 Radius Surrounding the Project Area

Author(s)	Date	Report Title	Study Type	IC File No.	Results
Berg, John E. Julia G. Costello, and Stephen R. Wee	Jun 1995	Archaeological Survey Report and Historic Study Report State Route 70 Expressway/Freeway Project in Sutter and Yuba Counties, California	Archaeological, Excavation, Field study	008351C	n/a
Bouey, Paul D.	Mar 1990	Sacramento River Flood Control System Evaluation Marysville- Yuba City Area Cultural Resources Survey	Archaeological, Excavation, Field study	007922	1 resource recorded
EDAW, Inc.	Apr 2006	Cultural Resources Inventory and Evaluation Report for the Southern Floodway Restoration Area of the Feather-Bear Rivers Levee Setback Project, Yuba and Sutter Counties, CA	Archaeological, Field study	006927	Negative survey
EDAW, Inc.	Oct 2004	Cultural Resources Inventory and Evaluation Report for the Proposed Feather-Bear Rivers Levee Setback Project	Archaeological, Architectural/ historical, Evaluation, Field study	006297	7 resources recorded
Grant, Joanne S.	Jul 2008	Cultural Resources Survey for the Urban Levee Project	Archaeological, Field study	009423	Negative survey
Jensen, Peter	Mar 2000	Archaeological Inventory Survey Proposed Sawyer's Landing Development Project, Apx. 54 acres near Rio oso and the Bear River, Southern Yuba County, California	Archaeological, Field study	008349	Negative survey
Jones & Stokes	May 2004	Cultural Resources Inventory and Evaluation Report for the Bear River and Western Pacific Interceptor Canal Levee Improvements Project	Archaeological, Evaluation, Field study	006298	3 resources recorded
Mikesell, Stephen D.	Jun 1995	Addendum Historic Architectural Survey Report, Route Adoption Study, Route 70 in Sutter and Yuba Counties	Architectural/ Historical, Evaluation, Field study	008351D	n/a
Morgan, Sally S., and Jeffrey D. Zimmerman	Jun 1995	Historic Property Survey Report, Request for Determination of Eligibility and Finding of Effect, State Route 70 Expressway/Freeway Project in Sutter and Yuba Counties, California	Evaluation, Other research	008351B	n/a
Stoll, M., and S. Thompson	Jan 1960	Report on the Archaeological Survey of the Bear River	Archaeological, Field study	000511	8 resources recorded
Wee, Stephen R.	Jun 1995	Historic Resource Evaluation Report, Western Pacific Railroad	Evaluation	008351E	n/a

Author(s)	Date	Report Title	Study Type	IC File No.	Results
Wee, Stephen, Stephen Mikesell, and Rand Herbert	Nov 1994	Historic Architectural Survey Report and Resource Evaluation Report State Route 70 Expressway/Freeway Project in Sutter and Yuba Counties	Architectural/ historical, Field study	008351	1 resource recorded

The NEIC and NCIC databases indicate that there have been nine cultural resources recorded within the project area and 0.25 mile search radius – two prehistoric sites, one historical site, and six built environment resources. Resource CA-YUB-001911H, a segment of the Western Pacific Railroad (WPRR), was determined ineligible for listing on the NRHP; all other sites are considered unevaluated. Interestingly, the Historic Properties Data File for Sutter County lists nine buildings in the community of Rio Oso determined ineligible for NRHP listing.[1] However, no corresponding resource records were provided. Based on a review of available information, it seems likely that these structures were evaluated for Caltrans' Route 70 project and were removed for the highway realignment.

Prehistoric Sites

There are no previously recorded sites plotted within the project footprint; however there is one prehistoric mound site plotted directly adjacent to the west of the project footprint near the town of Rio Oso, "ca. 200 yds. West of Highway 24, and about ½ mi. south of Rio Oso Bridge" (**Table 3**). It appears to be plotted to the west of El Centro Boulevard, within the 0.25 mile buffer. The site is a prehistoric mound that included projectile points, charm stones, and midden and was recorded in December 1960 by Sacramento State College. The site record is sparse, but is reported to be "no longer mounded-small in area." Active "pot-hunting" was mentioned by the recorder, and the site components were reported by the property owner. Site P-58-01276 sits north of the Bear River in the 0.25 mile buffer and may be the ethnographic village of *Lelikian*. The 2004 site record update noted that no surface artifacts were observed but that there was a high likelihood for buried subsurface deposits.

Table 3: Previously Recorded Prehistoric Archaeological Sites

Primary No.	Trinomial	Resource Type	NRHP[1] / CRHR[2] Status	Intersects Project Area?
P-51-00132	CA-SUT-00132	Mound, projectile points, charm stones, midden	Unevaluated	No
P-58-01276	CA-YUB-01313	AP02 (lithic scatter), AP15 (habitation debris) - midden	Unevaluated	No

[1]National Register of Historic Places
[2]California Register of Historical Resources

Historical Archaeological Sites

There is one previously recorded historic archaeological site within the project footprint (**Table 4**). The site is the remains of the Rio Oso Brick Company kiln (dating to 1922). The site has not been evaluated for the NRHP or CRHR.

[1] Each of the listed structures is coded as "6Y – determined ineligible for NR by consensus through Section 106 process."

Table 4: Previously Recorded Historical Archaeological Sites

Primary No.	Trinomial	Resource Type	NRHP / CRHR Status	Intersects Project Area?
P-51-000081	CA-SUT-81	Remains of the Rio Oso Brick Company kiln (1922).	7K – "Resubmitted to OHP for action but not re-evaluated."	Yes

Historical Built Environment Resources

Two previously recorded built environment resources are within the project footprint (**Table 5**). The sites include the Palermo-East Nicolaus Transmission Line, and the Palermo-Rio Oso No. 2 Transmission Line. Neither of these transmission lines have been evaluated. An additional four historic built environment resources were recorded within the 0.25 mile radius surrounding the project area – the Bear River Levee, a Union Pacific Railroad (UPRR) segment, a Sacramento Northern Railroad grade, and Feather River Road. The UPRR segment has been determined to be ineligible for the NRHP. The other three are unevaluated.

Table 5: Previously Recorded Historical Built Environment Resources

Primary No.	Trinomial	Resource Type	Construction Date (circa [c.])	NRHP / CRHR Status	Intersects Project Area?
P-51-00222	CA-SUT-222H	Palermo-East Nicolaus Transmission line.	1908	Unevaluated	Yes
P-51-00223	CA-SUT-223H	Palermo-Rio Oso No. 2 Transmission Line	1919	Unevaluated	Yes
P-58-01366	N/A	Bear River Levee	N/A	Unevaluated	No
P-58-01371	N/A	Feather River Road	1939	Unevaluated	No
P-58-01372	CA-YUB-01911H	Union Pacific Railroad Segment over 5th Street along the Marysville Ring Levee	1909	Ineligible (NRHP)	No
P-58-01642	CA-YUB-01449H	Sacramento Northern Railroad Spur	1928	Unevaluated	No

Historic Map Review

General Land Office (GLO) plat maps were reviewed to identify potential historical era resources within the project footprint and the 0.25-mile buffer (**Table 6**). These plats date to 1856 and 1860. Some resources on historic maps may become archaeological sites as they disintegrate over time. Potential cultural resources identified include houses, fences, roads, and sloughs. The "Johnson Rancho" is indicated north of the Bear River in the 0.25-mile buffer in Section 11.

Table 6: Resources Depicted on GLO Survey Plats

Date	Resource Type	Location	Intersects Project Area?
1860	Road	SW ¼ of T13N R5E Sec. 16	No
1860	Barn	SW ¼ of T13N R5E Sec. 16; SE ¼ of T13N R5E Sec. 18	Yes
1860	Road to Nicolaus	N ½ of T13N R5E Sec. 18	No
1860	Yankee Slough	T13N R5E Sec. 17, 18; T13N R4E Sec. 13, 14, 15, 16, 21, 22	Yes
1860	"Negroe's Ho." (house)	SW ¼ of T13N R4E Sec. 13	Yes

Date	Resource Type	Location	Intersects Project Area?
1860	Road from Nicolaus to Johnson's Rancho (and various associated roads)	T13N R4E Sec. 13, 21, 22, 23, 27	Yes
1860	Fence	NW ¼ of T13N R4E Sec.13; NE ¼ of T13N R4E Sec. 14	No
1860	Jopson's House	NW ¼ of T13N R4E Sec. 21	Yes
1860	Berry's House	SW ¼ of T13N R4E Sec. 21	Yes
1860	Various fencing	T13N R4E Sec. 21	Yes
1860	Crabtree's House	NW ¼ of T13N R4E Sec. 22	Yes
1860	Brown's House	NW ¼ of T13N R4E Sec. 22	Yes

Early USGS topographic maps were also reviewed to identify potential areas where historical structures may be found (**Table 7**). Nicolaus 1910 and 1952 maps show the town of Rio Oso in its present-day location (USGS 1910, 1952) with a few scattered residences. Nicolaus 1910 depicts the WPRR running northwest-southeast just east of the town of Rio Oso, while the SNERR railroad runs north-south through Rio Oso along a section line (currently Highway 70 / El Centro Boulevard) that forms the western boundary of the project. The Nicolaus 1952 quadrangle shows a proliferation of residences located within Rio Oso and spreading east through the project area. This map also indicates a levee constructed along the south side of Yankee Slough within the project area, as well as a levee along the northern side of the slough in the 0.25 mile buffer. Sheridan 1953 shows more residences on the eastern part of the project area as well as various paved and unpaved county roads. A windmill and silo are plotted within the project area on USGS maps from the early 1950s (USGS 1952, 1953).

Table 7. Resources depicted on historical USGS topographic maps

Date	Map (Scale)	Resource Type	Intersects Project Area?
1910	Nicolaus (1:31680)	Sacramento Northern Electric Railroad Western Pacific Railroad	Yes
1952	Nicolaus (1:24000) Sheridan (1:24000)	Sacramento Northern Electric Railroad Western Pacific Railroad Yankee Slough (levee) Windmill (T13N, R4E, Sec. 22)	Yes
1953	Lincoln (1:62500)	Silo (T13N R5E Sec. 18)	Yes

Reconnaissance Survey

Today the project area is generally low and topographically flat and land use is predominantly walnut orchards, row-crop agriculture (alfalfa), and cattle pasture. Irrigation water is provided by a network of canals and ditches. A few historic-era farm and ranch complexes – with their collection of associated barns, sheds, pump houses, silos, and other outbuildings – are scattered throughout the project area. The area specifically around Rio Oso consists primarily of rural residences dating to the 1960s and later, mostly along Rio Oso Road and Pacific Avenue. The (former) townsite is today only marked by the Rio Oso Community Hall and a small post office. The railroad underpass on Rio Oso Road is stamped "Western Pacific 1927." The plotted location of the former mound site, P-51-00132, was located within a grove of mature walnut trees. No archaeological material was observed. The available documentation for the site indicated that the mound had been, or was in the process of

being, levelled. The record also notes that the then-property owner likely had collected artifacts associated with the site and actively allowed pot-hunting.

Conclusion

Archaeological and built environment sensitivity within the project area and 0.25-mile buffer is variable and contingent on the type of resource (prehistoric vs. historical) and geography (proximity to the river, one of the historical ranch complexes, or the central portion of Rio Oso). For most of the project area, near-surface archaeological sites have likely been disturbed, and possibly destroyed, by decades of agricultural practices and levee construction. Most of the project area has not been previously surveyed for archaeological sites and, accordingly, there is a low-to-moderate potential for near-surface unrecorded prehistoric or Native American sites within the unsurveyed portions of the project area; as well as a moderate to high potential for buried archaeological sites throughout the entire project area due to the flood plain along the Feather and Bear rivers and Yankee Slough where it is common to find archaeological sites that have been buried by alluvial sediment. Sensitivity for historic-era archaeological sites and historical built environment resources ranges from low to high throughout the project area and is largely contingent on proximity to historical roadways, residences, and ranches. Furthermore, the project is traversed by two historical railroads (the WPRR and SNERR) and, accordingly, there is a moderate-to-high likelihood of resources associated with the railroads (e.g. grades, spurs, culverts, and other infrastructure) within the project area.

Summary

The findings in this memo represent a preliminary, high-level review of potential cultural resources constraints in the project area and should not be considered an identification effort sufficient for complying with local, state, or federal laws. The prehistoric, ethnographic, and historical contexts indicate a low to moderate sensitivity of the project area for unrecorded surficial archaeological sites with a high potential for those sites, when identified, to have buried components. Further, the project exhibits a high sensitivity for historical features and buildings in the vicinity of known historical resources. Project activities have the potential to impact any of the aforementioned cultural resources, should they be identified within, or potentially in the vicinity of, a proposed work area.

Literature Cited

U.S. Department of Interior, General Land Office (GLO). 1856. Original survey plat map of Township 13 North, Range 5 East. Available online at https://glorecords.blm.gov.

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----.1952. Topographic map of Nicolaus (1:24000). Available online at http://historicalmaps.arcgis.com/usgs.

----.1952. Topographic map of Sheridan (1:24000). Available online at http://historicalmaps.arcgis.com/usgs.

----.1953. Topographic map of Lincoln (1:62500). Available online at http://historicalmaps.arcgis.com/usgs.

ATTACHMENT D

Financial Feasibility – Technical Memorandum

LARSEN WURZEL
& Associates, Inc.

2450 Venture Oaks Way, Suite 240 • Sacramento, CA 95833
www.larsenwurzel.com

Technical Memorandum

Nicolaus & Rio Oso Flood Risk Reduction Feasibility Study
Small Communities Flood Risk Reduction Program

Financial Feasibility *April 24, 2020*

Prepared by: Elisabet Abdissa
Reviewed by: Sean Myers, David Lee, & Derek Larsen, P.E., CFM

1. Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the Nicolaus and Rio Oso Flood Risk Reduction Feasibility Studies under the Department of Water Resources Small Communities Flood Risk Reduction (SCFRR) Program. LWA expects that the conclusions presented within this memorandum will be utilized during the alternatives evaluation phase, particularly to help screen the alternatives not financially feasible for the local communities. LWA prepared a separate funding sources memorandum that provides a summary of available State and federal funding sources to advance flood risk reduction projects.

This memorandum and the funding sources memorandum were used to develop a conceptual financial plan for implementation of the preferred alternative. The conceptual finance plan and funding sources memorandum are presented separately as part of a final Feasibility Study Report.

Organization

This memorandum is divided into six sections. This section provides the purpose of the memorandum; Sections 2 and 3 outline the approach and methodology used to analyze the financial feasibility of the proposed alternatives; Section 4 describes the constraints facing flood risk reduction projects; Section 5 outlines the alternative analysis screening constraints in determining the capacity of the local communities to generate new assessment revenue for Operations and Maintenance (O&M) and capital improvement projects; and Section 6 provides recommendations for the alternatives evaluated.

Attachment 1 Provides a summary of the local funding methods used by local agencies in California to fund flood risk reduction improvements and services. The table describes the general uses of the funding source and the attributes and applicability of the mechanism for flood control and management projects. In addition to these sources, many local agencies supplement funding for flood risk reduction through enterprise revenues related to storm water management and general fund revenues (primarily property tax revenue).
Attachment 2 Provides the series of tables referenced throughout this memorandum.

2. Approach

Multiple local funding mechanisms are available to fund flood risk reduction efforts as shown in Attachment 1. Flood risk reduction projects provide a special benefit to property owners and are most commonly funded by property-based assessment districts. Therefore, the primary approach for analyzing financial feasibility starts with the assumption that the local funding required for a flood risk reduction project will be raised through a property-based special benefit assessment. As a result, the requirements associated with imposing a benefit assessment would apply. These requirements, primarily those associated with Proposition 218, are discussed further below.

The next assumption is that the local beneficiaries would be solely responsible for long-term ongoing O&M of any improvements. Therefore, locally generated annual assessment revenue would first be utilized to pay for the on-going O&M of the project. Any remaining annual revenue would then be allocated toward the local share of the capital cost either on a pay-go basis or to service debt.

LWA's analysis starts by determining the proportionality of assessment revenue between land uses and applying the following approaches to gauge feasibility:

1) Estimate the assessment rates required to generate, on an aggregate basis, $100,000 of annual revenue and review the resulting rates to determine whether any land use assessment rate exceeds a level that could preclude approval of the assessment;
2) Establish the O&M funding requirements based on project team input and determine whether there is sufficient revenue to fund adequate levee maintenance;
3) Establish criteria based on an assumed maximum single-family residence assessment rate ($200) developed by the project team; and
4) Estimate the amount of annual revenue that could be generated from benefiting properties given the special benefit proportionality requirements of Proposition 218 and an assumed feasible single-family residence assessment rate developed by the project team.

The methodologies utilized to determine the project beneficiaries and the relative benefits received are documented in section 3 and are based upon the assumption that a Proposition 218 Assessment will fund the local cost share of the project.

The small communities of Nicolaus and Rio Oso are within the same hydraulic basin and remediation of levees near each community impacts the entire basin. All of the levee improvements are required to achieve the planned flood risk reduction goals. A breach in the levees in the Nicolaus plan would inundate Rio Oso, and a breach in the levees in the Rio Oso plan would inundate Nicolaus. Therefore, a combined cost for the preferred alternative was prepared for both communities. Through geotechnical evaluation, an alternative alignment with multiple alternative remediations was identified for both the Nicolaus and Rio Oso Project. For the purpose of this analysis, the minimum and maximum repair costs associated with each remediation alternative was considered in determining the recommended approach.

3. Methodology

Special benefit assessments for flood control projects have historically utilized the following parcel attributes to apportion benefit:

- Land use;
- Parcel size;
- Parcel improvements;
    - Permanent Crop Type; and/or
    - Structure type and size; and
- Relative Damage.

Proposition 218 requires first; that parcels only be assessed for the special benefits received by the service, meaning that all general benefits provided by the service and available to the public at large be excluded from the assessment, and second; that a property only be assessed for its proportionate share of the special benefits received. Given this, once the special benefits received by all parcels have been quantified, each individual parcel would be assessed based on its proportionate share of the total special benefits.

Benefit Area

LWA was provided composite flood depths from the hydraulic analyses showing the post project reduction in flood depths. The extents of these areas were considered the preliminary benefit areas for the alternatives evaluated in the feasibility study.

The project team identified nine areas within the Nicolaus & Rio Oso area that require remediation to maintain 100-year flood protection. As shown in **Figure 1** and **Figure 2**, breach occurrences along **19 miles** of levee on the Feather River and **6.8 miles** of levee on the Bear River levees would result in flood in the communities of Nicolaus & Rio Oso . As stated in the MBK's *Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus* memorandum, In the event of breach scenarios along either the Feather or Bear river, both communities will face potential flood risk.

Land Use

Land uses for properties within the benefit area were compiled from Sutter County Assessor's data obtained from ParcelQuest. Each land use code was evaluated and assigned to a generalized Land Use Category (e.g.: Agricultural, Single-Family Residential, Commercial, etc.) to identify the category for use in apportioning special benefit. A table presenting the County's use type code and the associated land use category is displayed in **Table 1** of **Attachment 2.**

Parcel Size

The Sutter County Assessor's data obtained from ParcelQuest included the acreage of each parcel. This data was reviewed for completeness. Where data was missing, the parcel size was estimated using parcel GIS data obtained

from Wood Rogers. For this feasibility level analysis, no effort was made to verify or reconcile the GIS data or County Assessor data.

Structure Type and Size

The Sutter County Assessor's data obtained from ParcelQuest also included structure size data. Structures on a parcel were assumed to be consistent with the Land Use Category assigned to the property for the purposes of this analysis. For example, all structures on a parcel with a Commercial land use category designation by the County Assessment were analyzed as Commercial structures. Agricultural and vacant land uses assume no structural damage. **Table 2** provides a summary of the total acreage of parcels with structures, total structure size, and the average structure size per acre for each land use category within the benefit area.

Relative Damage Rate

The special benefits received from flood control projects are assumed to be proportional to the amount of flood damage avoided by implementing the projects and/or performing O&M services. For the purpose of this analysis, a simplified approach has been used to quantify the flood damages avoided for each Land Use Category.

Composite structure depth-damage values were prepared for each Land Use Category based on the U.S. Army Corps of Engineers (USACE) guidance. The composite structure damage values consider the structure replacement value, the contents-to-structure ratio and the percentage of damage to the structure and contents at an average flood depth. The flood depth for each parcel was provided to LWA to calculate the average flood depth per land use.

Agricultural land was assigned a crop damage value of $300/acre based on data provided in the 2010 Central Valley Flood Protection Plan.

Vacant land was assigned a damage value of $100/acre to reflect minor damage to infrastructure and/or damage from site erosion.

Table 3 provides the structure replacement value, the contents-to-structure ratios and the composite damage values for each Land Use Category, excluding agricultural and vacant land uses across a range of flood depths.

The average damage per acre for each Land use Category was calculated using the following formula:

$$\begin{bmatrix} Average \\ Damage \\ per\ Acre \end{bmatrix} = \begin{bmatrix} Composite \\ Damage\ Value \\ (Table\ 3) \end{bmatrix} \times \begin{bmatrix} Average \\ SF\ per\ Acre \\ (Table\ 2) \end{bmatrix}$$

A Relative Damage Factor was calculated by normalizing the average damage per acre to the Agricultural Land Use (i.e., Agricultural = 1.0). The normalization does not change the proportionality and maintains compliance with Proposition 218.

Alternatives

An alternative alignment with multiple alternative remediations was identified for the Project. The minimum and maximum construction cost for the remediation alternatives will be utilized to determine the local funding capacity for the Project capital costs in Section 5. The Nicolaus and Rio Oso project teams provided the total project costs to LWA and also determined that the existing local assessment generates revenue that covers the cost of O&M activities and provides remaining capital that will be allocated toward the total assessment capacity to be used to advance the preferred alternative.

Assessment Rate

The special benefit for each parcel was determined by calculating the amount of Equivalent Benefit Units (EBU) using the following formula:

$$EBU_{parcel} = \begin{bmatrix} Parcel \\ Acreage \end{bmatrix} \times \begin{bmatrix} Relative \\ Damage\ Factor \\ (Table\ 4) \end{bmatrix}_{\substack{Based\ on \\ Parcel\ Land \\ Use\ Category}}$$

The Assessment Rate is equal to the amount of revenue required divided by the sum of EBUs from all benefitting parcels.

The assessment for a particular parcel is equal to the quantity of EBUs for that parcel multiplied by the resulting Assessment Rate per EBU. **Table 4** summarizes these EBU and Assessment rate calculations.

In order to generate an estimated range of maximum revenue, **Table 5** summarizes the aggregate assessment amount, the average assessment per parcel, and the average assessment per acre, required to generate $100,000 in annual assessment revenue

4. Financial Feasibility Constraints

Demonstrating Federal Interest

The USACE planning process has a defined approach to determine flood risk reduction project benefits. The USACE analysis is based on the value of damageable property and the projected reduction in flood damages once flood risk reduction projects are implemented. Less densely populated rural areas like agricultural areas produce lower benefits than densely populated urban areas. This approach makes demonstrating Federal interest in rural or small communities that are primarily agricultural very difficult.

Securing Federal funding for flood risk reduction projects will continue to be highly competitive. In the past, funding for authorized projects has relied heavily on prioritizing appropriations based on a project's Benefit to Cost Ratio (BCR). The approach limits Federal investments to areas that can achieve a very robust BCR and generally funded projects are in urban areas where significant flood damage reduction benefits exist. In FY 2019 budget requests, the current administration sought to limit funding to ongoing flood risk reduction projects with

a BCR greater than 2.5 to 1.[1] While the BCRs for projects vary each year, the competition for limited Federal funding also increases as authorizations continue to outpace appropriations.

Limited Availability of Federal Funding

The USACE has historically been a major financial contributor in the development of flood risk reduction infrastructure in California. It is estimated the USACE has a backlog of authorized projects higher than $96 billion nationally.[2] Annual appropriations for construction funding nationally in FY 2018 and FY 2019 were $2.1 billion and $2.2 billion respectively, or just over 2% of the total backlog of authorized projects. However, some of the backlogged appropriations are related to projects that are unlikely to be constructed, as throughout the nation they are not competitive when compared against other projects.

There are multiple factors contributing to the growth of the USACE backlog; authorizations have outpaced appropriations, aging infrastructure requires more substantial financial investments, and construction related costs continue to escalate.

Availability of State Funds

Following the passage of the Water Resources Development Act of 1986, non-Federal interests were required to share more of the financial and management burdens. These requirements, coupled with more stringent environmental regulations, resulted in further reduction in the Federal share of spending for flood and water management projects. With the reduction in Federal authorizations and the more stringent conditions on State and local financing of flood management projects, the State turned to general obligation (GO) bonds.

In 2006, the State passed water management bond propositions 84 and 1E. The Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1E) authorized $4.09 billion in general obligation bonds to rebuild and repair California's most vulnerable flood control structures to protect homes and prevent loss of life from flood-related disasters, including levee failures, flash floods, and mudslides and to protect California's drinking water supply system by rebuilding delta levees that are vulnerable to earthquakes and storms. Proposition 84 enhanced these efforts with an additional $800 million for flood projects. Proposition 1 was passed on November 4, 2014 and included $395 million for flood projects. Proposition 68 was passed on June 5, 2018 and included another $550 million for flood projects.

Proposition 1E funds have been allocated to conduct Feasibility Study investigations that are consistent with the DWR Small Community Flood Risk Reduction (SCFRR) Program Guidelines (2016) and support the (2012 and 2017)

[1] https://fas.org/sgp/crs/natsec/IF10864.pdf

[2] Carter, N. (2018). *Army Corps of Engineers Annual and Supplemental Appropriations: Issues for Congress.* Congressional Research Service.

Central Valley Flood Protection Plan goals of promoting flood risk management actions to reduce flood risk to people and property protected by State Plan of Flood Control facilities. The study objectives include assessing a community's existing flood hazards, evaluating structural, non-structural and multi-benefit projects, and making recommendations to implement a flood risk protection project that integrates other resources' needs, as much as is feasible.

Limited Local Funding Sources/Proposition 218 Assessments

Funding local infrastructure and services, including flood and water management projects, became more difficult when voters in California passed Proposition 13 in 1978, Proposition 62 in 1986, and Proposition 218 in 1996. Proposition 13 limited ad valorem taxes on California properties. The proposition limited the amount of tax that could be collected based on the assessed value of private property, including real estate, to 1 percent of the assessed value of the property. Proposition 13 also decreased the assessed value of the properties to 1975 values (negating three years of increased value), and limited increases of assessed value to a maximum of 2 percent per year. Property that is sold or declines in value after an initial purchase may be reassessed. The enactment of Proposition 13 significantly reduced local property tax revenue, causing cities and counties to raise user fees and other local taxes. In response, voters approved Proposition 62, the Voter Approval of Taxes Act, in 1986. Proposition 62 required that new general taxes be approved by two-thirds of the local agency's governing body and a majority of voters, and new special taxes be approved by a two-thirds majority of voters. This led local agencies and communities to use assessments and property-related fees (among other fees) to pay for government services. Proposition 218 was passed by voters in 1996 and added requirements and limits on local governments' ability to impose or increase assessments and fees.

Proposition 26, which was passed in 2010, redefined many existing fees as taxes. The impacts of institutional and legal constraints associated with raising local funding for flood infrastructure and services is described in greater detail in a 2014 Public Policy Institute of California's report ("Paying for Water in California," 2014). Constraints from Proposition 218 and 13 have been thoroughly documented by the State and also highlighted as a major challenge in DWR's January 2005 White Paper, "Responding to California's Flood Crisis."

Tax Rate and Infrastructure Burden Considerations

In order to consider an area's ability to generate new revenue through special taxes and assessments, the uses of taxing capacity for all infrastructure and services should be considered. The California Debt and Investment Advisory Commission (CDIAC) promulgates guidelines with respect to land secured financing, including the use of assessments and Mello-Roos Special Taxes. CDIAC's Mello-Roos Guidelines (1991) suggest that jurisdictions should integrate Mello-Roos financing into the land use regulatory framework. Local governments can create a process for coordinating the use of land secured financing through the provision of this form of integration. The main concern is that in the absence of coordinated planning, property owners/taxpayers could find themselves vulnerable to onerous overlapping property tax burdens imposed by a multitude of local governments that may provide services to the same group of properties. Further, the services funded by these burdens may not reflect property owners' collective priorities for services and infrastructure. This issue is analogous to the current ongoing

efforts associated with planning for the future of flood management infrastructure, to the extent that there are a multitude of planning efforts, all developing concurrent funding and financing strategies. These efforts should be coordinated to ensure that there is sufficient funding capacity available from the identified beneficiaries and the funding is dedicated toward the beneficiaries' collective highest priorities.

Overlapping property tax burdens imposed by a multitude of local governments that may provide services to the same group of properties. Further, the services funded by these burdens may not reflect property owners' collective priorities for services and infrastructure. This issue is analogous to the current ongoing efforts associated with planning for the future of flood management infrastructure, to the extent that there are a multitude of planning efforts, all developing concurrent funding and financing strategies. These efforts should be coordinated to ensure that there is sufficient funding capacity available from the identified beneficiaries and the funding is dedicated toward the beneficiaries' highest collective priorities.

5. Alternative Analysis Screening Constraints

For the purpose of determining the capacity of the local communities to generate new assessment revenue for capital improvements, the capacity is assumed to be limited by the assessment rate that would be imposed on residential properties. A baseline $100,000 assessment for each alternative is show in **Table 5**. The baseline assessment was prepared to provide context and allow the County to scale assessment rates for each additional $100,000 in revenue needed. For example, if an additional $100,000 in assessment revenue was needed, the assessment rates would increase by 100%. **Table 6** and **Table 7** provide an estimated range of the maximum revenue that might be generated for each alternative by constraining the maximum assessment for single-family residential. The $100,000 assessment was used determine the impacts on different land use rates when scaling the capacity up or down. **Table 6** constrained the analysis to a $100 annual assessment for single-family residential and **Table 7** constrained the analysis based on a $200 annual single-family residential assessment. The results of the assessment evaluation are shown in **Table 8** in **Attachment 2** and are summarized in the table below.

Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Alternatives Cost Summary of Results

Alternative	Total Construction Cost	New Assessment Capacity	
		$100 Constraint	$200 Constraint
Preferred	$465,678,200	$44,000	$88,000
Min	$464,531,000	$44,000	$88,000
Max	$590,832,190	$44,000	$88,000

6. Recommendations for Alternatives Evaluation

Alternatives Analysis Screening Process

The capital costs of the remediation alternatives were compared to the two community's ability to generate local matching funds as a percent of the total project cost. The ability to pay analysis was a three-step screening process. First, a new maximum annual land-based assessment was calculated assuming the limitations noted above along with the proportionality requirements of Proposition 218 for the benefited area. Second, based on the calculated assessment revenue, it was determined that $88,000 in new assessment revenue would be allocated toward the local share of the capital costs either on a pay-go basis or to service debt. Finally, the project team determined that the existing local assessment generates a total annual revenue of $953,000, of which $470,000 will cover required O&M[3] costs. Sixty-five percent (65%) of the remaining existing assessment revenue or $313,950, in addition to $88,000 in new assessment capacity, was allocated toward the capital assessment capacity of $401,950. This represents the total amount of local assessment capacity available to advance the preferred alternative.

The preferred, minimum, and maximum alternatives would raise between $5.62 million to $7.16 million on varying debt financing interest rates between 3% to 5%. A range of local capital amount was developed and compared to the estimated alternative cost to determine the percent of local matching funds available for the range of remediation alternatives. The alternatives are ranked based on the percent of the project that could be paid with local capital. The results of the potential debt financing for the range of alternatives are shown in **Table 9** in **Attachment 2** and are summarized in the table below.

[3] Revenue and costs based on RD1001 2018 Fiscal Year.

Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Local Funding Analysis

Alt.	Capital Assessment Capacity $	Low Int. Rate Millions $ [1,2,4]	High Int. Rate Millions $ [1,3,4]	Project Cost Millions $	Local High %	Local Low %	Non-Local High %	Non-Local Low %	Fund Capacity Ranking
Preferred	$401,950	$7.16	$5.62	$465.68	1.54%	1.21%	98.8%	98.5%	2
Min	$401,950	$7.16	$5.62	$464.53	1.54%	1.21%	98.8%	98.5%	1
Max	$401,950	$7.16	$5.62	$590.83	1.21%	0.95%	99.0%	98.8%	3

Notes:

[1] Assumes 1.1 Debt Coverage Ratio

[2] Low interest rate for debt issuance assumed to be 3%

[3] High interest rate for debt issuance assumed to be 5%

[4] Term for bond repayment assumed to be 30 years.

Figure 1

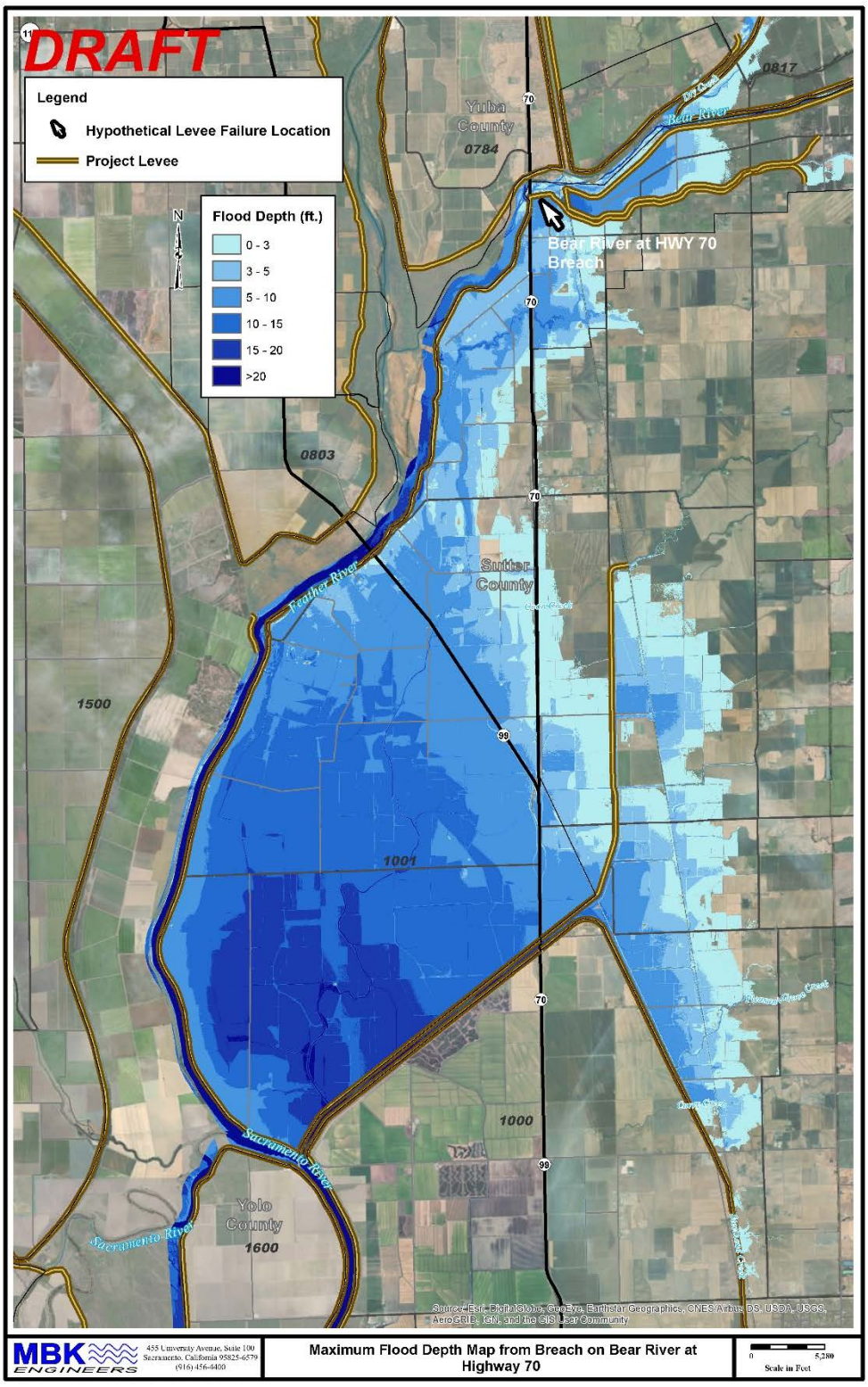
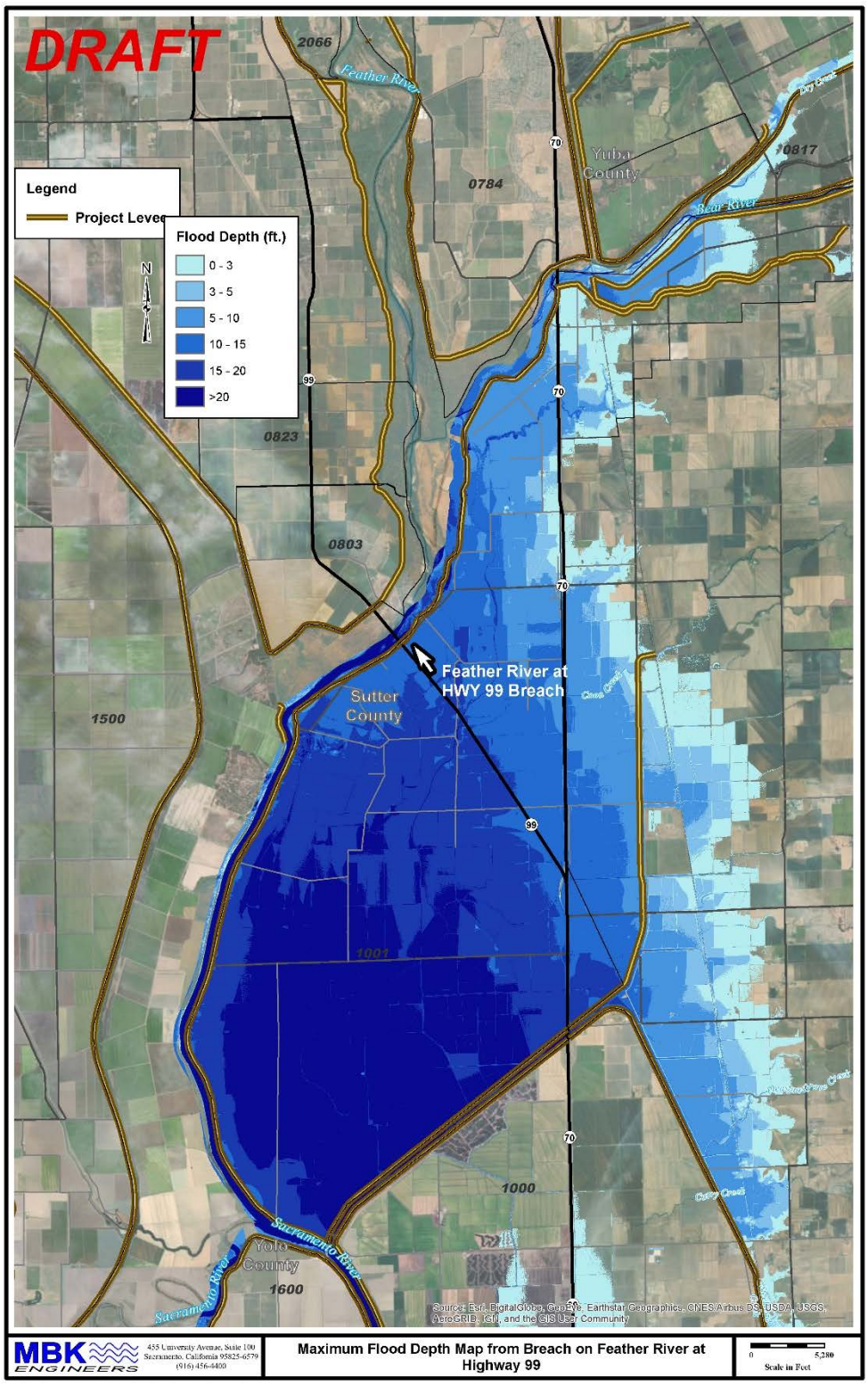

DRAFT
Legend
Hypothetical Levee Failure Location
Project Levee
Flood Depth (ft.)
0 - 3
3 - 5
5 - 10
10 - 15
15 - 20
>20
N
Bear River at HWY 70 Breach
Yuba County
0784
0817
0803
1500
1001
1000
1600
Sutter County
Feather River
Bear River
Sacramento River
Yolo County
70
99
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
MBK ENGINEERS
455 University Avenue, Suite 100
Sacramento, California 95825-6579
(916) 456-4400
Maximum Flood Depth Map from Breach on Bear River at Highway 70
0
5,280
Scale in Feet

Figure 2


DRAFT
Legend
Project Levee
Flood Depth (ft.)
0 - 3
3 - 5
5 - 10
10 - 15
15 - 20
>20
N
Feather River at HWY 99 Breach
Sutter County
Yuba County
Yolo County
Feather River
Bear River
Sacramento River
2066
0784
0817
0823
0803
1500
1001
1000
1600
99
70
MBK ENGINEERS
455 University Avenue, Suite 100
Sacramento, California 95825-6579
(916) 456-6400
Maximum Flood Depth Map from Breach on Feather River at Highway 99
0
5,280
Scale in Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Attachment 1
Summary of Local Funding Mechanisms

LWA
LARSEN WURZEL & Associates, Inc.

Item	Funding Attribute: Use	Voter Approval	Benefit Test	Bonds Allowed	Funding Period	Entity	Pro/Con: Pro	Pro/Con: Con	Note
Enterprise Revenues									
Utility User Fees	O&M/ Capital Improvements	50% of Property Assessed	Yes	Yes	Long-Term	Varies	Would be broad based applying to all parcels. Depending upon service provided, could be exempt from Prop 218 balloting process. (Solely flood control would not apply.)	Might require enabling legislation for the specific district. Prop 218 would apply.	
Sales Tax Measure	O&M/ Capital Improvements as Approved	2/3 of Electorate	No	Yes	As Authorized	Cities or Counties	Flexible if approved.	Difficult to approve and limited to amount over Statewide sales tax rate.	
Assessment Districts [1]									
Various Water Code Sections	O&M/ Capital Improvements	50% of Property Assessed	Yes	No	Long-Term	Reclamation & Levee Districts	Simple Majority Approval, Ongoing Funding Source	Applicability of Prop 218 - Must Show Benefit	Used to fund maintenance or capital works. Through other authority, can be used to finance improvements.
Benefit Assessment District Act of 1982	O&M/ Capital Improvements	50% of Property Assessed	Yes	No	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements/Services must be within the Boundary	Could provide some reimbursement of Advance Funding. Bonds must be issued under separate authority.
Municipal Improvement District Act	Capital Improvements	50% of Property Assessed	Yes	Yes	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements/Services must be within the Boundary	Could provide some reimbursement of Advance Funding
Community Facilities Districts [1]	O&M/ Capital Improvements	2/3 of Electorate	No	Yes	Long-Term	Flexible	Benefit not Needed, Flexible in Forming District, Improvements located anywhere	2/3 Approval Difficult to Obtain	Voting requirements change depending upon presence of registered voters (no more than 12) within boundary.
Development Impact Fees	Capital Improvements	NA	Yes	NA	Long-Term	County & City (Land Use Agencies)	Implemented by Agency Action in Short Time Period	-Must Show Benefit -Development Feasibility Issues -Only works if area of flood control Benefit is slated for Development	Could provide some reimbursement of Advance Funding
Advance Funding [2]	Planning & Capital Improvements	NA	NA	NA	Short-Term	N/A	Can cover upfront planning/operations costs	Limited/Uncertain Availability	Could be subject to reimbursement from various sources over time.
Tax Increment Financing (Enhanced Infrastructure Financing District)	Capital Improvements	No - to form and Allocate Revenues, Yes - for any Bonded Debt Issuance (55%)	No (but allocation of TI could be structured to ensure proportionality to benefit)	Yes - With Voter Approval (55%). Maximum 45 Year term.	Long Term	New EIFD Public Financing Authority	Could generate significant revenues in areas planned for development especially when improvements have a regional benefit to several local taxing entities over the long term.	Not a new source of funding, would allocate future general fund property taxes from an existing entity that would otherwise be used to provide general governmental services. Given this, a detailed Fiscal Impact Analysis is needed to ensure that there is no significant impact to providing municipal services to the developing area. Fiscal mitigation measures may need to be put in place to demonstrate viability.	All Participating entities would need to agree to allocate funds to the EIFD. Schools cannot participate. An Infrastructure Financing District "Plan" that describes everything needs to be prepared. The new EIFD implements the plan. The boundary of the EIFD cannot cover any area of a former RDA unless a finding of completion is certified by the DOF.

Sources: California Flood Future's Report - Attachment I, Finance Strategies, California Government Code and LWA.
[1] Can be implemented by cities, counties, special independent districts, and JPA's with these types of members.
[2] Advance Funding is defined as General Fund, developer, and/or other local public or private funding which could be subject to reimbursement from long term funding sources.

Attachment 2

Referenced Tables

1. **Zoning and Land use Code**……Table 1
2. **Structure Size by Land Use**……Table 2
3. **Damage Per Acre Calculations**……Table 3
4. **Equivalent Benefit Unit Summary Table**……Table 4
5. **$100,000 Assessment**……Table 5
6. **Revenue Estimate - $100 SFR**……Table 6
7. **Revenue Estimate - $200 SFR**……Table 7
8. **Alternatives Cost Summary of Results**……Table 8
9. **Local Funding Analysis**……Table 9
10. **Structure Damage Value**……Table 10
11. **Contents Damage Value**……Table 11
12. **Structure and Contents Value**……Table 12

Prepared by LWA

Table 1
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Zoning and Land use Code

Use Type	Description	County Use Type	FeasibilityLand Use Type
10	Lodge building/club house or school building	Institutional	Commercial
11	Privately owned schools	Institutional	Commercial
20	Funeral homes or mortuary	Institutional	Commercial
30	Churches and temples	Institutional	Commercial
40	Cemetery or mausoleum	Institutional	Vacant
50	Government taxable	Institutional	Commercial
60	Government non-taxable	Institutional	Commercial
70	Manufactured home lots with licensed mobile homes	Residential	Residential Single
80	Vacant R-2	Vacant Land	Vacant
90	Vacant R-3 and R-4	Vacant Land	Vacant
100	Vacant R-1	Vacant Land	Vacant
120	One residence	Single Family Residences	Residential Single
130	Two (2) single family residences	Single Family Residences	Residential Single
131	Three (3) single family residences	Single Family Residences	Residential Single
132	Four (4) single family residences	Single Family Residences	Residential Single
133	Five (5) or greater single family residences	Single Family Residences	Residential Single
140	Duplex unit	Duplexes	Residential Single
150	Triplex or duplex and single unit mix	Duplexes	Residential Multi
160	Fourplex or two duplex units or mix	Duplexes	Residential Multi
170	Apartment or MFR over 4 units	Duplexes	Residential Multi
180	Single family residence - Half-plexes	Apartments	Residential Multi
190	Single family residence - Condominium	Apartments	Residential Multi
200	Open land over 15 acres - no SFR	Agricultural	Agricultural
201	Open land over 15 acres w/one (1) SFR	Agricultural	Agricultural
202	Open land over 15 acres w/two (2) SFR	Agricultural	Agricultural
203	Open land over 15 acres w/three (3) SFR	Agricultural	Agricultural
204	Open land over 15 acres w/four (4) SFR	Agricultural	Agricultural
205	Open land over 15 acres w/five (5) SFR & greater	Agricultural	Agricultural
220	Home site or small ranch under 15 acres - no SFR	Agricultural	Agricultural
221	Home site or small ranch under 15 acres w/one (1) SFR	Agricultural	Agricultural
222	Home site or small ranch under 15 acres w/two (2) SFR	Agricultural	Agricultural
223	Home site or small ranch under 15 acres w/three (3) SFR	Agricultural	Agricultural
224	Home site or small ranch under 15 acres w/four (4) SFR	Agricultural	Agricultural
225	Home site or small ranch under 15 acres w/five (5) SFR & great	Agricultural	Agricultural
230	Orchard over 15 acres - no SFR	Agricultural	Agricultural
231	Orchard over 15 acres w/one (1) SFR	Agricultural	Agricultural
232	Orchard over 15 acres w/two (2) SFR	Agricultural	Agricultural
233	Orchard over 15 acres w/three (3) SFR	Agricultural	Agricultural
234	Orchard over 15 acres w/four (4) SFR	Agricultural	Agricultural
235	Orchard over 15 acres w/five (5) SFR & greater	Agricultural	Agricultural
240	Ag business - vacant land or orchard - no SFR	Agricultural	Agricultural

Table 1
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Zoning and Land use Code

Use Type	Description	County Use Type	FeasibilityLand Use Type
241	Ag business - orchard w/one (1) SFR	Agricultural	Agricultural
242	Ag business - orchard w/two (2) SFR	Agricultural	Agricultural
243	Ag business - orchard w/three (3) SFR	Agricultural	Agricultural
244	Ag business - orchard w/four (4) SFR	Agricultural	Agricultural
245	Ag business - orchard w/five (5) SFR & greater	Agricultural	Agricultural
260	Dry farming or grazing land	Agricultural	Agricultural
280	Duck clubs	Agricultural	Agricultural
290	Horse stables	Commercial	Agricultural
310	Improved commercial - Store type	Commercial	Commercial
311	Improved commercial - service type	Commercial	Commercial
320	Improved commercial - shopping center	Commercial	Commercial
321	Restaurant/bars	Commercial	Commercial
322	Fast food restaurant	Commercial	Commercial
329	Medical building	Commercial	Commercial
330	Office building	Commercial	Commercial
331	Mixed use	Commercial	Commercial
332	Mini-storage building	Commercial	Commercial
333	Mini-mart-gas	Commercial	Commercial
334	Small grocery store	Commercial	Commercial
335	Misc. and special use	Commercial	Commercial
340	Auto services	Commercial	Commercial
350	Motels	Commercial	Commercial
360	Mobile home parks	Commercial	Mobile Home
370	Rest homes/skilled nursing	Commercial	Commercial
375	Rice dryers	Commercial	Commercial
377	Dairy	Commercial	Commercial
380	Marinas	Commercial	Commercial
400	Vacant industrial land	Industrial	Vacant
410	Improved industrial land	Industrial	Industrial
415	Steel buildings	Industrial	Industrial
420	Airport, crop dusting	Industrial	Industrial
430	Mines and quarries	Industrial	Industrial
600	Recreational	Industrial	Industrial
610	Water companies	Industrial	Industrial
620	Private roads	Industrial	Vacant
700	Gas wells	Industrial	Vacant
MH0	Manufactured Homes	Residential	Mobile Home

Source: Parcelquest

Table 2
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Structure Size by Land Use

Land Use	Acres with Structures [A]	Structure Size (Sq Ft.) [B]	Avg Structure (Sq Ft/Acre) [C = B/A]
Agricultural [1]	0.00	0	0.00
Commercial	174.54	39,668	227.27
Industrial	158.38	20,033	126.49
School	51.73	45,814	885.64
Residential Multi	6.33	5,420	856.24
Mobile Home	16.79	20,397	1,214.83
Rural Residential	534.15	276,739	518.09
Residential Single	257.42	302,878	1,176.60
Vacant [1]	0.00	0	0.00
Total	**1,199.34**	**710,949**	**592.79**

[1] No structural damage assumed.

Table 3
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Damage Per Acre Calculations

Land Use	Structure Replacement Value ($/Sq Ft.) [A] [1,3]	Contents Damage Ratio [B] [2,3]	Average Depth (Ft.) [C][4]	Average Damage Value (per Acre or Sq Ft) [D][3]		Avg Structure (Sq Ft/Acre) [E] [5]	Relative Damage/ Acre [F] = [D] * [E]	Relative Damage/acre Normalized [G] = [F] / 300
Agricultural	$300.00	100%	3.14	300.00	acre	1	300	1
Commercial	$85.56	51%	3.00	86.24	Building SF	227	19,600	65
Industrial	$54.51	31%	4.33	35.37	Building SF	126	4,473	15
School	$144.46	38%	3.00	98.52	Building SF	886	87,254	291
Residential Multi	$84.40	50%	3.25	59.90	Building SF	856	51,291	171
Mobile Home	$45.85	50%	2.83	66.94	Building SF	1,215	81,322	271
Rural Residential	$111.67	50%	3.25	86.75	Building SF	518	44,944	150
Residential Single	$111.67	50%	3.11	88.93	Building SF	1,177	104,637	349
Vacant	$100.00	0%	3.13	100.00	acre	1	100	0.33

[1] See Table 10: Structure Damage Value

[2] See Table 11: Contents Damage Value

[3] See Table 12 Structure, Contents, and Land Damage Value

[4] Average depth damage for each land use

[5] See Table 2: Structure Size by Land Use

Table 4
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Equivalent Benefit Unit Summary Table

Land Use	Acres	Parcels	Relative Damage/acre Normalized	Total EBU	Avg EBU/Parcel
	[A]	[B]	[C]	[D= A*C]	[E = D/B]
Agricultural	26,980.31	378.00	1.00	26,980.31	71.38
Commercial	197.62	28.00	65.33	12,910.87	461.10
Industrial	160.23	5.00	14.91	2,389.22	477.84
School	56.40	4.00	290.85	16,403.84	4,100.96
Residential Multi	6.33	2.00	170.97	1,082.25	541.12
Mobile Home	41.62	10.00	271.07	11,282.07	1,128.21
Rural Residential	337.22	88.00	149.81	50,519.60	574.09
Residential Single	157.81	137.00	348.79	55,042.26	401.77
Vacant	62.22	48.00	0.33	20.74	0.43
Total	**27,999.76**	**700.00**		**176,631.15**	

Notes:

[A] Acres from Calculated per each Alternative

[B] Based on modeling of assessor data in benefit zone. Calculated per each Alternative.

[C] Relative damage per acre from Table 2

Table 5
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
$100,000 Assessment

Land Use	Total Assessment	Avg. Assessment/Parcel	Avg. Assessment/Acre
Agricultural	$15,274.94	$40.41	$0.57
Commercial	$7,309.51	$261.05	$36.99
Industrial	$1,352.66	$270.53	$8.44
School	$9,287.06	$2,321.77	$164.66
Residential Multi	$612.72	$306.36	$96.80
Mobile Home	$6,387.36	$638.74	$153.47
Rural Residential	$28,601.75	$325.02	$84.82
Residential Single	$31,162.26	$227.46	$197.47
Vacant	$11.74	$0.24	$0.19
Total	**$100,000.00**		

Table 6
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Revenue Estimate - $100 Residential Constraint

Land Use	Total Assessment	Avg. Assessment/Parcel	Avg. Assessment/Acre
Agricultural	$6,720.98	$17.78	$0.25
Commercial	$3,216.18	$114.86	$16.27
Industrial	$595.17	$119.03	$3.71
School	$4,086.31	$1,021.58	$72.45
Residential Multi	$269.59	$134.80	$42.59
Mobile Home	$2,810.44	$281.04	$67.53
Rural Residential	$12,584.77	$143.01	$37.32
Residential Single	$13,711.39	$100.08	$86.89
Vacant	$5.17	$0.11	$0.08
Total	**$44,000.00**		

Table 7
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Revenue Estimate - $200 Residential Constraint

Land Use	Total Assessment	Avg. Assessment/Parcel	Avg. Assessment/Acre
Agricultural	$13,441.95	$35.56	$0.50
Commercial	$6,432.37	$229.73	$490.92
Industrial	$1,190.34	$238.07	$7.43
School	$8,172.61	$2,043.15	$144.90
Residential Multi	$539.19	$269.59	$85.18
Mobile Home	$5,620.88	$562.09	$135.05
Rural Residential	$25,169.54	$286.02	$74.64
Residential Single	$27,422.79	$200.17	$173.77
Vacant	$10.33	$0.22	$0.17
Total	**$88,000.00**		

Table 8
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Alternatives Cost Summary of Results

Alternative	Total Construction Cost	New Assessment Capacity	
		$100 Constraint	$200 Constraint
Preferred	$465,678,200	$44,000	$88,000
Min	$464,531,000	$44,000	$88,000
Max	$590,832,190	$44,000	$88,000

[1] O&M Assessment Revenue Provided by project Team.

[2] Annual O&M costs provided by Project Team.

Table 9
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Local Funding Analysis

Alt.	Capital Assessment Capacity $	Low Int. Rate Millions $ [1,2,4]	High Int. Rate Millions $ [1,3,4]	Project Cost Millions $	Local High %	Local Low %	Non-Local High %	Non-Local Low %	Fund Capacity Ranking
Preferred	$401,950	$7.16	$5.62	$465.68	1.54%	1.21%	98.8%	98.5%	2
Min	$401,950	$7.16	$5.62	$464.53	1.54%	1.21%	98.8%	98.5%	1
Max	$401,950	$7.16	$5.62	$590.83	1.21%	0.95%	99.0%	98.8%	3

Notes:

[1] Assumes 1.1 Debt Coverage Ratio

[2] Low interest rate for debt issuance assumed to be 3%

[3] High interest rate for debt issuance assumed to be 5%

[4] Term for bond repayment assumed to be 30 years.

Table 10
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Structure Damage Value

Structure Land Use		Replacement Value	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	**[1]**	300	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Commercial	**[2]**	85.56	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
School	**[3]**	144.46	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
Industrial	**[4]**	54.51	7.00%	21.70%	30.20%	31.20%	32.40%	32.40%	39.80%	42.80%	51.70%	53.10%	54.10%	61.80%	64.80%	64.80%	65.50%	86.10%
Mobile Home	**[5]**	45.85	9.90%	44.70%	45.70%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%	96.50%
Residential Multi	**[6]**	84.4	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Rural Residential	**[7]**	111.67	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Residential Single	**[8]**	111.67	13.40%	23.30%	32.10%	40.10%	47.10%	53.20%	58.60%	63.20%	67.20%	70.50%	73.20%	75.40%	77.20%	78.50%	79.50%	80.20%
Vacant		100	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Reference Table C-1 2012 CVFPP HEC-FDA Structure and Damage Functions - CVFPP Attachment 8F Flood Damage Analysis

[1] Assumed Crop damage per acre

[2] Source: Table B-9 - Good Status for Commercial Retail

[3] Source: Table B-29 Good Status for Public and Private Schools

[4] Source: Table B-21 - Good Status for Industrial Light

[5] Source: Table B-25 - Good Status for Mobile Home

[6] Source: Table B-26 - Good Status Construction Class and Quality for Multi-Family Residential

[7] Source: Table B-33 - Good Status for Single Family Residential

[8] Source: Table B-33 - Good Status for Single Family Residential

Table 11
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Contents Damage Value

Land Use	Contents Damage Ratio	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Commercial	51%	0.00%	79.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
School	38%	0.00%	87.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Industrial	31%	0.20%	87.60%	96.40%	99.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Mobile Home	50%	0.00%	85.00%	95.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%	99.00%
Residential Multi	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Rural Residential	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Residential Single	50%	8.10%	13.30%	17.90%	22.00%	25.70%	28.80%	31.50%	33.80%	35.70%	37.20%	38.40%	39.20%	39.70%	40.00%	40.00%	40.00%
Vacant	0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Reference Table C-1 2012 CVFPP HEC-FDA Structure and Damage Functions - CVFPP Attachment 8F Flood Damage Analysis

Reference Table 3-10 Contents to Structure Ratio - 2012 CVFPP Attachment 8F Flood Damage Analysis

Table 12
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Structure, Contents, and Land Damage Value

Land Use		Replacement Value	Contents Damage Ratio	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agricultural	**[1]**	300	100%	0.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Commercial	**[2]**	85.56	51%	5.99	53.39	69.47	70.33	71.36	71.36	77.69	80.26	87.87	89.07	89.92	96.51	99.08	99.08	99.68	117.30
School	**[3]**	144.46	38%	10.11	79.55	98.52	99.97	101.70	101.70	112.39	116.72	129.58	131.60	133.05	144.17	148.50	148.50	149.52	179.27
Industrial	**[4]**	54.51	31%	3.85	26.63	32.75	33.74	34.56	34.56	38.59	40.23	45.08	45.84	46.39	50.59	52.22	52.22	52.60	63.83
Mobile Home	**[5]**	45.85	50%	4.54	39.98	42.73	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94	66.94
Residential Multi	**[6]**	84.4	50%	14.73	25.28	34.65	43.13	50.60	57.05	62.75	67.60	71.78	75.20	77.99	80.18	81.91	83.13	83.98	84.57
Rural Residential	**[7]**	111.67	50%	19.49	33.45	45.84	57.06	66.95	75.49	83.03	89.45	94.98	99.50	103.18	106.09	108.38	109.99	111.11	111.89
Residential Single	**[8]**	111.67	50%	19.49	33.45	45.84	57.06	66.95	75.49	83.03	89.45	94.98	99.50	103.18	106.09	108.38	109.99	111.11	111.89
Vacant		100	100%	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Reference Table 6 Reclamation District 2140 - Hamilton City Levee O&M Assessment

[1] Assumed Crop damage per acre

[2] Source: Table B-9 - Good Status for Commercial Retail

[3] Source: Table B-29 Good Status for Public and Private Schools

[4] Source: Table B-21 - Good Status for Industrial Light

[5] Source: Table B-25 - Good Status for Mobile Home

[6] Source: Table B-26 - Good Status Construction Class and Quality for Multi-Family Residential

[7] Source: Table B-33 - Good Status for Single Family Residential

[8] Source: Table B-33 - Good Status for Single Family Residential

ATTACHMENT E

Conceptual Finance Plan – Technical Memorandum

LWA
LARSEN WURZEL
& Associates, Inc.
2450 Venture Oaks Way, Suite 240 • Sacramento, CA 95833
www.larsenwurzel.com

Technical Memorandum

Nicolaus and Rio Oso Flood Risk Reduction Feasibility Study
Small Communities Flood Risk Reduction Program

Conceptual Finance Plan *April 24, 2020*

Prepared by: Elisabet Abdissa
Reviewed by: Sean Myers, David Lee, & Derek Larsen, P.E., CFM

Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the communities of Nicolaus and Rio Oso Flood Risk Reduction Feasibility Studies under the Department of Water Resources (DWR) Small Communities Flood Risk Reduction (SCFRR) Program. This memorandum provides a conceptual financial plan and funding strategy for implementation of the preferred alternative.

Approach

The conceptual finance plan applies information from the Financial Feasibility and Funding Sources memos prepared by LWA with funding information provided by the local agencies to identify potential local and non-local matching funds to implement the preferred alternative. Based on cost estimates provided by the Nicolaus and Rio Oso project teams, a funding "sources and uses" table was prepared to determine funding capabilities for flood risk reduction features. This memo does not address funding mechanisms for identified multi-benefit projects.

Selected Alternative

The ability to pay analysis was a three-step screening process. First, a maximum annual land-based assessment was calculated using a rate analysis for the benefited area(s). Second, the range of remediation alternatives cost were compared to the community's ability to generate local matching funds as a percent of the total project costs. Each project has one alternative alignment, with multiple remediation measures for **19 miles** of levee for Nicolaus and **6.8 miles** of levee for Rio Oso, for a total of 25.8 miles of continuous levee improvement. Each segment of levee can feature up to two separate measures with varying repair costs. Finally, the project team determined the amount of existing assessment revenue that could be allocated toward funding the capital project. The existing capital revenue was combined with the additional local assessment capacity to determine the total capital capacity, $401,950.

Funding Approach

Total Project costs estimates provided by the Nicolaus and Rio Oso Project teams are displayed in **Table 1.**

Table 1
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Alternatives Cost Summary of Results

Alternative	Total Construction Cost	Existing Assessment Revenue [1]	Annual O&M [2]	Remaining Revenue [3]	Maximum Assessment Capacity	Remaining Capital Capacity
		A	B	C= (A-B)*65%	D	E=C+D
Preferred	$465,678,200	$953,000	$470,000	$313,950	$88,000	$401,950
Min	$464,531,000	$953,000	$470,000	$313,950	$88,000	$401,950
Max	$590,832,190	$953,000	$470,000	$313,950	$88,000	$401,950

[1] Total existing Assessment Revenue Provided by project Team.
[2] Annual total district O&M costs provided by Project Team.
[3] District's funding for levee work limited to 65% of total revenues; 35% of total revenues for other-than-levee work.

As shown in **Table 1**, the preferred alternative's total construction cost estimate is $466 million. The maximum capital costs total $591 million and the minimum total $465 million. The existing assessment revenue for the cities of Nicolaus and Rio Oso is $953,000, of which $470,000 covers the district's total annual O&M costs, and 65% or $313,950 of that equates to the available remaining revenue for levee improvements[1]. The maximum revenue for the new assessment is $88,000. The estimated remaining annual capital capacity for each alternative totals $401,950, which could raise between $5.62 million to $7.16 million based on varying debt financing with interest rates between 3% to 5%. **Table 2** provides a funding sources and uses breakdown for the existing Nicolaus and Rio Oso assessment revenue.

A detailed breakdown of the potential debt financing for the range of alternatives is displayed in **Table 3**.

Table 4 is a funding sources and uses table developed for the preferred project**.** It is assumed that the capital improvement project will secure 90% of non-local matching funds revenue from State and federal sources. The remaining revenue to cover general overhead and administration (GO&A), operations, maintenance, repair, replacement and rehabilitation (OMRR&R), and the local matching share would be raised locally. GO&A was assumed to be 1% of the total cost of the estimated Capital Improvements projects. The annual O&M costs were

[1] District limits available revenue for levee improvement to 65% of total annual revenues. Remaining 35% of annual revenues designated for O&M and capital improvements on drainage and other projects.

provided by the Nicolaus and Rio Oso project team[2]. The GO&A represents the increased level of effort by the County to complete the planned capital improvements. It was assumed the County would be able to secure a portion of the required local matching funds to supplement local revenue raised through a land-based assessment. Unidentified local funding sources would be necessary to meet a full 10% local cost share on planned improvements. **Table 5** provides a summary of potential State and federal funding sources that could be sought to complete proposed improvements.

Table 2
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Existing Assessment Revenue Sources and Uses

Sources	**Cost [1]**
Existing Assessment	$953.00
Total Sources [A]	**$953.00**

Existing Uses	**Cost**
Existing OMRR&R Costs	$470.00
Non-O&M Costs	$169.05
Total Uses [B]	**$639.05**

Remaining Uses	**Cost**
Available Capital	$313.95
Total Capital Uses [C]	**$313.95**
Total Uses [D = B + C]	**$953.00**
End Cash Position (Deficit) [E = A - D]	**$0.00**

Notes:
[1] All values reported in thousands of dollars.

[2] Annual O&M costs anticipated to remain unchanged pre and post improvement.

Table 3
Nicolaus & Rio Oso Small Communities Flood Risk Reduction
Local Funding Analysis

Alt.	Capital Assessment Capacity $	Low Int. Rate Millions $ [1,2,4]	High Int. Rate Millions $ [1,3,4]	Project Cost Millions $	Local		Non-Local		Fund Capacity Ranking
					High %	Low %	High %	Low %	
Preferred	$401,950	$7.16	$5.62	$465.68	1.54%	1.21%	98.8%	98.5%	2
Min	$401,950	$7.16	$5.62	$464.53	1.54%	1.21%	98.8%	98.5%	1
Max	$401,950	$7.16	$5.62	$590.83	1.21%	0.95%	99.0%	98.8%	3

Notes:

[1] Assumes 1.1 Debt Coverage Ratio

[2] Low interest rate for debt issuance assumed to be 3%

[3] High interest rate for debt issuance assumed to be 5%

[4] Term for bond repayment assumed to be 30 years.

Table 4
Nicolaus and Rio Oso - Conceptual Finance Plan
Preferred Project Sources and Uses

Sources	Cost [1]	Percent
Existing Assessment for O&M	$0.47	0.1%
Existing & New Assessment Available for Capital [2]	$7.16	1.5%
Unidentified Local Funding Source	$44.21	9.4%
State/Federal Funding (90% Share of Capital Project)	$419.11	89.0%
Total Sources [A]	**$470.95**	**100.0%**
GO&A & O&M Uses	**Cost**	**Percent**
General Overhead and Admin	$4.80	1.0%
OMRR&R Costs	$0.47	0.1%
Total GO&A and O&M Uses [B]	**$5.27**	**1.1%**
Capital Improvement Projects Uses	**Cost**	**Percent**
Preferred Project	$465.68	98.9%
Total Capital Uses [C]	**$465.68**	**98.9%**
Total Uses [D = B + C]	**$470.95**	**100.0%**
End Cash Position (Deficit) [E = A - D]	**$0.00**	

Notes:
[1] All values reported in millions of dollars.
[2] Assumes 30-year assessment with a 3% debt financing (cost and revenue escalation not included)

Table 5
SCFRR - Funding Sources Memo
Funding Sources by Solution Matrix

		Structural		Non-Structural		Study/ Plan/ O&M	
Funding Program	**Agency**	**Levee| Dam| Floodwall| Erosion**	**Bypass**	**Changes to NFIP**	**Relief Cut**	**Feasibility Study & Flood Management Plan**	**OMRR&R**
Urban Stormwater and Waterways Improvement Program	California Natural Resources Agency	**X**	**X**		**X**		
Urban Green Infrastructure Program	California Natural Resources Agency	**X**	**X**		**X**		
Flood Control Subventions Program (FCSP)	DWR	**X**	**X**		**X**		
Central Valley Tributaries Program (CVTP)	DWR	**X**	**X**		**X**		
Flood Damage Reduction Projects (FDRP)	USACE	**X**	**X**		**X**	**X**	
Flood-Related Continuing Authorities Program (FRCA)	USACE	**X**	**X**		**X**	**X**	
Watershed and Flood Prevention (WFPO)	USDA	**X**			**X**		
Inland Wetlands Conservation Program (IWC)	WCB	**X**	**X**		**X**		

Notes:
[1] Potential Funding Programs Identified by LWA from the Funding Sources Memo.

Recommended Next Step

The County should work to determine if advancing a land-based assessment would be a viable approach and should refine assumptions associated with the amount of funding required to complete the proposed improvements. In order to secure local funding, the County will need to prepare a detailed project financing plan and cash flow model to support a land-based assessment. This plan would ultimately become part of a required Engineer's Report. The County could advance design and environmental compliance of the preferred alternative to develop a construction ready project that can better compete for State and federal funding.

The project teams determined that the Nicolaus and Rio Oso local funding capacity is sufficient to fund all of the Alternative Remediation's O&M costs. The 65% of the remaining capital revenue from the existing assessment along with the maximum revenue from the new assessment, totaling $401,950, could be utilized to raise up to 1.21% to 1.54 of project costs for the preferred remediation alternatives, through debt financing, towards the required local share of project costs. In LWA's experience, typical capital improvement projects require at least 10% to 15% local matching funds in order to qualify for State and Federal funding programs.

The County should explore developing a regional assessment district to fund a regional Capital Improvement Program (CIP) that could leverage a larger benefit assessment area to generate local funds to match State and federal funding. The regional assessment district could initially be utilized to fund SCFRR projects within the County and then other critical projects within the Sutter County.

As part of developing a larger regional program and CIP, the County would need to determine how to address governance prior to advancing the preferred alternative under a regional approach.

ATTACHMENT F

Funding Sources – Technical Memorandum

LWA
LARSEN WURZEL
& Associates, Inc.
2450 Venture Oaks Way, Suite 240 • Sacramento, CA 95833
www.larsenwurzel.com

DRAFT Technical Memorandum

Small Community Flood Risk Reduction (SCFRR)

Funding Sources Memorandum *February 28, 2020*

Prepared by: Elisabet Abdissa
Reviewed by: Derek Larsen, P.E.

Purpose

This memorandum has been prepared by Larsen Wurzel & Associates, Inc. (LWA) in support of the Department of Water Resources (DWR) Small Communities Flood Risk Reduction (SCFRR) Program. It is intended that this Memorandum will be used in conjunction with the Financial Feasibility Memo to inform Conceptual Finance Plans in identifying non-local funding sources for preferred structural and non-structural alternatives. The memo provides an extensive list of potential Federal and State funding sources to be considered in flood risk reduction and multi benefit SCFRR projects.

Background

The SCFRR Program was created based on recommendations in the 2012 Central Valley Flood Protection Plan (CVFPP). The intention of this program is to invest in qualifying projects that reduce flood risks for small communities. As specified in the CVFPP, small communities are defined as developed areas with fewer than 10,000 residents, which do not fall in the category of urban. A goal in the 2012 CVFPP was to target a "100-year" level of protection for Small communities. The Federal Emergency Management Agency (FEMA) standard "100-year" level of flood protection is defined as protection from a flood with a 1-in-100 probability of occurrence in any given year for property located within a flood hazard zone.

The SCFRR Program will support the implementation of flood risk mitigation projects for small communities protected by State Plan of Flood Control (SPFC) facilities in the Sacramento-San Joaquin Valley. With assistance from the State, small communities and counties are conducting design, construction, and financial feasibility studies. Projects under the SCFRR Program conduct feasibility studies of structural and/or non-structural alternatives to reduce the risk of flooding for small communities. The structural alternatives are intended to lead to the design of projects that repair, rehabilitate, reconstruct, or replace SPFC facilities to improve flood protection. In the sections to follow, this memorandum will address structural and non-structural alternatives along with possible funding sources to be utilized by Small Communities in implementing flood risk reduction and multi-benefit projects.

Structural & Non-Structural Alternatives

Structural Solutions

Structural solutions are any physical construction implementation intended to avoid or reduce potential impacts of flood hazards. Through the application of engineering techniques or technology, structural solutions are implemented to achieve hazard resistance and resilience in flood structures or systems. Measures including the construction and reconstruction of water courses and water protection facilities such as levees, dikes, dams, floodgates, pumping stations, and other flood protection infrastructure are implemented in areas where flood risk cannot be sufficiently reduced by non-structural methods alone. The State and Federal governments offer funding programs to match local funds for structural projects.

This report examines funding for structural solutions that can be implemented to mitigate against flood risk and provide multi-benefit objectives. These alternatives are discussed further in the Structural Solution Summaries section; 1) Levees, 2) Floodwalls, 3) Flood Bypass, 4) Erosion Control, and 5) Dams.

Non-Structural Solutions

According to the United States Army Corp of Engineers (USACE), non-structural solutions are contingent physical or nonphysical measures utilized to mitigate or prevent potential damages from flooding.[1] Implementing such nonstructural flood risk reduction measures is proven to reduce overall flood risk and flood damage. Physical nonstructural measures are applied on a structure by structure basis while nonphysical non-structural measures are floodplain management activities intended to address flood risk through regulation, programs, and best management practices. The State and Federal governments offer funding programs to match local funds for non-structural projects.

This report considers funding for non-structural solutions which are discussed further in the Non-Structural Solution Summaries Section; 1) Changes to National Flood Insurance, 2) Levee Relief Cuts, 3) Emergency Flood Fight Plan, 4) Flood Emergency Evacuation Plan, 5) Flood Emergency Warning System, 6) Voluntary Structure Elevation & Floodproofing, and 7) Buyout/Acquisitions.

Multi-Benefit Improvements

The State strongly supports and encourages the planning and implementation of projects that include multi-benefit improvement objectives. multi-benefit projects can include increasing flood system resiliency by protecting and restoring crucial ecosystems, enhancing water supply and water quality, creating recreational opportunities, and improving public education related to integrated water management. Multi-benefit objectives within and surrounding small communities can be integrated into identified flood improvement alternatives to enhance the function of the region's flood system and management process. According to the 2017 CVFPP update, a multi-benefit alternative more efficiently and effectively leverages flood infrastructure to

[1] The USACE Nonstructural Flood Risk Management Measures: http://www.nwd-mr.usace.army.mil/rcc/MRFTF/docs/USACE-NFPC%20Nonstructural%20Measures%20Definitions.pdf

achieve a broader array of public benefits and may potentially increase access to more funding sources.[2] Available State funding sources for multi-benefit improvement projects are provided in a later section of this memo.

Funding Sources

In general, funding for Flood Risk Management efforts comes from three sources; Federal, State and local governments. For the purposes of this of memo, the below sections cover **Federal** and **State** funding mechanisms, available programs, requirements, and constraints.

Securing Federal Funding

The process for garnering Federal funding for flood risk reduction projects requires that a Federal interest in the project be identified. Federal interest has generally been identified and evaluated within feasibility studies prepared by the USACE that evaluate various criteria and generally emphasize the cost in relation to flood damage-reduction benefits associated within a specific project.

Small communities and rural areas generally lack the necessary benefits to justify a significant Federal interest, however, under programs such as SCFRR, these communities can be served through State lead Federal funding solicitations. **Table 1**, **Table 2**, and **Table 3** provide a summary of the Federal programs that are currently and expected to be available to local agencies to assist with funding structural and non-structural projects. Each table is broken apart by specific Federal agency. **Table 1** lists available Federal programs currently provided under the Federal Emergency Management Agency (FEMA). **Table 2** lists available Federal funding programs under USACE, and **Table 3** lists available United States Department of Agriculture (USDA) Federal programs. The typical cost share percentages for these programs are listed, however, cost sharing percentages can vary widely based upon project specific attributes.

[2] 2017 CVFPP update: https://cawaterlibrary.net/wp-content/uploads/2017/10/2017CVFPPUpdate-Final-20170828.pdf

Table 1
SCFRR - Funding Sources Memo
FEMA Hazard Mitigation Assistance Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Requirements	Stafford Act Authorization
Flood Mitigation Assistance (FMA)	FEMA	Grant	Mitigate flood-damaged properties in order to reduce or eliminate claims under NFIP	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	Only for NFIP insured properties and planning grants - up to 75%/ repetitive loss up to 90%/Severe repetitive loss - 100%	Depends on type of activity funded	Structural and nonstructural projects	All sub applicants for FMA must be participating in the NFIP, and not be withdrawn or suspended, to be eligible to apply for grant funds.	Section 1366 of the National Flood Insurance Act
Repetitive Flood Claims Grant Program (RFCP)	FEMA	Grant	Reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program (NFIP) that have had one or more claim payment(s) for flood damages.	RFC awards will prioritize acquisition projects that create the greatest savings to the NFIF based on a Benefit-Cost Analysis (BCA).	Up to 100%	RFC grants are awarded nationally without reference to State allocations, quotas, or other formula-based allocation(s) of funds. The RFC program is subject to the availability of appropriation funding.	Structural and nonstructural projects	All Applicants and sub applicants must be participating in the National Flood Insurance Program (NFIP), and must not be suspended or withdrawn from the NFIP.	Section 1323 of the National Flood Insurance Act
Pre-disaster Mitigation (PDM)	FEMA	Grant	Assist in Implementation of flood risk mitigation prior to disasters.	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	up to 75% & up to 90% if applicant is small, impoverished community	$4 M - Mitigation project/ $400,000 new mitigation plan/ $150,000 local mitigation plan update	Structural and nonstructural projects	HMGP and PDM mitigation project sub applications for projects sited within an SFHA are eligible only if the jurisdiction in which the project is located is participating in the NFIP. There is no NFIP participation requirement for HMGP and PDM project sub applications for projects located outside of the SFHA.	Section 203 of the Stafford Act, 42 U.S.C. §5133.
Hazard Mitigation Grant Program (HMGP)	FEMA	Grant	Flood risk reduction and reduction of reliance on future federal disaster assistance	Acquisition, demolition, floodproofing, relocations, elevation, mitigation, flood risk reduction	Up to 75%	There is no minimum or maximum project/planning grant award amount (within availability of funds)	Structural and nonstructural projects	Available only after a Federally Declared Disaster. HMGP and PDM mitigation project sub applications for projects sited within an SFHA are eligible only if the jurisdiction in which the project is located is participating in the NFIP. There is no NFIP participation requirement for HMGP and PDM project sub applications for projects located outside of the SFHA.	Section 404 of the Stafford Act, 42 U.S.C. §5170c.

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

Table 2
SCFRR - Funding Sources Memo
USACE Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Authorization
Flood Damage Reduction Projects (FDRP)	USACE	Study and construction Grant	Improvements to reduce riverine and coastal storm damages. Pursued as individual projects and not under authorized national program	Flood-damage reduction works, typically engineered works (e.g., levees, engineered dunes and beaches, storm surge gates and dams). Projects generally are required to have national benefits exceeding costs, or address public safety concerns	50% & when P.L 115-123 monies are used and 100% for feasibility study	Depends on project-specific authorization of appropriations	limited to projects that reduce riverine and coastal flood damage; generally do not address drainage or flooding from groundwater	Construction of individual projects is authorized by Congress, typically in a Water Resources Development Act or other omnibus water authorization legislation.
Flood-Related Continuing Authorities Program (FRCA)	USACE	Study and construction Grant	Reduce flood damages via structural and non-structural method (CAPs) section 205.	Flood damage reduction works that have not previously been specifically authorized by Congress and are not part of a larger project.	Study: 50% after initial $0.1 M// Construction: 65%// O&M: 0% (for territories and tribes first $0.455 M of O&M covered)	The maximum federal expenditure per project is $7 million, including feasibility study, design and construction costs.	Limited to projects that reduce flood damages (not including drainage from within community)	Under authorized Continuing Authorities Programs (CAPs) (§205)33 U.S.C. §701s. (§103) 33 U.S.C. §426g. (§14) 33 U.S.C. §701r. (§111) 33 U.S.C. §426i.

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

Table 3
SCFRR - Funding Sources Memo
USDA Grant Programs

Program	Agency/Dept.	Type of Assistance	Purpose	Eligibility	Cost Share	Maximum Project Assistance	Role of Flood In Program	Authorization
Emergency Watershed Protection (EWP) - Floodplain Easements	U.S Department of Agriculture (USDA)	Technical assistance and Grant	floodplain easements are meant to safeguard lives and property from future floods, drought, and the products of erosion through the restoration and preservation of the land's natural values.	Restore and enhance floodplain function and values, includes removing all structures, including buildings, within easement boundaries.	100% of restoration costs and up to 75% of building removal costs.	Landowners receive the smallest of the following values as an easement payment: (1) geographic area rate established by the NRCS; (2) fair market value based on an area-wide market analysis or an appraisal completed according to the Uniform Standards of Professional Appraisal Practices; or (3) the landowner's offer	Land must be within an eligible floodplain	33 U.S.C. §701b-1 and 16 U.S.C. §§2203-2205.
Watershed and Flood Prevention (WFPO)	U.S Department of Agriculture (USDA)	Grant	Planning and installation of watershed projects	Land treatment and structural and non-structural facilities for flood prevention and erosion reduction (structural: dams, levees, canals, and pumping stations)	100% for construction for flood protection up to $25 M before congressional approval is needed / up to 50% of costs for land, easements, and rights-of-way allocated to public fish and wildlife and recreational developments may be paid with program funds. Local sponsors must agree to all O&M	No project may exceed 250,000 acres, and no more than 12,500 acre-feet of floodwater detention capacity or 25,000 acre-feet of total capacity without congressional approval. Congressional approval is also required when a project includes an estimated federal contribution of more than $25 million for construction.	Flood prevention and protection	projects built under two authorities—the Watershed Prevention and Flood Protection Act of 1954 (P.L. 83-566) and the Flood Control Act of 1944 (P.L. 78-534). 33 U.S.C. §701b-1, and 16 U.S.C. §§10011008

Source: Congressional Research Services (2018 Flood Resilience and Risk Reduction: Federal Assistance and Programs)

State Funding

The state of California carries out several programs designed to provide flood management and multi-benefit ecosystem restoration and protection objectives. While some programs are operated directly by the State, others provide grants to local agencies for similar purposes. State flood management and multi-benefit restoration programs have also been funded through general funds. Since 1996, voters have authorized several state general obligation bonds, Including Propositions 1E, 1, 68, and 84. Along with these current general bond provisions, additional programs may potentially become available in the future.

Proposition 1E

The Disaster Preparedness and Flood Prevention Bond Act of 2006 (Proposition 1E) authorized funding to repair, rehabilitate, reconstruct, or replace levees, weirs, and bypasses to the SPFC Facilities. The State is Utilizing the remaining Proposition 1E bonds authorized to fund projects consistent with the CVFPP adopted in July 2012. Proposition 1E bond funds used for the SCFRR Program has allowed and continues to allow DWR to fund projects such as repairing erosion sites, removing sediment from channels or bypasses, evaluating and repairing levees and other SPFC facilities, and implementing mitigation measures for projects. **Table 4** presents the total bond allocation and remaining balance of Proposition 1E as of September 2018. Flood management and multi-benefit projects have utilized and continue to utilize grants administered under this proposition. With a total remaining balance of about $34 million of uncommitted funds, SCFRR projects should continue to utilize funding from grant programs that fall under Proposition 1E.

Proposition 1

On November 4, 2014, California voters approved the Water Quality, supply, and infrastructure improvement Act of 2014 (Proposition 1). Like Proposition 1E, this State approved general obligation bond has been utilized to fund multi-benefit and flood management projects. $163 Million has been committed and awarded to multiple flood management projects with a remaining balance of $232 Million. **Table 5** presents the total bond allocation and remaining balance of Proposition 1 as of February 2019. Along with flood management committed funds, Proposition 1 authorized $403 million in Integrated Regional Water Management (IRWM) funding. On October 5, 2018 DWR released the 2018 IRWM Implementation Grant Program which is the first round of the Proposition. The IRWM Implementation Grant Program provides funding for implementation projects that meet the intent of Proposition 1, Chapter 7. Funds are allocated to 12 hydrologic region-based Funding Areas. The 2018 IRWM Grant Program is designed to encourage integrated regional strategies for management of water resources by providing funding for projects and programs that support integrated water management. DWR plans to award grants on a competitive basis in at least two funding rounds. DWR is proposing that approximately $194 million be made available for implementation projects with approximately $18 million designated for projects that provide benefits to disadvantaged communities.

Proposition 68

The California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act (Proposition 68) is a more recent general obligation bond passed by voters in June 2018. Multi-benefit ecosystem restoration

and recreational projects serve to benefit from this funding source. Listed below in **Table 6** is the total bond allocation and remaining balance of Proposition 68 as of March 2019.

Proposition 84

The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) is another general obligation bond that has been utilized to fund flood protection and multi-benefit projects. Listed in **Table 7**; the total bond allocation and remaining balance to fund future projects as of February 2019.

Table 8 provides a breakdown of current and future State programs available to local agencies to fund structural and non-structural flood management and multi-benefit objective improvement projects. The typical cost share percentages for these can vary widely based upon project specific attributes. Information specified in the table reflect figures provided by the California Natural Resources Agency. Available funding dollar values are as of January 2019.

Table 4
SCFRR - Funding Sources Memo
Proposition 1E Allocation Balance Report (as of September 2018)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Section 5096.821 State plan of flood control	$3,000,000,000	$2,926,650,367	$2,875,371,583	$51,278,784
Section 5096.824 Flood control and flood prevention projects	$500,000,000	$487,775,061	$478,627,900	$9,147,161
Section 5096.825 Flood protection corridors and bypasses	$290,000,000	$282,909,535	$269,397,245	$13,512,291
Section 5096.827 Storm water flood management	$300,000,000	$292,665,037	$289,474,811	$3,190,226
Section 5096.953 et seq. Statewide Bond Cost	$0	$0	$43,150,000	($43,150,000)
Reallocated to Proposition 1	$0	$100,000,000	$100,000,000	$0
Total	**$4,090,000,000**	**$4,090,000,000**	**$4,056,021,539**	**$33,978,462**

Source: State of California Resources

1"Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 1 distributed across all program chapters.

2"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.

3"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 5

SCFRR - Funding Sources Memo

Proposition 1 Allocation Balance Report (as of February 2019)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Ch. 5 Clean, Safe and Reliable Drinking Water	$520,000,000	$520,000,000	$504,045,698	$15,954,302
Ch. 6 Protecting Rivers, Lakes, Streams, Coastal Waters and Watersheds	$1,495,000,000	$1,495,000,000	$1,251,258,911	$243,741,089
Ch. 7 Regional Water Security, Climate, and Drought Preparedness	$810,000,000	$810,000,000	$786,712,177	$23,287,823
Ch. 8 Statewide Water System Operational Improvement and Drought Preparedness	$2,700,000,000	$2,700,000,000	$2,646,000,000	$54,000,000
Ch. 9 Water Recycling	$725,000,000	$725,000,000	$697,461,270	$27,538,730
Ch. 10 Groundwater Sustainability	$900,000,000	$820,000,000	$788,375,100	$31,624,900
Ch. 11 Flood Management	$395,000,000	$395,000,000	$163,000,000	$232,000,000
Ch. 4/12 Statewide Bond Costs	$0	$0	$149,300,000	($149,300,000)
Reallocated to Proposition 68	$0	$80,000,000	$80,000,000	$0
Total	**$7,545,000,000**	**$7,545,000,000**	**$7,066,153,156**	**$478,846,844**

Source: State of California Resources

1 "Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 68 for WC 79772.

2 "Committed" means any amount appropriated in a current or prior year Budget or proposed for appropriation in a current Proposed Budget.

3 "Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 6
SCFRR - Funding Sources Memo
Proposition 68 Allocation Balance Report (as of March 2019)

Chapter	Allocation	Committed[1]	Balance[2]
Ch. 2 Investments in Environmental and Social Equity, Enhancing California's Disadvantaged Communities	$706,875,000	$277,379,000	$447,621,000
Ch. 3 Investments in Protecting, Enhancing, and Accessing California's Local and Regional Outdoor Spaces	$277,875,000	$186,012,000	$98,988,000
Ch. 4 Restoring California's Natural, Historic, and Cultural Legacy	$212,550,000	$22,750,000	$195,250,000
Ch. 5 Trails and Greenway Investment	$29,250,000	$117,000	$29,883,000
Ch. 6 Rural Recreation, Tourism, and Economic Enrichment Investment	$24,375,000	$30,000	$24,970,000
Ch. 7 California River Recreation, Creek, and Waterway Improvements Program	$157,950,000	$67,909,000	$94,091,000
Ch. 8 State Conservancy, Wildlife Conservation Board, and Authority Funding	$747,825,000	$132,873,000	$634,127,000
Ch. 9 Ocean, Bay, and Coastal Protection	$170,625,000	$32,652,000	$142,348,000
Ch. 10 Climate Preparedness, Habitat Resiliency, Resource Enhancement, and Innovation	$431,925,000	$182,741,000	$260,259,000
Ch. 11 Clean Drinking Water and Drought Preparedness	$243,750,000	$63,250,000	$186,750,000
Ch. 11.1 Groundwater Sustainability	$78,000,000	$74,000,000	$6,000,000
Ch. 11.5 Flood Protection and Repair	$536,250,000	$98,617,000	$451,383,000
Ch. 11.6 Regional Sustainability for Drought and Groundwater, and Water Recycling	$380,250,000	$120,150,000	$269,850,000
Ch. 13 Statewide bond costs	$102,500,000	$102,500,000	($102,500,000)
Total	**$4,100,000,000**	**$1,360,980,000**	**$2,739,020,000**

Source: State of California Resources
1"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.
2"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 7
SCFRR - Funding Sources Memo
Proposition 84 Allocation Balance Report (as of February 2019)

Chapter	Original Allocation	Adjusted Allocation[1]	Committed[2]	Balance[3]
Ch. 2 Safe Drinking Water and Water Quality Projects	$1,525,000,000	$1,495,281,200	$1,466,833,000	$28,448,000
Ch. 3 Flood Control	$800,000,000	$784,409,800	$752,247,000	$32,163,000
Ch. 4 Statewide Water Planning and Design	$65,000,000	$63,733,300	$62,299,000	$1,435,000
Ch. 5 Protection of Rivers, Lakes and Streams	$928,000,000	$909,915,400	$847,219,000	$62,696,000
Ch. 6 Forest and Wildlife Conservation	$450,000,000	$441,230,500	$446,667,000	($5,436,000)
Ch. 7 Protection of Beaches, Bays and Coastal Waters	$540,000,000	$529,476,600	$488,841,000	$40,635,000
Ch. 8 Parks and Nature Education Facilities	$500,000,000	$490,256,100	$453,901,000	$36,355,000
Ch. 9 Sustainable Communities and Climate Change Reduction	$580,000,000	$568,697,100	$552,859,000	$15,838,000
Ch. 10/11 Statewide Bond Cost	$0	$0	$83,580,000	($83,580,000)
Reallocated to Proposition 1	$0	$105,000,000	$105,000,000	$0
Total	**$5,388,000,000**	**$5,388,000,000**	**$5,259,446,000**	**$128,554,000**

Source: State of California Resources
1"Adjusted Allocation" reflects the "Original Allocation" less an adjustment mandated by Prop 1 distributed across all program chapters.
2"Committed" means the amount appropriated, the amount proposed for appropriations, or amount committed in out years.
3"Balance" equals Chapter Balance plus Chapter Set Asides as found on the Summary for Chapters in the Balance Allocations Report under Featured Links.

Table 8
SCFRR - Funding Sources Memo
State Flood Management & Multi-benefit Programs

Program	Department	Program Approach	Purpose	Eligible to Apply	State Cost Share	Status	Type of Assistance	Funding Source	Available Funding as of January 2019
Delta Levees Maintenance Subventions	Department of Water Resources (DWR)	Flood Management	Receives funding from Prop 1E, 1 and Proposition 84 for financial assistance to local levee maintaining agencies in the Sacramento - San Joaquin Delta for the maintenance and rehabilitation of nonproject and eligible project levees authorized in the California Water Code § 12980(f)	Local levee maintaining agencies and Reclamation Districts compliant with all requirements in CA Water Code §§ 12980-1299	75%	Ongoing	Grant	Proposition 1E, 1, & 84	$12 million
Delta Levees Special Flood Control Projects	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Receives funding from Prop 1E & 84. Provides financial assistance to local levee maintaining agencies for flood control and levee rehabilitation projects in the Delta as authorized in the California Water Code sections 12300-12318	Local levee maintaining agencies and Reclamation Districts compliant with all requirements in CA Water Code §§ 12980-1299	75%	Ongoing	Grant	Proposition 1E & 84	$60 million
Early Implementation Program (EIP) & Urban Flood Risk Reduction (UFRR)	Department of Water Resources (DWR)	Flood Management	The EIP was a State program related to the SPFC and was created to fund high-priority projects to restore or improve flood protection in advance of the 2012 Central Valley Flood Protection Plan (CVFPP). EIP projects existed in both urban and non-urban areas. Since adoption of the CVFPP in 2012, the Urban Flood Risk Reduction (UFRR) Program has extended the work begun under the EIP to support implementation of regional flood-damage-reduction projects for urban areas protected by the SPFC. Section 8.4.4 provides more details on UFRR projects.	Urban areas protected by the SPFC	50% to 90%	Ongoing	Grant	Proposition 1E	$1.2 Billion of Prop 1E
Regional Flood Management Planning (RFMP)	Department of Water Resources (DWR)	Flood Management	Intended to provide meaningful engagement by the Regional Partners in the Central Valley Flood Protection Plan (CVFPP) and maintain working relationships to develop a common understanding of regional flood issues and priorities. formulate and assess flood management solutions and strategies that reflect the vision, feasibility projects, assess the performance of the projects, and develop a plan that reflects the vision of local entities in reducing flood risks in their region.	A California local public agency with responsibility for flood management in the region that is a part of the area protected by the facilities of the SPFC that is willing to participate in, coordinate, and collaborate with other interested parties in the region that are participating in the development of their RFMP.	75%	Ongoing since October 2012	Direct Funding	Proposition 1E	$2.4 million
Small Communities Flood Risk Reduction Program (SCFRRP)	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Projects to reduce flood risk in small communities in the Central Valley. Funds for feasibility studies, design, and construction of proactive repairs to flood control facilities of the State Plan of Flood Control (SPFC).	Local Agencies with Land Use Authority (cities/counties), protected by SPFC, and within the Levee Flood Protection one	50% cost share for costs above $500,000.	Ongoing	Grant Funds	Proposition 1E	Phase 2 - Design and Implementation: Approximately $27 million.
Flood System Repair Projects (FSRP)	Department of Water Resources (DWR)	Flood Management/ Multi-Benefit	Evaluate (feasibility), design, and construct repairs of non-urban SPFC Facility (levees, channels, structures, etc.) deficiencies	The FSRP is limited to facilities of the SPFC maintained by LMAs or by DWR, as defined in Public Resources Code § 5096.805(j):	50% to 90%	Ongoing	Grant	Proposition 1E	Up to $150 million Proposition 1E funds
Flood Control Subventions Program (FCSP)	Department of Water Resources (DWR)	Flood Management	Funded by both IE and 84 funded. Implementation of federally-authorized, locally-led, flood control projects (minor or major) and Watershed Protection Flood Prevention Projects.	Local public agencies with federal projects that are not part of the State Plan of Flood Control.	75%	Ongoing	Funds (Claims Reimb.)	Proposition 1E & 84	>170 million
California Streamflow Enhancement Program (CSEP)	Wildlife Conservation Board (WCB)	Multi-Benefit	Providing enhanced stream flow, especially in those streams that support anadromous fish; special status, threatened, endangered or at risk species; or provide resilience to climate change.	Cities, counties, nonprofit organizations, special districts, tribes and state entities	Cost share not required	Ongoing	Grant	Proposition 1	$130 million
Lower American River Conservation Program (LARCP)	Wildlife Conservation Board (WCB)	Multi-Benefit	Work cooperatively with local agencies, particularly the County of Sacramento in its role as the American River Parkway Manager, and nonprofit organizations to restore, enhance, interpret, protect and improve public access to the American River Parkway's natural, recreational, educational and cultural resources.	Local agencies and nonprofit organizations.	Not Specified	Ongoing	Grant	Proposition 1	$10 million
Central Valley Tributaries Program (CVTP)	Department of Water Resources (DWR)	Multi-Benefit	Flood management projects that enhance water quality and ecosystems of rivers and streams tributary to the Sacramento-San Joaquin Delta.	Local Agencies	TBD	Future	Grant	Proposition 1	Up to $36 million. Additional future funding may be available.
Integrated Regional Water Management (IRWM)	Department of Water Resources (DWR)	Multi-Benefit	Development and revisions of IRWM Plans, and implementation of projects in IRWM Plans. Goals of Projects:(a) help water infrastructure systems adapt to climate change, including, but not limited to, sea level rise, (b) provide incentives for water agencies throughout each watershed to collaborate in managing the region's water resources and setting regional priorities for water infrastructure, and (c) improve regional water self-reliance consistent with Section 85021.	Public agencies, non-profit organizations, public utilities, federally recognized Indian tribes, state Indian tribes listed on the Native American Heritage Commission's Tribal Consultation list, and mutual water companies (Water Code Section 97917 (ab)).	Up to 50%	Ongoing	Grant	Proposition 1	$403 million for implementation grants, with not less than $51 million awarded to projects that directly benefit disadvantaged communities.
San Joaquin River Conservancy Proposition 1 Grant Program	San Juaquin River Conservancy	Multi-Benefit	Projects that demonstrate multiple benefits to water quality, water supply, and/or ecosystem and watershed protection and restoration within the Conservancy's jurisdictional planning area (San Joaquin River, Friant Dam to Highway 99). Projects must be consistent with the requirements and purposes of Proposition 1 and the Conservancy's Grant Guidelines	Public agencies, nonprofit 501(c)(3) organizations, public utilities, federally recognized Indian tribes, and mutual water companies	Not Specified	Ongoing	Grant	Proposition 1	$5.9 million
Delta Conservancy Ecosystem Restoration and Water Quality Grant Program	Sacramento-San Joaquin Delta Conservancy	Multi-Benefit	Planning and implementation grants are available for ecosystem protection, restoration and enhancement, water quality, and water-related agricultural sustainability projects	California public agencies, qualifying nonprofit organizations, public utilities, mutual water companies, and eligible tribal organizations	TBD	Future	Grant	Proposition 1	$17.1 million
Specialty Park Program (SPP) Round 3	California State Parks	Multi-Benefit	To Create new parks and new recreation opportunities in underserved communities across California	Cities, Counties, Districts as defined, Joint Powers Authorities, Non Profit Organizations	Cost share not required	Ongoing/ Application Deadline Aug 2019	Grant	Proposition 68	$254,942,000
Specialty Park Program (SPP) Future Rounds	California State Parks	Multi-Benefit	To Create new parks and new recreation opportunities in underserved communities across California	Cities, Counties, Districts as defined, Joint Powers Authorities, Non Profit Organizations	Cost share not required	Future	Grant	Proposition 68	$395,333,000
Regional Park Program (RPP)	California State Parks	Multi-Benefit	To Create, expand, or renovate parks and park facilities, including, but not limited to, trails, regional trail networks, regional sports complexes, low-cost accommodations in park facilities, and visitor, outdoor, and interpretive facilities.	Regional park districts, counties, and regional open-space districts, open-space authorities formed pursuant to Division 26 (commencing with Section 35100), joint powers authorities, and eligible nonprofit organizations	TBD	Future	Grant	Proposition 68	$23,125,000

Table 8
SCFRR - Funding Sources Memo
State Flood Management & Multi-benefit Programs

Program	Department	Program Approach	Purpose	Eligible to Apply	State Cost Share	Status	Type of Assistance	Funding Source	Available Funding as of January 2019
Flood Emergency Response Grants Program: Delta Flood ER Grant	Department of Water Resources (DWR)	Flood Management	Improve local flood emergency response in California and contribute to increased public safety. Examples of eligible projects include: • Preparing or updating the local flood emergency plan • Coordinating flood emergency planning and preparedness, including training and exercises • Developing processes to effectively communicate and coordinate response to flood emergencies • Collecting and exchanging flood information • Purchasing and installing equipment and materials needed for emergency communication and more flood fight, & stockpiling to protect critical infrastructure.	California Public Agencies within the legal delta including primary and secondary zones with primary responsibility for flood emergency response and coordination	TBD	Ongoing	Grant	Proposition 1E	$4.8 million
Urban Stormwater and Waterways Improvement Program	California Natural Resources Agency	Flood Management	Funding for the purposes of multi-benefit projects in urbanized areas to address flooding. Projects shall include but are not limited to stormwater capture and reuse, planning and implementation of low impact development, restoration of urban streams and watersheds, and increasing permeable surfaces to help reduce flooding.	Local agencies, nonprofit organizations, nongovernmental land conservation organizations, federally recognized Native American tribes, or nonfederally recognized California Native American tribes	TBD	Ongoing	Grant	Proposition 68	$92.5 million
Urban Green Infrastructure Program	California Natural Resources Agency	Multi-Benefit	Funding for multi-benefit green infrastructure investments in or benefiting disadvantaged or severely disadvantaged communities.	Local agencies, nonprofit organizations, nongovernmental land conservation organizations, federally recognized Native American tribes, or nonfederally recognized California Native American tribes listed on the California Tribal Consultation List maintained by the Native American Heritage Commission.	TBD	Ongoing	Grant	Proposition 68	$18.5 million
Urban Flood Protection Grant Program	California Natural Resources Agency	Flood Management	Funding for projects that address flooding in urbanized areas and provide multi-benefit components. Eligible projects shall include, but are not limited to, storm water capture and reuse, planning and implementation of low-impact development, restoration of urban streams and watersheds, and increasing permeable surfaces to help reduce flooding.	local and state agencies, joint powers authorities, public utilities, mutual water companies, nonprofit organizations, federally-recognized Native American tribes, or nonfederally-recognized California Native American tribes listed on the California Tribal Consultation List maintained by the Native American Heritage Commission.	25% cost share unless determined as a disadvantaged community	Ongoing	Grant	Proposition 68	$87.5 million
Habitat Enhancement and Restoration Program (HERP)	Department of Water Resources (DWR)	Multi-Benefit	Funded through Props 68 & 84. Consistent with Fish and Game Code section 1301, this program provides assistance for the restoration and enhancement of fish and wildlife resources	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Proposition 68 & 84	$105 million under the Propositions. Under HCF receive approximately $1 million annually for wetland restoration outside the Central Valley until the year 2020.
Sustainable Groundwater Planning/ Implementation Program	Department of Water Resources (DWR)	Multi-Benefit	Competitive grants to support planning and implementation of local and regional groundwater projects required to support sustainable groundwater management.	Eligible applicants are GSAs or member agencies of the GSAs for the basin for which the application is submitted. Only one application will be accepted per basin.	Not Specified	Ongoing	Grant	Proposition 1 & 68	At least $88 million will be available for competitive grants for projects
California Riparian Habitat Conservation Program	Wildlife Conservation Board (WCB)	Multi-Benefit	Supports a coalition of state, federal, local and private organizations whose mission is to develop a coordinated approach to the protection of riparian ecosystems. Grants are awarded for the protection, restoration and enhancement of riparian habitat systems.	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Habitat Conservation Fund	$3 million annually for restoration and acquisitions until the year 2020
Inland Wetlands Conservation Program (IWC)	Wildlife Conservation Board (WCB)	Multi-Benefit	To assist the Central Valley Joint Venture in its mission to protect, restore and enhance wetlands and associated habitats in the Central Valley. The public/private partnership works to increase the populations of wintering and breeding waterfowl, shorebirds, water birds, and riparian songbirds.	Cities, counties, nonprofit organizations, special districts and state entities	Not Specified	Ongoing	Grant	Habitat Conservation Fund, Inland Wetland Conservation Fund	$2 million annually for restoration and acquisitions until the year 2020
Watershed Restoration Grant Program	California Department of Fish and Wildlife	Flood Management/ Multi-Benefit	Program funds water quality, river, and watershed protection and restoration projects of statewide importance outside of the Delta.	Public agencies, Native American tribes, and nonprofit organizations	Not Specified	Ongoing	Grant	Proposition 1	Approximately $122.9 million
Flood Maintenance Assistance Program (FMAP)	Department of Water Resources (DWR)	Flood Management	This program will help ensure that State Plan of Flood Control facilities are properly maintained and have sufficient resources, including funding, to meet applicable federal regulations and Operation and Maintenance (O&M) manual requirements.	Local Maintaining Agencies (LMAs) and Maintenance Areas (MAs) protected by SPFC	75% for the first $10,000 per mile expenditure & 50% for expenditures in excess of $10,000 per mile.	Ongoing/ Application deadline 03/2019	Grant	Budget Act of 2018	All funding will depend on the program demand and fund availability
State Community Development Block Grant (CDBG)	Housing Urban Development (HUD)	Multi-Benefit	States award grants to smaller units of general local government that develop and preserve decent affordable housing, to provide services to the most vulnerable in our communities, and to create and retain jobs. Annually, each State develops funding priorities and criteria for selecting projects.	Non-entitlement areas, which include those units of general local government which do not receive CDBG funds directly from HUD and have a populations of less than 50,000	Amounts expended on administration in excess of $100,000 must be matched.	Ongoing	Grant	Housing and Community Development Act of 1974, amended 1981	Annually, each State develops funding priorities and criteria for selecting projects.

Sources:
[1] State of California Resources Site
[2] Department of Water Resources Site
[3] Wildlife Conservation Board Site

Structural Solution Summaries

Structural measures such as the ones listed below, are physical infrastructures that alter characteristics of the flood and reduce the probability of flooding in the location of interest. This section discusses four structural alternatives and potential funding opportunities for communities considering solutions to mitigate against the risk of flooding and meet multi-benefit objectives. **Table 9** provides a matrix of viable funding sources/programs to consider for the implementation of the below structural solutions.

Solution 1: Levees

A levee is an earthen (soil) embankment, designed and constructed to contain, control, or divert the flow of water to provide protection from temporary flooding. A levee is built parallel to a body of water (most often a river) in order to protect lives and properties behind it from some level of flooding. A levee is certified or accredited if a licensed professional engineer or the Federal agency responsible for levee design has demonstrated that the structure meets current design, construction, maintenance, and operation standards to provide protection from a flood. To enhance the multi-benefit possibility of levees, implementation of a setback levee or addition of waterside planting berms can be considered. Creating more room for rivers by moving the levee further away reduces flood risk while also providing additional benefits such as improved fish and wildlife habitat and recreational opportunities. Construction berms along the water side slopes provide an area for riparian habitat plantings and allows opportunity for natural channel meandering. Small communities implementing levee construction for flood mitigation should also consider a multi-benefit approach, which provides additional funding source eligibility from State programs.

Solution 2: Floodwall

Like Levees, floodwalls are built parallel to a waterway in order to provide protection from flooding. Floodwalls are more likely to be found in urban areas and are made of concrete, steel (or vinyl), or other impermeable and structurally resilient material.

Solution 3: Flood Bypass

A flood bypass is an area along a river or within a floodplain that is intentionally kept undeveloped for the purpose of diverting excess water into the river. This implementation is intended to reduce the risk of flooding in a nearby area, such as a city or business district. If constructed properly, bypasses can also provide valuable wetland and aquatic habitat. This flood control method can be designed and operated without eliminating processes needed to sustain habitats. Unlike levees or floodwalls, bypasses do not block lateral connectivity between the river and its floodplain. Communities in the Central Valley have the most limited access to parks among all California communities and bypass areas can be developed as parks or open spaces when not being used to manage floodwater. Fortunately, this multi-benefit approach, which expands floodways to convey floodwater safely, can improve public safety while also creating riverside parks and trails.

Solution 4: Erosion Control/Repairs

Erosion control and repair projects are implemented to re-stabilize and protect river and stream banks after a flood event to prevent levee breaches. There are different erosion control methods, depending on severity of

the erosive forces during the design flood event, including channel bank armoring, bio-engineered vegetation plantings, and hard engineered structures.

Solution 5: Dams

Dams are barriers that impound hydrologic flows and retain floodwaters before they reach areas of risk. In situations of high-precipitation periods, dams hold upstream floodwaters that are gradually released to minimize the likelihood of damage to downstream communities. However, during events of magnitude, the storage capacity of a dam can be exceeded and uncontrolled flood flows are passed downstream. In these circumstances, downstream levees may not be able to contain floodwaters or may be stressed to the point of failure. Unlike a levee, a dam built for flood protection is usually designed to reduce downstream flow during a flood by containing excess water and releasing it slowly over time. Dams also provide multi-benefit functions such as storing water for irrigation, community water supplies, recreation, and hydroelectric power.

Non-Structural Solution Summaries

In contrast to physical structures, which mitigates flood risk by controlling floodwaters, non-structural approaches adapt to and accommodate the potential of floods occurring. Unlike structural measures, Non-structural methods alter the impact or consequences of flooding and have little to no impact on the characteristics of the flood. In this section, we describe seven major non-structural approaches to consider for implementation. A matrix in **Table 9** outlines viable funding sources/programs corresponding to non-structural and structural solutions.

Solution 1: Changes to the National Flood Insurance Programs (NFIP)

The National Flood Insurance Program (NFIP) was established in 1968 by congress to address several policy objectives, including 1) provisioning affordable insurance premiums to residents located in flood risk areas, 2) reducing Federal disaster assistance costs, 3) pushing efficiency in community-based floodplain management programs, and 4) identifying flood risk regions across the USA. Participating NFIP communities have requirements for mandatory flood insurance for structures with Federally backed loans as well as minimum building standards to reduce damages from flooding. However, these building standards can often result in inequitable costs for low risk agricultural structures and may negatively impact the agricultural use of the floodplain. Revising NFIP standards to allow low risk agricultural development in floodplains would help preserve equitable use and continue to provide an assessment base for these otherwise un-developable high flood risk areas.

Solution 2: Levee Relief Cuts

Levee relief cuts are flood mitigation techniques where an intentional break is executed in a downstream levee to allow flood water from a breach in an upstream levee to be drained back into an existing river. Levee relief cuts reduce the interior flood elevation by reducing the height of the levee preventing the flood water from flowing back into the system. If appropriately located to ensure that floodwater can be managed efficiently and safely, levee relief cuts can reduce flood damage.

Solution 3: Emergency Flood Fight Plan

An Emergency Flood Flight Plan is a written document that establishes how a specific maintaining agency will manage resources and operate during a flood event. To protect life and property, local agencies should utilize available resources to support flood response efforts and seek assistance from State and Federal Agencies when capabilities are exceeded. According to the 2003 Flood Fighting Methods DWR report, the main causes of levee failure during periods of high water are seepage, erosion, and overtopping. To combat such failures, maintaining agencies need to be equipped with the necessary flood fight stockpiling materials, such as, sandbags, lumber, sacks, and plastic sheeting such as Visquine. In addition, maintainers should be adequately trained in flood fight methods and the Standardized Emergency Management System (SEMS).

Solution 4: Flood Emergency Evacuation Plan[3]

Evacuation plans require detailed hydrologic analyses for determining the rate of rise of floodwaters for various rainfall or snowmelt events. Additionally, these plans identify total depth of flooding and velocities, which are often the most significant aspect of flooding. Utilizing evacuation plans in conjunction with other flood preparedness plans such as, evacuation warning systems, there is significant potential for the reduction of risk to human life. This solution should only be implemented if there is provision for adequate response and action time available for residents to evacuate. It is critical that rally points and evacuation routes be established and communicated to the public.

Solution 5: Flood Emergency Warning System

A flood emergency warning system is crucial in allowing the public as much time as possible to evacuate or avoid flood areas. Each community's jurisdiction is responsible for notifying residents when conditions of area levees threaten flooding. A well-informed public is likely to respond efficiently in cases of flooding disasters. There are different ways of educating the public, including, a siren system, alert system, emergency calling system, and neighborhood watch and community support programs.

Solution 6: Voluntary Structure Elevation & Floodproofing

a. Elevation

Elevating structures above flood level is a common and effective way of minimizing damage from floodwaters, and a key flood protection provision of the NFIP. This process consists of separating a building from its foundation by lifting the hydraulic jacks and placing it on a new or extended foundation. Elevation can be conducted on existing fills, foundation walls, piers, piles, and posts or columns. The proper elevation technique depends on the overall flood characteristics (depth or velocity).

b. Floodproofing

Floodproofing is another effective way of minimizing any potential damages caused by floodwaters. This nonstructural solution can be categorized into two techniques; dry floodproofing and wet floodproofing. Dry

[3] The USACE Nonstructural Flood Risk Management Measures: http://www.nwd-mr.usace.army.mil/rcc/MRFTF/docs/USACE-NFPC%20Nonstructural%20Measures%20Definitions.pdf

floodproofing involves methods such as sealing building walls with waterproof compounds (membranes/sealants) for the provision of watertight closures. An important factor to keep in mind with this technique is that walls should be strong enough to withstand the hydrostatic force of the water. Safeguards can also be installed to seal off doors, windows, and any additional openings.

Wet floodproofing is a technique that can reduce the damage to a structure and its contents while still allowing the structure to flood. With this method, the structure needs to be anchored to avoid flotation and include some form of permanent opening that will allow water to flow in and out of the structure without causing damage to the foundation.[4] The most effective method of protection for equipment and contents is to relocate threatened items out of harm's way. Vulnerable items, such as electrical, mechanical, and utility must be relocated either permanently or temporarily to higher elevations or protected locations. The preferred depth of flood protection is a critical consideration in structure elevation and the floodproofing processes. The Base Flood Elevation (BFE) will determine the costs associated with executing this nonstructural solution.

Solution 7: Buyout/Acquisition

An acquisition or buyout is a process in which, a local agency or the State decides to acquire and eliminate damageable structures. This would allow property owners to relocate away from flood hazards. This form of nonstructural technique can be executed either by demolishing or auctioning off the structure. New development sites can be established through this proposed solution in order to provide opportunities for displaced individuals to rebuild homes within other established communities.

Multi-Benefit Funding Summary

Limited funding resources are currently available to support the development of multi-benefit projects as presented in **Table 8**. Multi-benefit projects use time-tested, common sense approaches combined with the latest engineering data to lower flood risk, enhance habitat, increase recreational opportunities, and improve water quality. Setting levees back or adding berms in strategic places and creating designated bypasses are just a few ways of reducing flood risk while protecting and restoring habitat ecosystems.

Habitat Restoration

State Agencies such as the Wildlife Conservation Board (WCB) have provided funding programs such as the California Riparian Habitat Conservation Program to support organizations whose mission is to develop a coordinated approach to protecting and enhancing riparian ecosystems. Riparian areas are strips of land adjacent to streams, rivers, and wetlands. While riparian areas comprise only a very small portion of the land area in the State, they are an extremely important component for healthy watersheds and ecological functions. These areas provide critical habitat for wildlife including plant species or vegetations. Healthy riparian

[4] FEMA Mitigation Directorate: https://www.fema.gov/media-library-data/20130726-1511-20490-8042/tb_7_complete_scan.pdf

vegetation helps to reduce erosions and can provide shade, which works to lower water temperatures. Lowered water temperatures support higher oxygen levels, which is important in maintaining fisheries.[5]

Recreational Opportunities

The California State Parks department offers two funding programs that promote the creation, expansion, or renovation of parks and park facilities; Regional Park Program (RPP) and Specialty Park Program (SPP). These funding programs support multi-benefit projects that assist underserved communities across California. Recreational implementations can include, individual trails, regional trail networks, regional sports complexes, low-cost accommodations in park facilities, and visitor, outdoor, and interpretive facilities.

Water Quality Improvement

The IRWM program promotes multi-benefit projects that improve water quality and water management efficiency. The program's objectives include, providing clean, safe, reliable drinking water, implementing water use efficiency to meet or exceed State and Federal requirements, and protect groundwater resources from contamination. Along with IRWM, programs such as the Watershed Restoration Grant Program offered by the California Department of Fish and Wildlife (CDFW) provides funding for projects that increase water quality and watershed protection and restoration.

Conclusion

State and Federal funding is crucial for the viability of many small community flood risk reduction projects in the Central Valley. This Funding Sources Memo, along with the Financial Feasibility Memo provide a guide for small communities in identifying non-local funding sources for structural and non-structural implementation strategies. The matrix provided in (**Table 9**) should be used and cross referenced with (**Tables 1 through 8**), which outline the available State and Federal funding programs.

[5] Wyoming Department of Environmental Quality: http://deq.wyoming.gov/wqd/non-point-source/resources/why-are-riparian-areas-important/

Table 9
SCFRR - Funding Sources Memo
Funding Sources by Solution Matrix

		Structural			Non-Structural						Multi-Benefit	Study/ Plan/ O&M	
Funding Program	**Agency**	**Levees/ Floodwalls/ Dams/ Weirs**	**Bypasses/ Culverts/ Channels/ Spillways/ Floodways**	**Basins/ Reservoirs**	**Changes to NFIP**	**Relief Cuts**	**Emergency Flood Fight Plan**	**Flood Emergency Evacuation Plan**	**Flood Emergency Warning System**	**Voluntary Structure Elevation & Floodproofing**	**Acquisition / Relocation**	**Recreational/habitat restoration/environmental protection/water quality**	**Feasibility Study /Flood Management Plan**	**OMRR&R**
Watershed Restoration Grant Program	Ca. DFWS	X	X								X	X		
Urban Stormwater and Waterways Improvement Program (Prop 68)	California Natural Resources Agency	X	X			X						X		
Urban Green Infrastructure Program (Prop 68)	California Natural Resources Agency	X	X			X						X		
Urban Flood Protection Grant Program (Prop 68)	California Natural Resources Agency	X	X	X		X				X	X	X		
Specialty Park Program (SPP) Round 3	California State Parks	X	X									X		
Specialty Park Program (SPP) Future Rounds	California State Parks	X	X									X		
Regional Park Program (RPP)	California State Parks	X	X									X		
Delta Levees Maintenance Subventions	DWR	X												
Delta Levees Special Flood Control Projects	DWR	X												
Early Implementation Program (EIP) & Urban Flood Risk Reduction (UFRR)	DWR	X	X											
Regional Flood Management Planning (RFMP)	DWR												X	
Small Communities Flood Risk Reduction Program (SCFRRP) - SPFC Facilities	DWR	X	X			X	X	X	X		X		X	
Flood System Repair Projects (FSRP) - SPFC Facilities	DWR	X	X									X		
Flood Control Subventions Program (FCSP)	DWR	X	X			X					X	X		
Central Valley Tributaries Program (CVTP)	DWR	X	X			X					X	X		
Integrated Regional Water Management (IRWM)	DWR	X	X								X	X		
Flood Maintenance Assistance Program (FMAP) - SPFC Facilities	DWR													X
Flood Emergency Response Grants Program: Delta Flood ER Grant	DWR						X	X	X					
Sustainable Groundwater Planning/ Implementation Program	DWR											X		
Flood Mitigation Assistance (FMA)	FEMA		X			X				X	X			
Pre-disaster Mitigation (PDM)	FEMA	X	X							X	X			
Hazard Mitigation Grant Program (HMGP)	FEMA	X	X							X	X			
Repetitive Flood Claims Grant Program (RFCP)	FEMA										X			
State Community Developmenmt Block Grant (CDBG)	HUD										X			
Delta Conservancy Ecosystem Restoration and Water Quality Grant Program	Sacramento-San Joaquin Delta Cons.	X	X								X	X		
San Joaquin River Conservancy Proposition 1 Grant Program	San Joaquin River Conservancy	X	X								X	X		
Flood Damage Reduction Projects (FDRP)	USACE	X	X			X	X	X	X		X		X	
Flood-Related Continuing Authorities Program (FRCA)	USACE	X	X			X	X	X	X	X	X		X	
Sacramento River Bank Protection Project (SRBPP)	USACE	X	X			X								
Emergency Watershed Protection (EWP) - Floodplain Easements	USDA										X			
Watershed and Flood Prevention (WFPO)	USDA	X				X						X		
Habitat Enhancement and Restoration Program (HERP)	WBC	X	X			X					X	X		
California Streamflow Enhancement Program (CSEP)	WCB		X									X		
Lower American River Conservation Program (LARCP)	WCB	X	X								X	X		
California Riparian Habitat Conservation Program	WCB	X	X								X	X		
Inland Wetlands Conservation Program (IWC)	WCB	X	X			X						X		

ATTACHMENT G

Memorandum of Understanding Respecting the Sacramento River Flood Control Project

November 6, 1953

MEMORANDUM OF UNDERSTANDING

RESPECTING THE SACRAMENTO RIVER FLOOD CONTROL PROJECT

This Memorandum of Understanding entered into this 30th day of November, 1953, by and between the Corps of Engineers, U. S. Army, represented by the Division Engineer, South Pacific Division, Corps of Engineers, United States Army, hereinafter called the Corps, and the State of California, represented by its agency the Sacramento and San Joaquin Drainage District, acting by and through The Reclamation Board, hereinafter called the State,

W I T N E S S E T H :

That, whereas the United States represented by the Corps and the State are collaborating in the prosecution of a public improvement commonly known as the Sacramento River Flood Control Project; and

Whereas, for Federal budgetary and appropriation purposes the said Sacramento River Flood Control Project is prosecuted by the Corps under two separate and distinct subdivisions; namely, that portion adopted by the Federal Flood Control Acts approved 1 March 1917, 15 May 1928, 26 August 1937 and 18 August 1941, hereinafter called the "Old Project", and that portion adopted by the Federal Flood Control Acts approved 22 December 1944 and 17 May 1950, hereinafter called the "Major and Minor Tributaries Project"; and

Whereas, on 29 September 1952 representatives of the Chief of Engineers and the State of California, represented by the State

Reclamation Board and the State Engineer, agreed as to the position of the several agencies with respect to the "Old" Sacramento River Flood Control Project, the basic principles of which are incorporated herein; and

Whereas, under the laws of the State of California the State, acting by and through its Reclamation Board, may, in cooperation with the Corps, adopt and carry out any project plans and give assurances satisfactory to the Secretary of the Army of the United States that the State will provide the local cooperation on the project required by Federal law to be furnished by the State and local interests; and

Whereas, total expenditures on the Old Project to date amount to about $125,000,000, of which approximately one-third has been expended by the United States and two-thirds by the State of California and other local interests; and

Whereas, under the laws of the State of California the Department of Public Works, Division of Water Resources of the State of California, acting by and through the State Engineer, has supervisory powers over the maintenance and operation of the works of the project, and has the direct obligation of maintaining and operating a major portion of such works; and

Whereas, a number of public districts and other local interests within the State are, pursuant to State law, responsible for the maintenance and operation, or for defraying the cost of maintenance and operation of such portions of the flood control works of the project as are within the boundaries or jurisdiction of such districts or local interests, subject, however, to the supervision of the State; and

Whereas, the State acting by and through its Reclamation Board has given to the United States, on behalf of the State and local interests, the assurances of local cooperation on the project required by Federal law, namely: That the State will provide without cost to the United States all lands, easements and rights of way; bear the expense of necessary highway, railroad and bridge alterations; hold and save the United States free from claims for damages resulting from construction of the works; and maintain and operate all works after completion; and

Whereas, Federal improvements constructed and authorized by the Congress, for construction by the Corps, on the Sacramento River, include, in addition to the Sacramento River Flood Control Project, a Navigation Project, both of which have been modified and enlarged from time to time by Federal legislation; and

Whereas, the construction and operation of Shasta Reservoir on the Sacramento River and other Federally authorized or proposed multi-purpose reservoirs on other streams within and without the Sacramento River Drainage Basin, not contemplated under the Sacramento River Flood Control Project, will materially alter the regimen of stream flow during both low and high water seasons and might adversely affect the stability of project river banks and levees and thereby increase the cost of the maintenance of flood control works; and

Whereas, it is considered advisable, necessary and expedient that the parties hereto arrive at an understanding regarding the project, and particularly concerning the respective obligations of the parties with reference thereto.

Now, Therefore, the parties hereto agree that the provisions hereof, under the following subject headings, represent

their mutual understanding, namely: 1. Items comprising the Old Sacramento River Flood Control Project; 2. Levee construction standards; 3. Costs of completion of the Old Project; 4. Respective responsibilities of the United States and the State with regard to the completion of construction and the operation and maintenance of the Old Project.

1. Items Comprising The Old Sacramento River Flood Control Project.

The following is a general description of the system of project works as the same have been authorized for construction by the Congress prior to December 22, 1944 (date of approval of Public Law 534, 78th Congress, 2d Session):

(1) Levees along the Sacramento River below Chico Landing and on the lower reaches of American, Feather, Bear and Yuba Rivers and on numerous other intercepted streams, canals and sloughs.

(2) Leveed by-passes through Yolo and Sutter basins along Butte Slough and leading from Moulton and Colusa Weirs.

(3) The Moulton, Colusa, Tisdale, Fremont and Sacramento Weirs located on the Sacramento River for the purpose of discharging excess river channel flood flows into Butte Basin and the Sutter and Yolo By-passes.

(4) Unleveed by-pass through Butte Basin.

(5) The enlarged Sacramento River channel extending from the mouth of Cache Slough to Collinsville.

(6) The Tisdale By-pass for conveyance of discharges over Tisdale Weir to Sutter By-pass, together with its levees.

(7) The Sacramento By-pass for conveyance of discharges over Sacramento Weir to Yolo By-pass, together with its levees.

(8) The Wadsworth Canal and East and West intercepting canals, together with their levees.

(9) The Western Pacific Interceptor, the Natomas Cross Canal, the Natomas East Canal, and the Coon Creek Group Interceptor, together with their levees.

(10) The levee adjacent to the east bank of Colusa Trough.

(11) The Knights Landing Ridge Cut, together with the levees on both sides thereof.

(12) The Cache Creek Settling Basin and its surrounding levees.

(13) The primary clearing of by-passes and overflow channels.

(14) Three major pumping plants adjacent to the east levee of Sutter By-pass.

(15) Two major outfall structures, one from the lower end of Butte Basin to Sacramento River near Colusa, and the other from the lower end of Colusa Trough to Sacramento River near Knights Landing.

(16) Appurtenant structures and gaging stations.

(17) Alteration of existing bridges, railroads and highways.

The following tabulation enumerates specifically the project works and features under the subject headings (a) Levees, (b) Weirs, (c) Drainage Pumping Plants, (d) Channels and Canals, (e) By-passes, (f) Check Dams and Drains, (g) Bridges, and (h) Gaging Stations:

(a) Levees

ITEM	STREAM OR CHANNEL	LOCATION	APPROX. LENGTH IN MILES
1	American River, left bank	Sacramento R. to Mayhew	11.3
2	American River, right bank	Sacramento R. to Swanston	5.9
3	Arcade Creek, left bank	Natomas E.Canal to Old Msvl.Rd.	2.1
4	Arcade Creek, right bank	Natomas E.Canal to Old Msvl.Rd.	2.0
5	Bear River, left bank	Feather R. to high ground	12.6
6	Bear River, right bank	Feather R. to high ground	14.2
7	Butte Sl. By-pass, R.Bk.	Butte Sl.Outfall Gates to Long Bridge	7.4
8	Cache Creek, left bank	Yolo By-pass to high ground	10.3
9	Cache Creek, right bank	Cache Cr.Set.Bsn.to high grnd.	9.5
10	Cache Cr.Set.Bsn. lt.bnk.	Cache Cr. to Yolo By-pass	2.3
11	Cache Cr.Set.Bsn. rt.bnk.	Cache Cr. to Yolo By-pass	4.7

(a) Levees (Cont'd.)

ITEM	STREAM OR CHANNEL	LOCATION	APPROX. LENGTH IN MILES
12	Cache Slough, left bank	Steamboat Sl. to Maine Prairie	9.5
13	Cache Slough, right bank	Yolo By-pass to Ulatis Creek	4.6
14	Colusa By-pass, lt. bk.	Sacramento R. easterly	1.1
15	Colusa By-pass, rt. bk.	Sacramento R. easterly	1.0
16	Colusa Trough, lt. bk.	Knights Lndg. to high ground	37.8
17	Coon Cr. Gp. Intercept. rt. bank	Natomas Cross Canal to near Trowbridge	4.8
18	E. Intercept.Canal,lt. bk.	Wadsworth Canal to nr.Pease Sta.	3.0
19	Elk Slough, left bank	Sacramento R. to Sutter Sl.	9.2
20	Elk Slough, right bank	Sacramento R. to Sutter Sl.	9.2
21	Feather R. left bank	Sacramento R. to Honcut Cr.	41.3
22	Feather R. right bank	Sutter By-pass to Western Canal Headgate	44.3
23	Georgiana Sl. lt. bk.	Sacramento R. to Mokelumne R.	12.8
24	Georgiana Sl. rt. bk.	Sacramento R. to Mokelumne R.	11.9
25	Haas Slough, lt. bk.	Cache Sl. to near Millar	8.6
26	Haas Slough, rt. bk.	Cache Sl. to near Maine Prairie	4.8
27	Honcut Creek, lt. bk.	Feather R. to high ground	4.1
28	Knights Ldg.Rdg.Cut, lt bk.	Sycamore Sl. to Yolo By-pass	6.3
29	Knights Ldg.Rdg.Cut,rt.bk.	Sycamore Sl. to Yolo By-pass	6.4
30	Linda Cr., left bank	Natomas E.Canal to high ground	1.4
31	Lindsey Sl. left bank	Yolo By-pass to Dozier Sta.	7.0
32	Lindsey Sl. rt. bank	Yolo By-pass to high ground	6.1
33	Miner Slough, left bank	Sutter Sl. to Cache Sl.	8.3
34	Miner Slough, right bank	Sutter Sl. to Yolo By-pass	2.5
35	Moulton By-pass, lt. bk.	Sacramento R. easterly	2.0
36	Moulton By-pass, rt. bk.	Sacramento River easterly	0.3
37	Natomas Cross Canal, lt.bk.	Sacramento R.to Natomas E. Canal	5.2
38	Natomas Cross Canal,rt.bk.	Sacramento R.to Coon Cr.Gr.Inter.	5.3
39	Natomas E.Canal, lt. bk.	American R. to Linda Cr.	4.1
40	Natomas E.Canal, rt. bk.	American R.to Natomas Cross Canal	15.8
41	Nigger Jack Sl.lt.bk.	Feather R. to Yuba R.	3.1
42	Nigger Jack Sl.rt. bk.	Feather R. to high ground	6.5
43	North Dry Crk.lt.bk.	W.P. Interceptor to high ground	2.1
44	Putah Cr., left bank	Yolo By-pass to W. of Davis	9.4
45	Putah Cr. right bank	Yolo By-pass to W. of Davis	7.5
46	Sacramento By-pass, lt.bk.	Sacramento R. to Yolo By-pass	1.8
47	Sacramento By-pass, rt.bk.	Sacramento R. to Yolo By-pass	1.7
48	Sacramento R. left bank	Mayberry Sl.to Butte-Glenn Co. Line	164.1
49	Sacramento R. rt. bk.	Junction Point to Ord Ferry	163.5
50	South Dry Cr.,lt. bk.	Bear R. to high ground	9.0
51	South Dry Cr., rt. bk.	Bear R. to high ground	1.6
52	Steamboat Sl., lt. bk.	Sacramento R. to Junct. Pt.	13.2
53	Steamboat Sl., rt. bk.	Sacramento R. to Junct. Pt.	11.9
54	Sutter By-pass, lt. bk.	High Ground near Long Bridge to Feather R.	23.4
55	Sutter By-pass, rt. bk.	Long Bridge to Sacramento R.	33.8
56	Sutter Sl. lt. bk.	Sacramento R. to Steamboat Sl.	6.9
57	Sutter Sl., rt. bk.	Sacramento R. to Steamboat Sl..	6.9

(a) Levees (Cont'd.)

ITEM	STREAM OR CHANNEL	LOCATION	APPROX. LENGTH IN MILES
58	Threemile Sl., lt. bk.	Sacramento R. to San Joaquin R.	4.1
59	Threemile Sl., rt. bk.	Sacramento R. to San Joaquin R.	3.6
60	Tisdale By-pass, lt. bk.	Sacramento R. to Sutter By-pass	4.4
61	Tisdale By-pass, rt. bk.	Sacramento R. to Sutter By-pass	4.4
62	Ulatis Cr. rt. bk.	Cache Sl. to near Dozier Sta.	3.9
63	Wadsworth Canal, lt. bk.	Sutter By-pass to E.Intercept.Cl.	4.6
64	Wadsworth Canal, rt. bk.	Sutter By-pass to W.Intercept.Cl.	4.5
65	W.Intercept.Canal, rt. bk.	Wadsworth Cl. to Sutter Buttes	1.8
66	Western Pac.Intercep.,lt.bk.	Bear R. to N. Dry Creek	2.3
67	W.P.Intercept.rt. bk.	Bear R. to near Alicia Sta.	6.3
68	Willow Sl., lt. bk.	Yolo By-pass to near Merritt Sta.	8.0
69	Willow Sl., right bank	Yolo By-pass to near Merritt Sta.	7.9
70	Yankee Sl., lft bank	Bear R. to high ground	3.8
71	Yankee Sl., right bank	Bear R. to high ground	6.3
72	Yolo By-pass, lt. bk.	Fremont Weir to Miner Sl.	37.1
73	Yolo By-pass, rt. bk.	Fremont Weir intermittently to near Rio Vista	34.4
74	Yuba River, left bank	Feather R. to high ground	7.2
75	Yuba River, right bank	Feather R. to high ground	8.0
		Total length	980.0

(b) Weirs and Control Structures

ITEM	STRUCTURE	LOCATION	
1	Moulton Weir	Lt.bk. Sacramento R.at River Mi.	159.0
2	Colusa Weir	Lt.bk.Sacramento R.at R. Mi.	146.5
3	Butte Sl.Outfall Gates	Lt.bk.Sacramento R. at R. Mi.	139.2
4	Tisdale Weir	Lt.bk.Sacramento R. at R. Mi.	129.4
5	Knights Ldg. Outfall Gates	Rt.bk.Sacramento R. at R. Mi.	89.6
6	Fremont Weir	Rt.bk.Sacramento R. at R. Mi.	82.3
7	Sacramento Weir	Rt.bk.Sacramento R. at R. Mi.	62.9

(c) Drainage Pumping Plants

ITEM	PUMPING PLANT	LOCATION
1	Sutter By-pass No. 1	Near Chandler
2	Sutter By-pass No. 2	At O'Banion Road
3	Sutter By-pass No. 3	Above mouth of Wadsworth Canal.

(d) Channels and Canals

ITEM	STREAM OR CHANNEL	LOCATION	LENGTH IN MILES
1	American River	Sacramento River to Mayhew	8.3
2	Arcade Creek	Natomas E.Canal to Old Msvl.Rd.	2.1
3	Bear River	Feather R.to E.Bdry of S-S.J.D.D.	13.4
4	Cache Cr. and Cache Cr. Settling Basin	Yolo By-pass to high ground	10.4
5	Cache Slough	Yolo B-P to W.Bdry of S-S.J.D.D.	11.0
6	Coon Cr. Grp.Intercept.	Natomas Cross Cnl.to nr Trowbridge	4.8
7	E.Intercepting Canal	Wadsworth Canal to nr Pease Sta.	3.0
8	Elk Slough	Sacramento R. to Sutter Slough	9.2
9	Feather River	Sacramento R. to Western Cnl. Headgate	45.0
10	Georgiana Slough	Sacramento R. to Mokelumne R.	12.8
11	Haas Slough	Cache Sl.to W.Bdry.S-S.J.D.D.	2.9
12	Honcut Creek	Feather R.to E.Bdry.S-S.J.D.D.	4.1
13	Knights Lndg.Ridge Cut	Sycamore Sl. to Yolo By-pass	6.4
14	Linda Creek	Natomas E.Canal to Old Msvl.Rd.	1.4
15	Lindsey Slough	Yolo B.P.to W.Bdry.S-S.J.D.D.	6.7
16	Miner Slough	Sutter Sl. to Cache Sl.	8.3
17	Natomas Cross Canal	Sacramento R.to Natomas E.Canal	5.2
18	Natomas East Canal	American R.to Natomas Cross Cnl	15.8
19	Nigger Jack (Simmerly) Sl.	Feather R. to W.P.R.R.	1.7
20	North Dry Creek	W.P.Intercept.Canal to Old Marysville Road	2.1
21	Putah Creek	Yolo By-pass to Winters	17.2
22	Sacramento River	Collinsville to Crd Ferry	184.6
23	South Dry Creek	Bear R. to E.Bdry.S-S.J.D.D.	9.0
24	Steamboat Slough	Sacramento R.to Junction Pt.	13.2
25	Sutter Slough	Sacramento R.to Steamboat Sl.	6.9
26	Threemile Slough	Sacramento R.to San Joaquin R.	3.6
27	Ulatis Creek	Cache Sl.to W.Bdry.S-S.J.D.D.	1.5
28	Wadsworth Canal	Sutter By-pass to E. & W. Intercept. Canal	4.5
29	W. Intercepting Canal	Wadsworth Canal to Sutter Buttes	1.3
30	W.P.Interceptor Canal	Bear R. to near Alicia Sta.	6.3
31	Willow Slough	Point on Willow Sl. near Merritt Sta. on S.P.R.R. in Yolo Co. to Yolo By-pass	8.0
32	Yankee Slough	Bear R.to E.Bdry.S-S.J.D.D.	6.3
33	Yuba River	Feather R.to Two Mi. E. of S-S.J.D.D.	8.0
		Total Length	446.0

(e) By-passes

ITEM	BY-PASS	LOCATION	LENGTH IN MILES	AREA IN ACRES
1	Butte Basin	Sacramento River to Butte Slough	33.0	110,000
2	Butte Slough	Butte Sl. Outfall Gts. to Long Brdg.	6.7	2,000
3	Sutter	Long Bridge to Sacramento R. at Verona & Fremont Weir	30.0	22,000
4	Colusa	Colusa Weir on Sacramento R. to Butte Basin	1.0	470
5	Tisdale	Tisdale Weir on Sacramento R. to Sutter By-pass	4.3	480
6	Yolo	Fremont Weir on Sacramento R. to Rio Vista	43.0	75,000
7	Sacramento	Sacramento Weir on Sacramento R. to Yolo By-pass	2.0	400
			120.0	210,350

(f) Check Dams and Drains

ITEM	CHANNEL OR CANAL	LOCATION
1	Borrow Pit, E.L. Sutter By-pass	0.7 mile below Wadsworth Canal
2	Borrow Pit, W.L. Sutter By-pass	Opposite mouth of Wadsworth Canal
3	Gilsizer Slough	Sutter By-pass, 2.5 miles S. of Tisdale By-pass
4	Willow Slough	Sutter By-pass near Chandler
5	Wadsworth Canal	South Butte Road
6	Collecting Canals and Seepage Ditches	Tributary to East side of Sutter By-pass

(g) Bridges

ITEM	STREAM OR CHANNEL	LOCATION
1	Sutter By-pass E. levee borrow pit	Chandler
2	Sutter By-pass E. levee borrow pit	Sutter Causeway
3	Sutter By-pass E. levee borrow pit	One-half mi, N. of O'Banion Road
4	Sutter By-pass E. levee borrow pit	Bogue Road
5	Sutter By-pass E. levee borrow pit	Below mouth of Wadsworth Canal
6	Sutter By-pass E. levee borrow pit	Franklin Road
7	Sutter By-pass W. levee borrow pit	Karnak
8	Sutter By-pass W. levee borrow pit	McClatchy Road
9	Sutter By-pass W. levee borrow pit	Franklin Road
10	Tisdale B.P. S. levee borrow pit	Reclamation Road
11	Tisdale B.P. N. levee borrow pit	R.D. No. 1660 Pumping Plant
12	Wadsworth Canal	Franklin Road
13	Wadsworth Canal	South Butte Road
14	Wadsworth Canal	Butte House Road
15	East Intercepting Canal	West of East Butte Road
16	East Intercepting Canal	East Butte Road
17	East Intercepting Canal	Township Road
18	East Intercepting Canal	East of Madison Road
19	West Intercepting Canal	East of Mallot Road
20	West Intercepting Canal	West of Cemetery Road

(g) Bridges (Cont'd.)

ITEM	STREAM OR CHANNEL	LOCATION
21	West Intercepting Canal	East of Butte Pass Road
22	West Intercepting Canal	West of Butte Pass Road
23	West Intercepting Canal	One-half mi. W. of Butte Pass Road
24	Collecting Canal	Sutter By-pass Pmpg.Plant #1
25	Collecting Canal	Marcuse and Sawtelle Roads
26	Collecting Canal	One mile S. of O'Banion Road near Sutter By-pass
27	Collecting Canal	One mile S. of O'Banion Rd. and one-half mile E. of Sutter By-pass
28	Collecting Canal	O'Banion Road
29	Collecting Canal	One mi. N. of Sutter By-pass Pumping Plant No. 2
30	Collecting Canal	One mile N. of Oswald Road
31	Collecting Canal	Bogue Road

(h) Gaging Stations

ITEM	STREAM OR CHANNEL	LOCATION
1	Sacramento River	Keswick
2	Clear Creek	Near Igo
3	Cottonwood Creek	Near Cottonwood
4	Battle Creek	Near Cottonwood
5	Sacramento River	Iron Canyon
6	Sacramento River	Red Bluff
7	Antelope Creek	Near Red Bluff
8	Mill Creek	Near Los Molinos
9	Thomas Creek	Paskenta
10	Deer Creek	Near Vina
11	Sacramento River	Hamilton City
12	Chico Creek	Near Chico
13	Stony Creek	Near Hamilton City
14	Stony Creek	St. John
15	Sacramento River	Ord Ferry
16	Sacramento River	Butte City
17	Sacramento River	Gordon Pump
18	Sacramento River	Moulton Weir
19	Sacramento River	Colusa Weir
20	Sacramento River	Colusa
21	Sacramento River	Butte Slough Outfall Gates
22	Sacramento River	Meridian
23	Sacramento River	Reclamation Dist. No. 70 Pump
24	Sacramento River	Tisdale Weir
25	Sacramento River	Tisdale
26	Sacramento River	Below Wilkins Slough
27	Sacramento River	Near Rough & Ready Bend
28	Sacramento River	Knights Landing

(h) Gaging Stations (Cont'd.)

ITEM	STREAM OR CHANNEL	LOCATION
29	Butte Creek	Near Chico
30	Butte Slough	Outfall Gates
31	Butte Slough	Mawson Bridge
32	Sutter By-pass	Long Bridge
33	Sutter By-pass	No. 3 Pumping Plant
34	Wadsworth Canal	Butte House Road
35	Sutter By-pass	No. 2 Pumping Plant
36	Tisdale By-pass	Reclamation Dist. No. 1660 Pump
37	Sutter By-pass	No. 1 Pumping Plant
38	Sutter By-pass	Reclamation Dist. No. 1500 Pump
39	Feather River	Five miles east of Oroville
40	Feather River	Oroville
41	Feather River	Near Gridley
42	Yuba River	Narrows Dam
43	Yuba River	Simpson Lane Bridge
44	Yuba River	Marysville
45	Feather River	Yuba City
46	Feather River	Below Shanghai Bend
47	Bear River	Near Wheatland
48	Feather River	Nicolaus
49	Sacramento River	West end Fremont Weir
50	Sacramento River	East end Fremont Weir
51	Sacramento River	Verona
52	Sacramento River	Pritchard Lake
53	Sacramento River	Sacramento Weir
54	Sacramento River	Opposite Sacramento Weir
55	Sacramento River	Second Bannon Slough
56	North Fork American River	Rattlesnake Bridge
57	South Fork American River	Coloma
58	American River	Folsom
59	American River	Fair Oaks
60	American River	H. Street Bridge
61	American River	Elvas
62	American River	Garden Highway
63	Sacramento River	I Street Bridge

The foregoing items (f) and (g) are pursuant to the provisions of portions of items (b), (c) and (d) of Section 8361 of the Water Code of the State of California, made part of the project for purpose of maintenance by the State, but said project items have not been specifically authorized by Congress. Also, only a portion of the gages in Item (h) has been authorized by Congress. Sections 8360 and 8361 read as follows:

"8360. On behalf of the State the Department of Public Works, acting by and through the State Engineer, has supervisory powers over the maintenance and operation of the flood control works of the Sacramento River Flood Control Project."

"8361. The department, acting by and through the State Engineer, shall maintain and operate on behalf of the State the following units or portions of the works of the Sacramento River Flood Control Project, and the cost of such maintenance and operation shall be defrayed by the State.

"(a) The east levee of the Sutter By-pass north of Nelson Slough.

"(b) The levees and channels of the Wadsworth Canal, Willow Slough Channel downstream from the Southern Pacific Railroad from Davis to Woodland except that portion of the north levee thereof lying within Reclamation District No. 2035, Putah Creek downstream from Winters, the intercepting canals draining into them, and all structures incidental thereto.

"(c) The collecting canals, sumps, pumps and structures of the drainage system of Project No. 6 east of the Sutter By-pass.

"(d) The by-pass channels of the Butte Slough By-pass, the Sutter By-pass, the Tisdale By-pass, the Yolo By-pass and the Sacramento By-pass with all cuts, canals, bridges, dams, and other structures and improvements contained therein and in the borrow pits thereof.

"(e) The levees of the Sacramento By-pass.

"(f) The channels and overflow channels of the Sacramento River and its tributaries within the Sacramento and San Joaquin Drainage District.

"(g) The Knights Landing Ridge Cut flowage area.

"(h) The flood relief channels controlled by the Moulton and Colusa Weirs and the training levees thereof.

"(i) The levee on the left bank of the Sacramento River adjoining Butte Basin, from the Butte Slough outfall gates upstream to a point four miles northerly from the Moulton Weir, after completion.

"(j) All weirs and relief structures.

"(k) The west levee of the Yolo By-pass, extending from the west end of the Fremont Weir southerly to the Cache Creek Settling Basin and from Willow Slough Channel to Putah Creek and the east levee of the Yolo By-pass from Fremont Weir southerly two miles.

"(l) The levee on the west bank of Feather River extending a distance of about two miles southerly from the Sutter-Butte Canal headgate.

"(m) The levees of Cache Creek and the easterly and westerly levees of Cache Creek Settling Basin.

"(n) The flowage area of Western Pacific Intercepting Canal extending northerly for a distance of five miles from Bear River."

The maintenance of all project works under the supervision of the State Engineer and in accordance with the foregoing Section 8360, except those enumerated in the foregoing Section 8361, is the responsibility and liability of local interests pursuant to Section 8370 of the Water Code, which reads as follows:

"8370. It is the responsibility, liability and duty of the reclamation districts, levee districts, protection districts, drainage districts, municipalities, and other public agencies within the Sacramento River Flood Control Project limits, to maintain and operate the works of the project within the boundaries or jurisdiction of such agencies, excepting only those works enumerated in Section 8361 and those for which provision for maintenance and operation is made by Federal Law."

Public Law 534, 78th Congress, 2d Session, and Public Law 516, 81st Congress, 2d Session, provide for the flattening of bypass levee slopes of the Sacramento River Flood Control Project; for the extension of the project to include the reclamation of Butte Basin; construction of two multi-purpose reservoirs on the Sacramento River and tributaries; and construction of levee and channel-improvement projects for flood control on nine minor tributary streams.

2. LEVEE CONSTRUCTION STANDARDS

The specifications for grade and section of the levees of the Sacramento River Flood Control Project are set forth in Senate Document No. 23, 69th Congress, 1st Session, (enacted by Public Law 391, 70th Congress) and in House Document 649, 78th Congress, 2d

The following tabulation, copied from House Document 649, 78th Congress, 2d Session, sets forth the specifications of Project levee sections:

	Crown Width	River Slope	Land Slope	Freeboard
Present authorized river levees (Old Project)	20 feet	1 on 3	1 on 2	3 feet
Proposed river levees (Major & Minor Tributaries Project)	20 feet	1 on 3	1 on 2	3 feet
Present authorized by-pass levees (Old Project)	20 feet	1 on 4 to 1 on 2½	1 on 2½	5 or 6 feet
Proposed By-pass levees (Major & Minor Tributaries Project)	20 feet	1 on 4	1 on 3	5 or 6 feet

The "present" sections as set forth in the tabulations were those in effect prior to 1944, and the "proposed" sections are those authorized by the Flood Control Act of 1944. Standards both prior and subsequent to 1944 provide for the construction of a surfaced roadway suitable for access, patrol, and maintenance on all levees. Levee standards for the minor tributary stream projects proposed in H. D. 649 provide for the same slopes and freeboard as the river levees, but with narrower crown widths.

The following exceptions to the foregoing standards have been adopted to conform to special local conditions after conference among Federal, State, and local interests. These exceptions provide for a crown width of only 12 feet on the following sections of Project levees. The numbers refer to the items denoted in the tabulation setting forth Project levees segregated by stream or by-pass channels and their respective left and right banks.

		Approximate length in miles
(a)	Items 10 and 11, levees within Cache Creek Settling Basin and levee adjacent to Sacramento Northern R. R. embankment	7.0
(b)	Portion of Item 12, levee on left bank of Cache Slough on Peters Tract, classified as minor tributary levee	2.6
(c)	Portion of Item 25, levee on left bank of Haas Slough, upstream from Duck Slough, classified as minor tributary levee	4.0
(d)	Portion of Item 26, levee on right bank of Haas Slough on Peters Tract, classified as minor tributary levee	3.6
(e)	Portions of Items 28 and 29, Knights Landing Ridge Cut levees between Sycamore Slough and the south line of Reclamation District No. 730	7.2
(f)	Portion of Item 42, levee on Nigger Jack Slough adjacent to Western Pacific R. R. embankment	4.8
(g)	Items No. 70 and 71, both levees of Yankee Slough, classified as a minor tributary	10.1
(h)	Small portion of Item 73, levee extending westerly from southern end of Yolo By-pass along Watson Hollow Drain to high ground	1.7
(i)	Item No. 67, west levee of the Western Pacific Interceptor along the W.P.R.R.	2.5
(j)	Portion of Item No. 39, east levee of Natomas East Canal from Globe Station to Linda Creek	3.6
(k)	Item No. 50, left bank South Dry Creek from 1.86 miles east of Bear River to high ground, including Grasshopper Creek levees.	8.5
	TOTAL	55.6

With reference to standards for by-pass levees as set forth in the table on page 14, the 2½:1 slopes were adopted during the early stages of the Project when practical considerations dictated a somewhat narrow base of levee to be placed with a floating clam-shell dredge of limited reach. The standards were progressively

changed with changes in methods of construction and as proven necessary by destructive wave-wash on the steeper waterward slopes and severe slips resulting from saturation of the landward slopes. About 52 miles of Sutter By-pass levees were reconstructed or contracts awarded therefor, by the State or the United States, prior to the adoption of the Flood Control Act of 1944, with waterward slopes of 1 on 4 and landward slopes of 1 on 3. These section standards were subsequently specifically authorized by the 1944 Flood Control Act, and the further flattening is to be accomplished as a part of the Major & Minor Tributaries Project.

3. COSTS OF COMPLETION OF PROJECT WORKS

The cost to complete the works of the Old Sacramento River Flood Control Project may be divided into two classifications, (a) Federal Costs, and (b) State Costs (inclusive of costs of all local interests).

(a) Federal Costs

The District Engineer, Corps of Engineers, Sacramento District, has made a field survey of the Old Sacramento River Flood Control Project with the objective of determining the work required to complete the Project.

The findings of the survey with reference to the work required to complete the levee system and the cost thereof in which the State concurs, follows. Item numbers refer to items denoted in the tabulation setting forth project levees segregated by stream or by-pass channels and their respective left and right banks.

Item	Stream or Channel	
1	American River, left bank	$ 18,654
2	American River, right bank	95,916
3	Arcade Creek, left bank	41,563
4	Arcade Creek, right bank	188,275
5	Bear River, left bank	72,869
6	Bear River, right bank	94,547
8	Cache Creek, left bank	572,001
9	Cache Creek, right bank	344,187
11	Cache Creek Settling Basin, right bank	28,614
12	Cache Slough, left bank	836,439
13	Cache Slough, right bank	189,124
16	Colusa Trough, left bank	1,006,748
17	Coon Creek Group Interceptor, right bank	129,505
19	Elk Slough, left bank	67,683
20	Elk Slough, right bank	171,085
21	Feather River, left bank	526,312
22	Feather River, right bank	672,749
25	Haas Slough, left bank	7,312
26	Haas Slough, right bank	128,555
28	Knights Landing Ridge Cut, left bank	76,612
29	Knights Landing Ridge Cut, right bank	84,728
30	Linda Creek, left bank	106,917
31	Lindsey Slough, left bank	263,795
32	Lindsey Slough, right bank	177,607
33	Miner Slough, left bank	202,149
34	Miner Slough, right bank	63,591

37	Natomas Cross Canal, left bank	130,907
38	Natomas Cross Canal, right bank	57,558
39	Natomas East Canal, left bank	304,703
40	Natomas East Canal, right bank	352,478
48	Sacramento River, left bank	4,210,210
49	Sacramento River, right bank	4,043,388
50	South Dry Creek, left bank	59,362
52	Steamboat Slough, left bank	943,946
53	Steamboat Slough, right bank	179,297
56	Sutter Slough, left bank	314,226
57	Sutter Slough, right bank	224,737
58	Threemile Slough, left bank	81,608
62	Ulatis Creek, right bank	114,075
70	Yankee Slough, left bank	16,383
71	Yankee Slough, right bank	59,363
73	Yolo By-pass, right bank	594,182
74	Yuba River, left bank	141,445
75	Yuba River, right bank	89,595
	Total Levee Costs	$18,085,000

The survey by the Corps also disclosed that the primary clearing of by-passes and overflow channels, a Project construction obligation, has not been accomplished on areas aggregating about 4,800 acres segregated by overflow channel or by-pass and their respective areas and costs, including contingencies, engineering and overhead, are as follows:

Overflow Channel or By-pass	Area in Acres	Cost
Sacramento River	350	$ 81,000
American River	95	16,000
Feather River	2,385	627,000
Bear River	570	250,000
Sutter By-pass	1,130	229,000
Yolo B y-pass	270	47.000
	4,800	$ 1,250,000

The total Federal cost, as estimated and submitted by the Corps to complete the Federal portion of the Project work at construction prices prevailing as of June 30, 1951, may be summarized as follows:

Levees - including structures, patrol roads, bank protection, contingencies, engineering and overhead	$ 18,085,000
Clearing by-pass and overflow channels	1,250,000
Dredging enlarged Sacramento River Channel below Cache Slough	200,000
Gaging Stations	25,000
Total Federal Costs	$ 19,560,000

The locations and lengths of sections of by-pass levees with waterward and landward slopes steeper than 4 to 1 and 3 to 1 are as follows:

Item	Location	Length in miles
(1)	Butte Slough By-pass, right bank	7.5
(2)	Sutter By-pass, right bank south of Long Bridge	5.3
(3)	Tisdale By-pass, right bank	4.4
(4)	Tisdale By-pass, left bank	4.4
(5)	Yolo By-pass, right bank, Fremont Weir South	12.2
(6)	Yolo By-pass, right bank, near Millar Sta. to Lindsey Sl.	10.6
(7)	Yolo By-pass, left bank, 2 mi. South of Fremont Weir to Miner Slough	31.0
(8)	Sacramento By-pass, right bank	1.7
(9)	Sacramento By-pass, left bank	1.8
	Total	78.9

The widths of the Tisdale and Sacramento By-pass channels are sufficiently narrow that there is no hazard from wavewash to their respective levees aggregating 12.3 miles in length designated items (3), (4), (8) and (9). The southerly 19.1 miles of the levee on the left bank of Yolo By-pass under present plans would be incorporated with the works of the authorized Sacramento Ship Channel. However, with favorable consideration of these items, there would still remain 47.5 miles of by-pass levees requiring flattening of waterward slopes to 1 on 4 and landward slopes to 1 on 3, for which no provision has been made in the estimate submitted by the Corps since this work is authorized under the Major and Minor Tributaries Project.

(b) State Costs (inclusive of costs of all local interests)

In addition to the Federal costs, there will be substantial State costs involved in completion of the Project. The Reclamation Board of the State of California has prepared an estimate of such State costs as of June 30, 1951, in which the Corps concurs, including the acquisition of levee rights of way and borrow areas, flowage easements, and alteration of improvements incidental to the items of construction or improvement set forth in this memorandum.

The estimates of State costs with reference to the rights of way required to complete the levee system are as follows (Item numbers refer to items denoted in the tabulation setting forth project levees, segregated by stream or by-pass channels and their respective left and right banks):

ITEM	STREAM OR CHANNEL		
1	American River, left bank	$	1,440
2	American River, right bank		39,870
3	Arcade Creek, left bank		62,860
4	Arcade Creek, right bank		215,930
5	Bear River, left bank		6,860
6	Bear River, right bank		17,260
8	Cache Creek, left bank		137,530
9	Cache Creek, right bank		70,735
12	Cache Slough, left bank		85,105
13	Cache Slough, right bank		28,340
16	Colusa Trough, left bank		154,830
17	Coon Creek Group Interceptor, right bank		10,800
19	Elk Slough, left bank		4,780
20	Elk Slough, right bank		20,350
21	Feather River, left bank		18,140
22	Feather River, right bank		367,450
25	Haas Slough, left bank		700
26	Haas Slough, right bank		20,025
28	Knights Landing Ridge Cut, left bank		4,075
29	Knights Landing Ridge Cut, right bank		4,500
30	Linda Creek, left bank		132,045
31	Lindsey Slough, left bank		69,820
32	Lindsey Slough, right bank		6,470
33	Miner Slough, left bank		18,500
34	Miner Slough, right bank		4,000
37	Natomas Cross Canal, left bank		12,020

ITEM	STREAM OR CHANNEL	
38	Natomas Cross Canal, right bank	$ 4,610
39	Natomas East Canal, left bank	184,640
40	Natomas East Canal, right bank	63,280
48	Sacramento River, left bank	1,489,790
49	Sacramento River, right bank	1,515,840
50	South Dry Creek, left bank	4,570
52	Steamboat Slough, left bank	72,840
53	Steamboat Slough, right bank	13,780
56	Sutter Slough, left bank	23,230
57	Sutter Slough, right bank	39,680
58	Threemile Slough, left bank	5,600
62	Ulatis Creek, right bank	15,470
70	Yankee Slough, left bank.	1,630
71	Yankee Slough, right bank	4,525
73	Yolo By-pass, right bank	163,850
74	Yuba River, left bank	36,170
75	Yuba River, right bank	18.700
	Total levee costs	$ 5,172,640

In addition to costs of rights of way for levee construction, State costs also include provision for the acquisition of additional flowage easements, not heretofore acquired in overflow areas, and the alteration of existing bridges, railroads and highways across river channels and by-passes where such are below flood plane elevation or otherwise obstruct flood flows. These additional items and their respective costs, including contingencies, engineering and overhead, are estimated as follows:

Bridge, railroad and highway alterations	$ 7,475,000
Flowage easements not yet acquired	2,112,000
Landside berm fills	130,000
Access to levee patrol roads, not yet constructed	15,000
Miscellaneous clearing, fence construction, etc.	60,000
Total additional items	9,792,000*
Levee rights-of-way	5,173,000
Total State costs	$ 14,965,000

*A detailed statement has been furnished to the District Engineer, Sacramento District, with respect to the additional items.

These total costs of the State and local interests do not include continuing expenditures by the State and local interests on the maintenance of Project works estimated to be in excess of $1,000,000 per year. Neither do they include the cost of acquisition of rights of way for flattening the slopes of 47.5 miles of sub-standard by-pass levees to waterward slopes of 1 on 4 and landward slopes of 1 on 3, for which no provision has been made in the estimate of Federal costs submitted by the Corps.

Summary of Costs to Complete Project

Work remaining to be performed by the Corps on the Old Sacramento River Flood Control Project, as determined by the Corps and concurred in by the State and listed in detail in this memorandum, comprises the reconstruction to adopted grade and section of 210 miles of levee, including miscellaneous structures; 46 miles of bank protection; 359 miles of levee patrol road; clearing 4,800 acres of by-pass and overflow channels; minor dredging of the enlarged Sacramento River Channel below Cache Slough; establishing gaging stations; all at an estimated Federal cost of $19,560,000, based on prices as of June 30, 1951. The estimated State cost for acquisition of levee rights of way and borrow areas, flowage ease-

ments, and alteration of improvements incidental thereto as determined by the State and concurred in by the Corps, is $14,965,000 as of June 30, 1951.

4. RESPECTIVE RESPONSIBILITIES OF THE UNITED STATES AND THE STATE WITH REGARD TO THE COMPLETION OF CONSTRUCTION AND THE OPERATION AND MAINTENANCE OF THE SACRAMENTO RIVER FLOOD CONTROL PROJECT.

Levee construction standards relative to the by-pass levees have been progressively changed from waterward and landward slopes of two and one-half to one, to waterward slopes of four to one and landward slopes of three to one, as proven necessary by destructive wavewash on the steeper waterward slopes and severe slips resulting from saturation of the landward slopes. About 52 miles of Sutter By-pass levees were so improved by the State or the United States prior to the adoption of the Flood Control Act of 1944 and the improved standards were subsequently specifically authorized by the 1944 Flood Control Act for by-pass levees. The total estimated Federal cost of $19,560,000 to complete the project works does not include the cost of completion of 47.5 miles of by-pass levees to revised standards nor the cost of completion of the southerly 19.1 miles of the levee on the left bank of Yolo By-pass for use in the event the Sacramento Ship Canal is not constructed, since this work is included in the Major & Minor Tributaries Project.

In addition to the Sacramento River Flood Control Project, there is a navigation project on the Sacramento River and each has

been authorized by the Congress as a separate and distinct project. The Sacramento River Deep Water Channel Project has been authorized by the Congress and construction thereon commenced.

The construction and operation of Shasta Reservoir of the Central Valley Project on the Sacramento River and other Federally authorized or proposed multi-purpose reservoirs have altered, or will materially alter, the regimen of stream flow during both low and high water seasons and might adversely affect the stability of project river banks and levees and thereby increase the cost of maintenance of flood control works.

The United States has sole responsibility for the construction of all levees to grade and section, and for the construction of all other project works as such are itemized under subject heading numbered 3 herein, and for the construction, operation and maintenance of all works relating to the improvement of navigation within the area of the Old Sacramento River Flood Control Project.

The State fully recognizes and accepts its obligation to operate and maintain all completed project works and has given assurances of local cooperation required by federal law. Such assurances obligating the State are limited to:

(a) Furnishing lands, easements and rights of way; bearing the expense of necessary highway, railroad and bridge alterations.

(b) Holding and saving the United States free from claims for damages due to construction of the works.

(c) The operation and maintenance of all the works, after completion, in accordance with regulations prescribed by the Secretary of the Army.

In conclusion, anything herein to the contrary notwithstanding, it is hereby agreed by the parties that the following represents the agreement of the parties with respect to the Sacramento River Flood Control Project (Old Project, so-called):

a. The State and the United States are in agreement as to the following:

1. The scope of the project;

2. The project standards;

3. The work to be done and the estimated cost thereof as of June 30, 1951;

4. The priority of the work will be determined by agreement between The Reclamation Board and the District Engineer, due consideration being given to the principle that in general the work, except strictly emergency work, be accomplished by beginning with the lower part of the project and working upstream.

Items 1, 2 and 3 are all as heretofore set forth herein.

b. The State accepts the fact that the flattening of certain by-pass levee slopes will be accomplished under the Major and Minor Tributaries Project, but urges that this work be expedited to the greatest extent practicable.

c. The State will continue to maintain locally constructed levees, including their contiguous waterway banks, which meet project standards, with or without patrol roads, and will accept for maintenance units of the project works as those units are satisfactorily completed.

d. In case any project works heretofore or hereafter accepted for maintenance by the State shall suffer damage or

deterioration due to the use of the river for functions other than flood control, such as for navigation or for the transportation of water as under the Central Valley Project, the State reserves any legal or equitable rights it may have, including the right to seek relief through judicial, legislative or administrative action.

e. Where works for navigation result in a shift in the channel or erosion of the opposing banks, corrective measures will be undertaken by the United States.

f. Pending completion and formal acceptance, it shall be the policy of the State to continue to perform normal maintenance to all project works.

g. The State recognizes that the Corps of Engineers interprets that the Federal obligation for the maintenance of the enlarged channel of Sacramento River below Cache Slough applies only to the navigation channel and that the maintenance of the remainder of the channel upon completion is a State obligation. However, the State reserves the right to request the future enactment by the Congress of legislation authorizing Federal maintenance of the entire channel in this reach of the Sacramento River. Further, The Reclamation Board is without State legislative authority to perform this maintenance, but upon failure to obtain such Federal enactment will seek State legislation to provide the required authority. Every effort will be made by The Reclamation Board to consummate the required Federal or State legislation prior to completion of this portion of the project.

In Witness Whereof, the respective parties hereto have

caused this Memorandum of Understanding to be executed as of the date first herein written.

THE UNITED STATES OF AMERICA

By _____
Division Engineer, South Pacific Division Corps of Engineers, United States Army

THE STATE OF CALIFORNIA, acting by and through The Reclamation Board

By _____
President

By _____
Secretary

APPENDIX H

Freeboard and Geometry Analysis – Levee Deficiencies Strip Maps

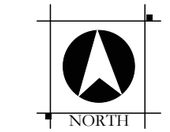
Levee Deficiencies Strip Maps – Yankee Slough South Levee

YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019



0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

Yankee Slough

0+00 1+00 2+00 4+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00

PRELIMINARY

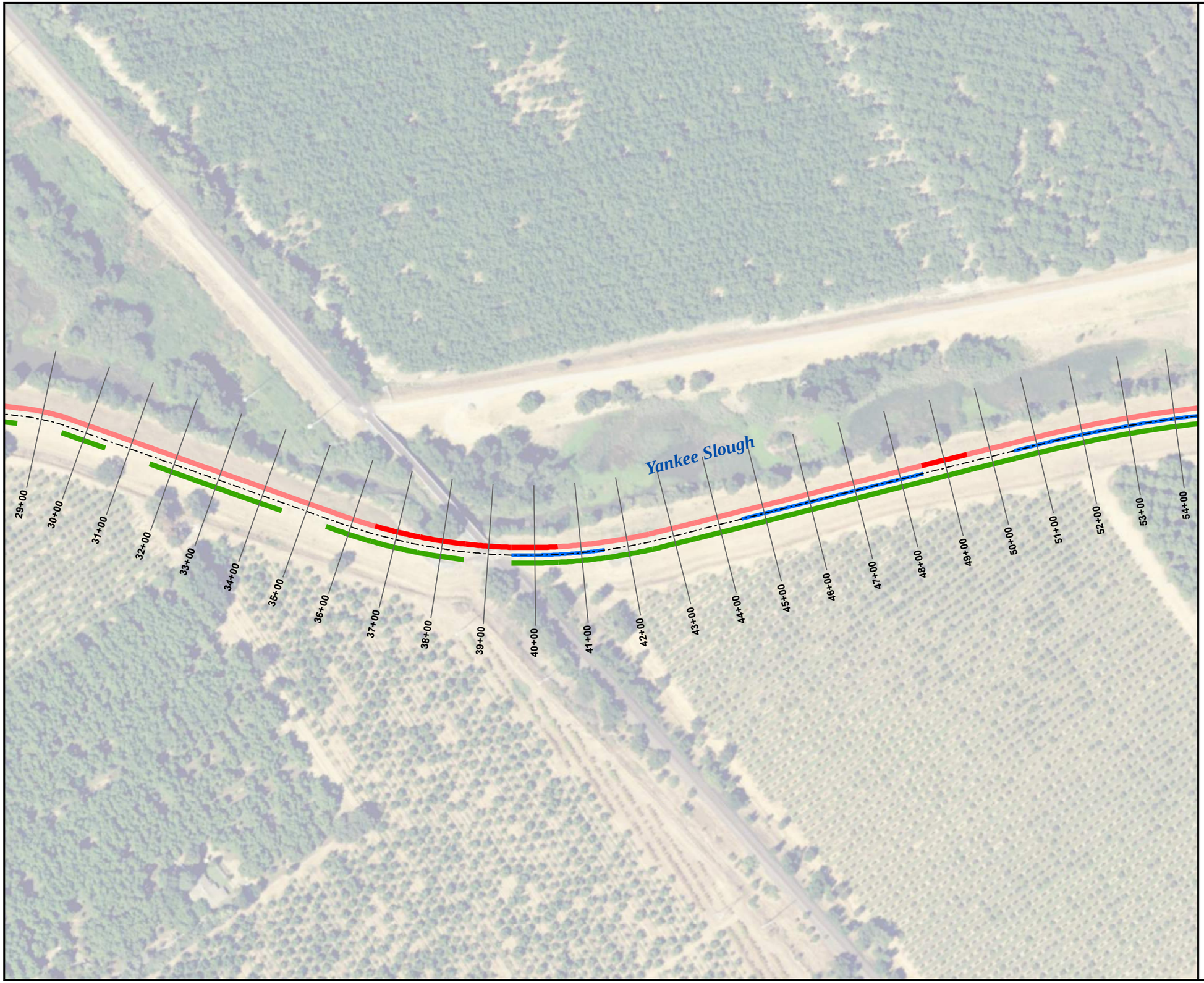
WOOD RODGERS

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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

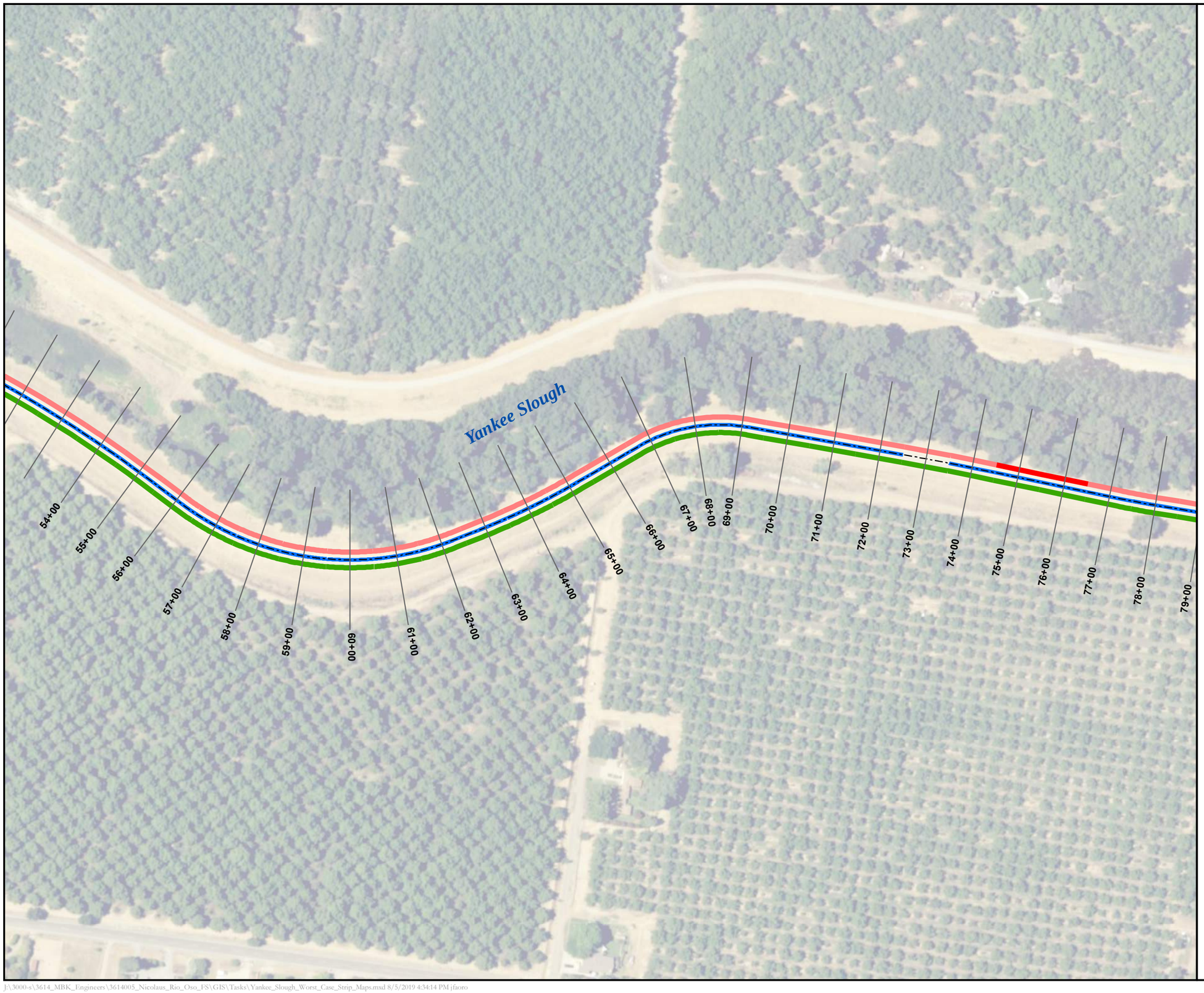
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

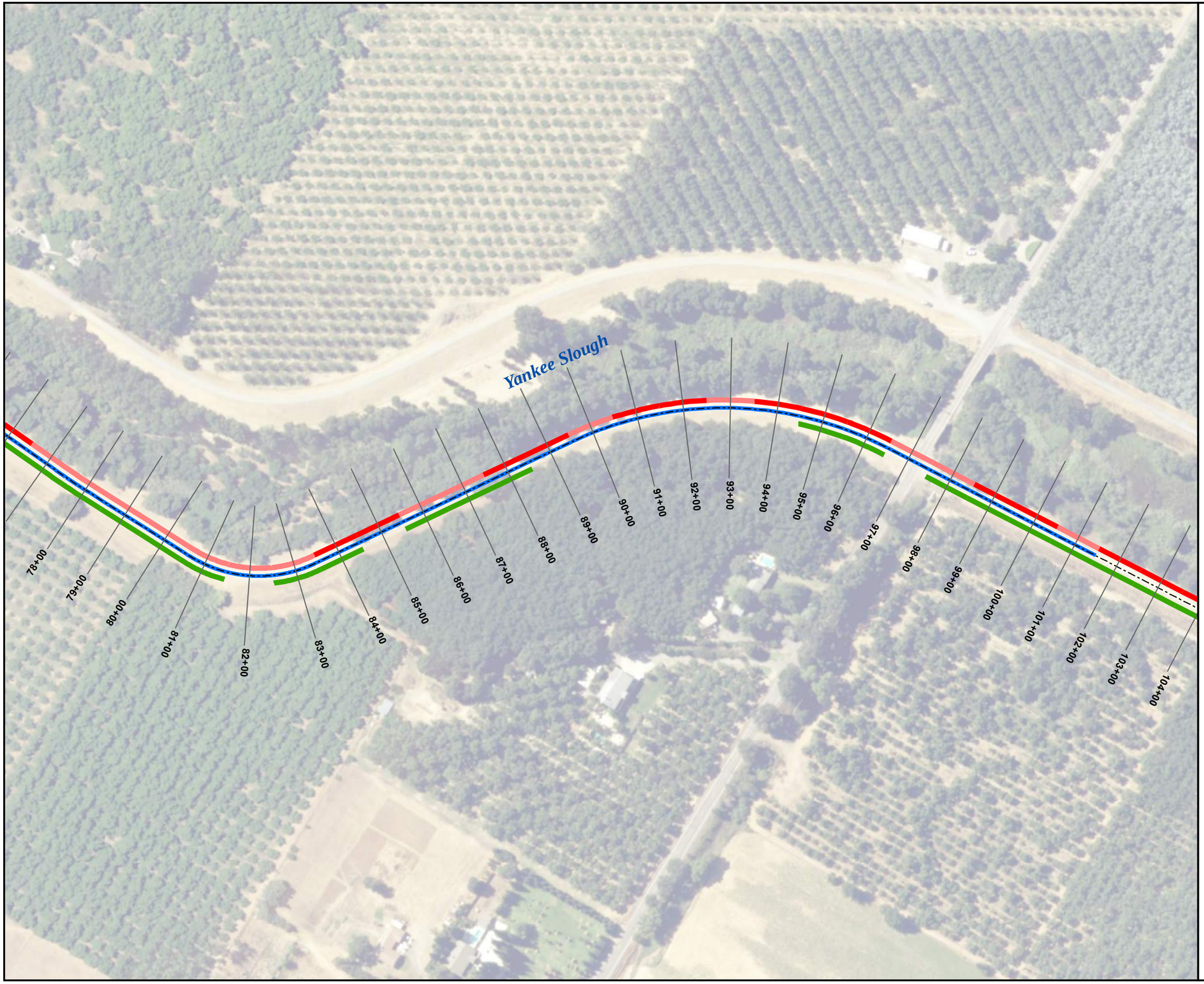
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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YANKEE SLOUGH
LEVEE DEFICIENCIES
RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

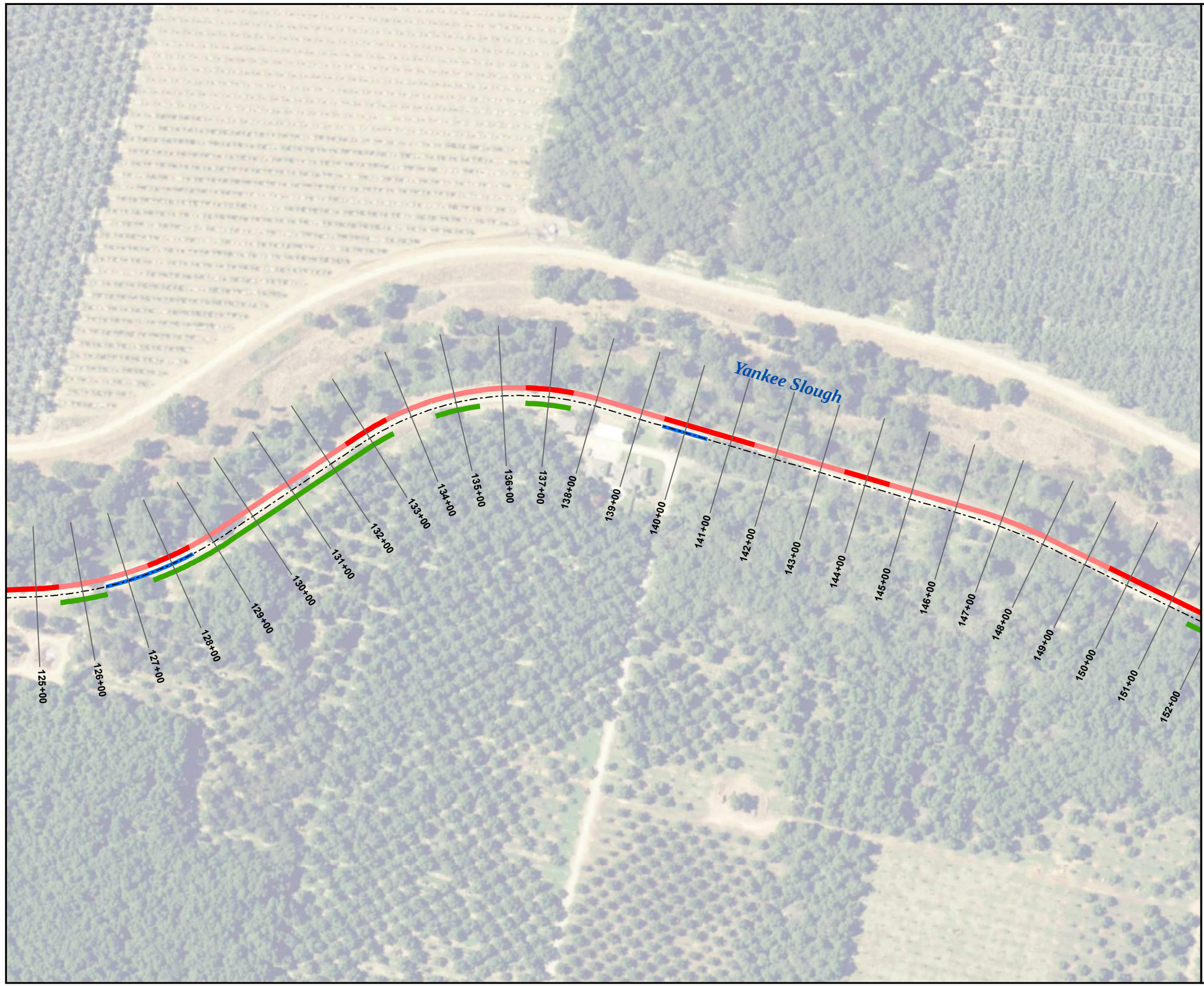
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

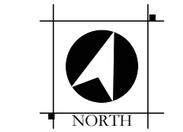
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

Yankee Slough

150+00 151+00 152+00 153+00 154+00 155+00 156+00 157+00 158+00 159+00 160+00 161+00 162+00 163+00 164+00 165+00 166+00 167+00 168+00 169+00 170+00 171+00 172+00 173+00 174+00

PRELIMINARY

WOOD RODGERS

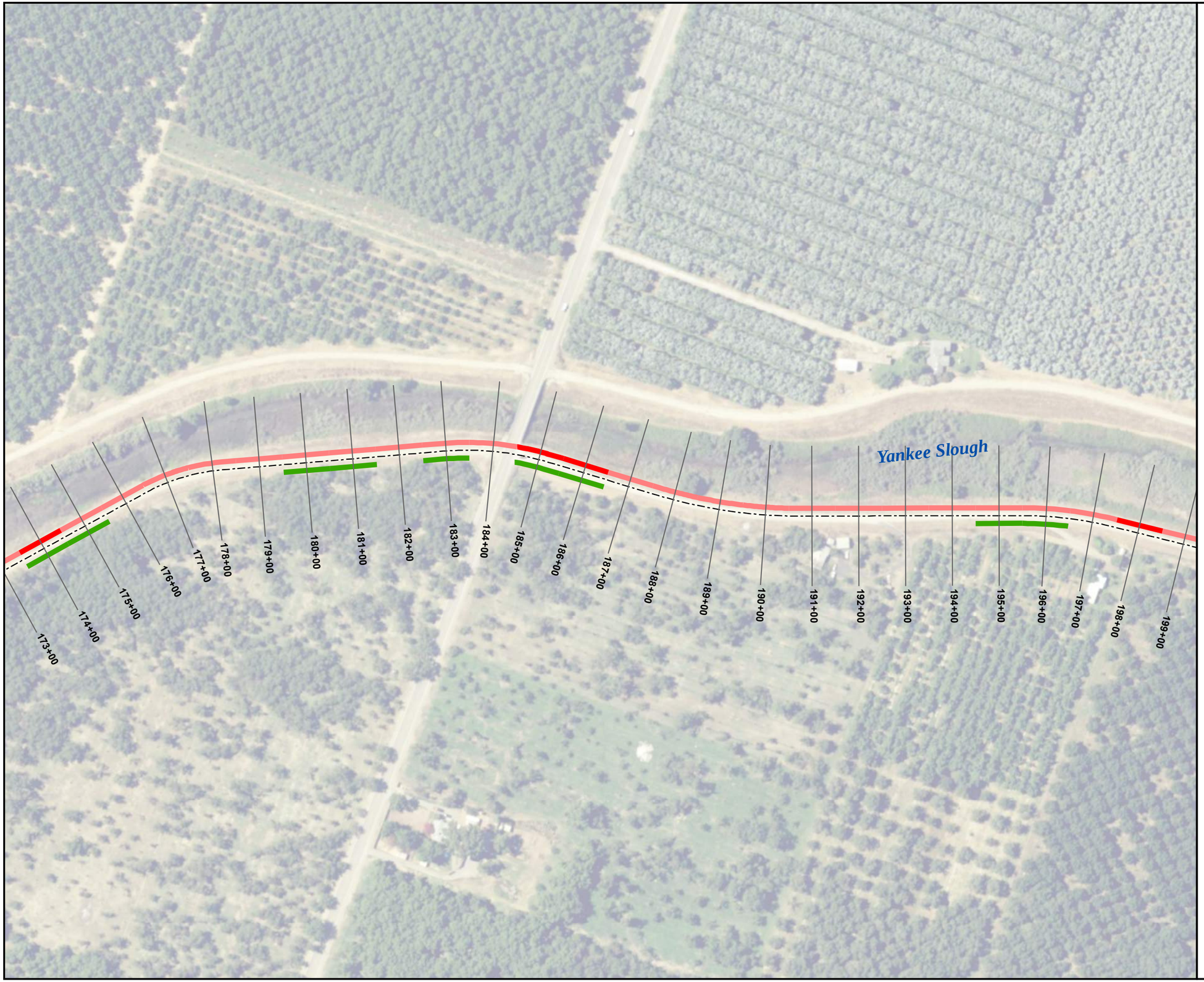
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

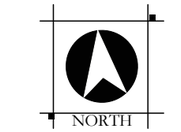
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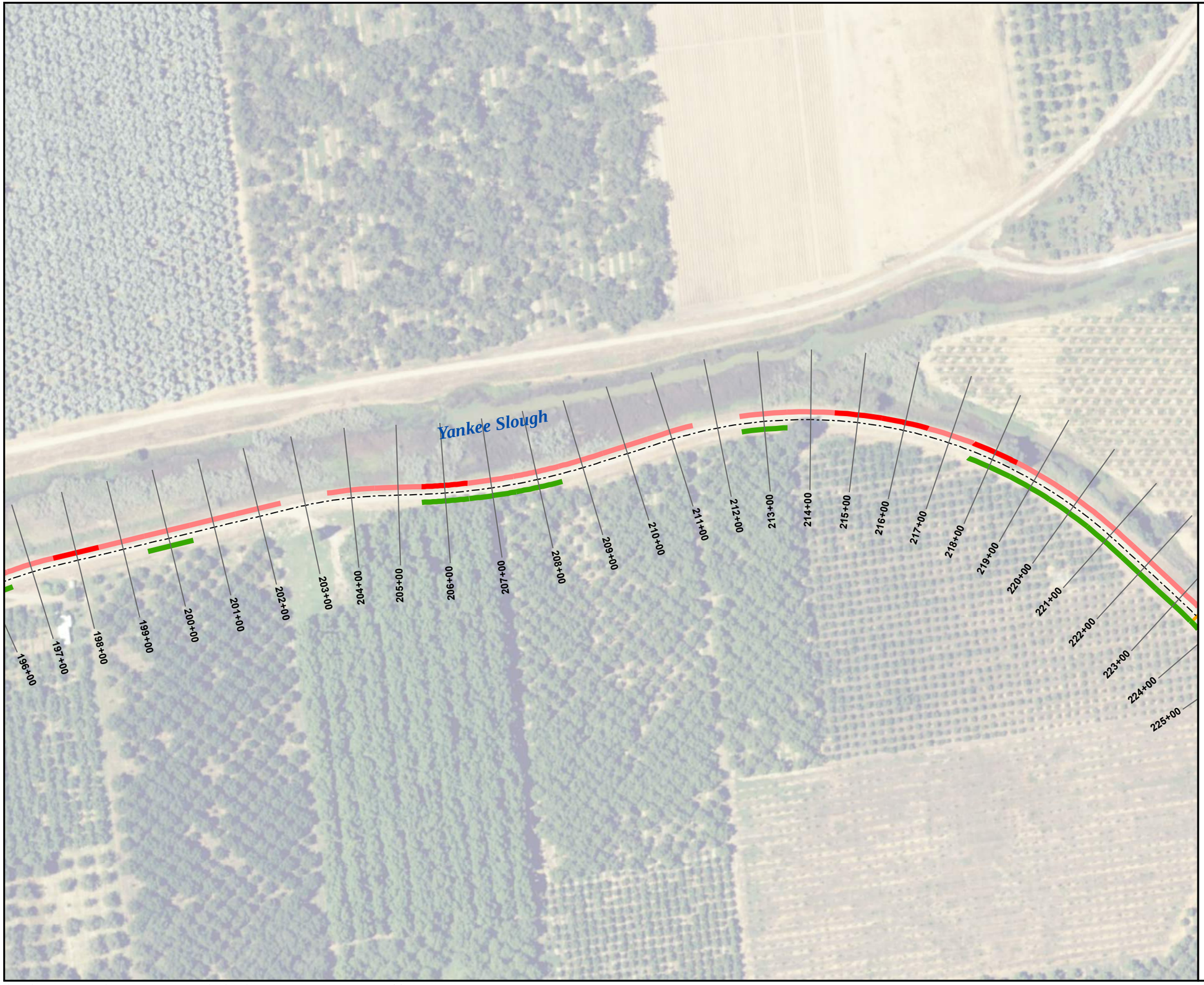
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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019





Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

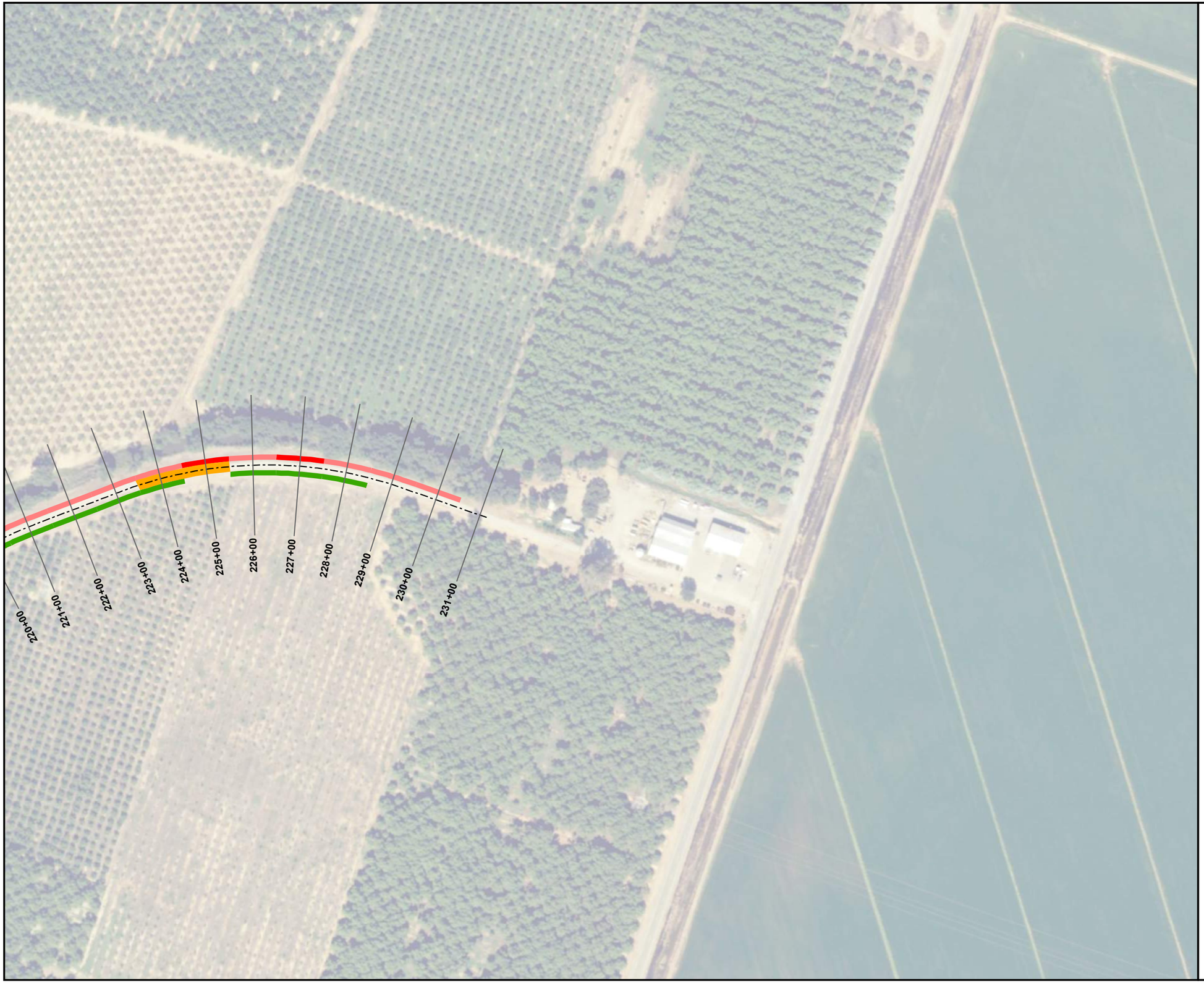
Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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YANKEE SLOUGH
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019

NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 12ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

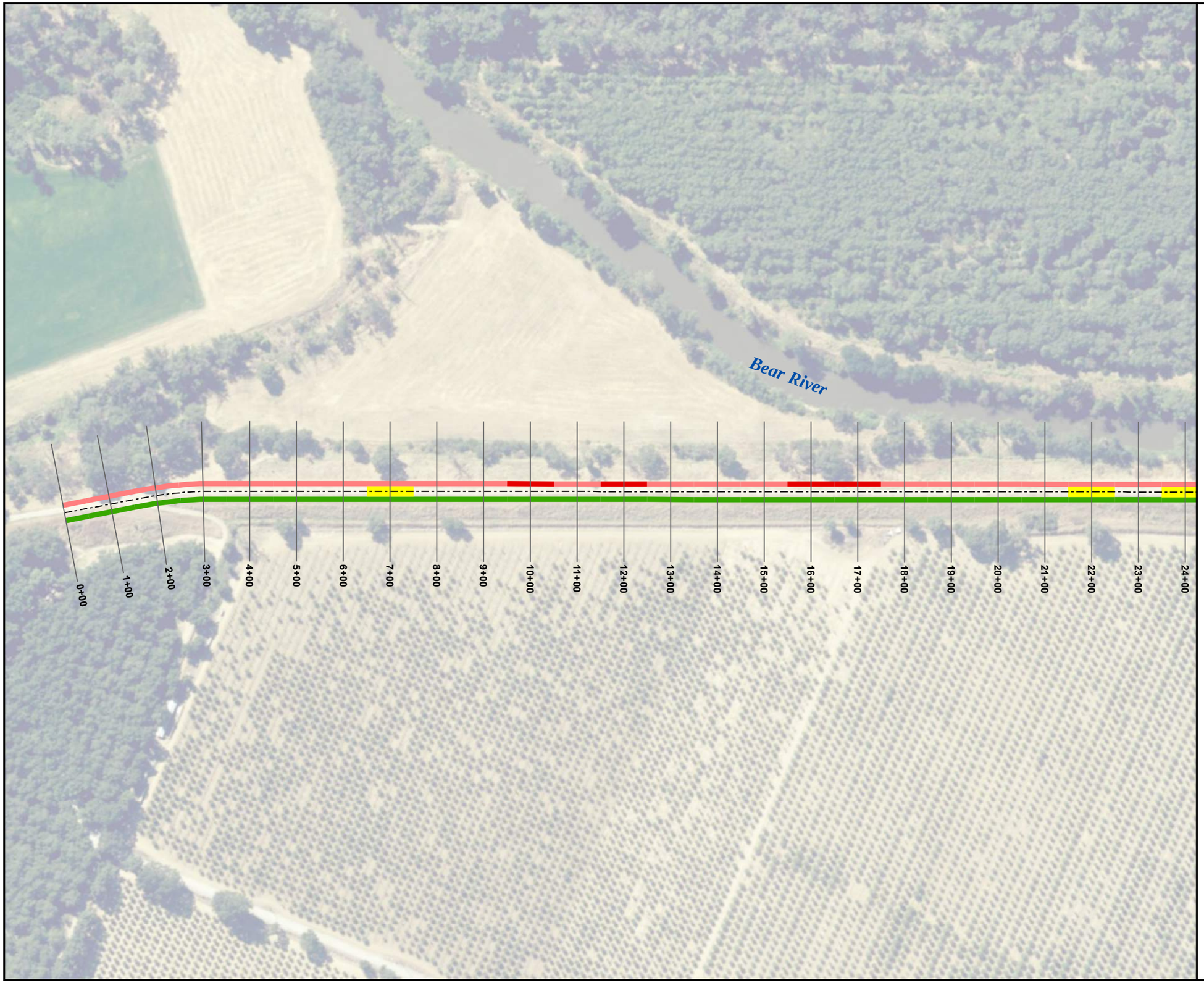
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Levee Deficiencies Strip Maps – Bear River East Levee

BEAR RIVER
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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BEAR RIVER
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00 45+00 46+00 47+00 48+00 49+00 50+00 51+00 52+00

Bear River

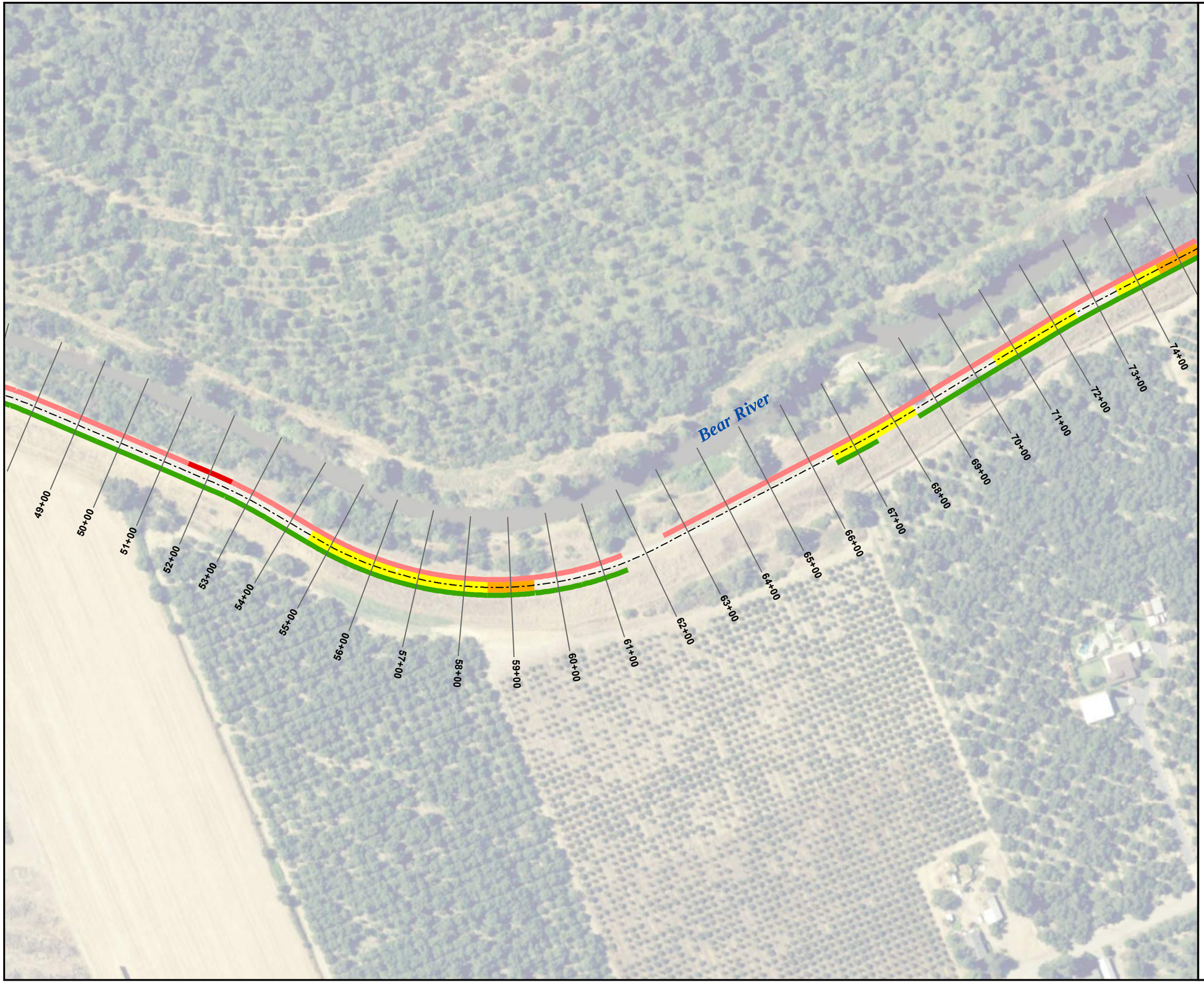
PRELIMINARY

WOOD RODGERS

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BEAR RIVER
LEVEE DEFICIENCIES
RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

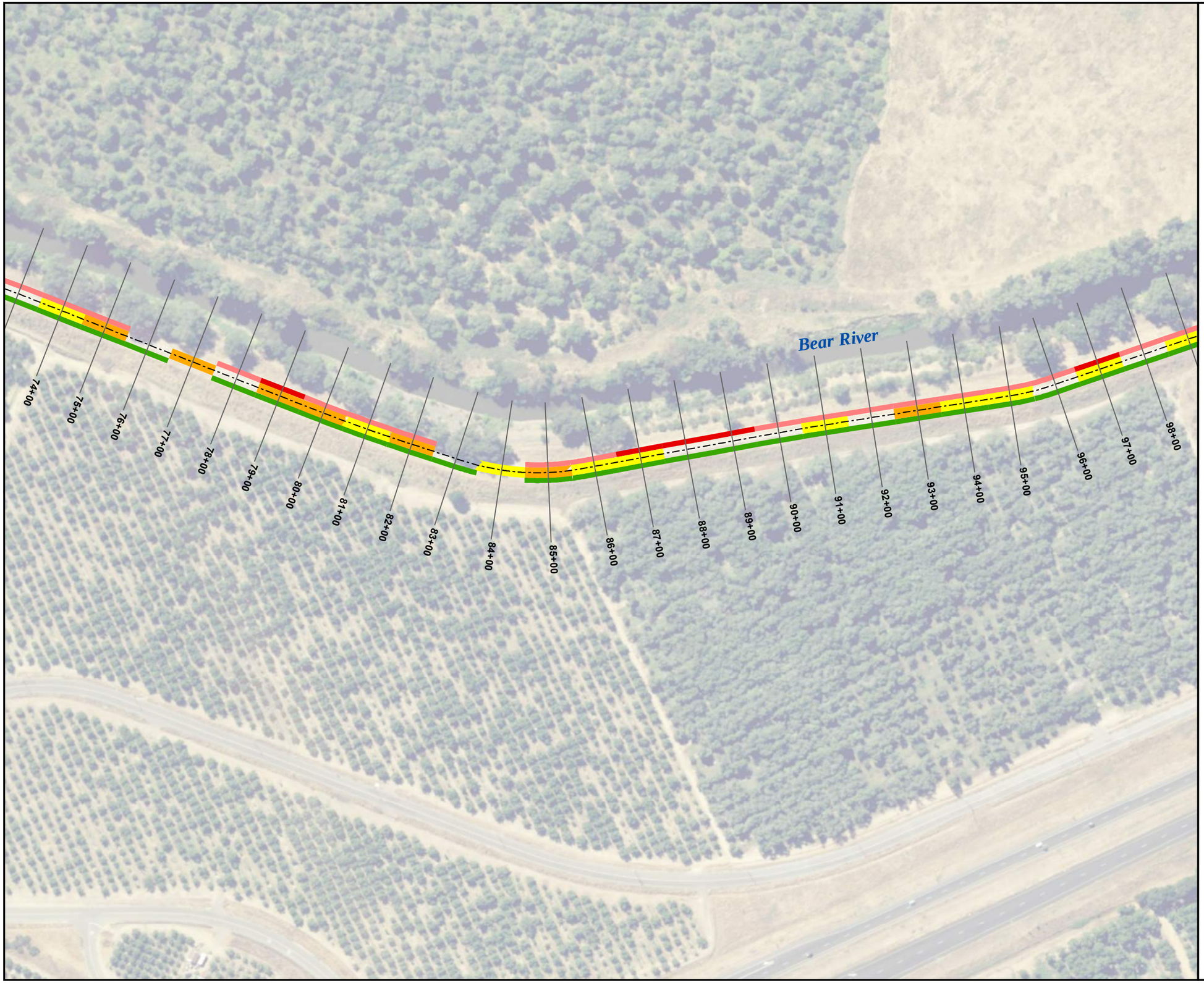
Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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BEAR RIVER
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019

NORTH

0 100 200
Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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BEAR RIVER
LEVEE DEFICIENCIES

RIO OSO FEASIBILITY STUDY

RIO OSO, CA

AUGUST, 2019

NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

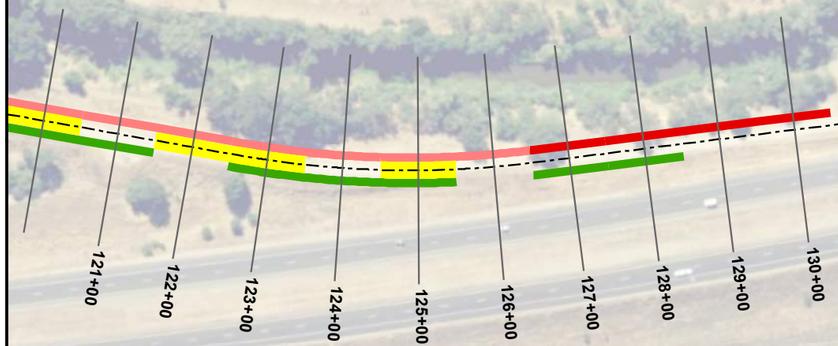
PRELIMINARY

WOOD RODGERS

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BEAR RIVER
LEVEE DEFICIENCIES
RIO OSO FEASIBILITY STUDY

RIO OSO, CA
AUGUST, 2019



Bear River

NORTH

0 100 200

Feet

Legend

- Levee Centerline
- 300ft Cross Section
- Levee Height Deficient
- Crown Deficient - Width < 20ft
- Crown Deficient - Width < 15ft

Slope Deficiencies

- Land Side Slope Steeper than 2:1
- Water Side Slope Steeper than 2:1
- Water Side Slope Between 2:1 and 3:1

PRELIMINARY

WOOD RODGERS

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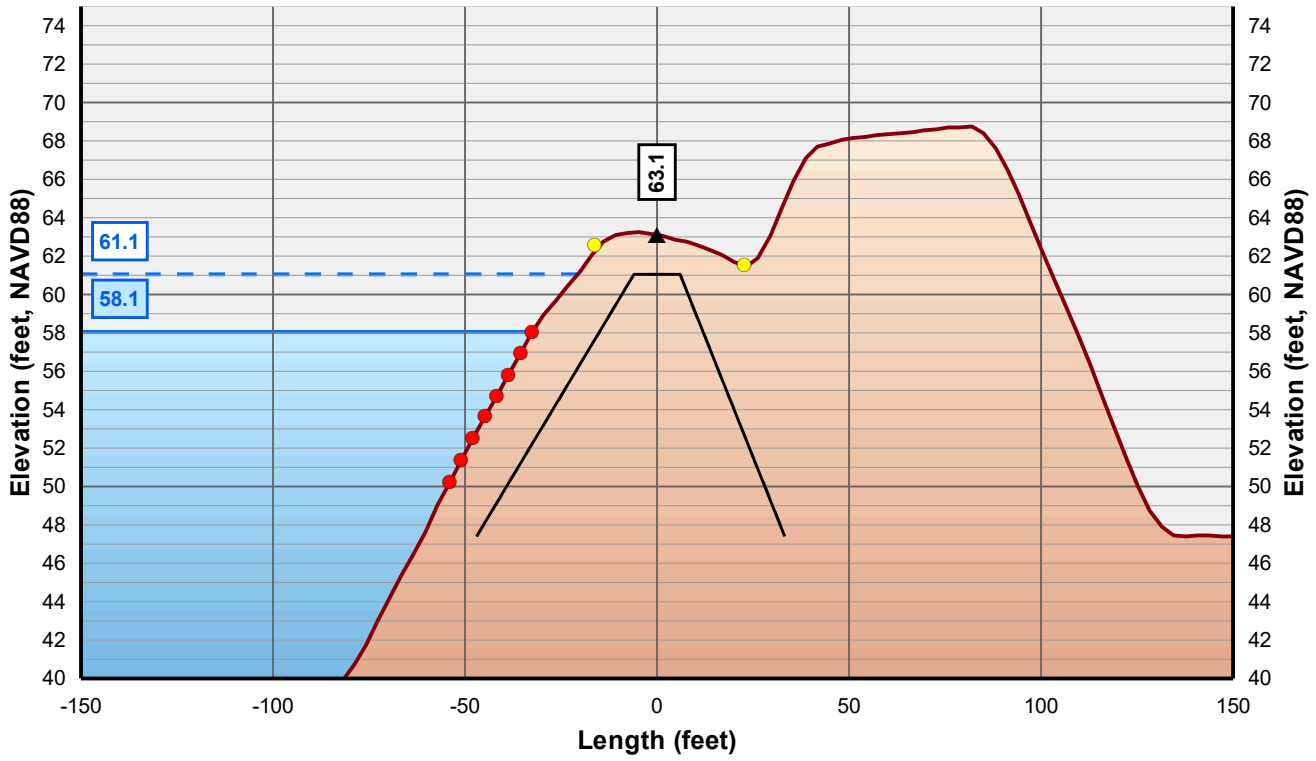
FIGURE 6 of 6

ATTACHMENT I

Freeboard and Geometry Analysis – Levee Cross Sections

Freeboard and Geometry Analyses – Yankee Slough South Levee

Cross Section: Yankee Slough 00+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

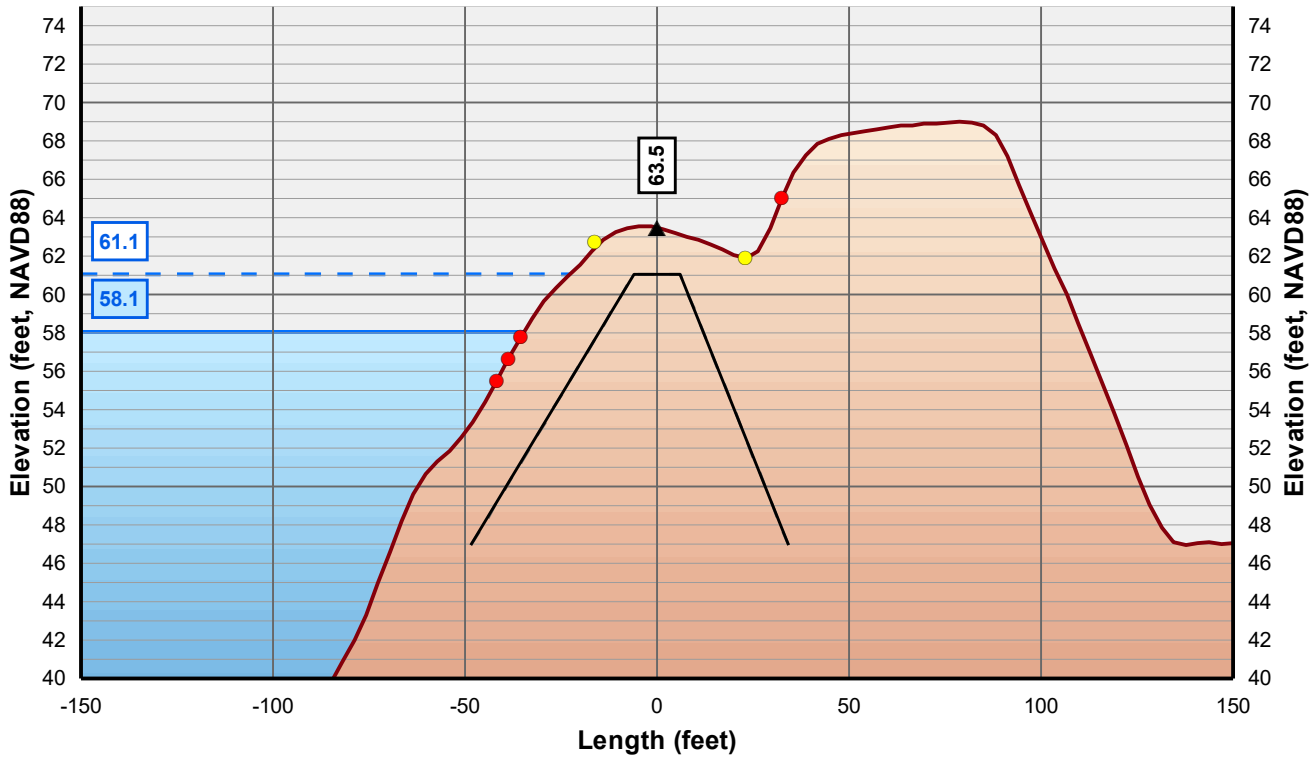
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

J:\3000-s\3614_MBK_Engineers\3614004_Wheatland_FS\GIS\Tasks\Profile_Slope_Analysis_Bear_River_20190322.mxd

Cross Section: Yankee Slough 01+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

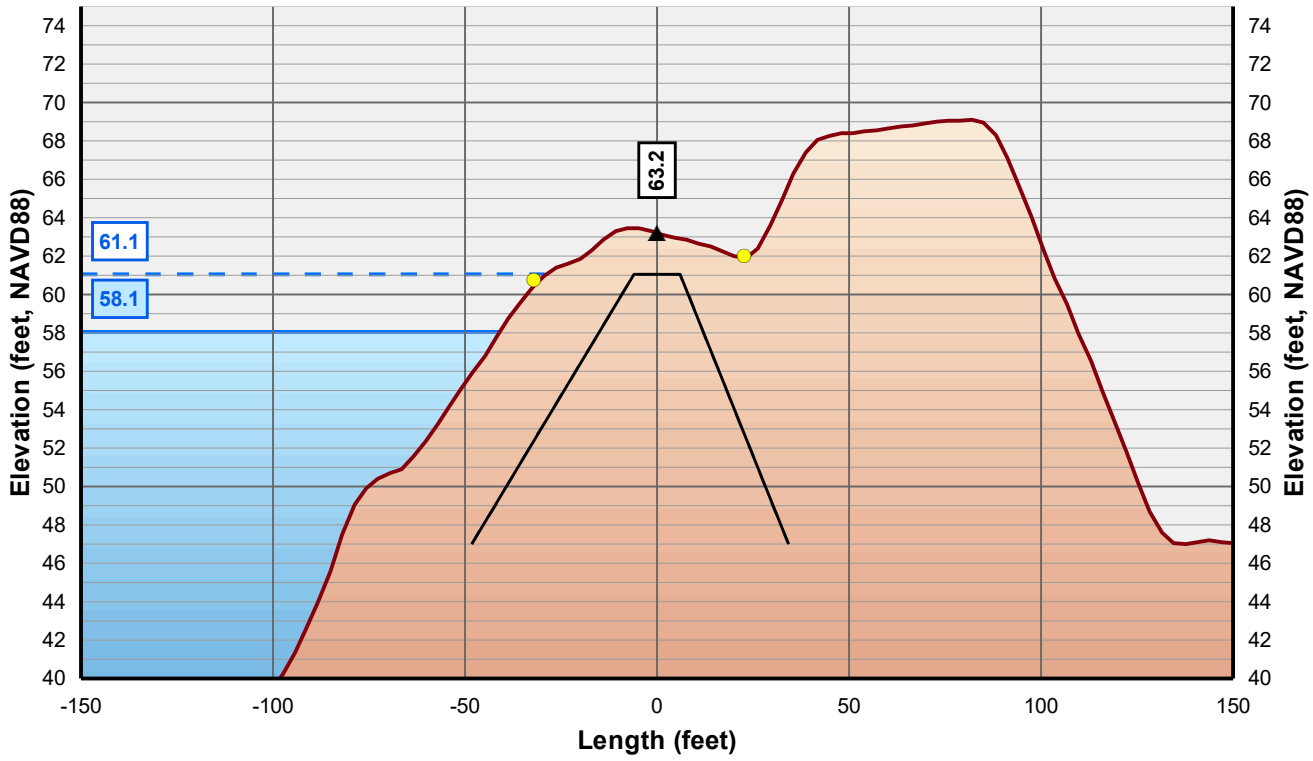
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

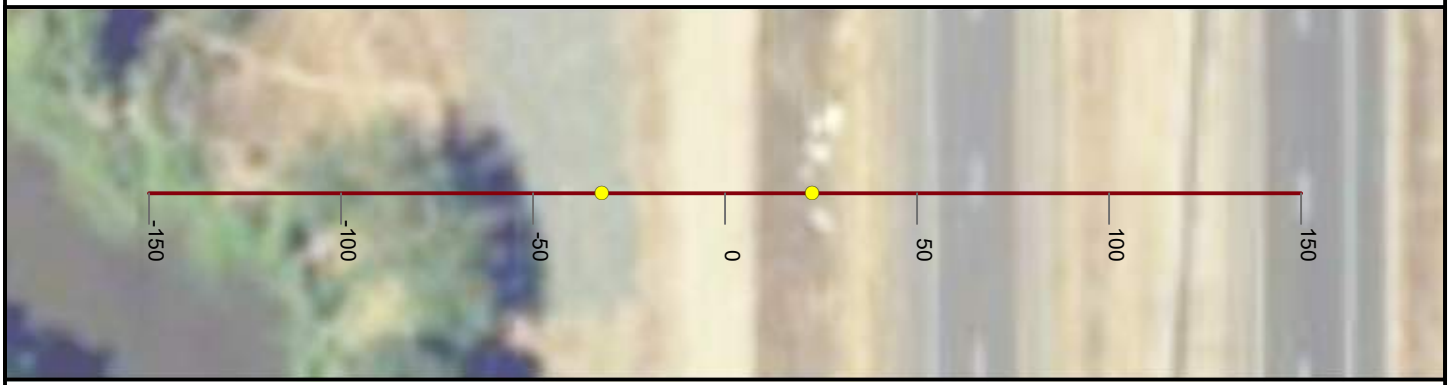
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Cross Section: Yankee Slough 02+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

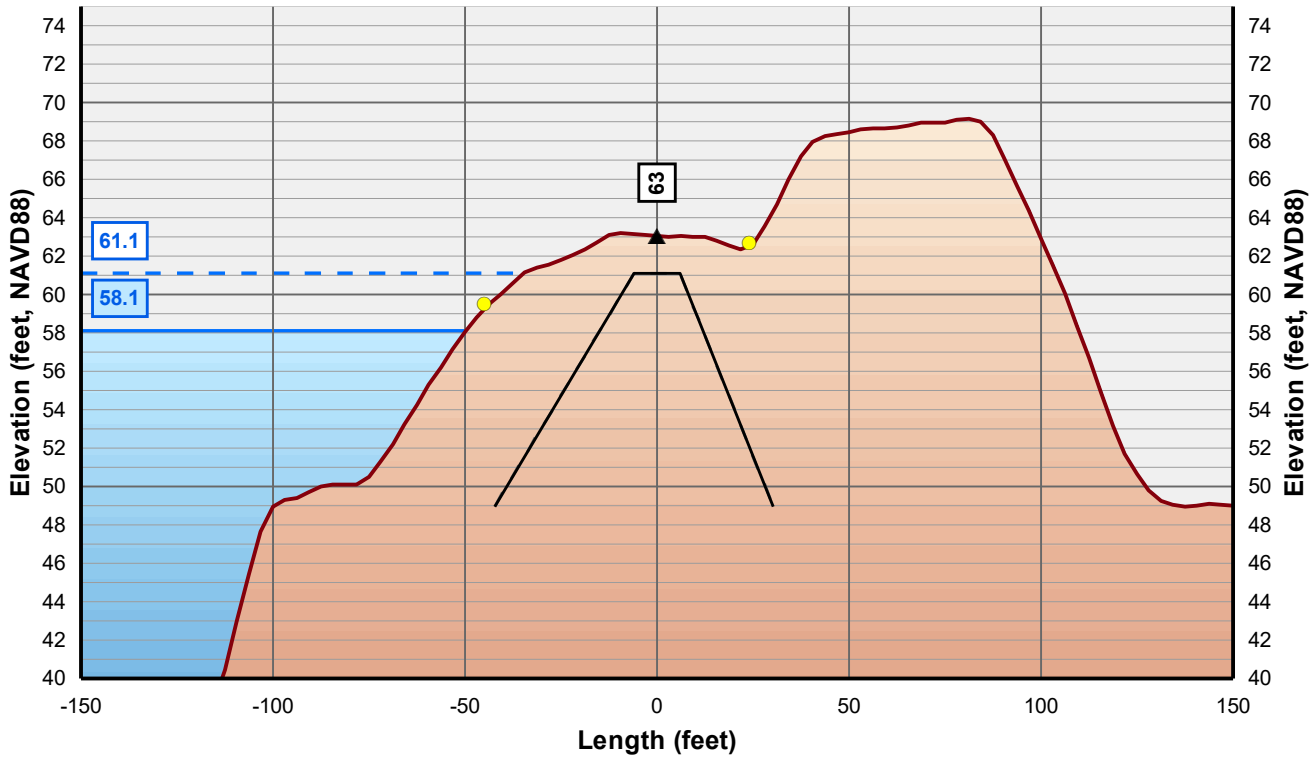
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

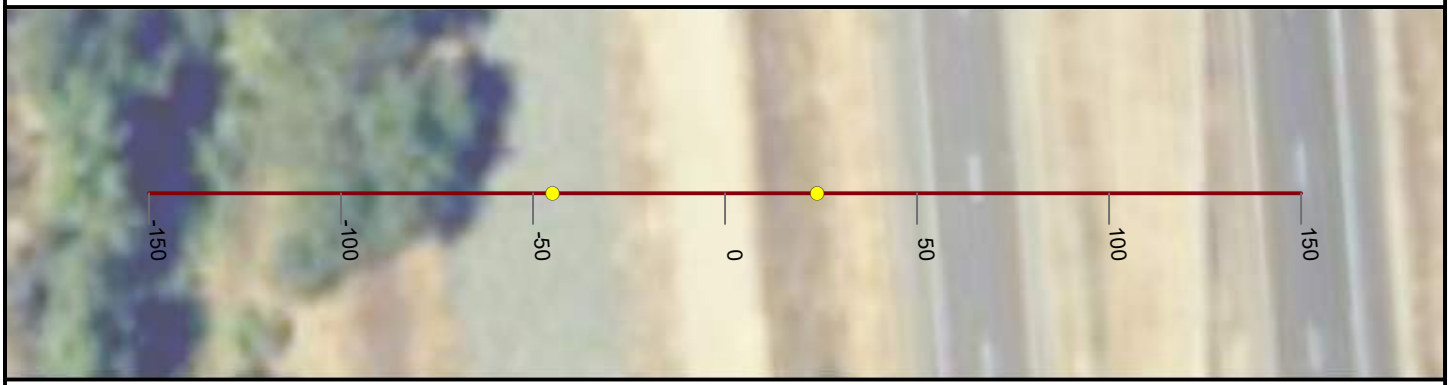
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Cross Section: Yankee Slough 03+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

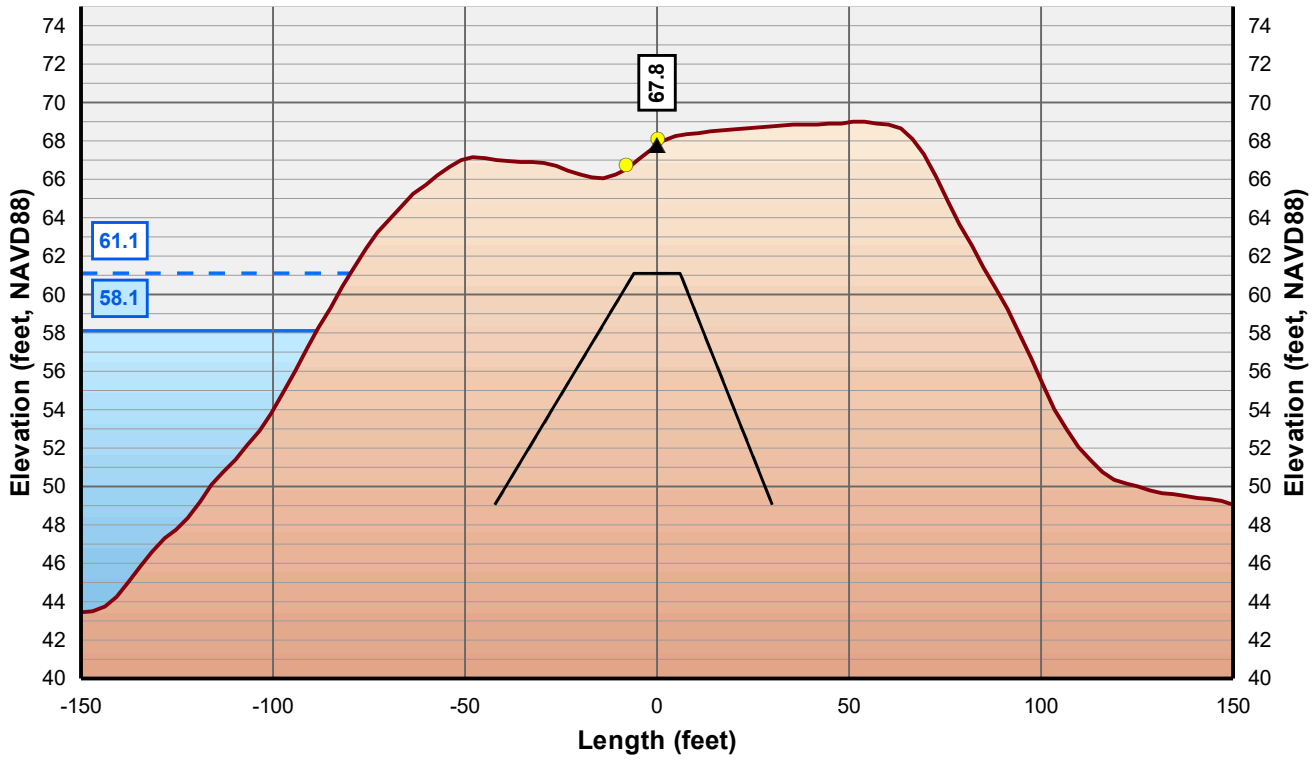
FEET

PRELIMINARY

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BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

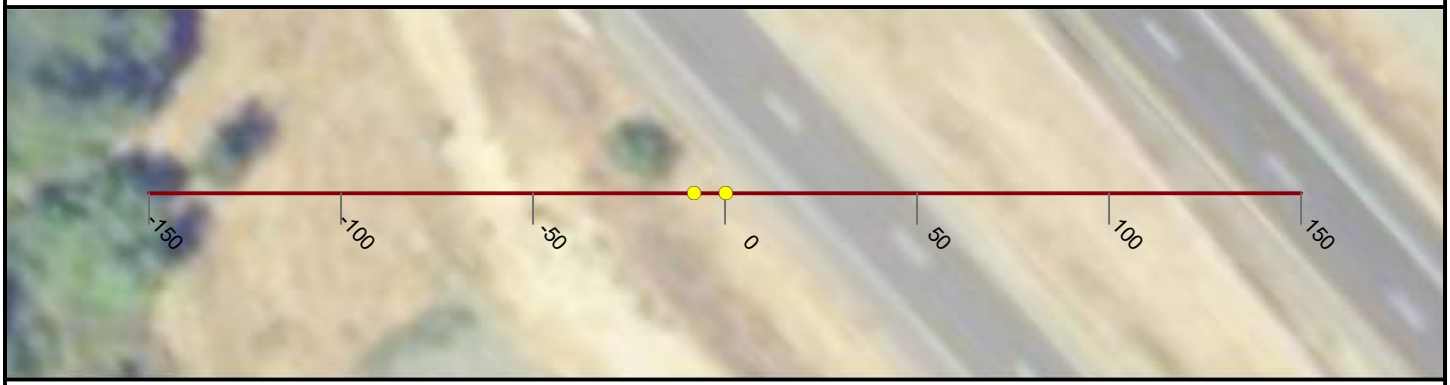
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Cross Section: Yankee Slough 04+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

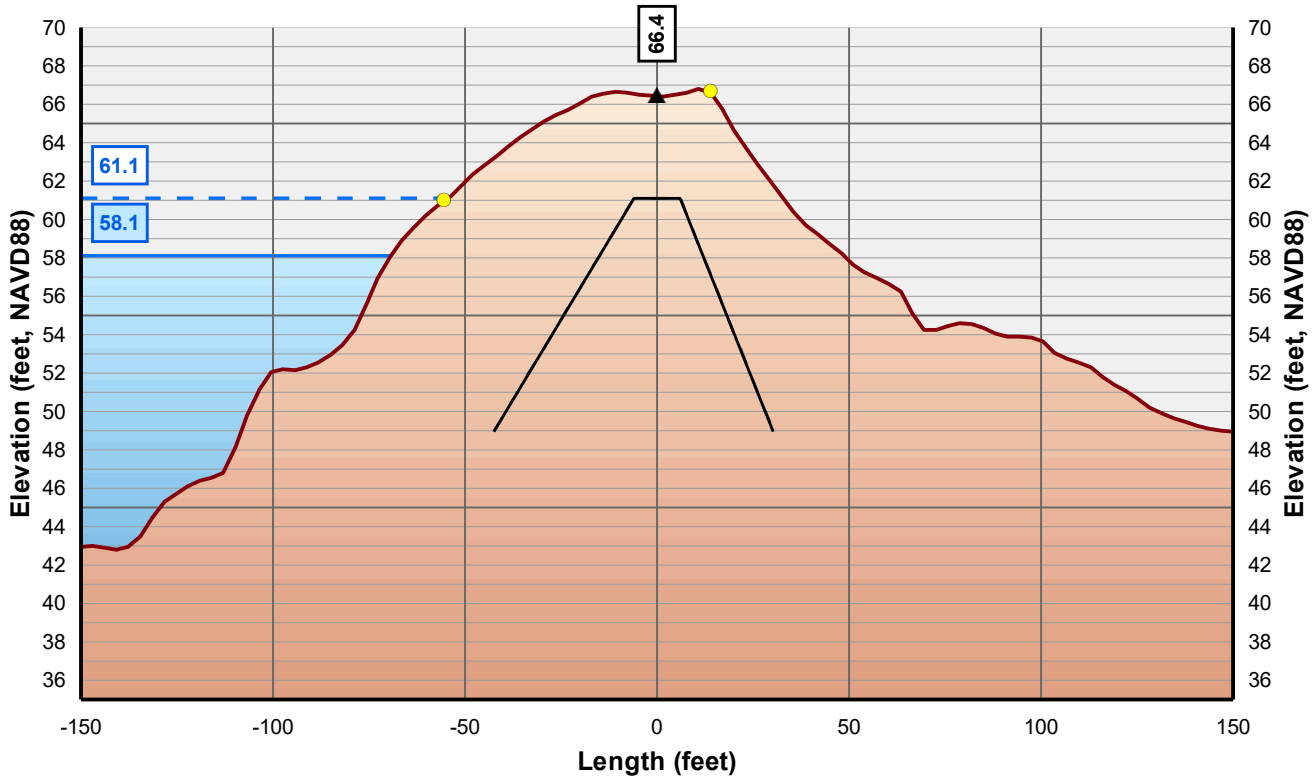
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

J:\3000-s\3614_MBK_Engineers\3614004_Wheatland_FS\GIS\Tasks\Profile_Slope_Analysis_Bear_River_20190322.mxd

Cross Section: Yankee Slough 05+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

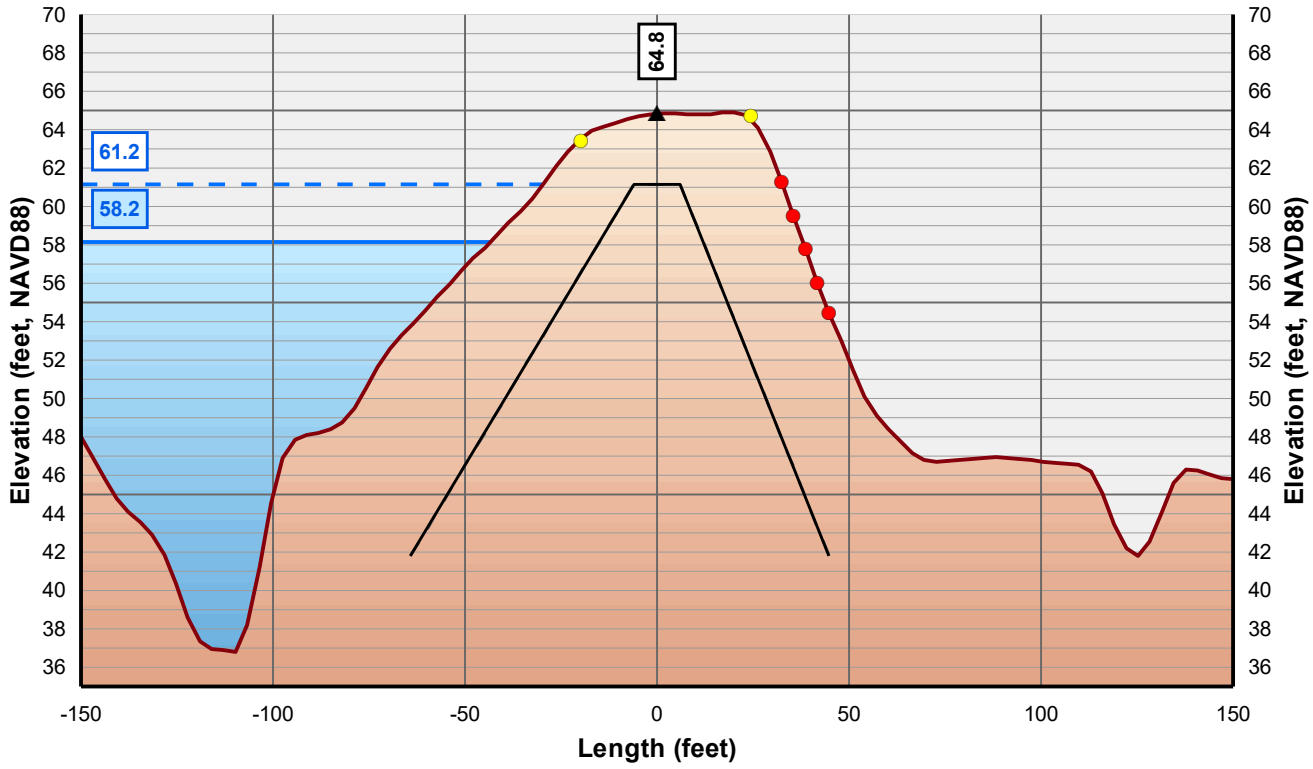
FEET

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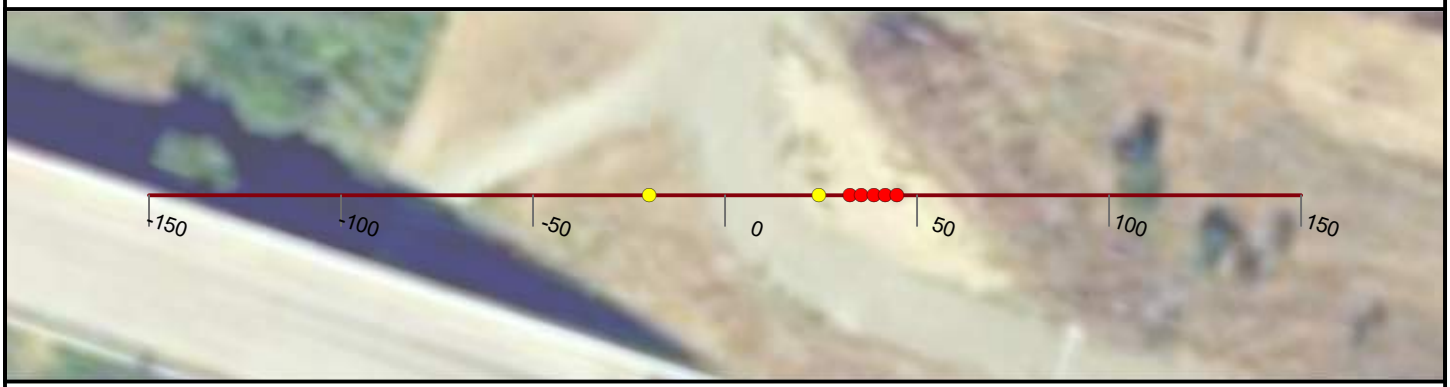
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Cross Section: Yankee Slough 06+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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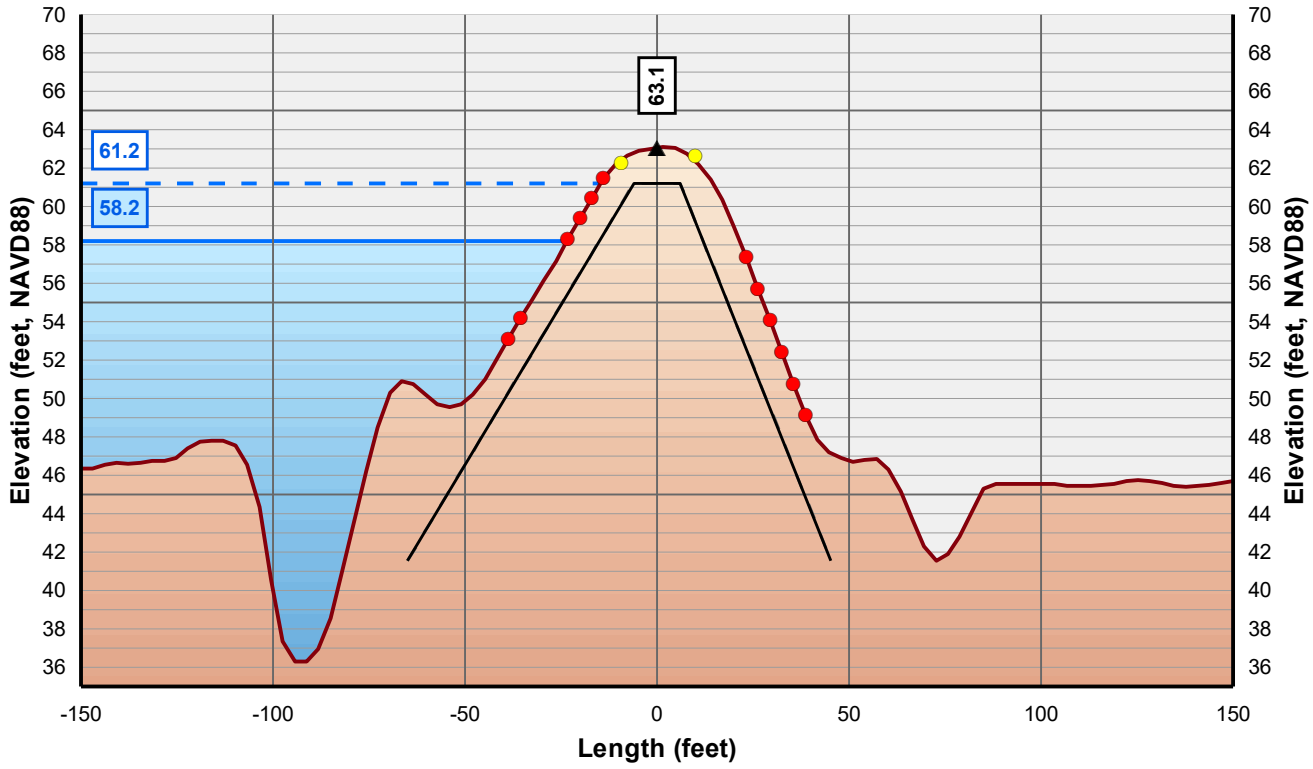
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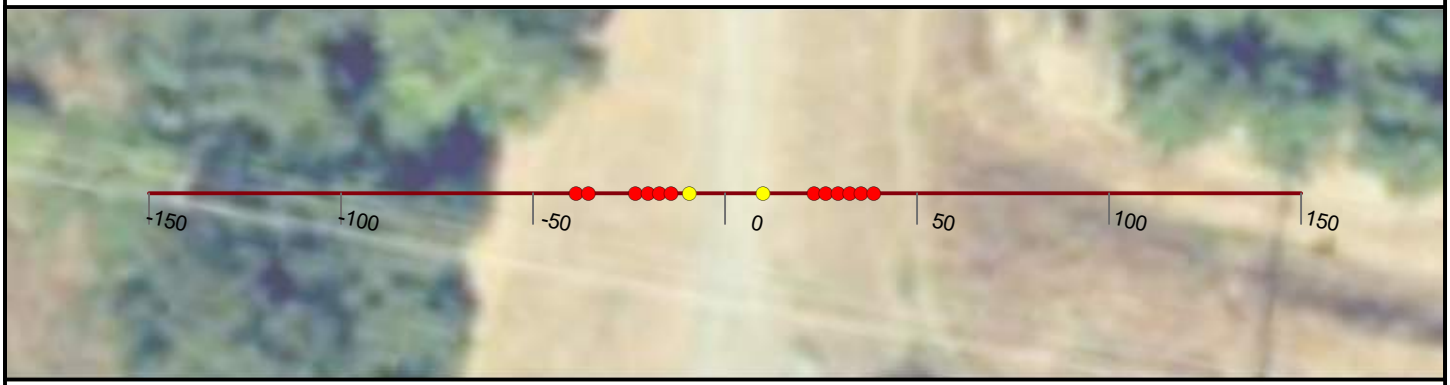
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Cross Section: Yankee Slough 07+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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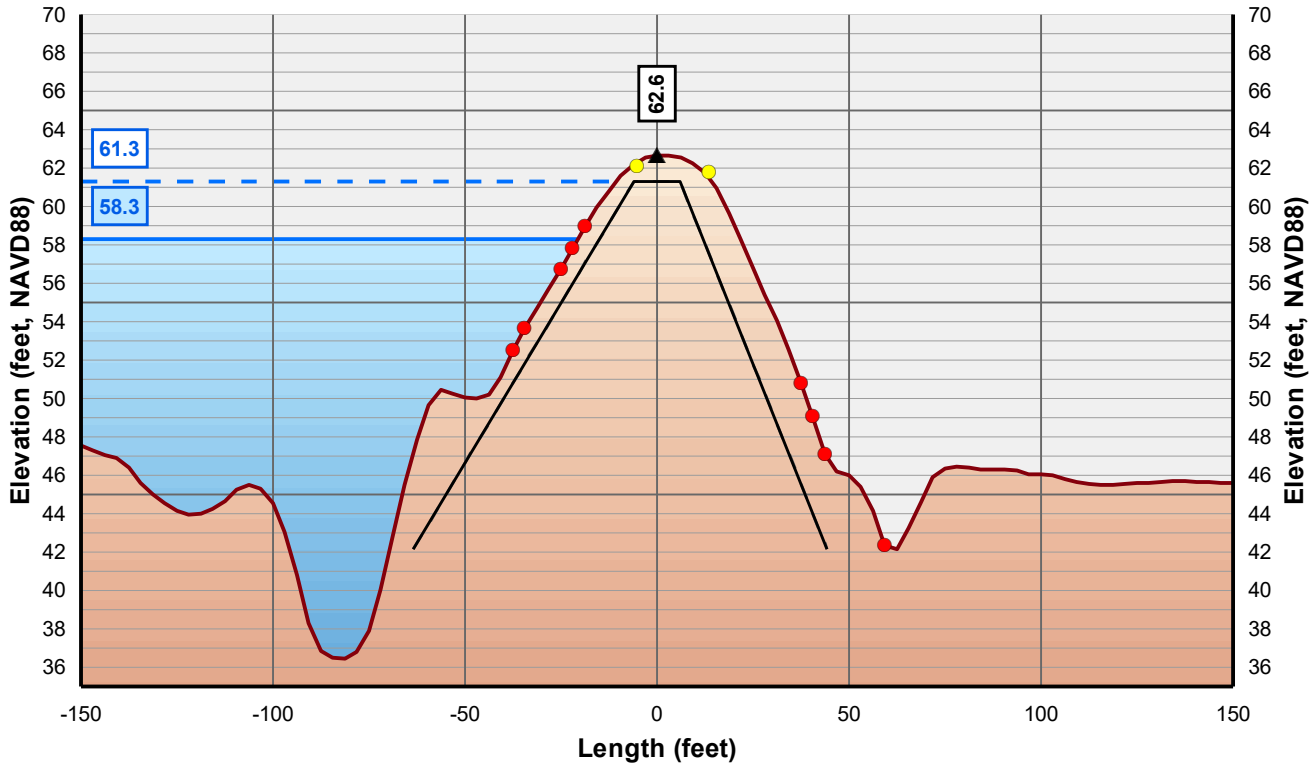
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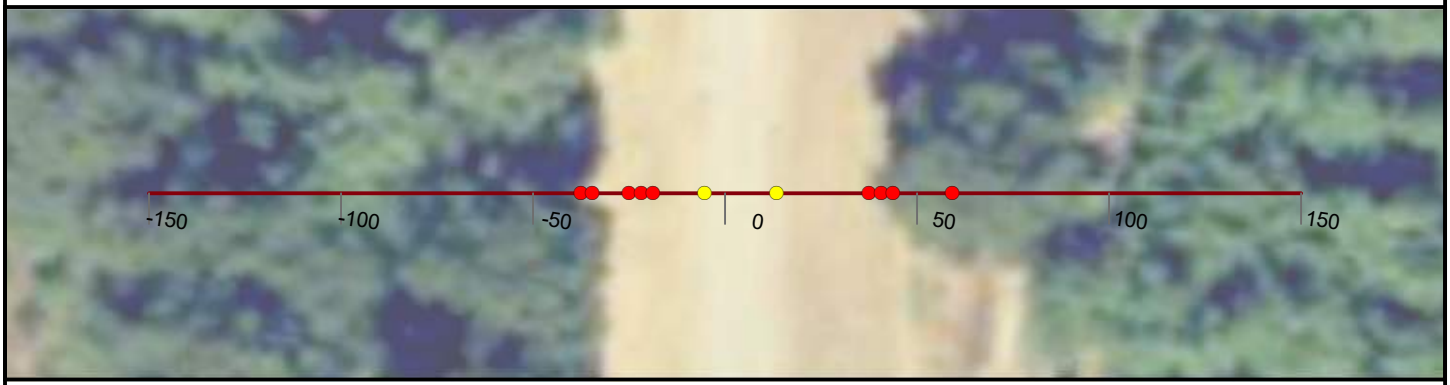
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Cross Section: Yankee Slough 08+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

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CALIFORNIA

AUGUST, 2019

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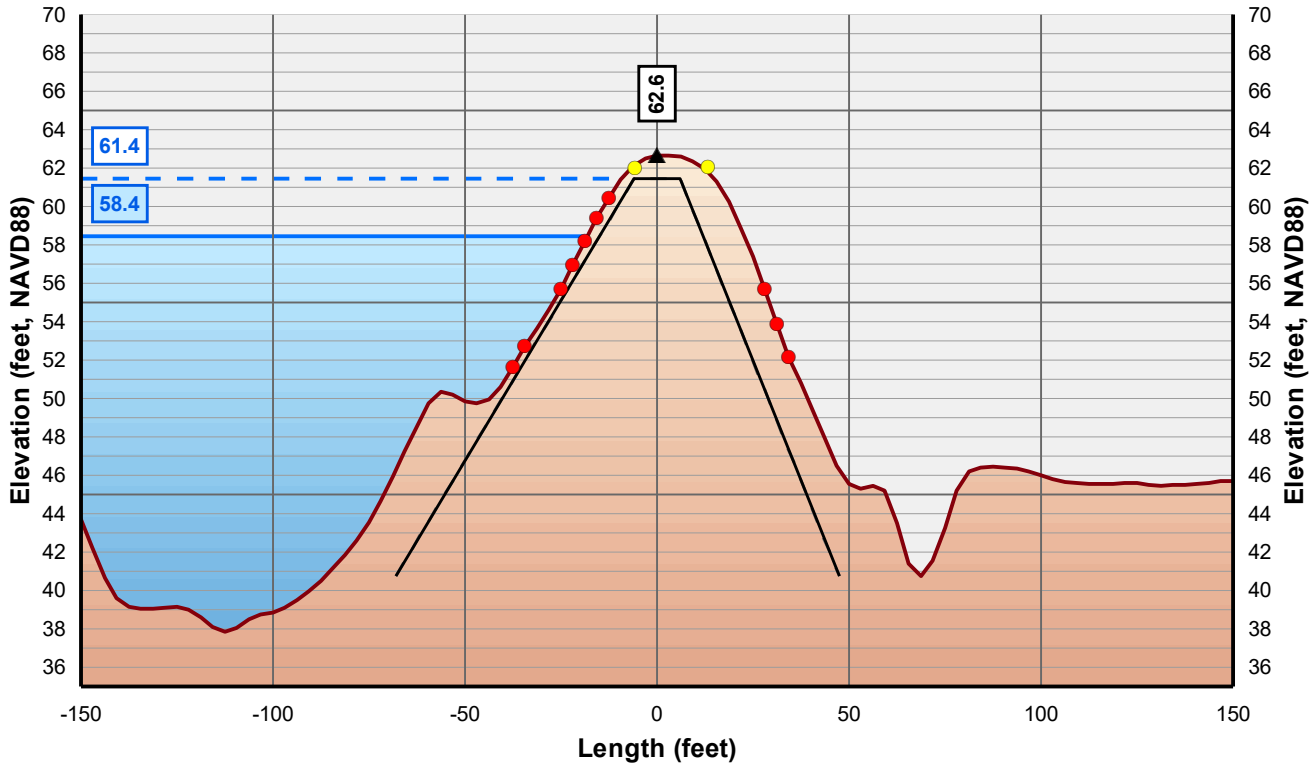
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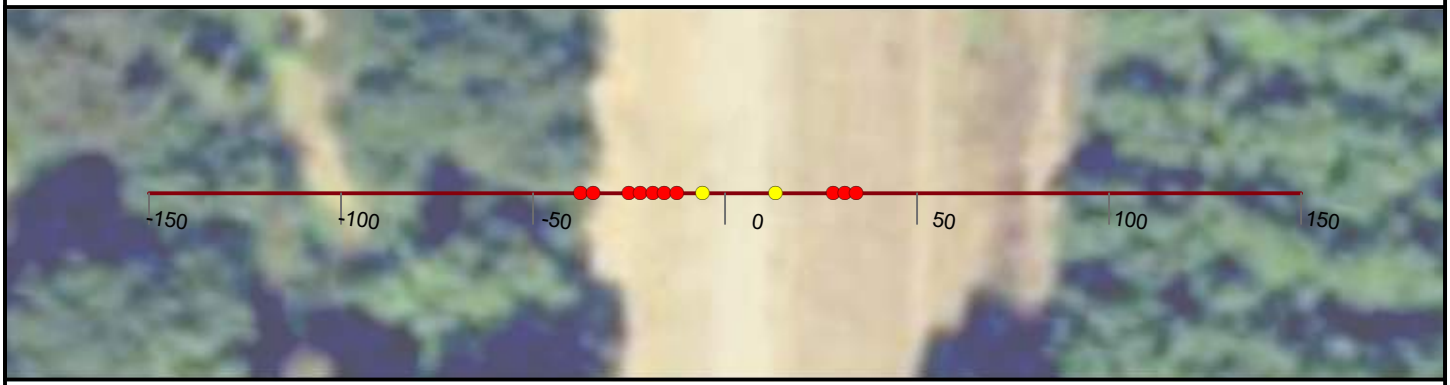
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Cross Section: Yankee Slough 09+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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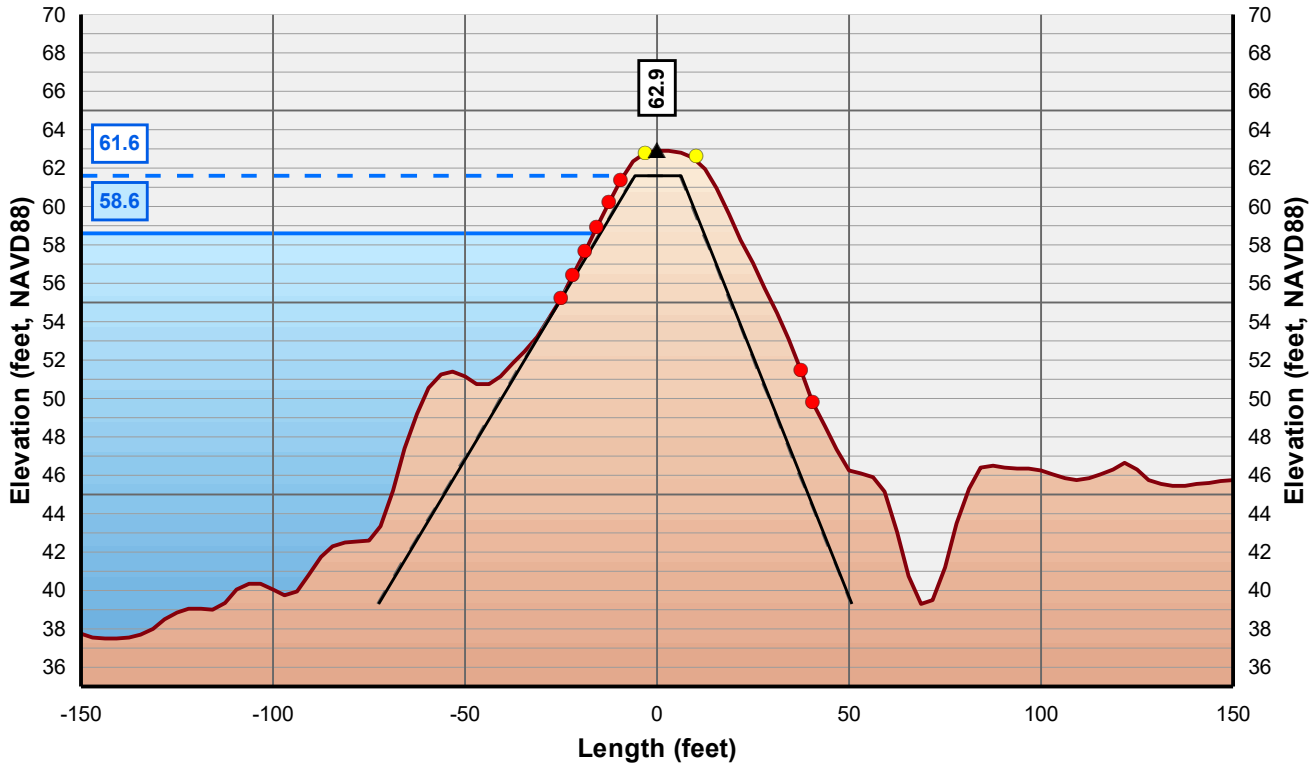
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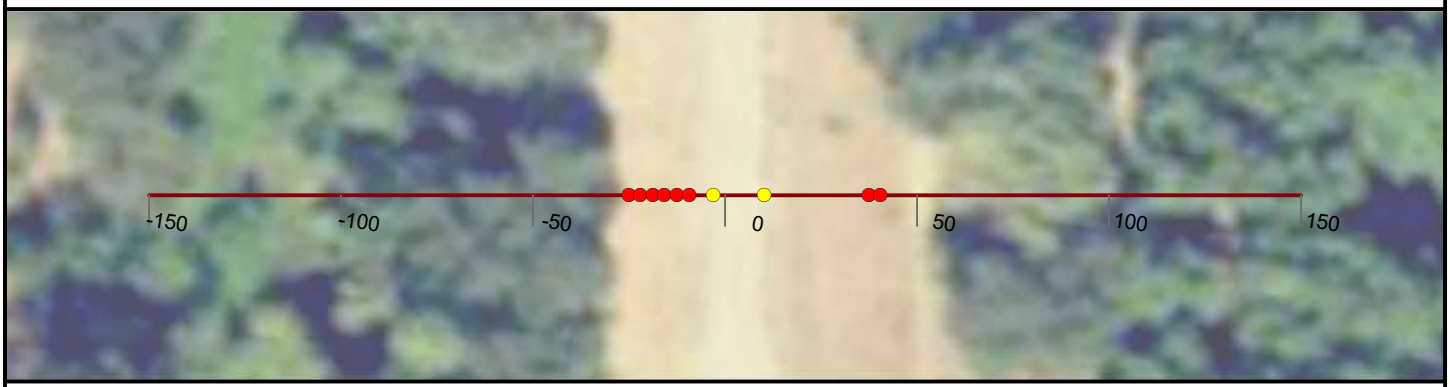
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Cross Section: Yankee Slough 10+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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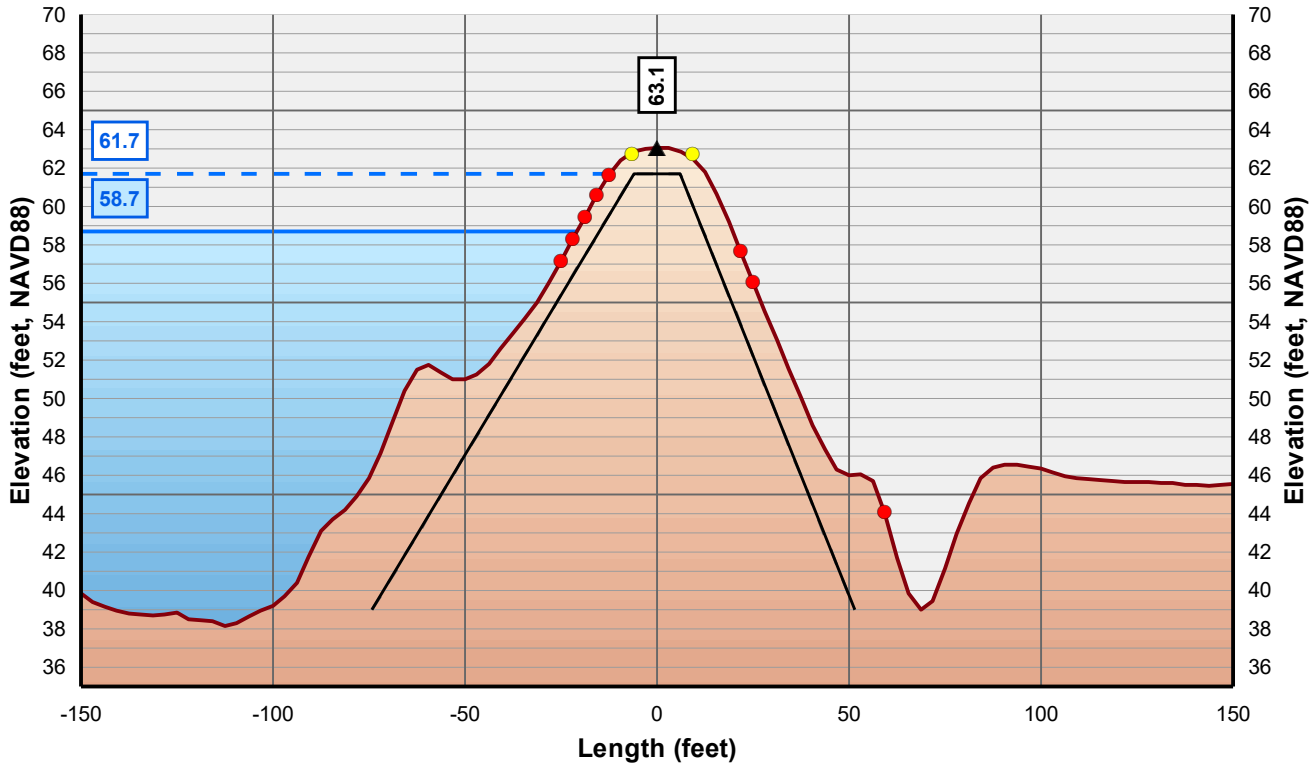
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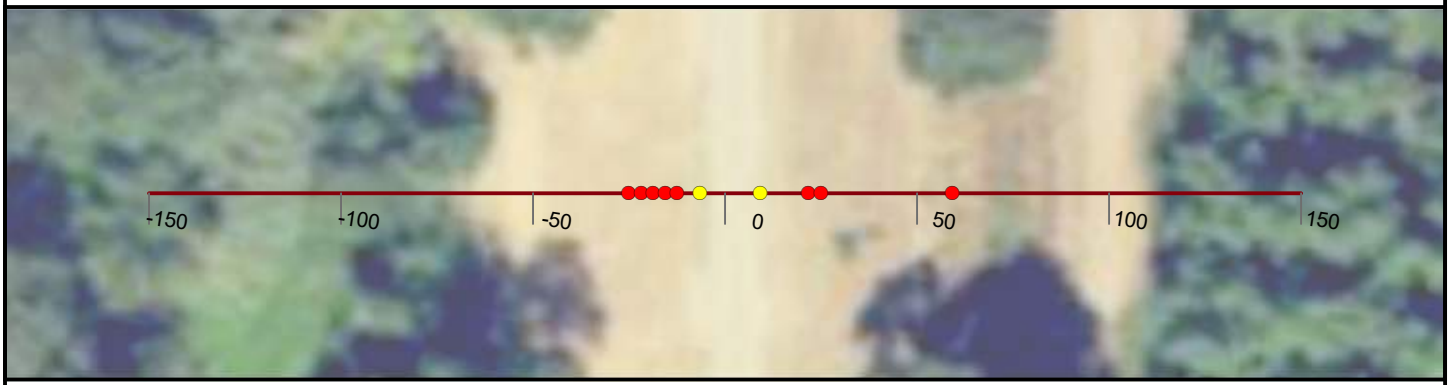
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Cross Section: Yankee Slough 11+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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AUGUST, 2019

NORTH

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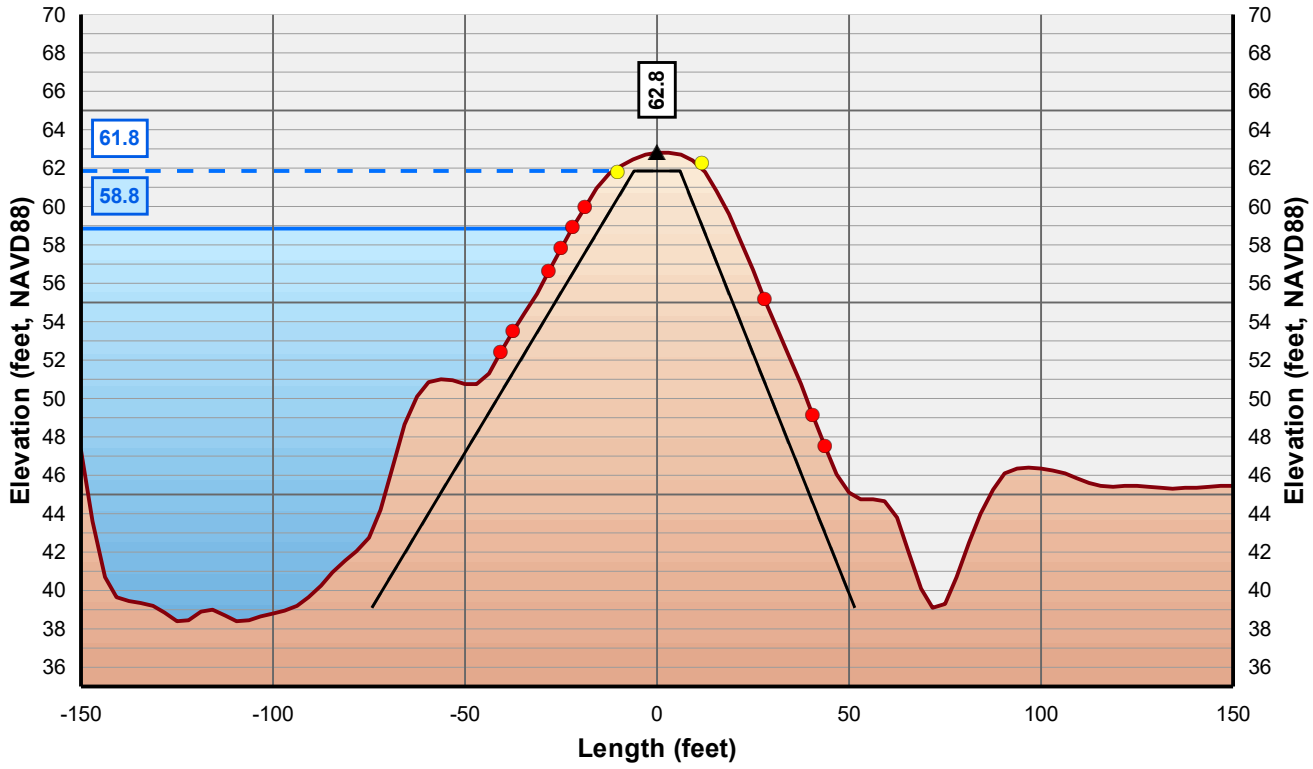
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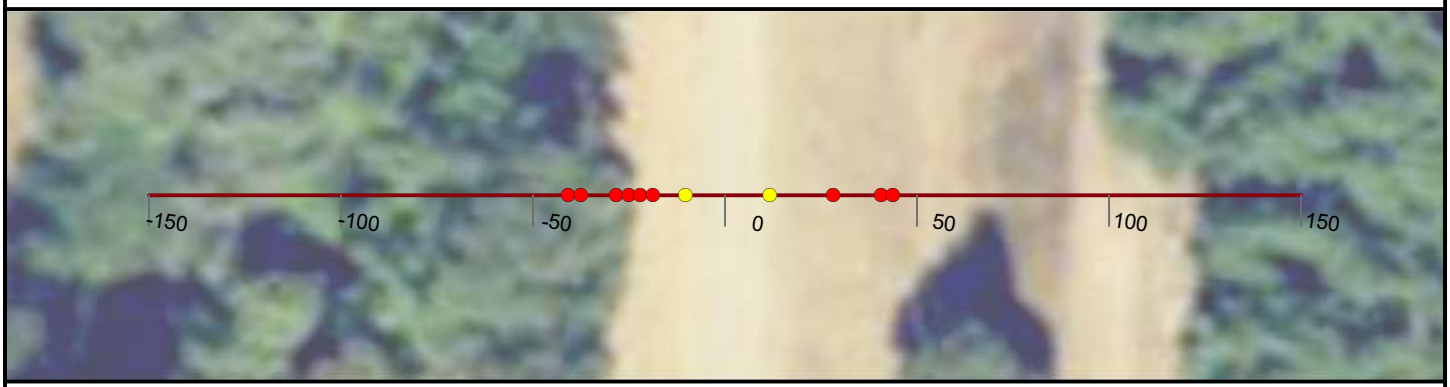
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Cross Section: Yankee Slough 12+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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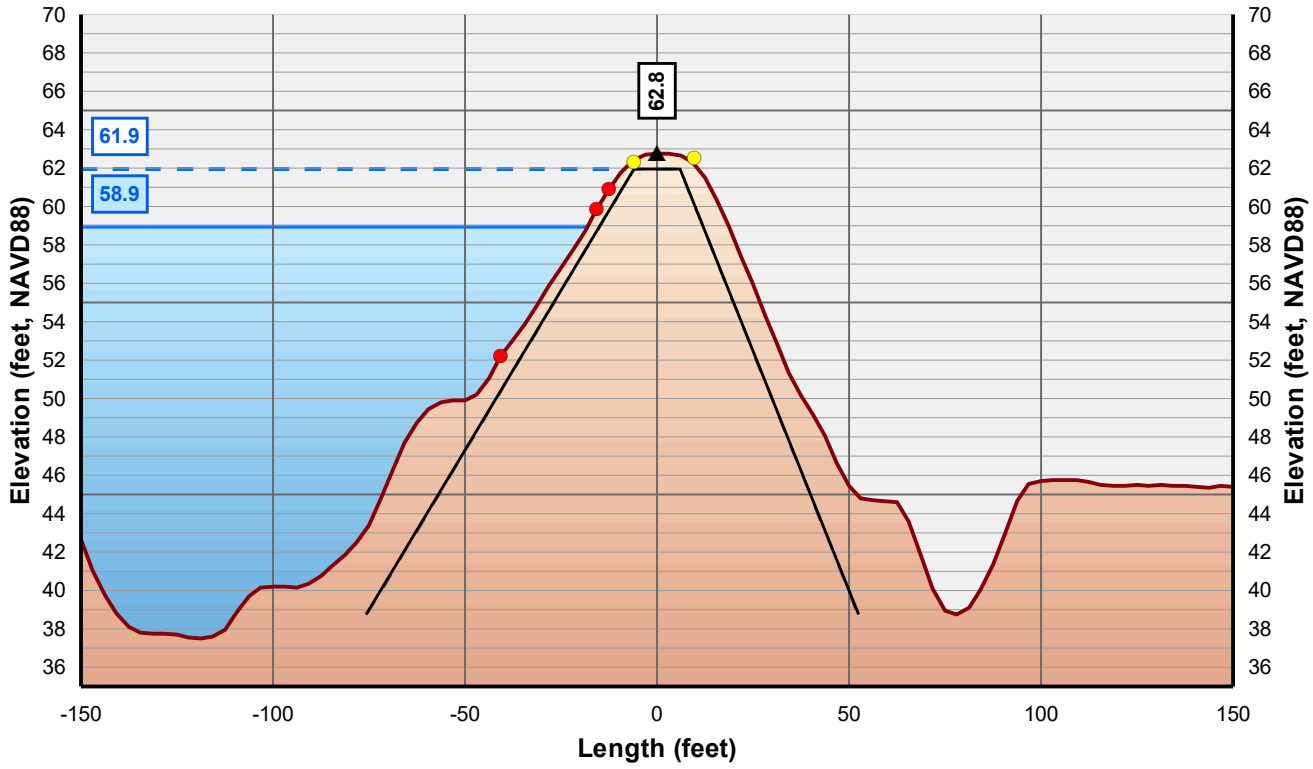
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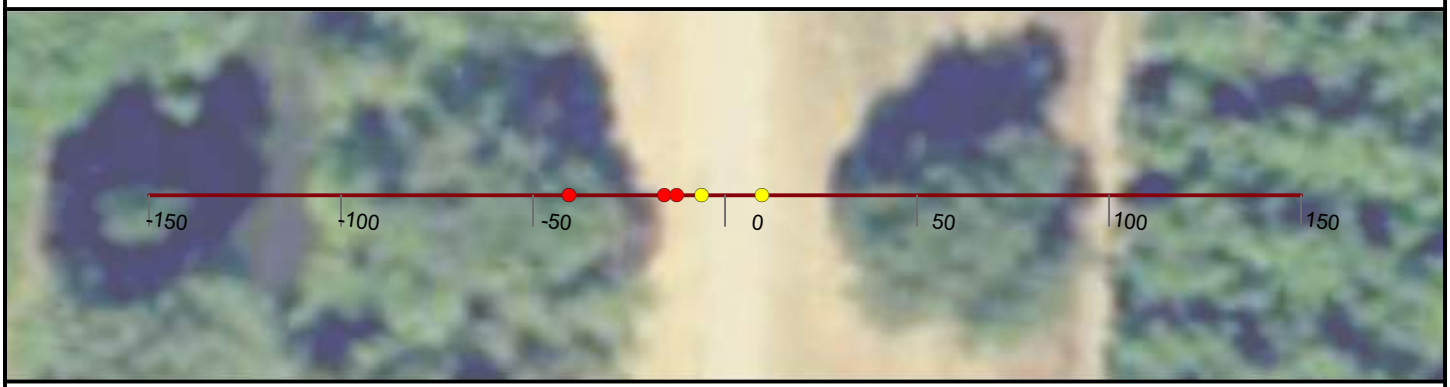
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Cross Section: Yankee Slough 13+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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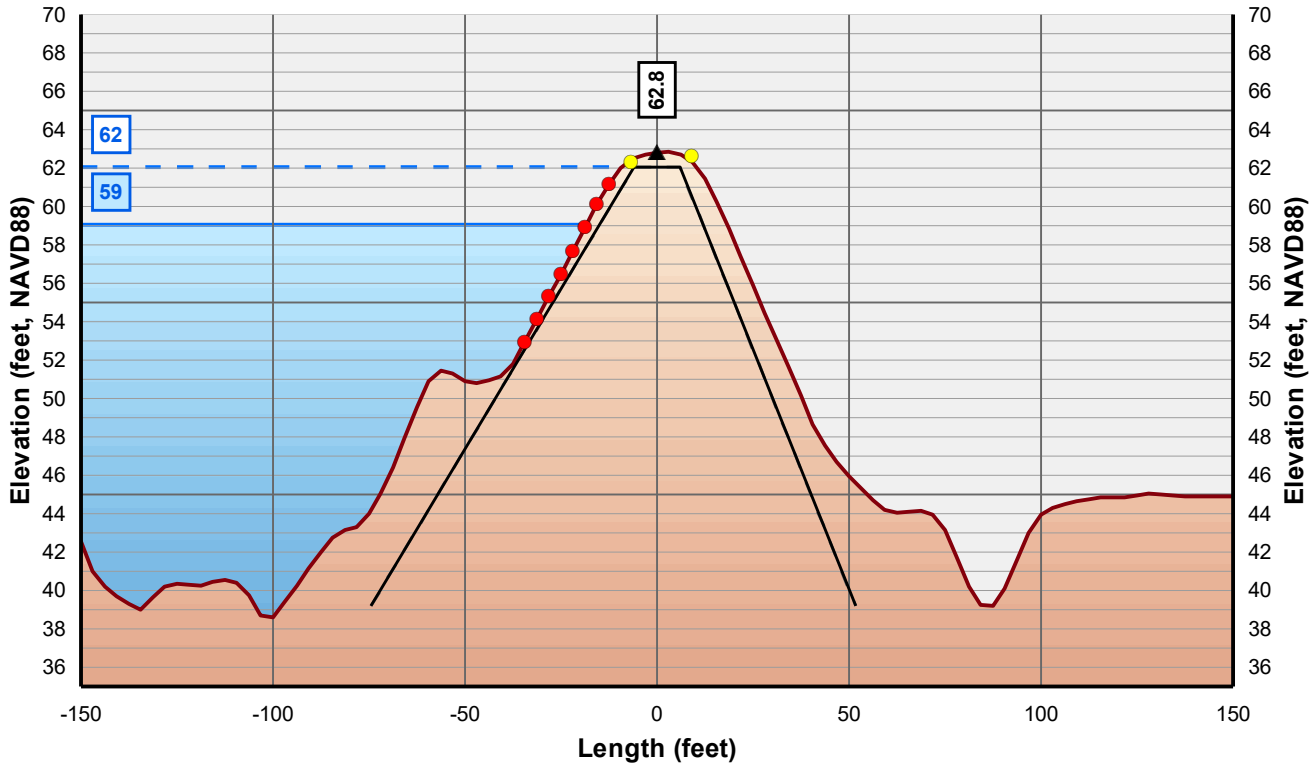
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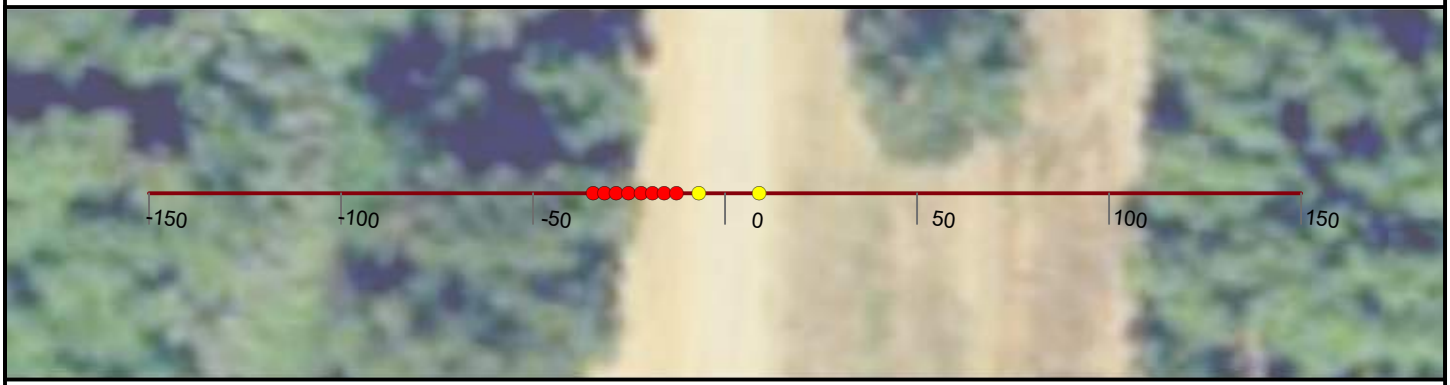
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Cross Section: Yankee Slough 14+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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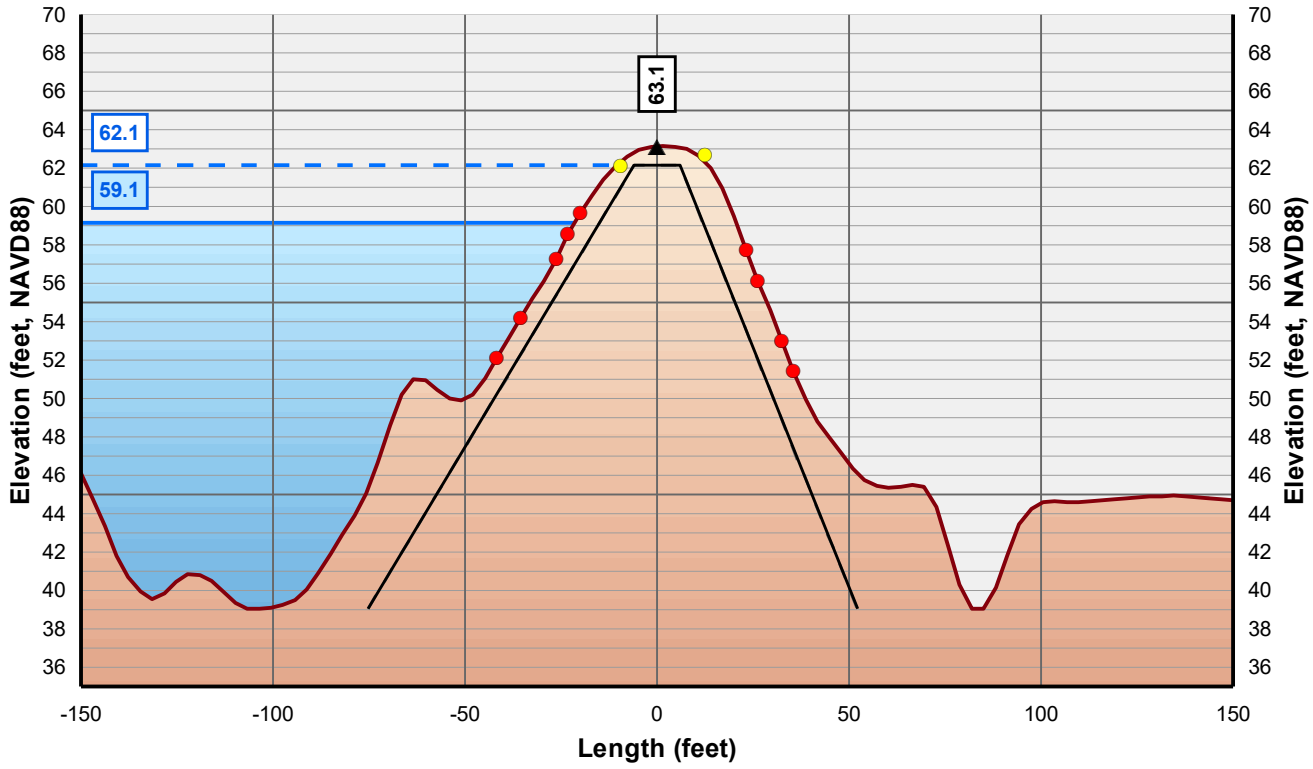
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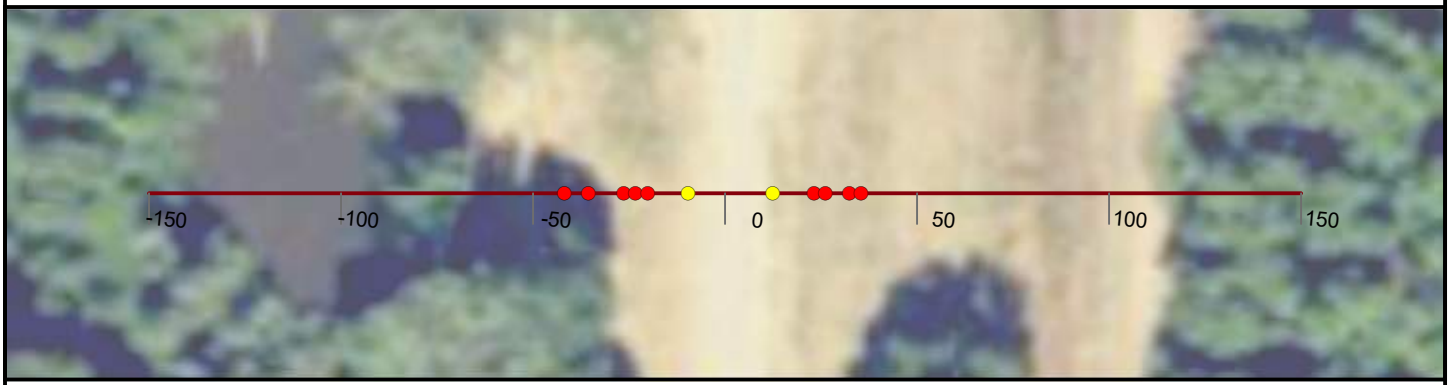
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Cross Section: Yankee Slough 15+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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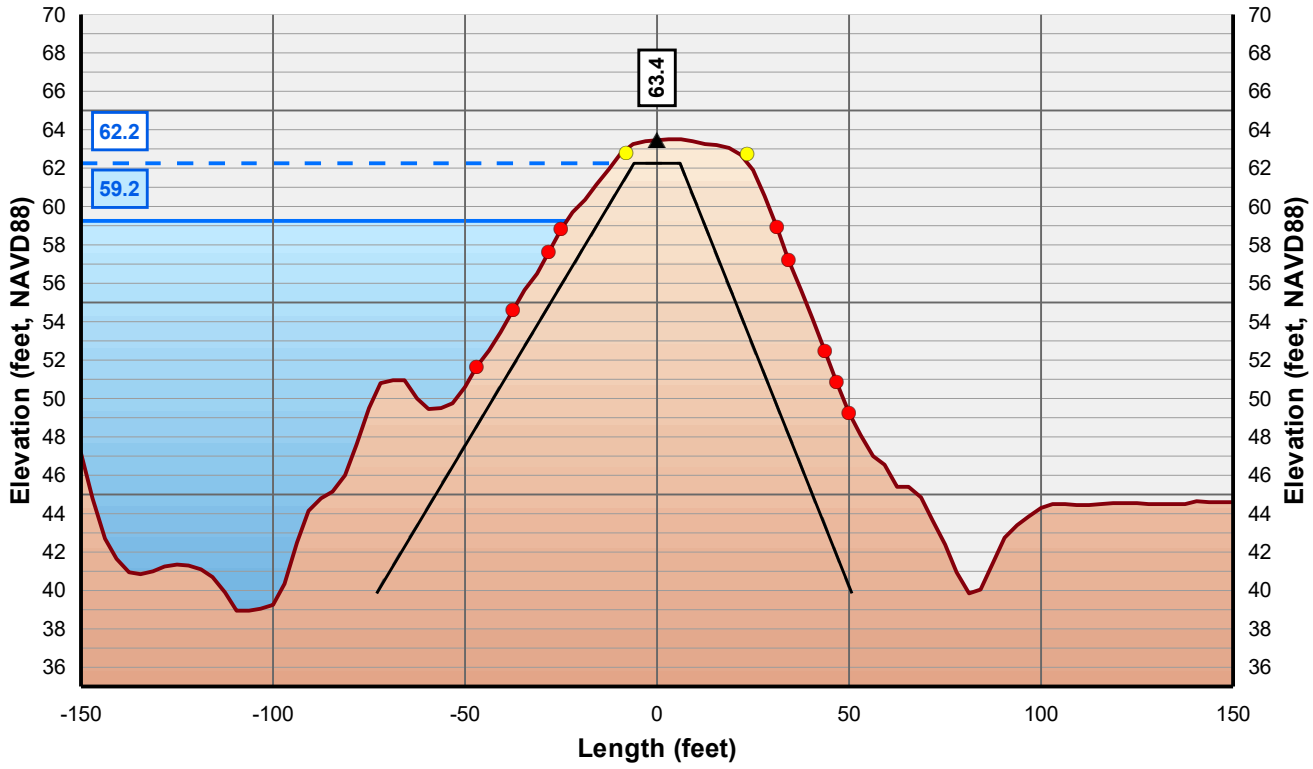
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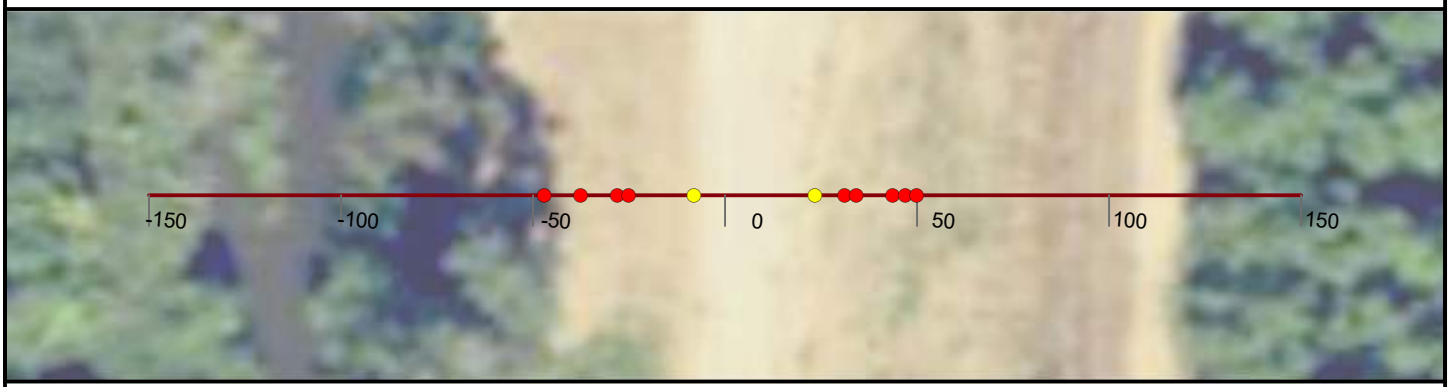
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Cross Section: Yankee Slough 16+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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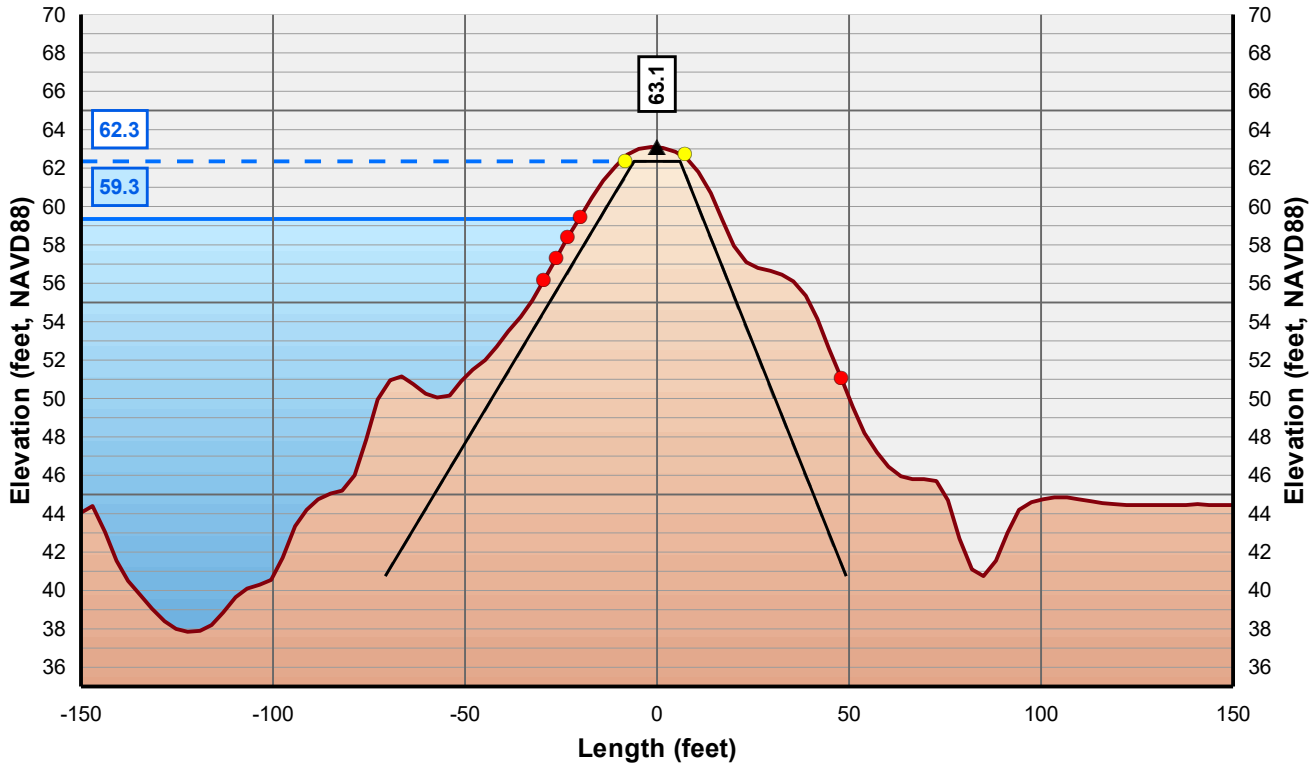
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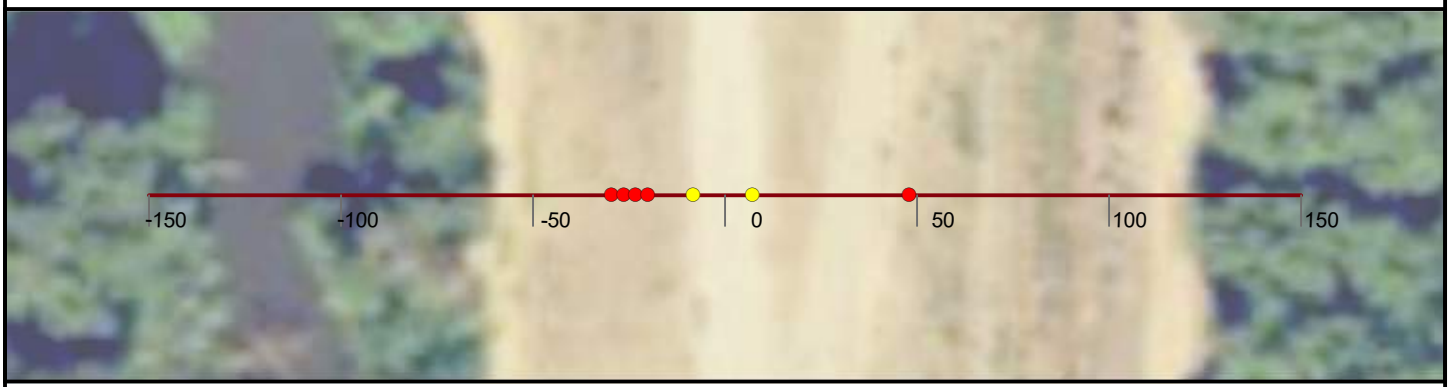
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Cross Section: Yankee Slough 17+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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CALIFORNIA

AUGUST, 2019

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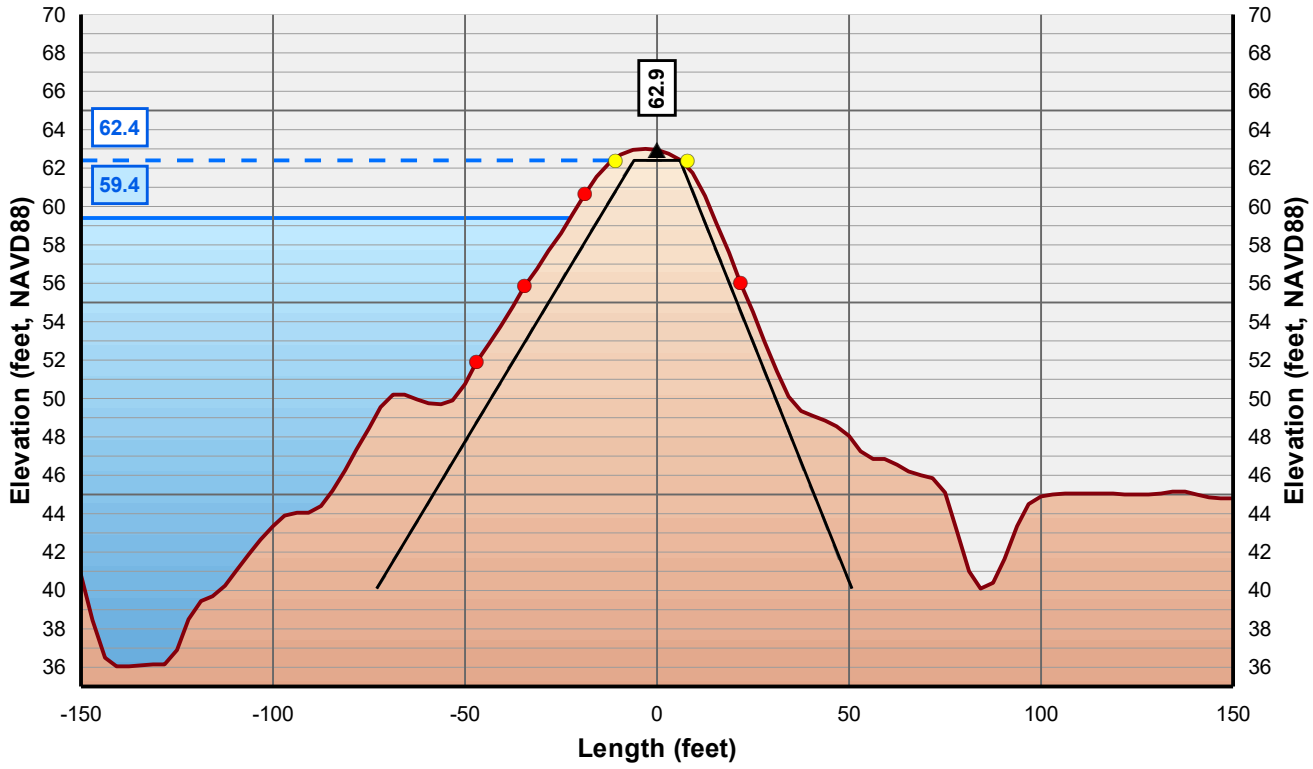
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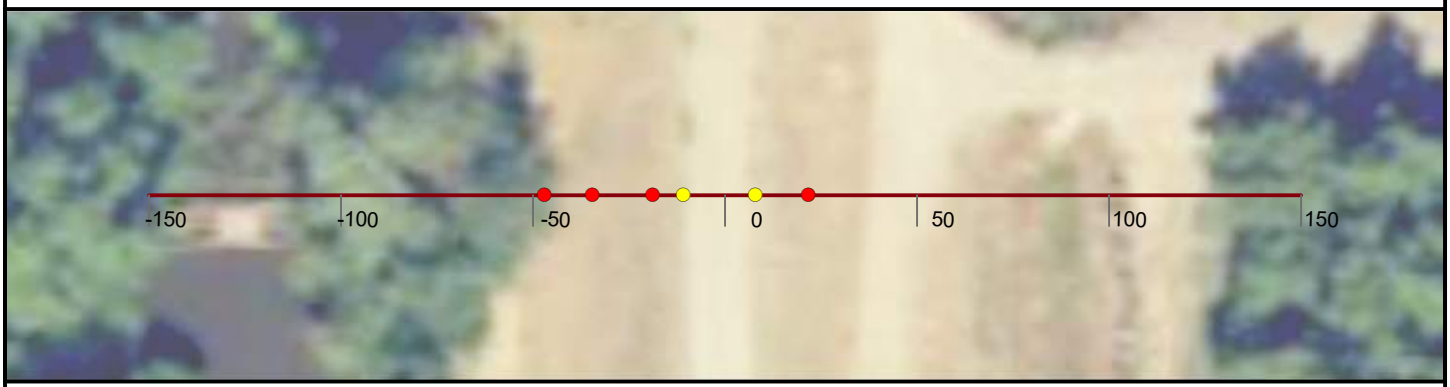
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Cross Section: Yankee Slough 18+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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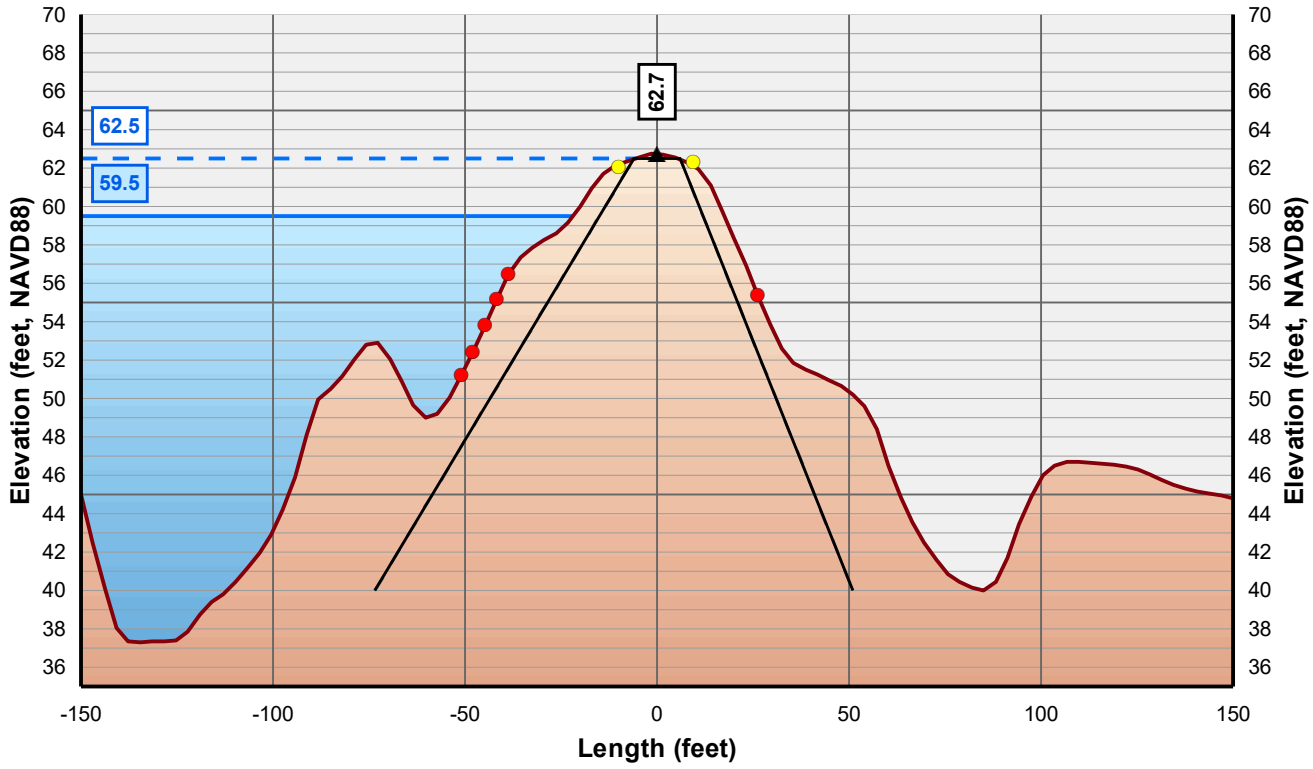
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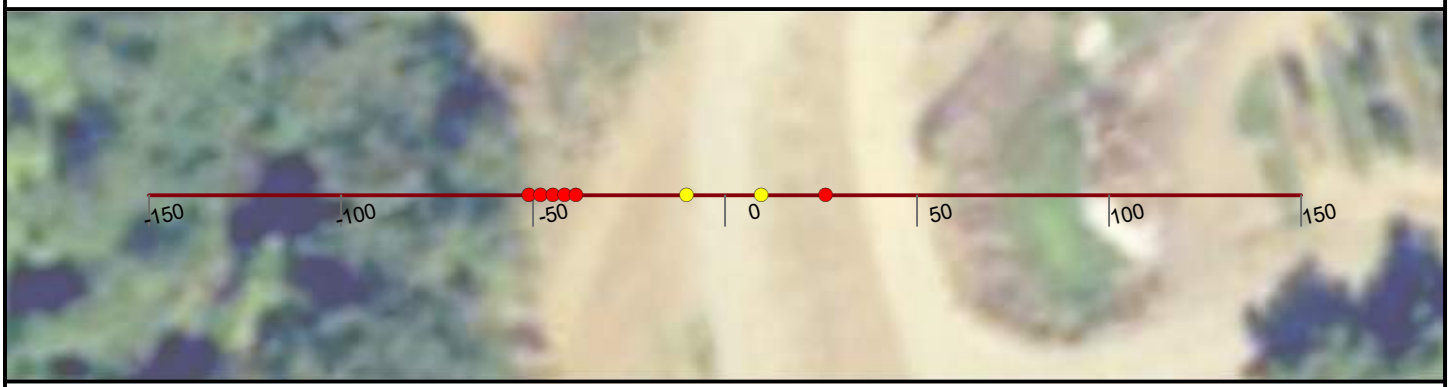
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Cross Section: Yankee Slough 19+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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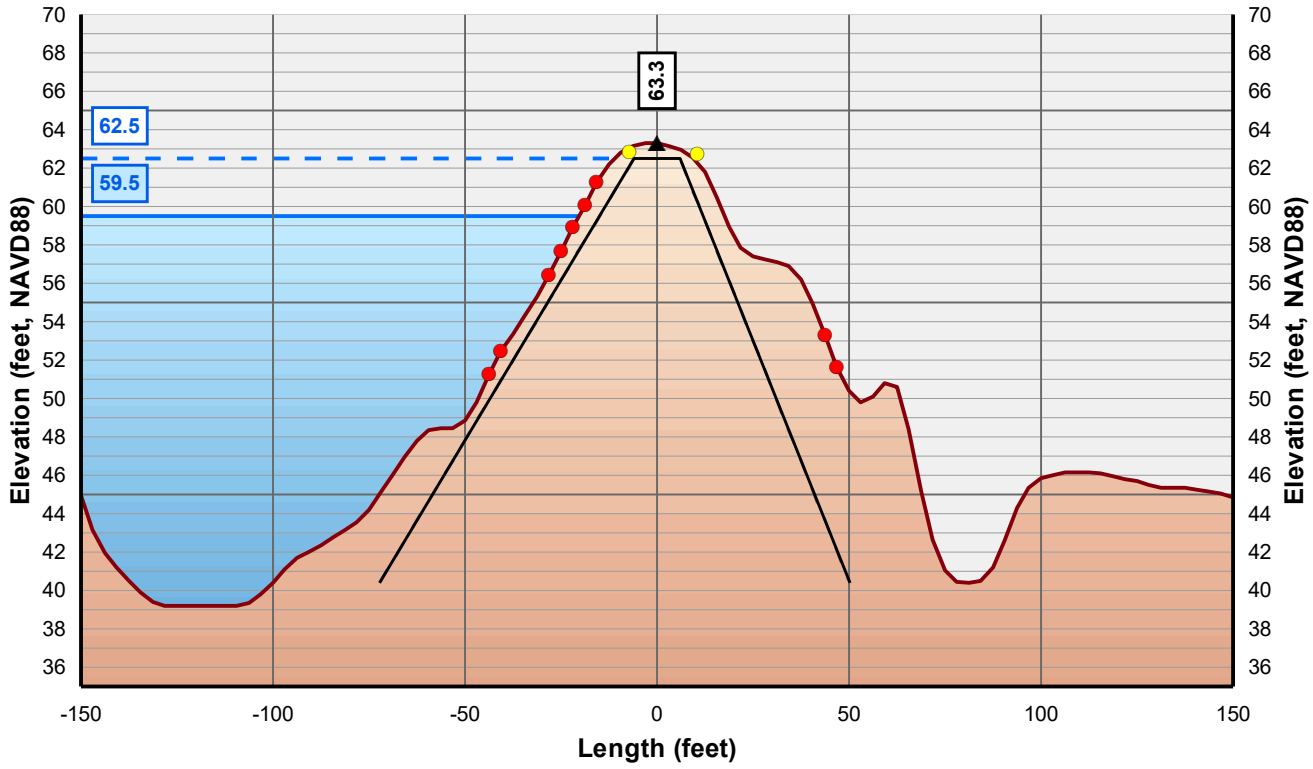
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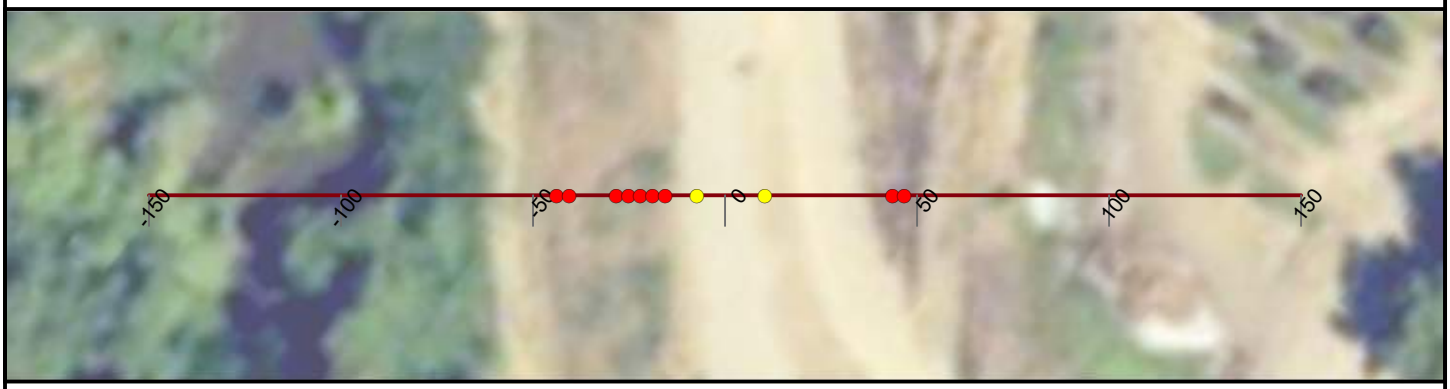
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Cross Section: Yankee Slough 20+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

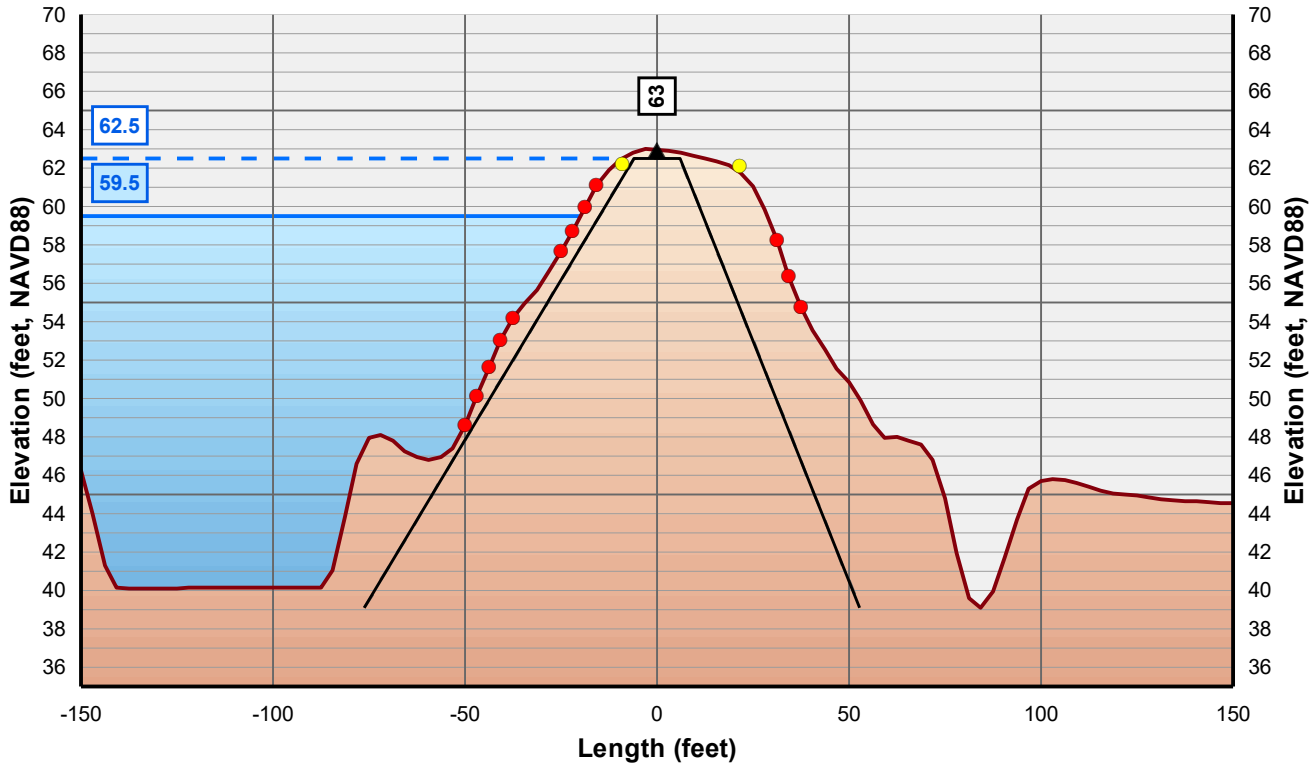
FEET

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WOOD RODGERS
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

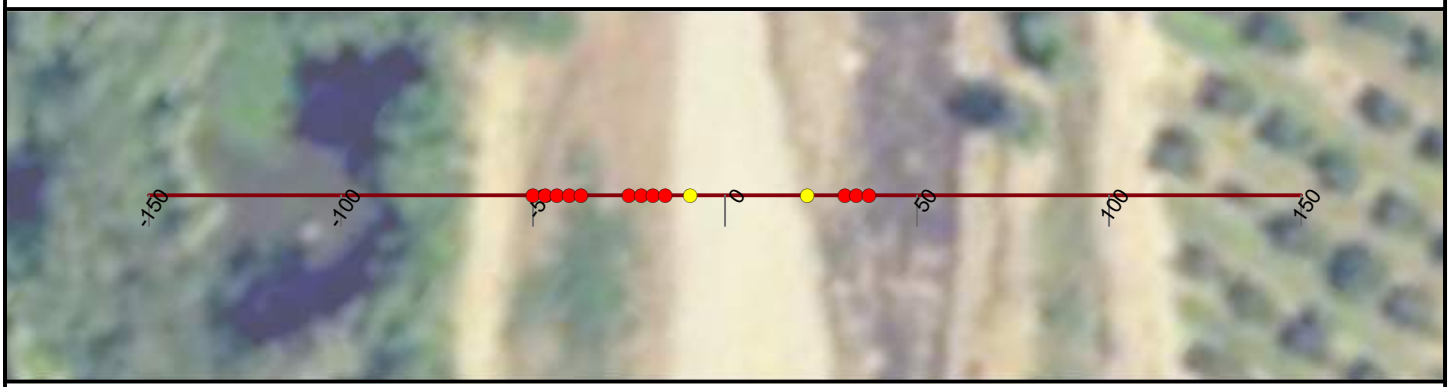
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Cross Section: Yankee Slough 21+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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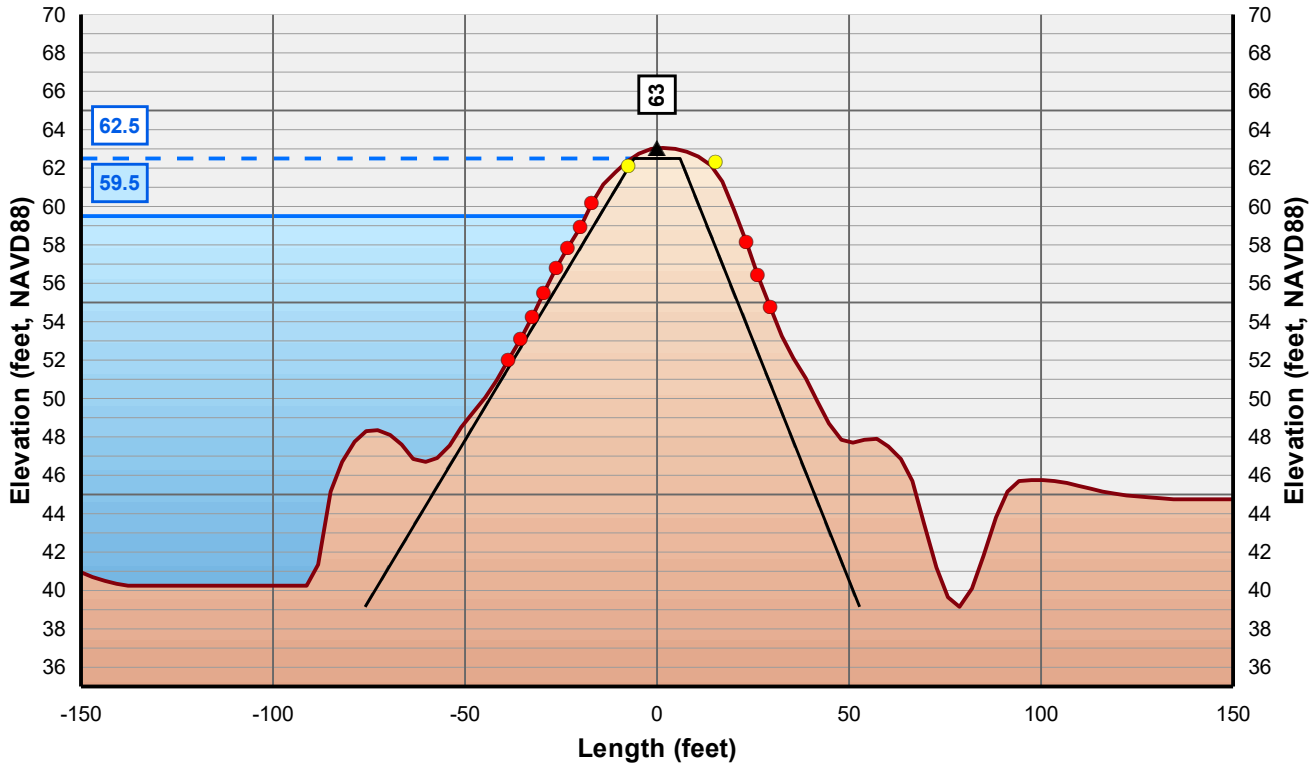
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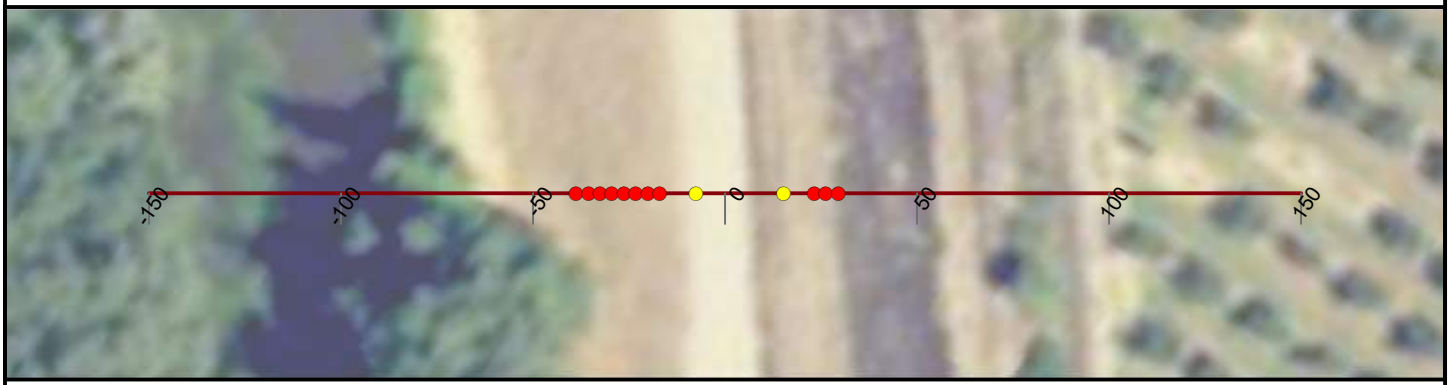
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Cross Section: Yankee Slough 22+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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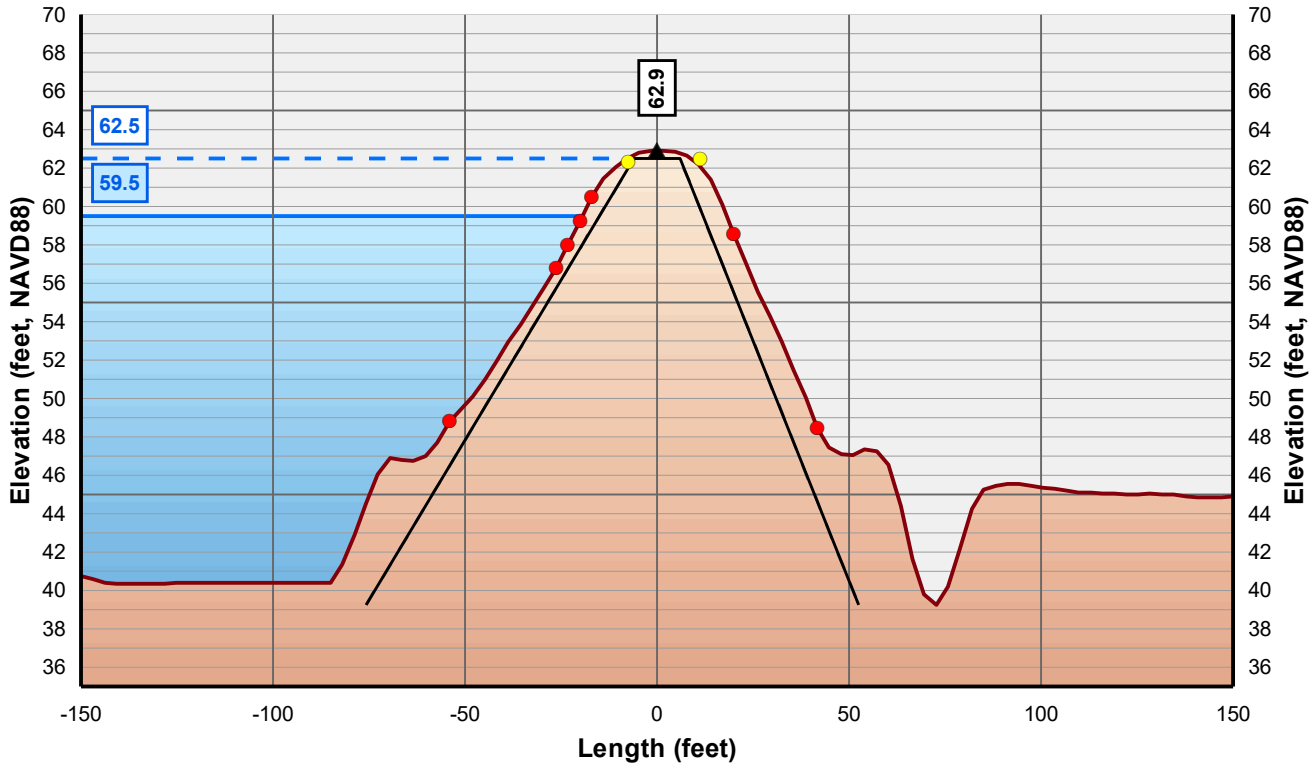
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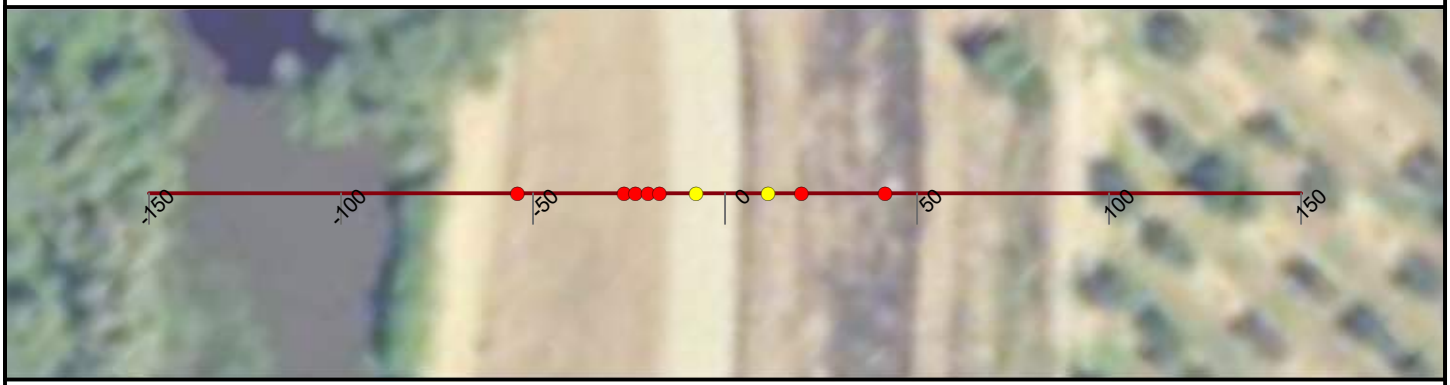
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Cross Section: Yankee Slough 23+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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NORTH

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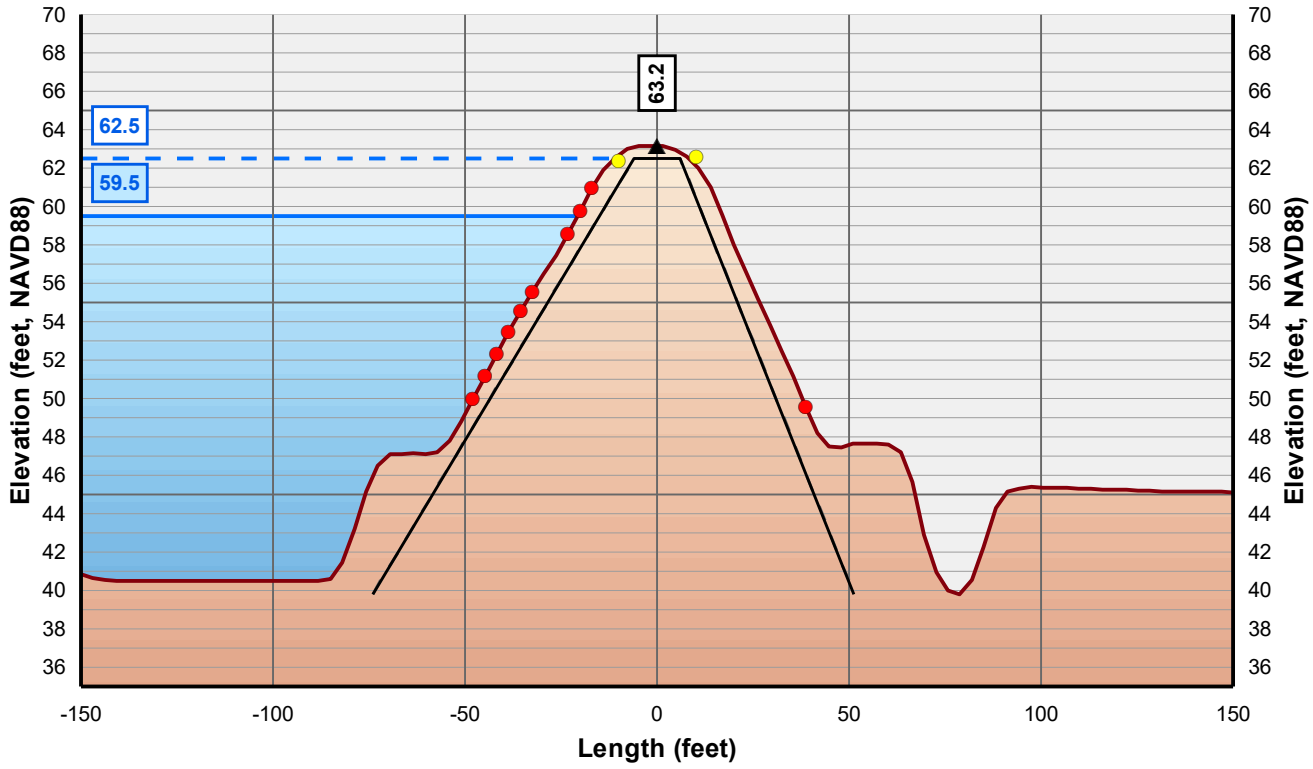
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Cross Section: Yankee Slough 24+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

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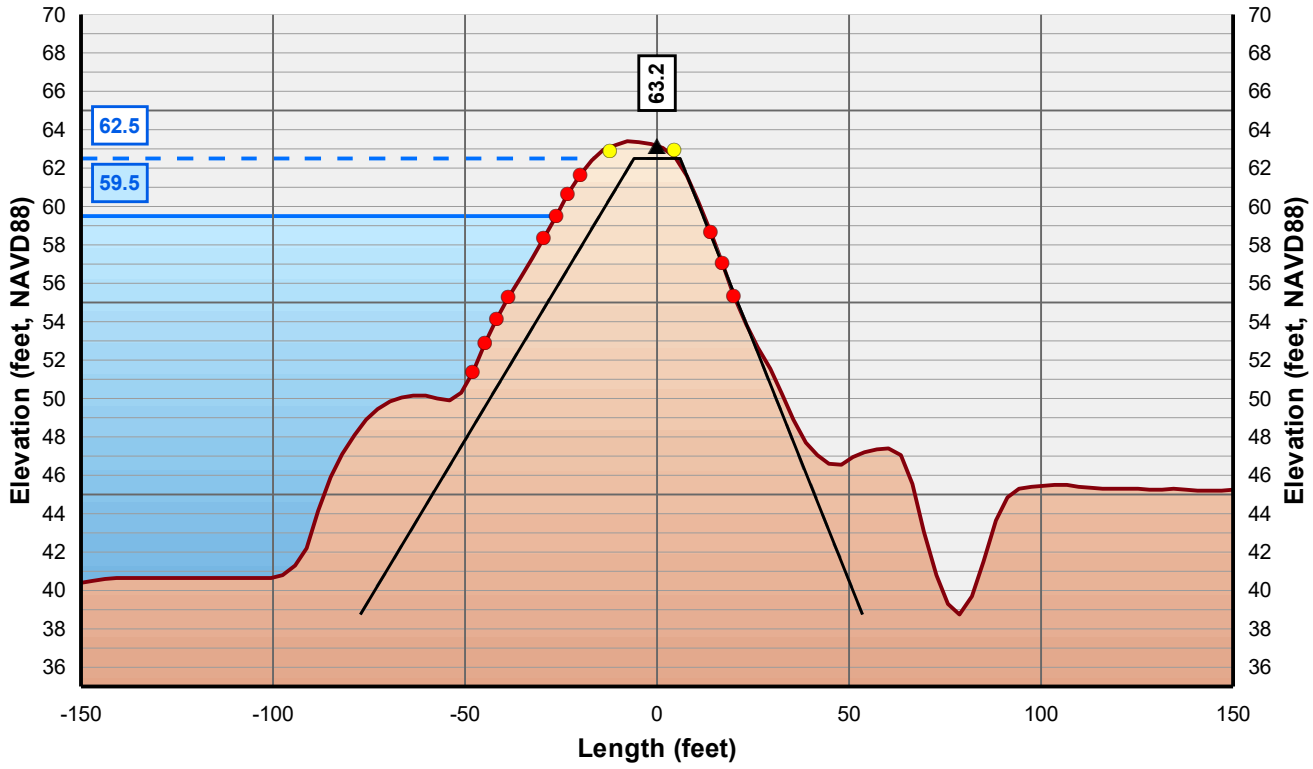
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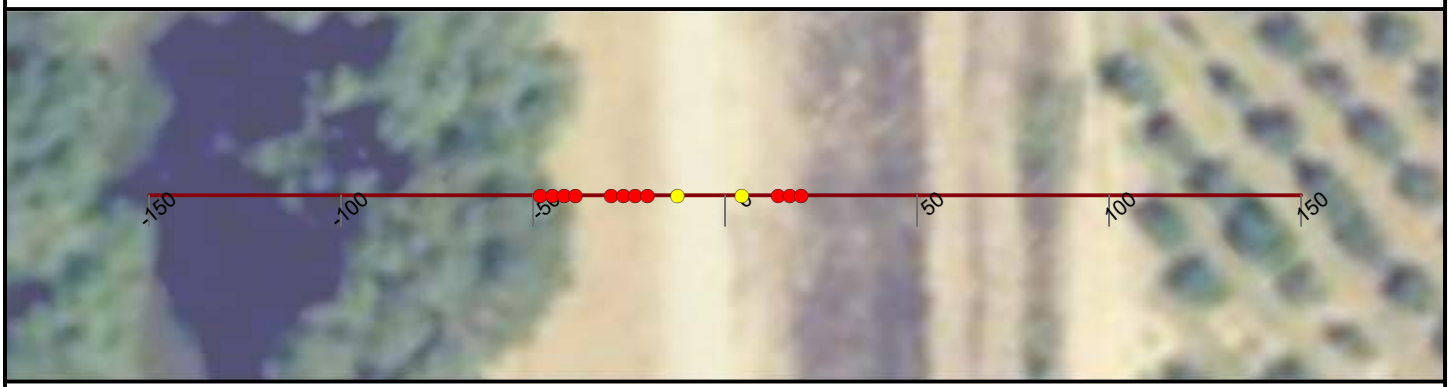
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Cross Section: Yankee Slough 25+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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AUGUST, 2019

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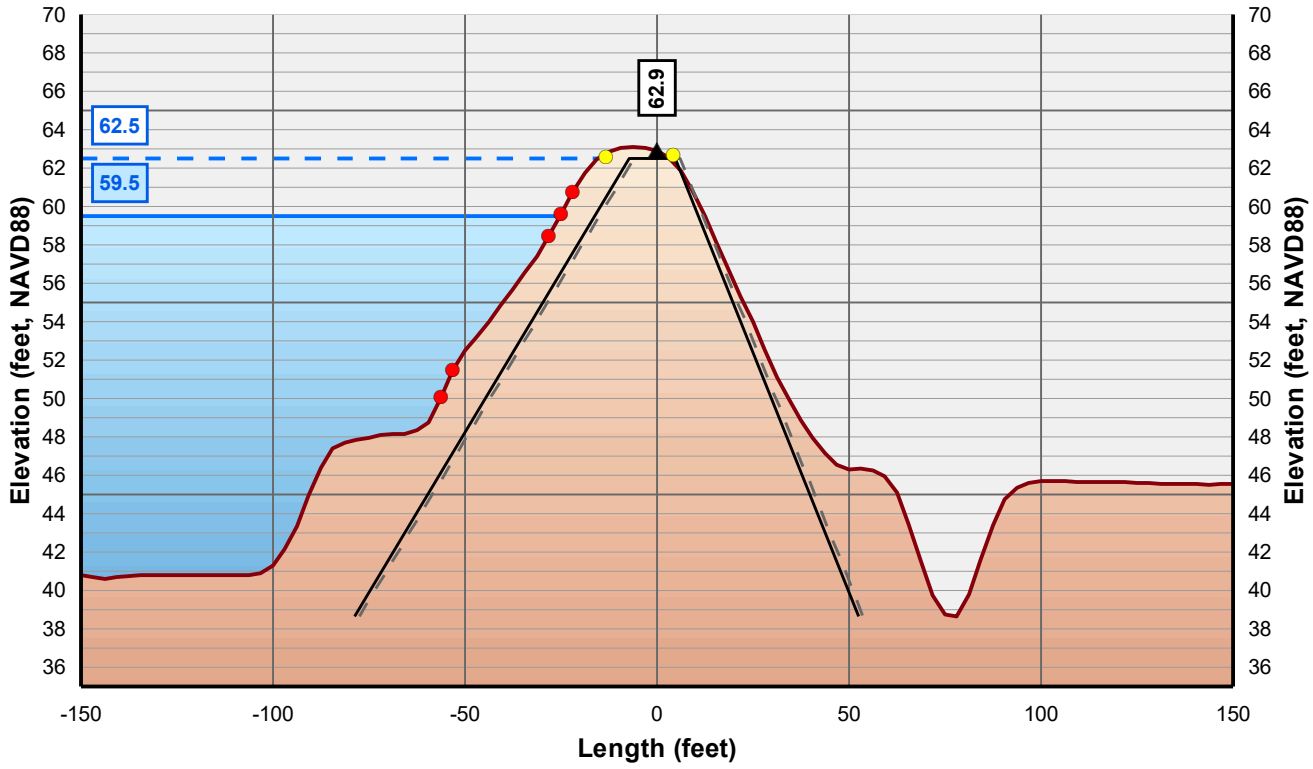
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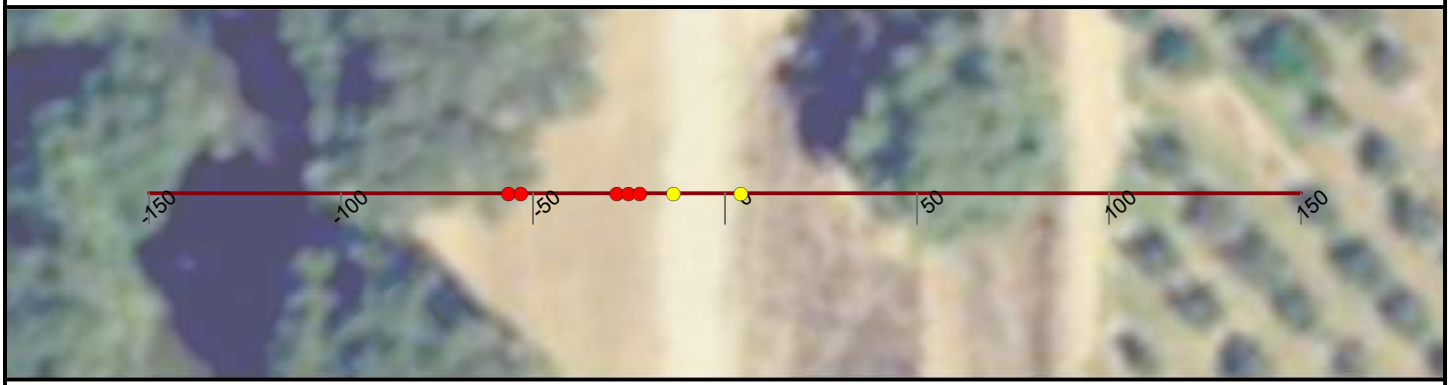
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Cross Section: Yankee Slough 26+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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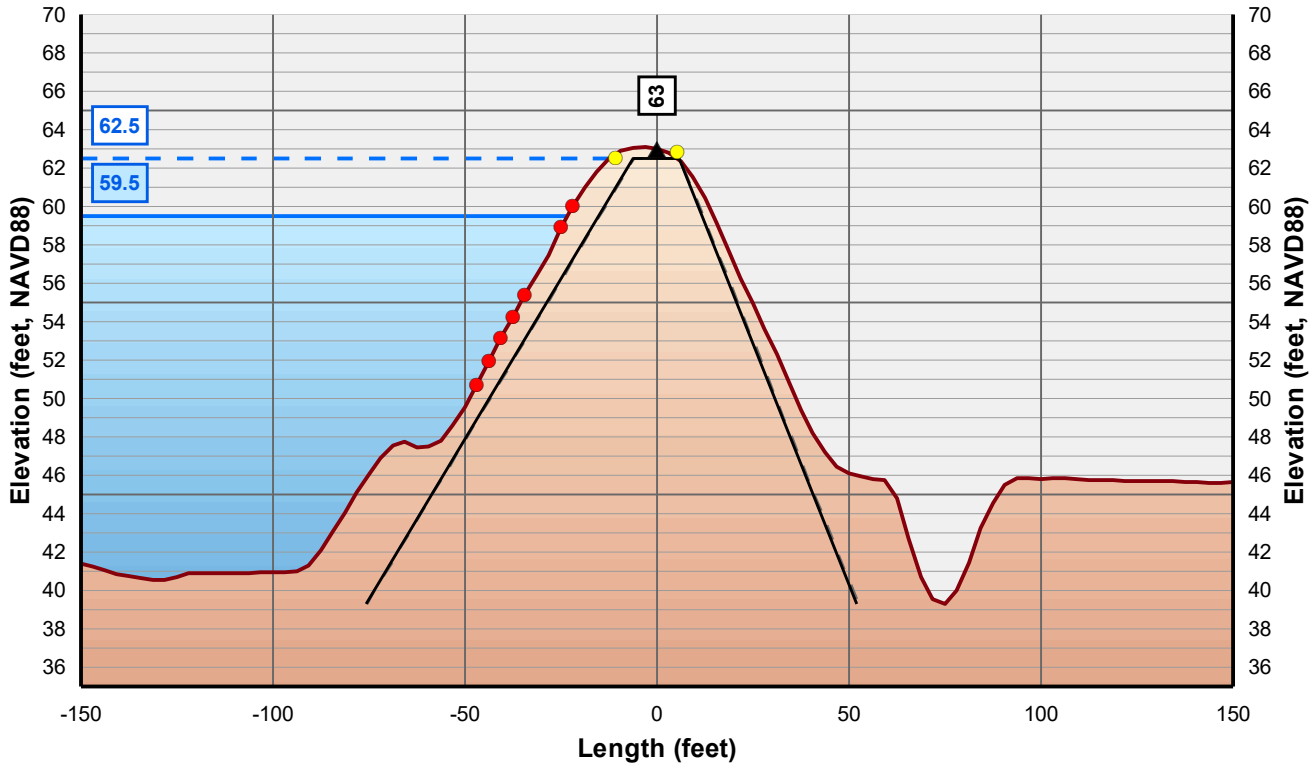
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Cross Section: Yankee Slough 27+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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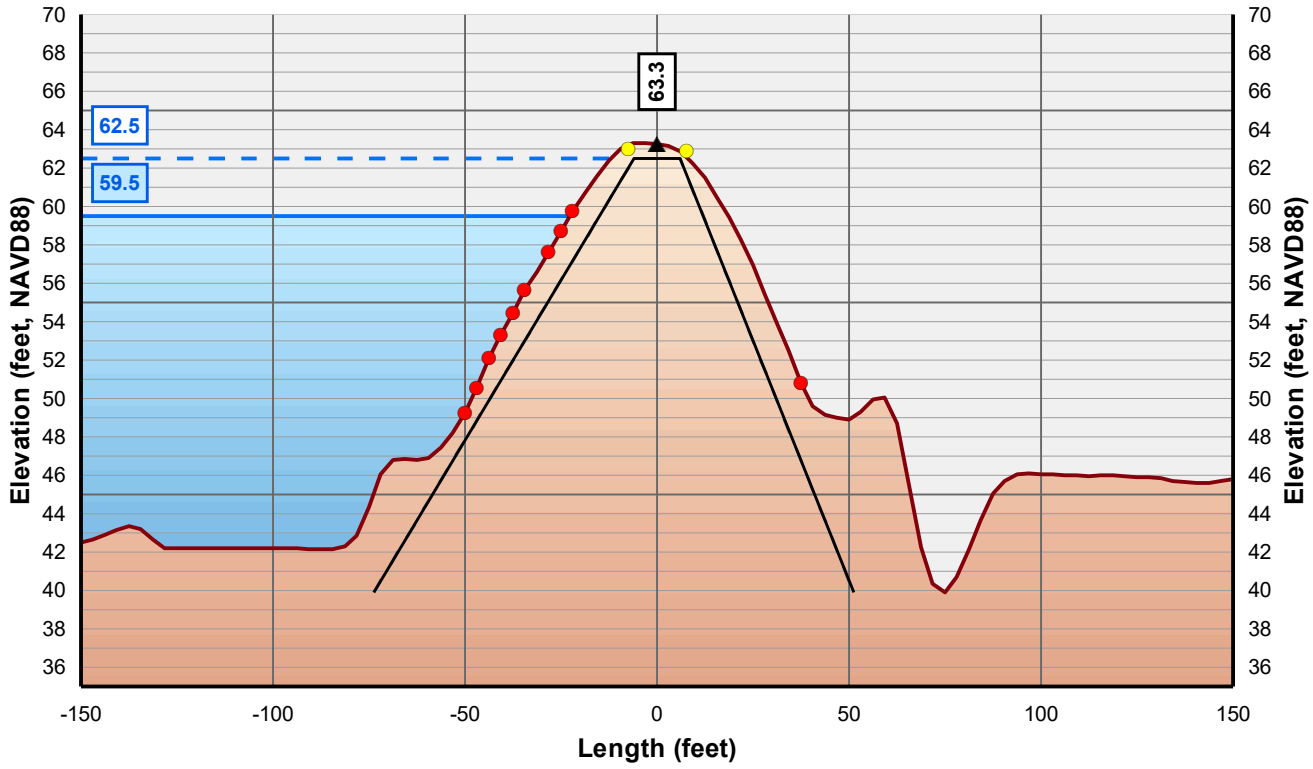
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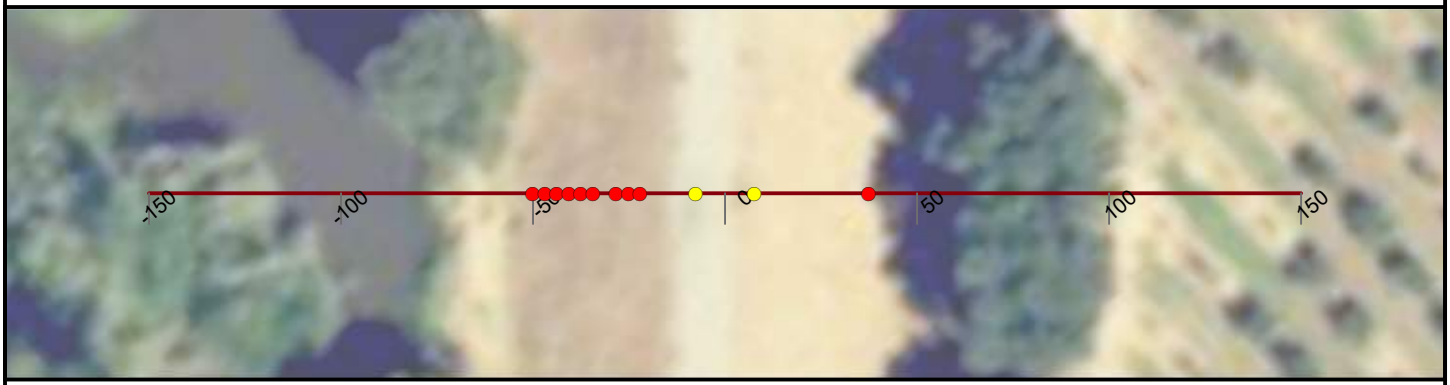
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Cross Section: Yankee Slough 28+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

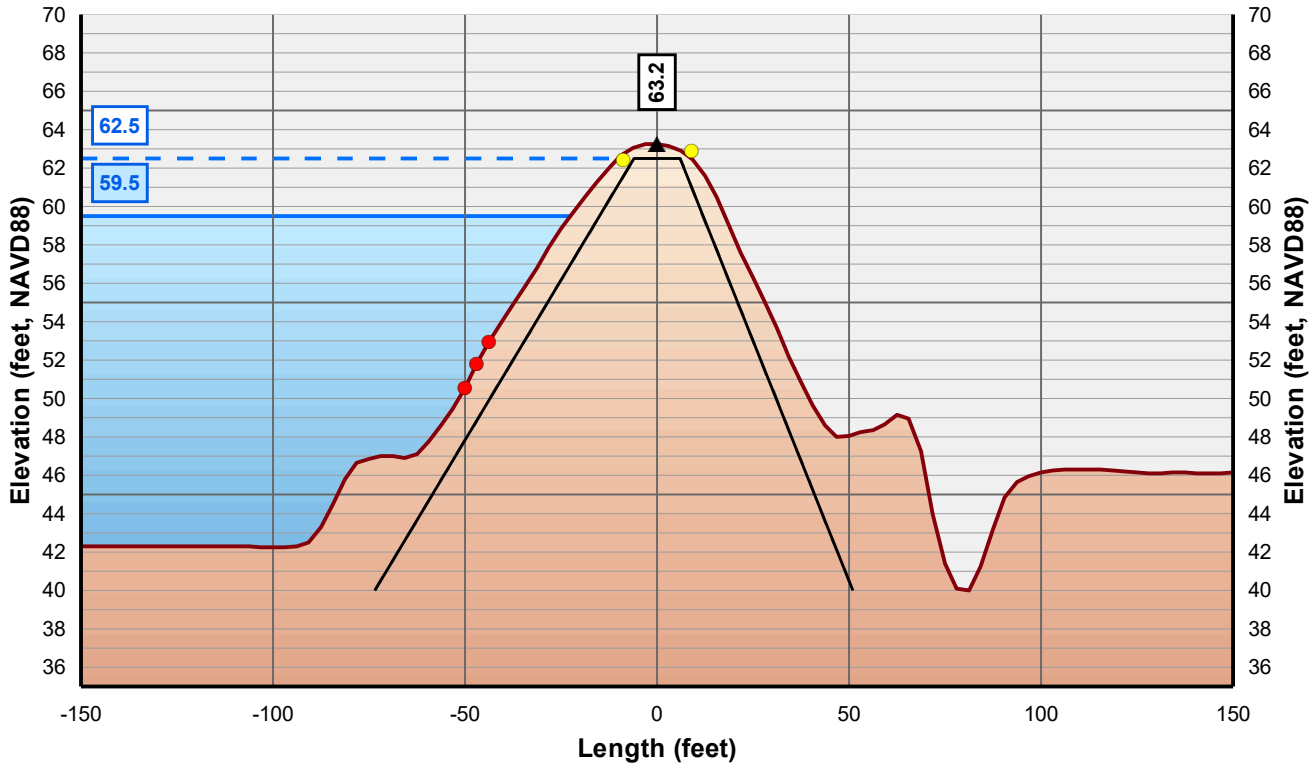
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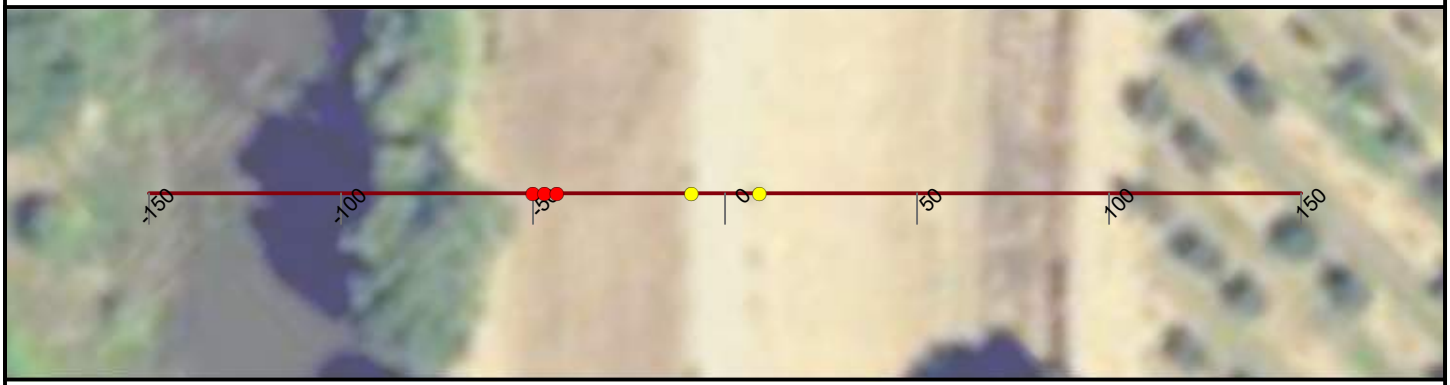
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Cross Section: Yankee Slough 29+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

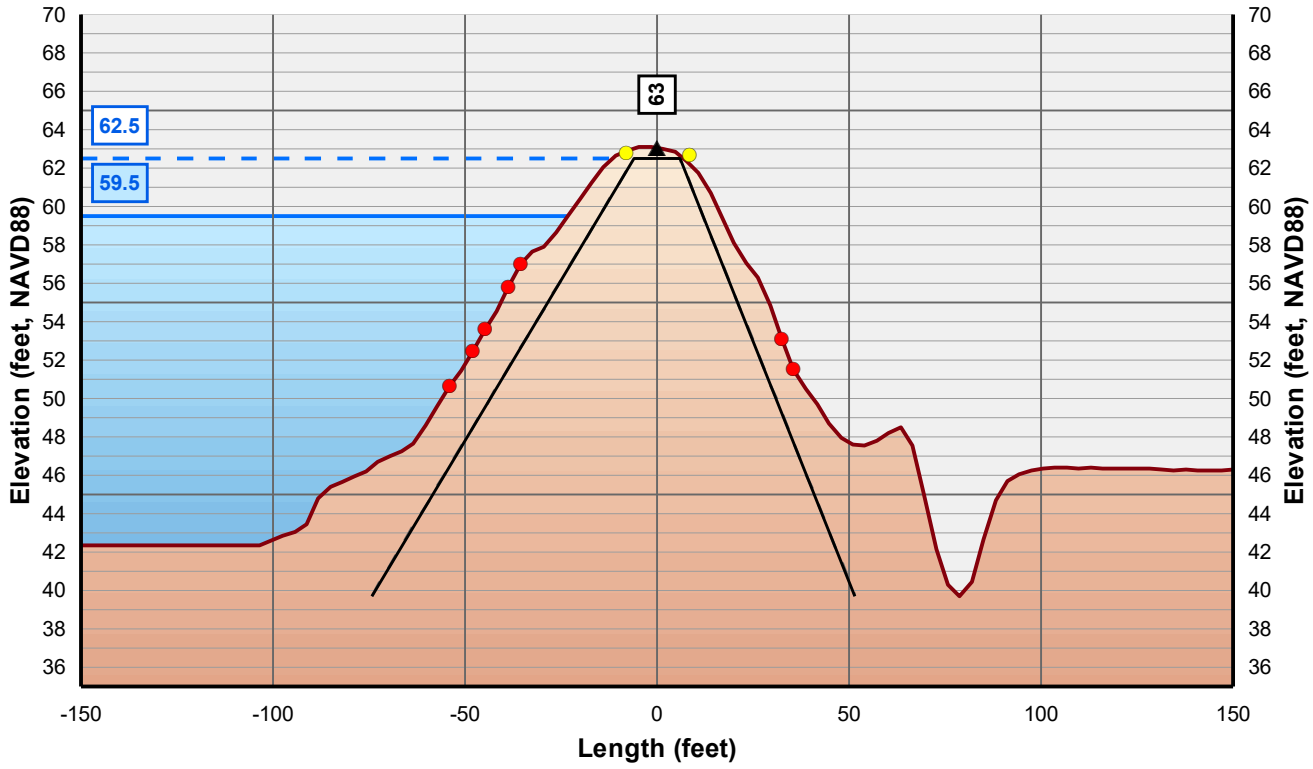
FEET

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Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

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Cross Section: Yankee Slough 30+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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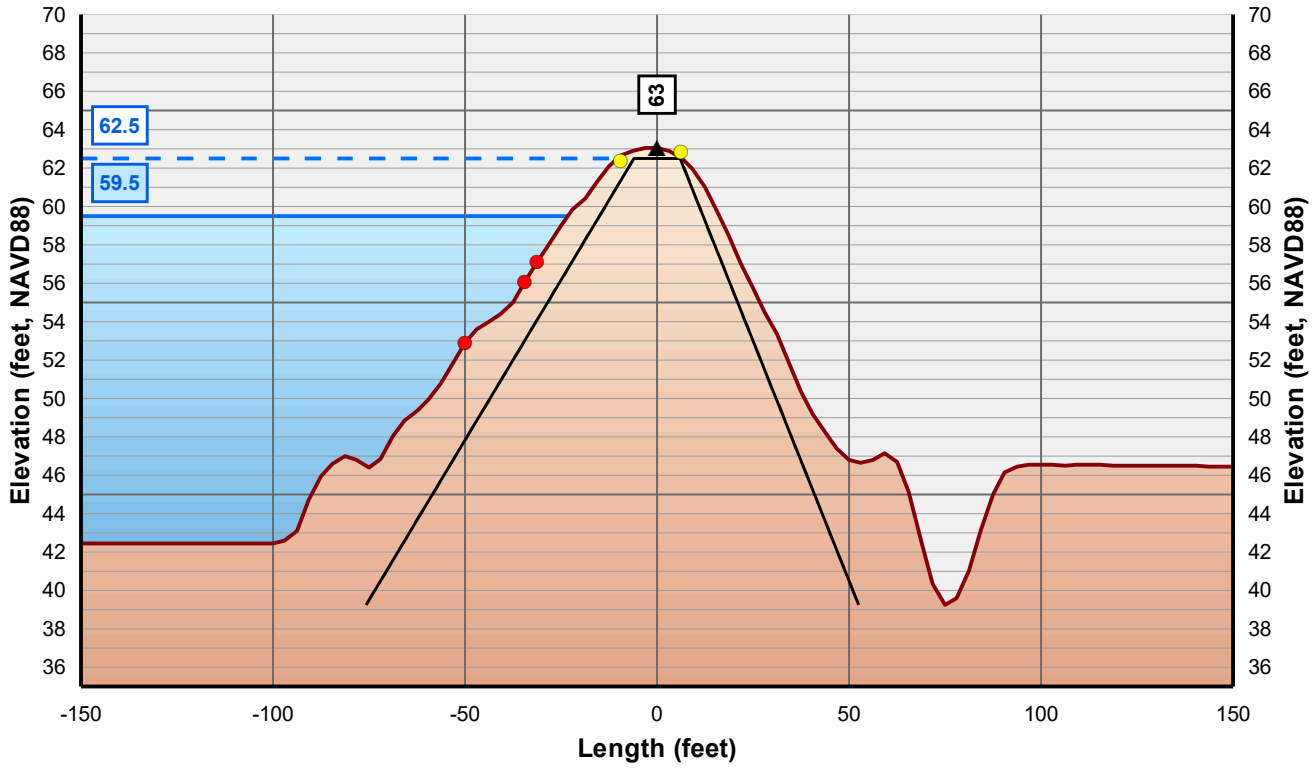
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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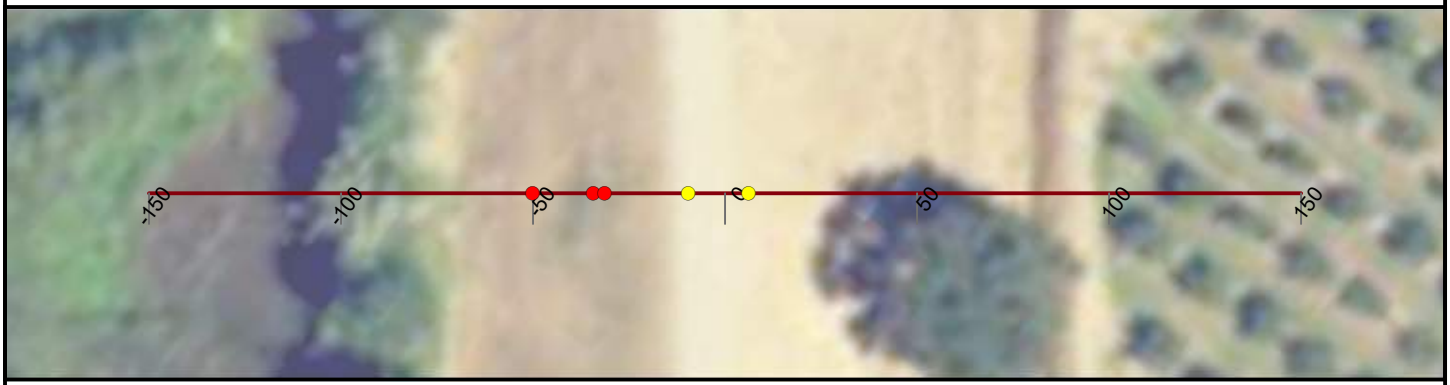
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Cross Section: Yankee Slough 31+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

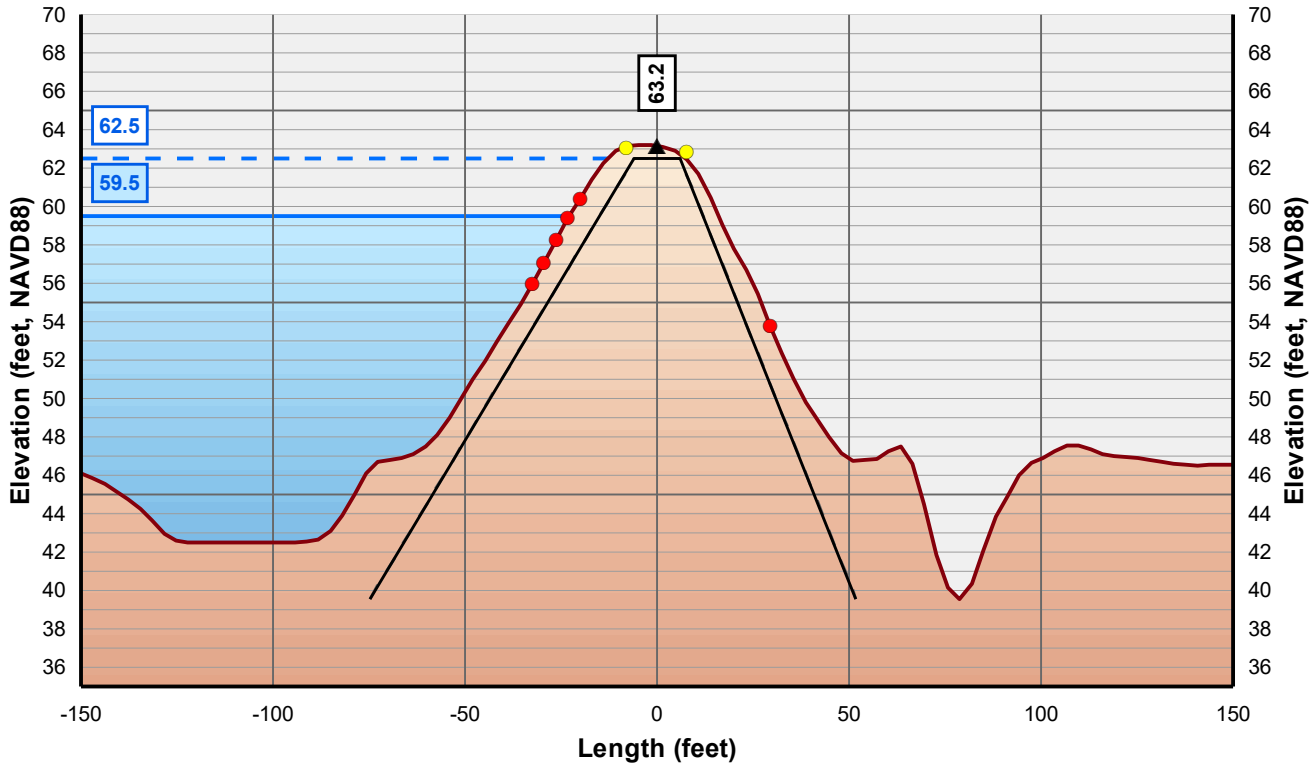
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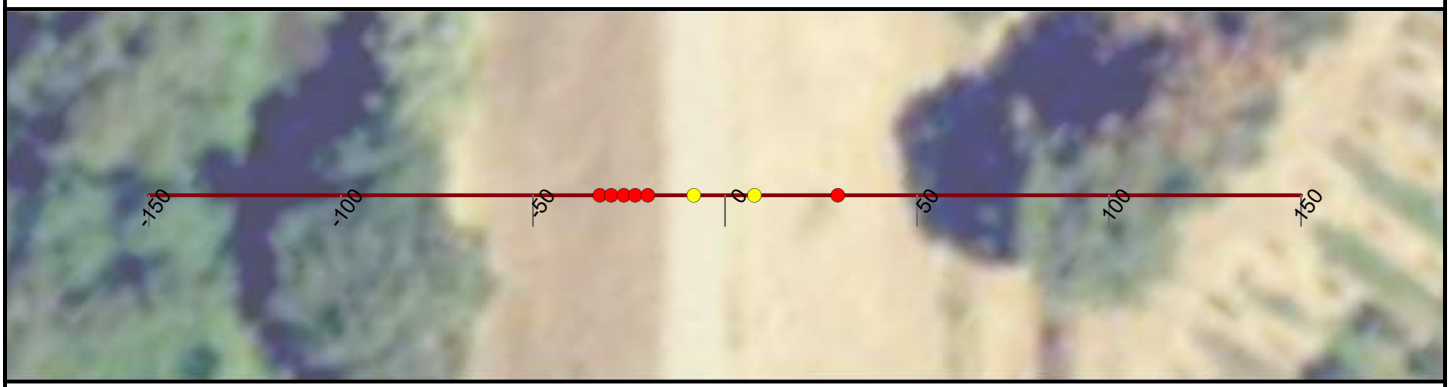
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Cross Section: Yankee Slough 32+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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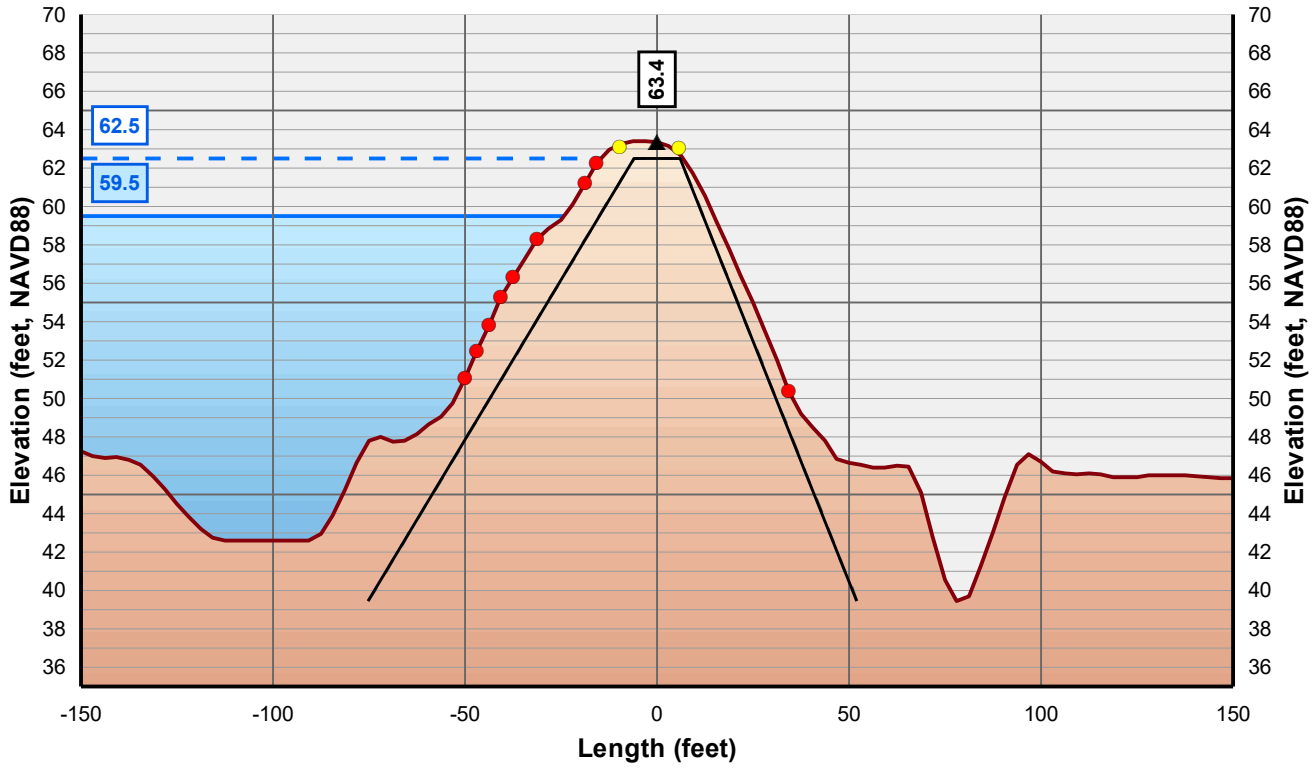
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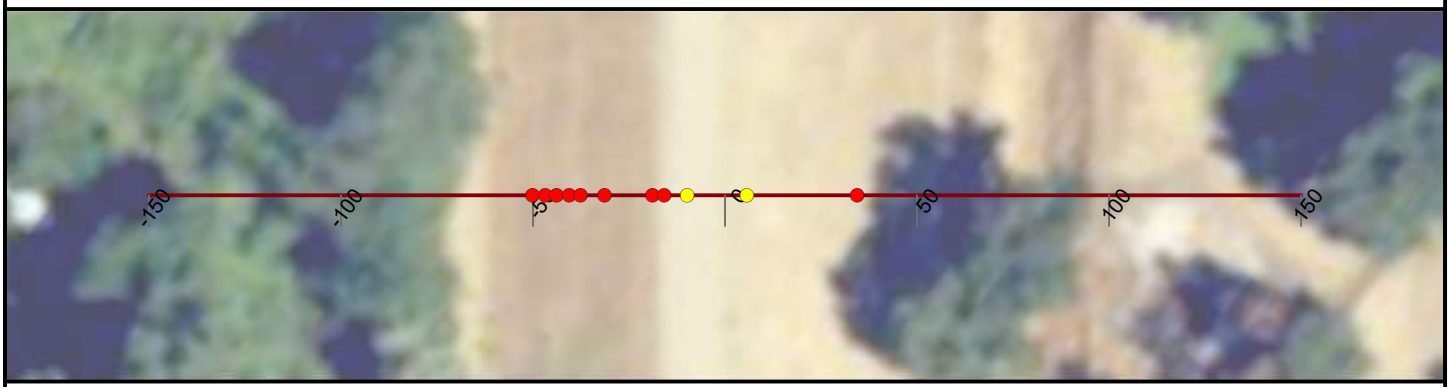
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Cross Section: Yankee Slough 33+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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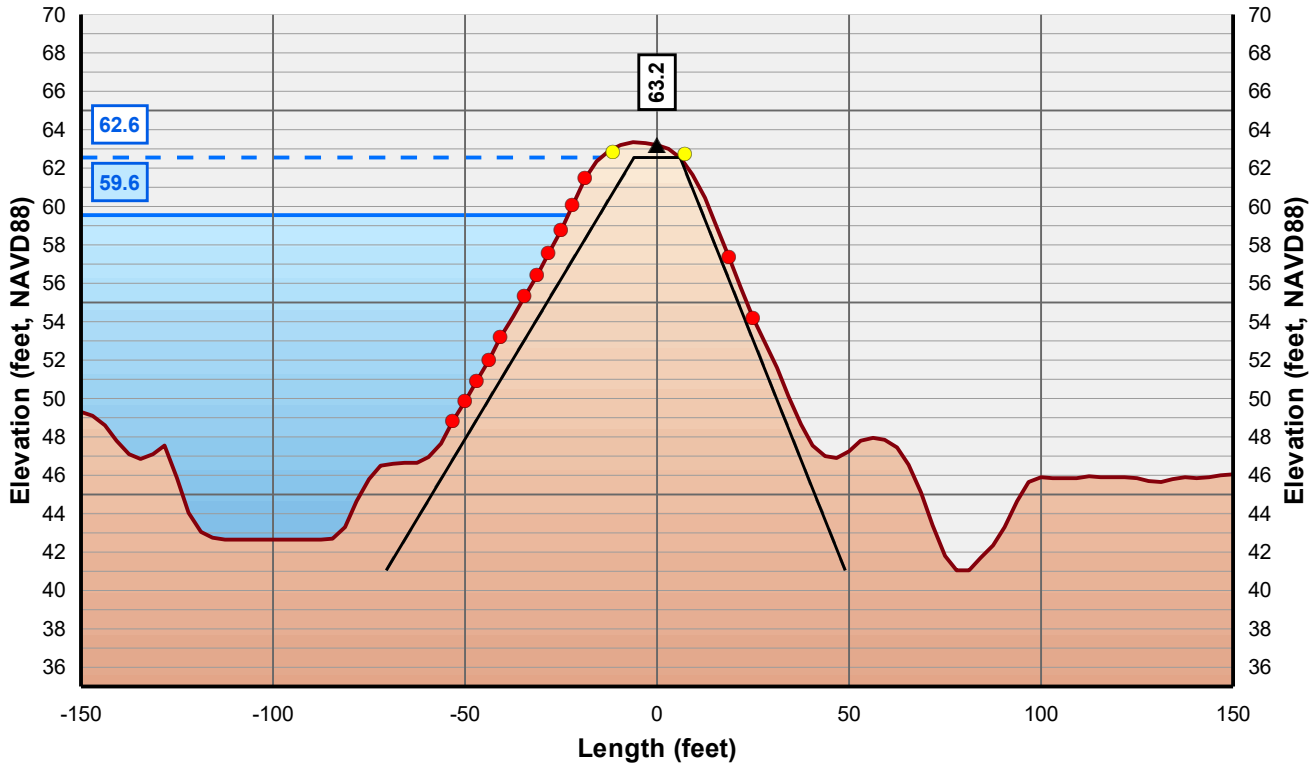
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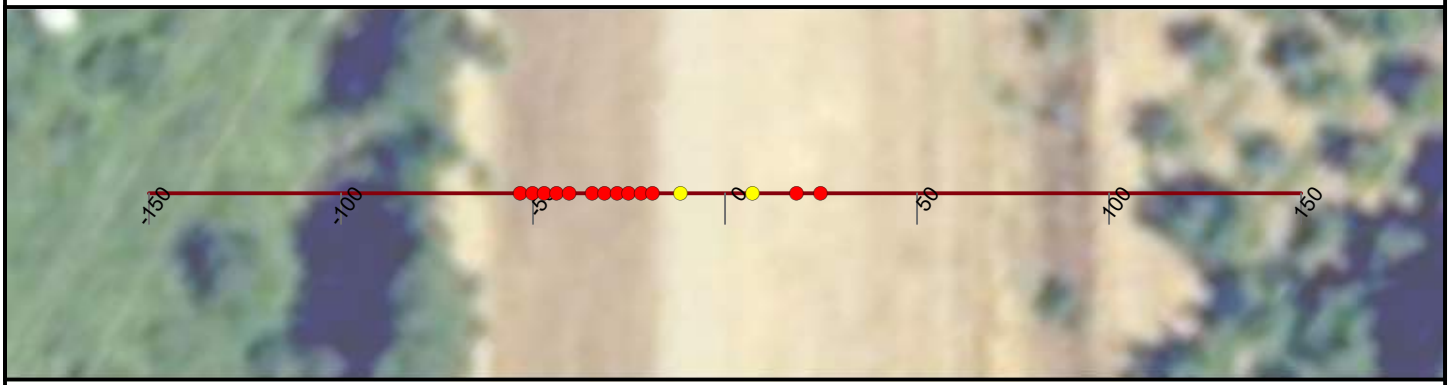
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Cross Section: Yankee Slough 34+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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CALIFORNIA

AUGUST, 2019

NORTH

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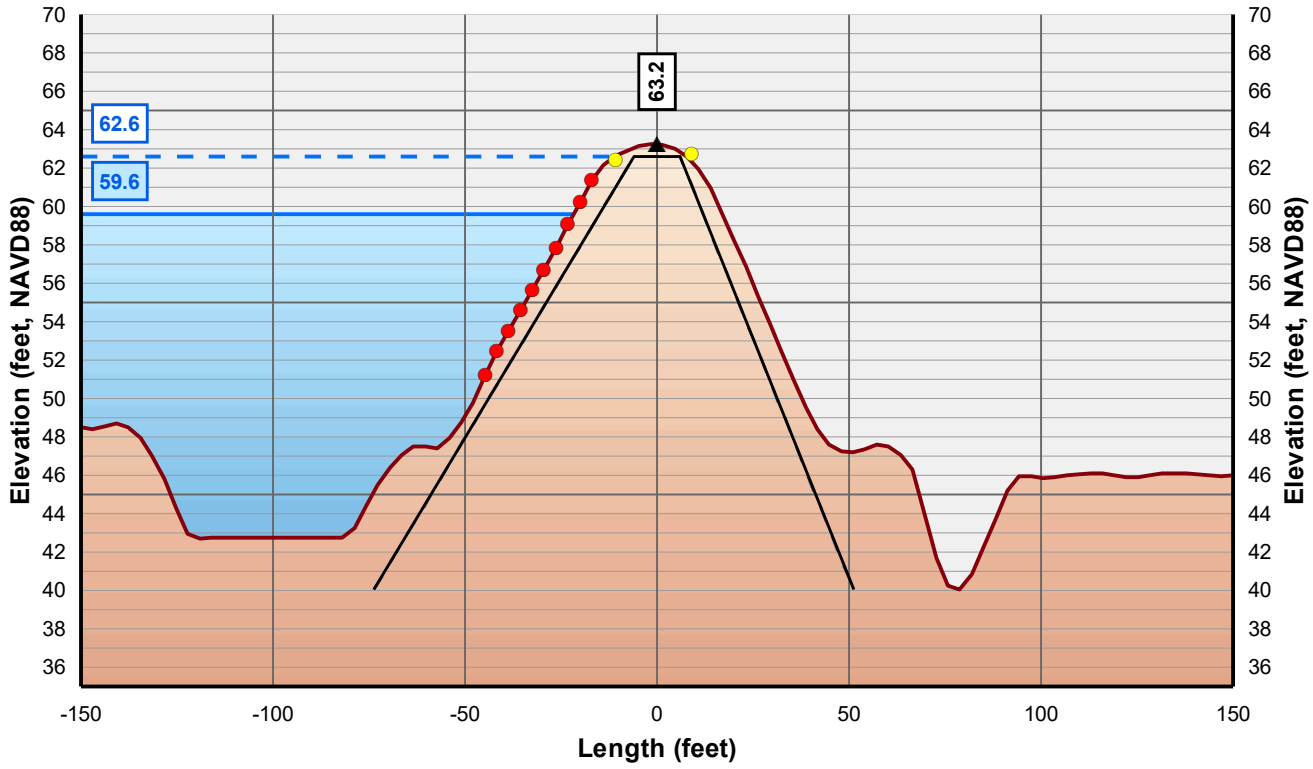
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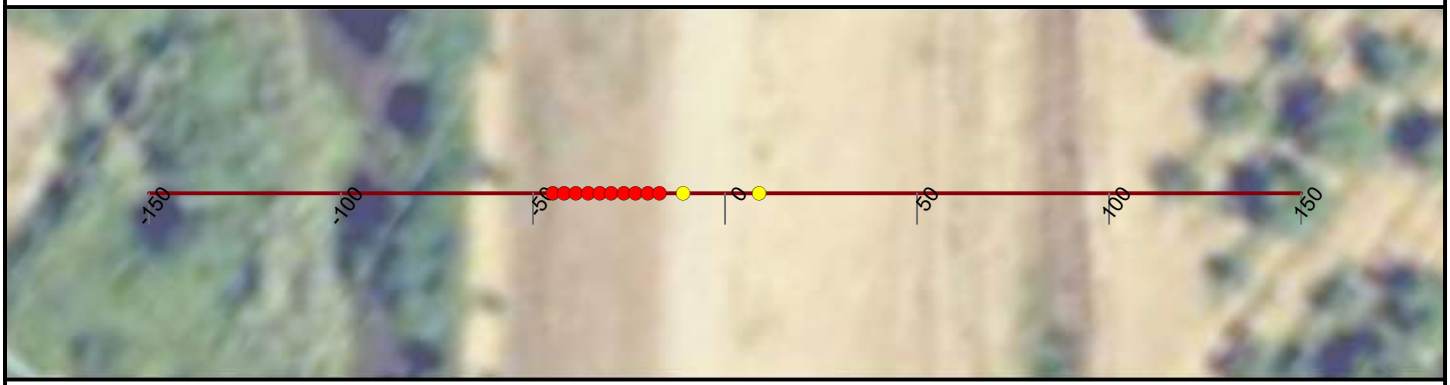
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Cross Section: Yankee Slough 35+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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NORTH

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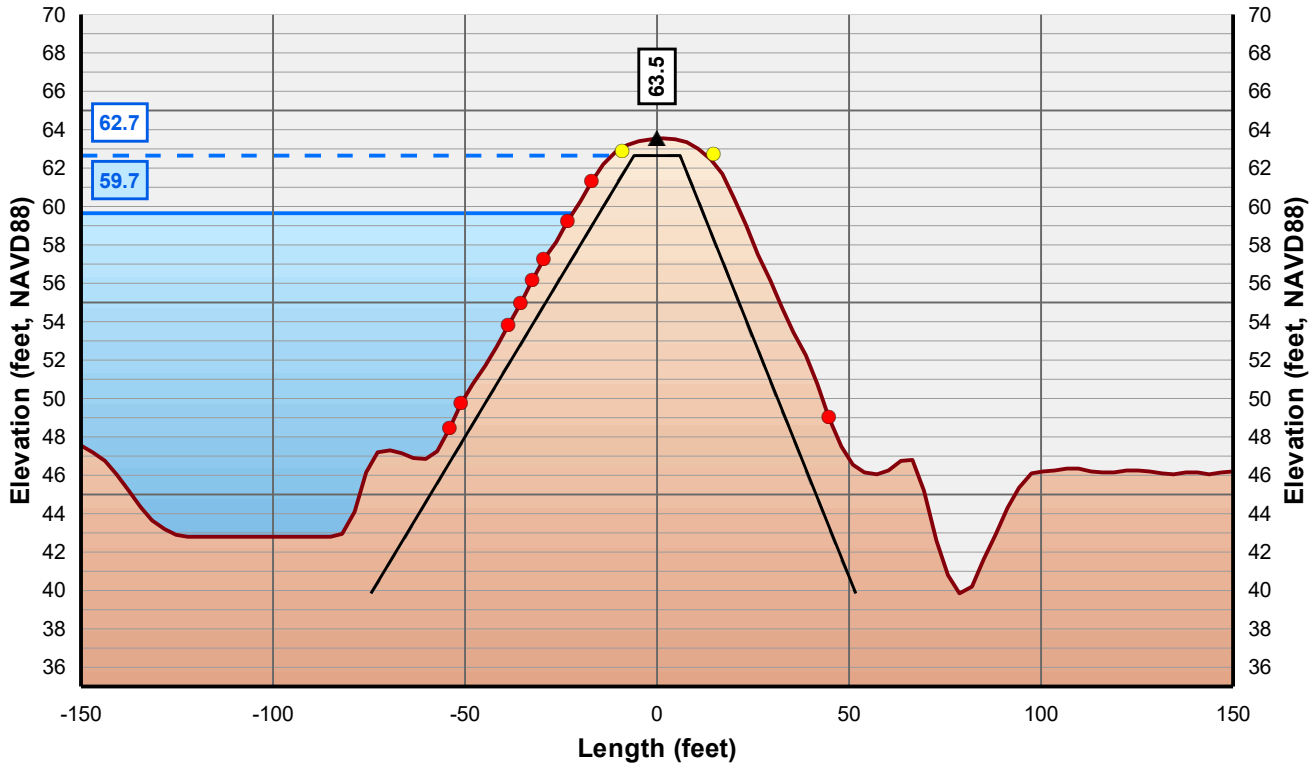
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Cross Section: Yankee Slough 36+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

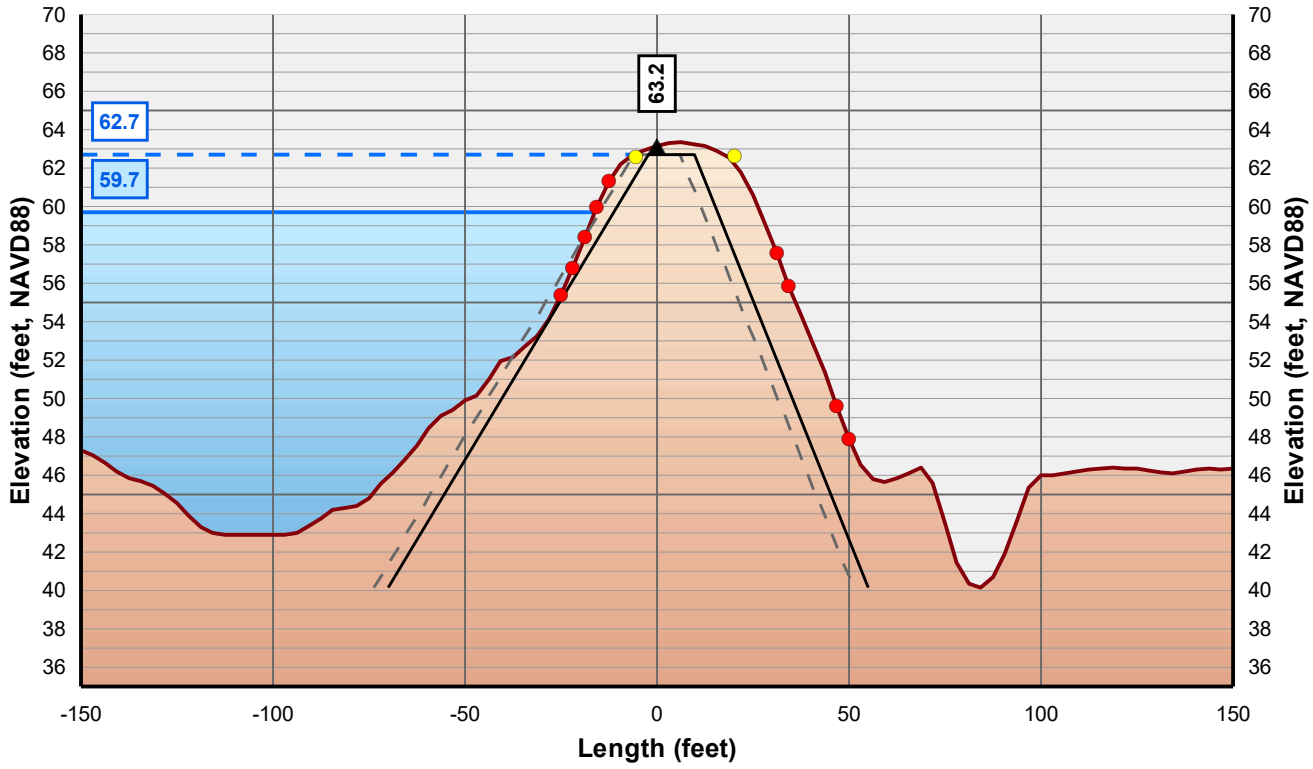
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

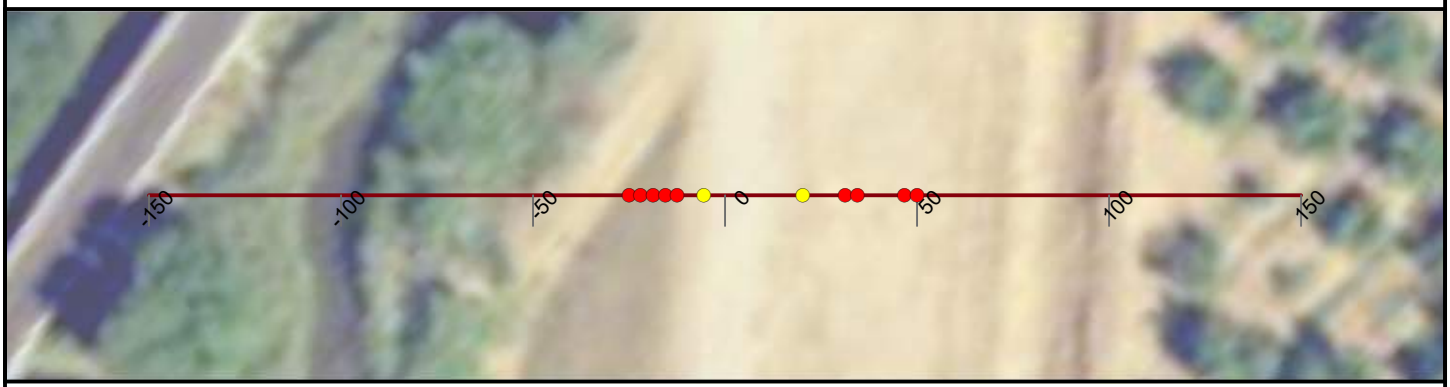
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Cross Section: Yankee Slough 37+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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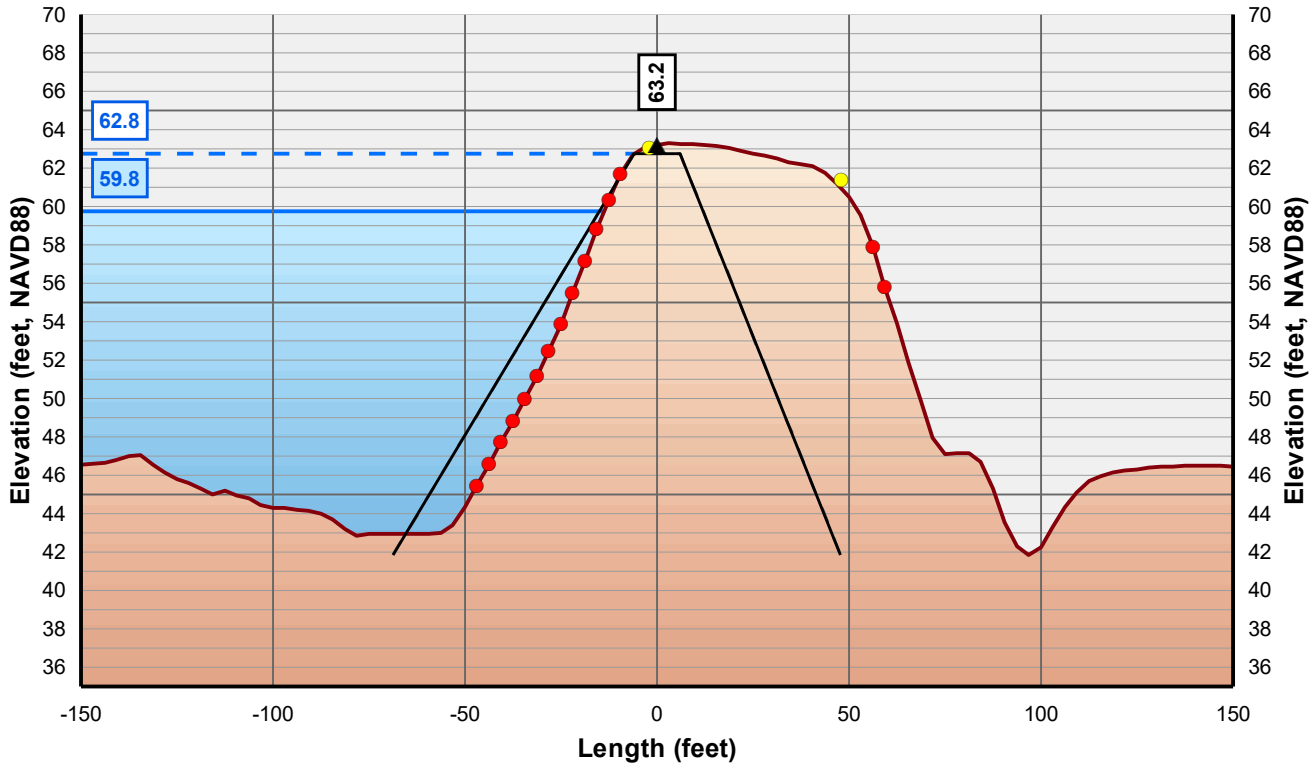
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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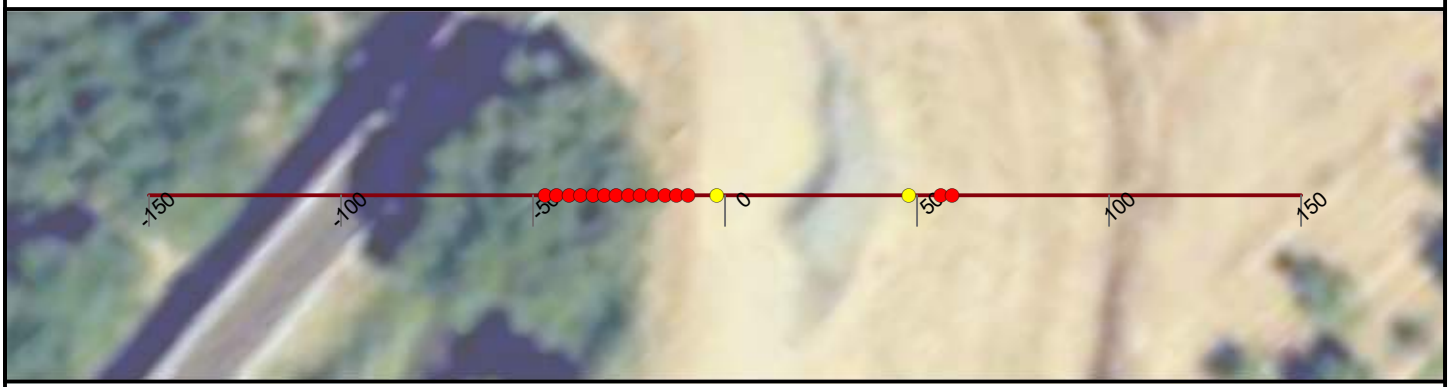
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Cross Section: Yankee Slough 38+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

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NORTH

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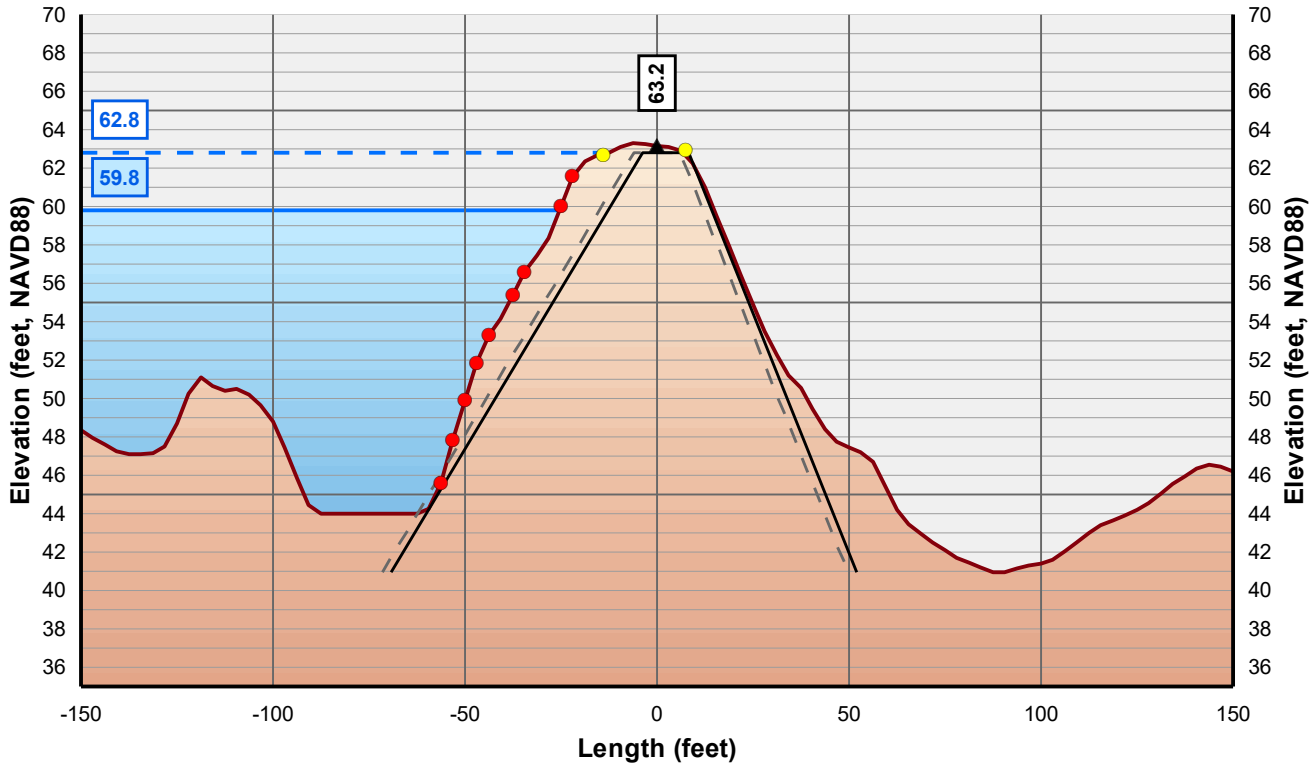
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Cross Section: Yankee Slough 39+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

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NORTH

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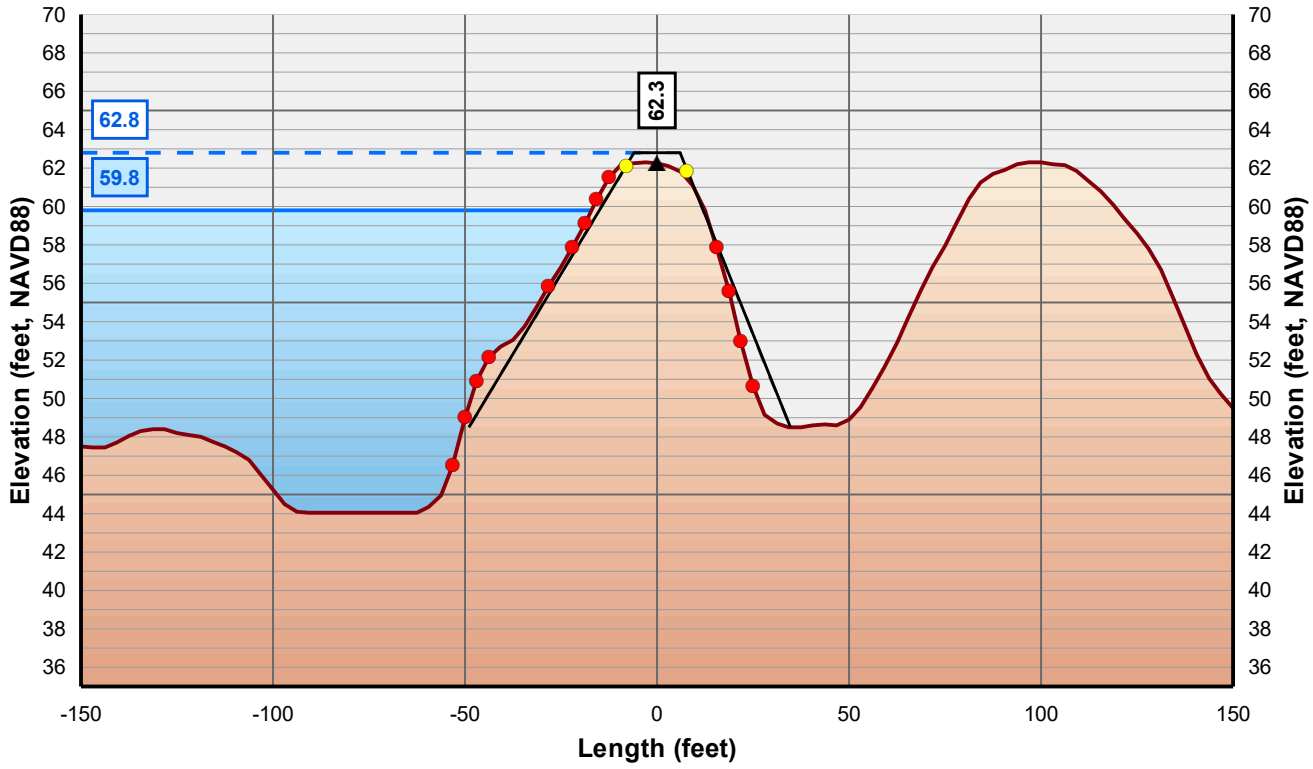
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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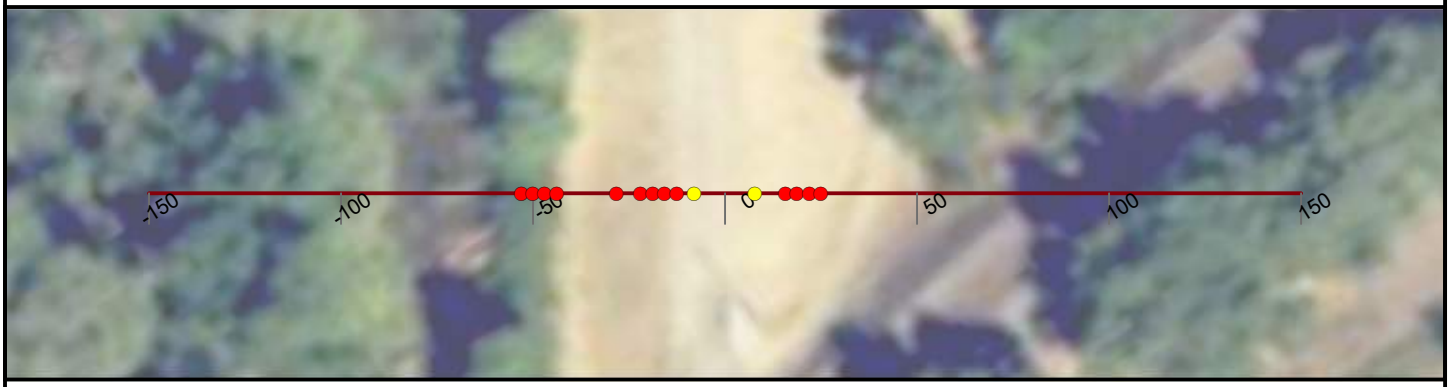
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Cross Section: Yankee Slough 40+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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AUGUST, 2019

NORTH

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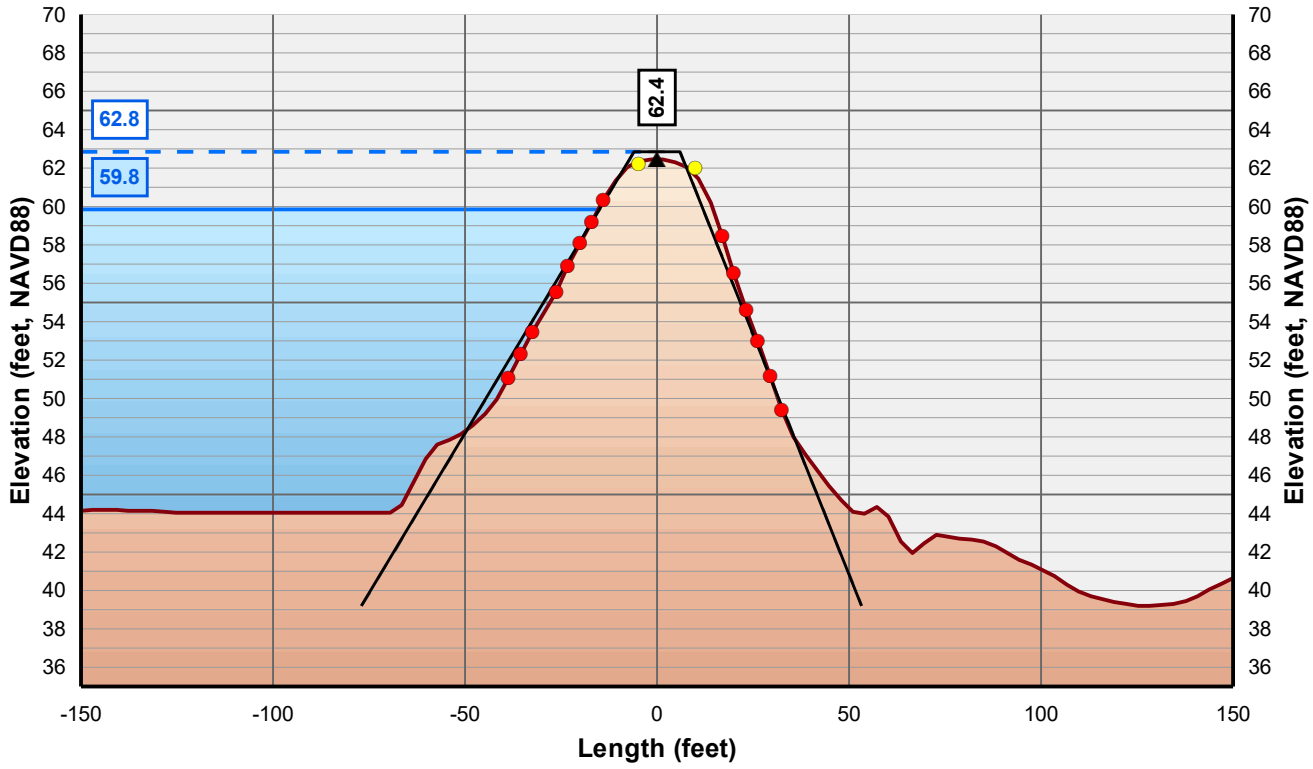
FEET

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3301 C Street, Bldg 100-B
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Cross Section: Yankee Slough 41+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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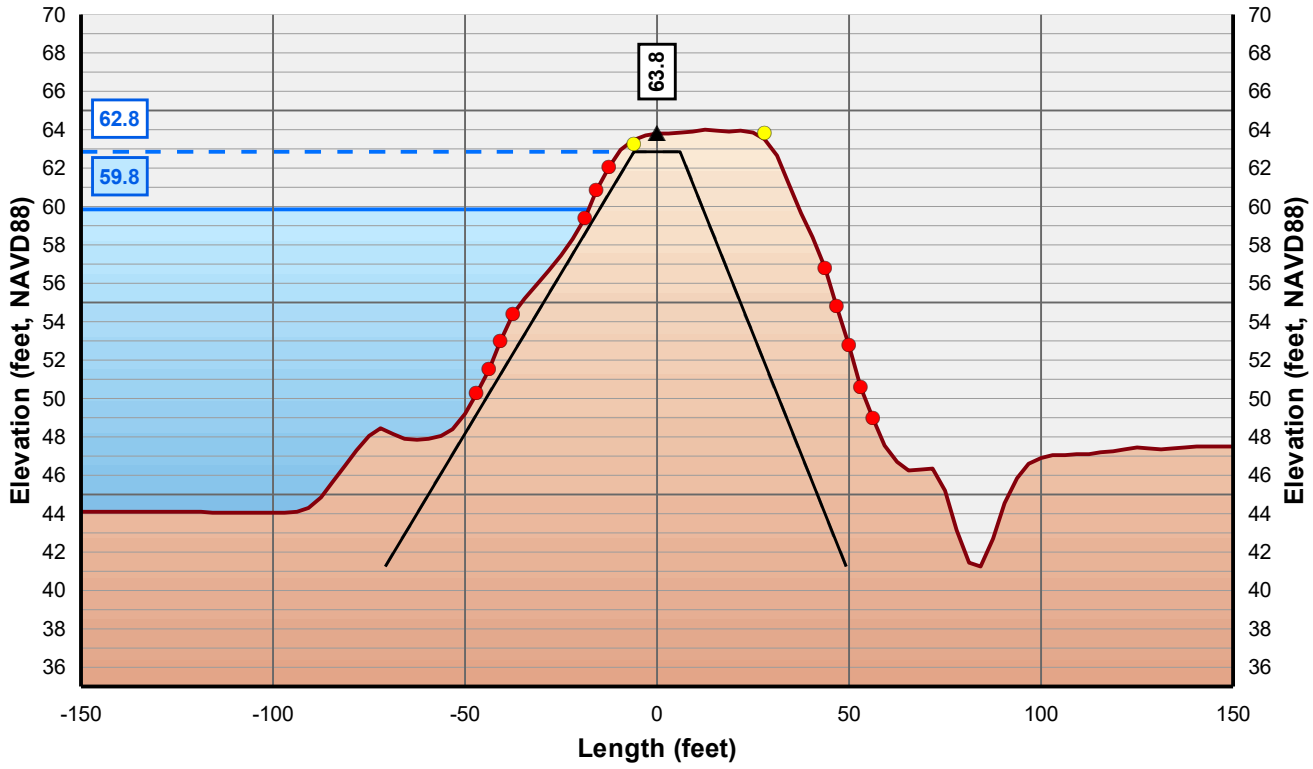
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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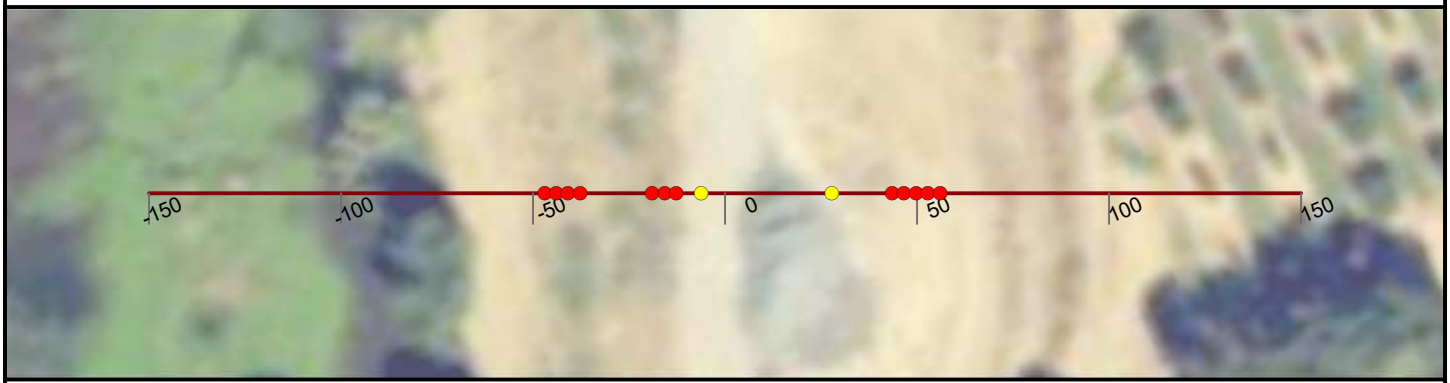
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Cross Section: Yankee Slough 42+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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CALIFORNIA

AUGUST, 2019

NORTH

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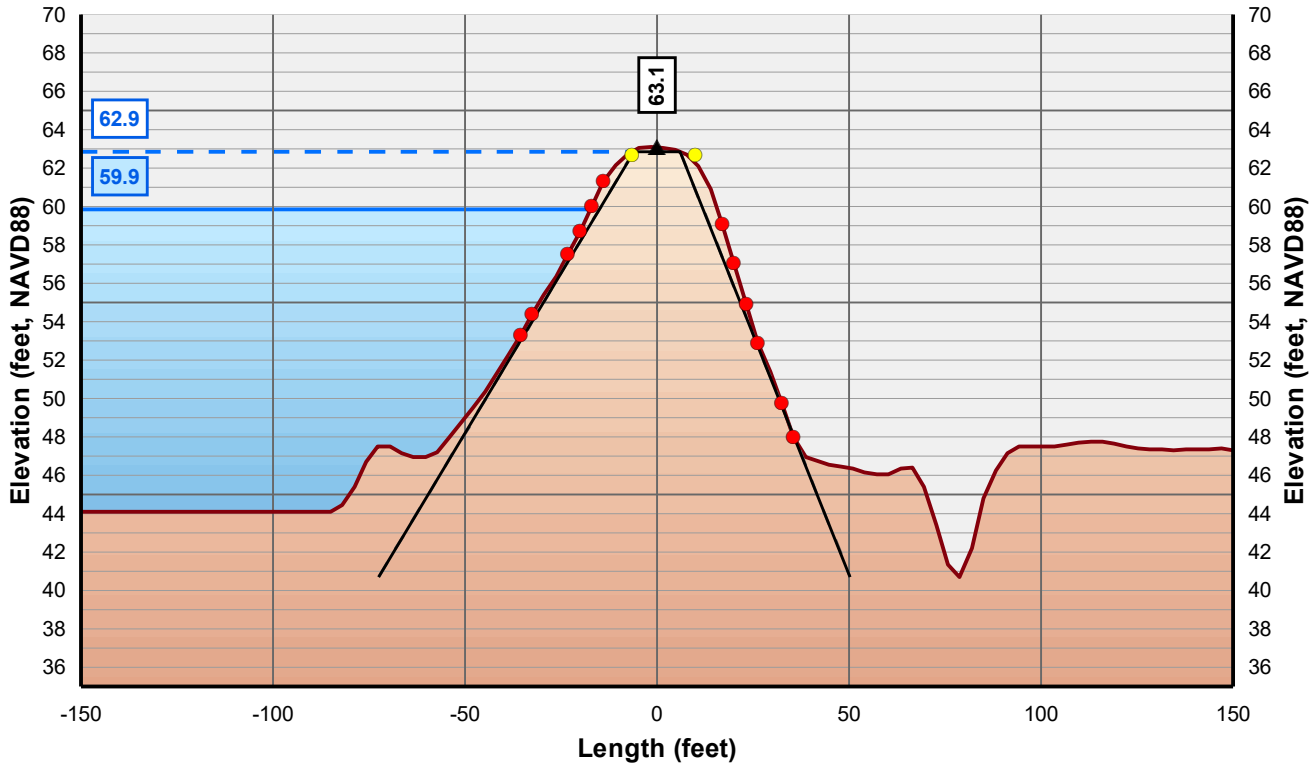
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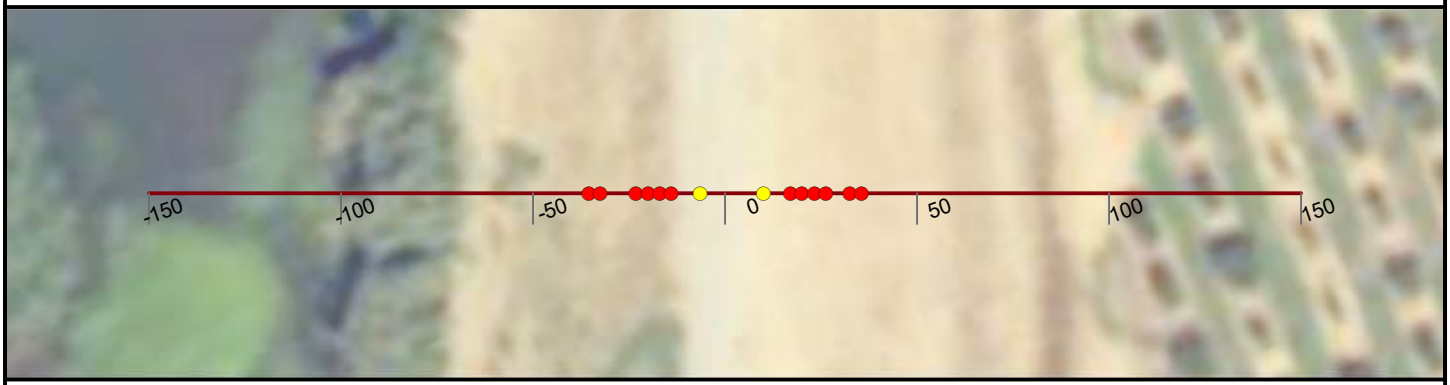
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Cross Section: Yankee Slough 43+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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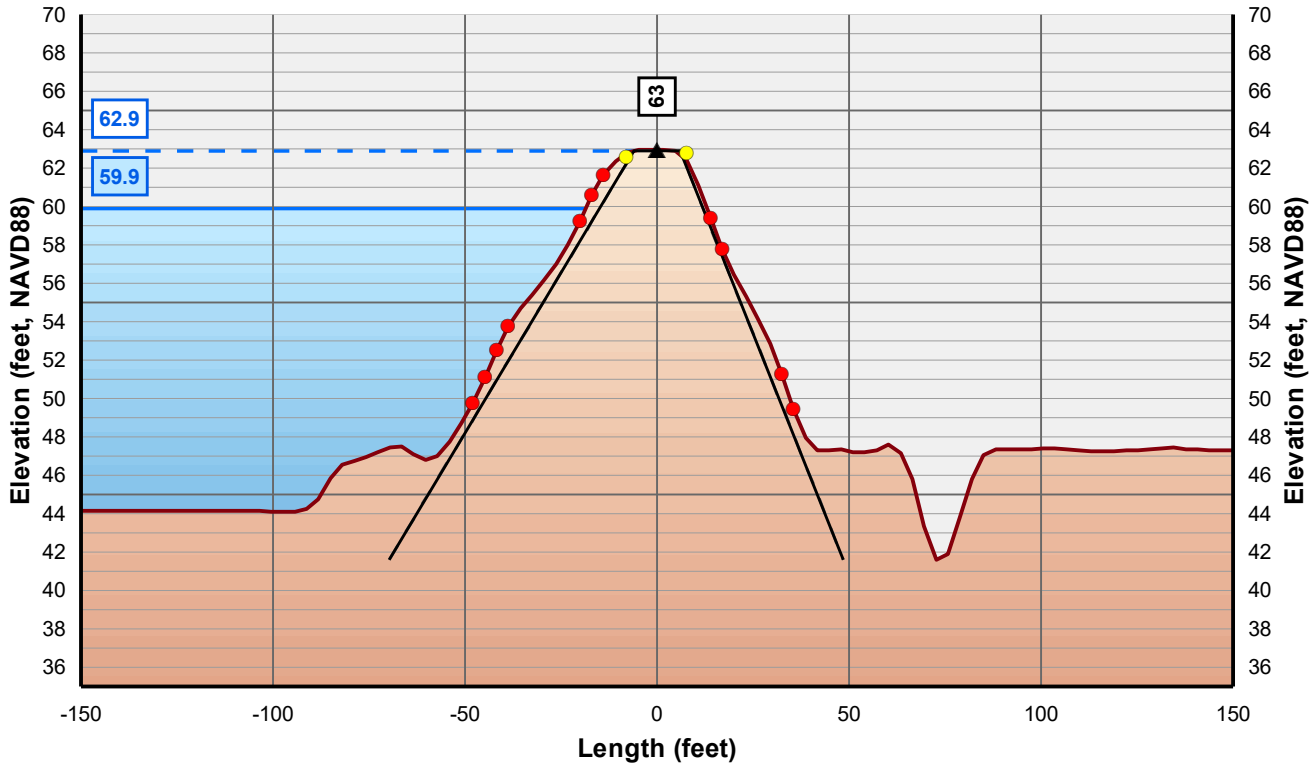
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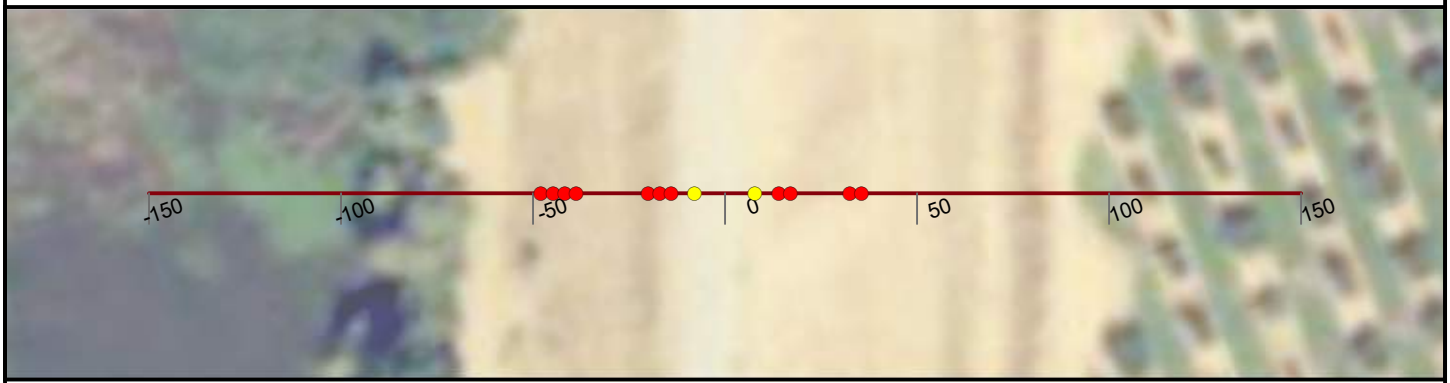
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Cross Section: Yankee Slough 44+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

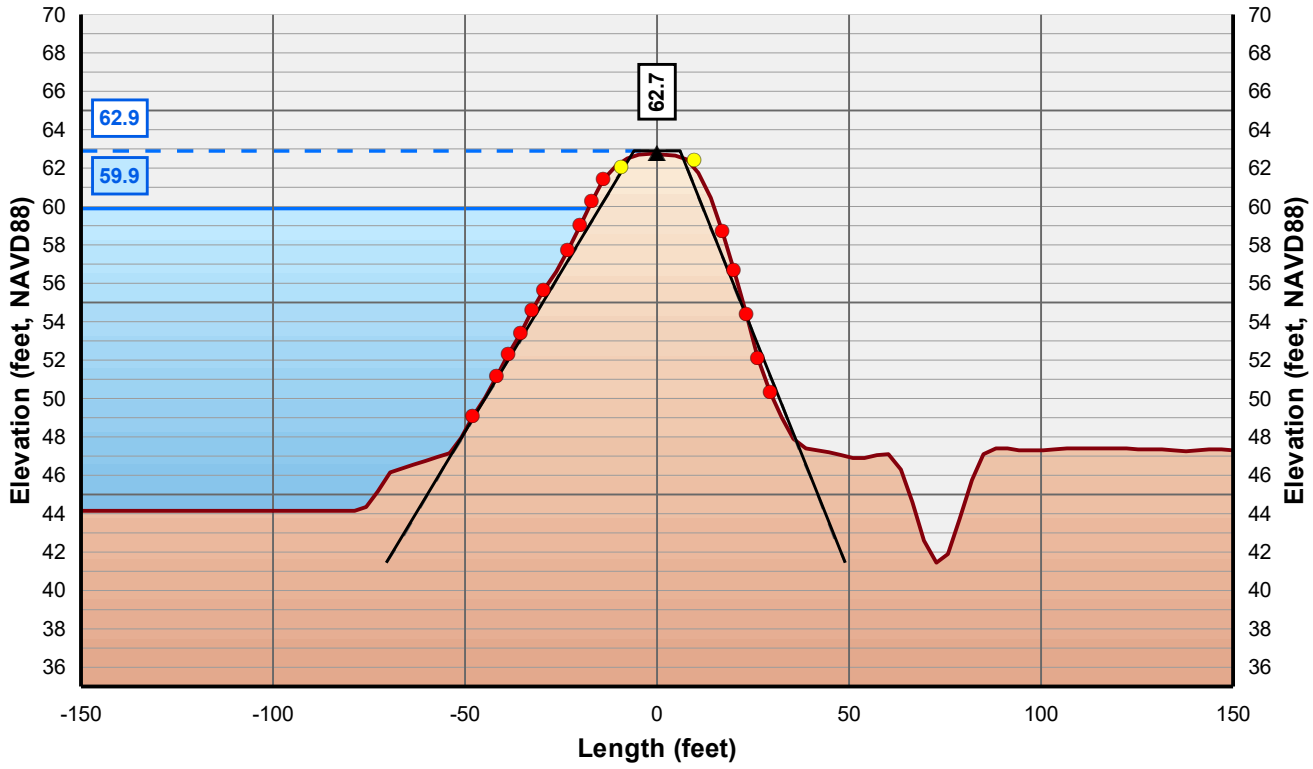
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3301 C Street, Bldg 100-B
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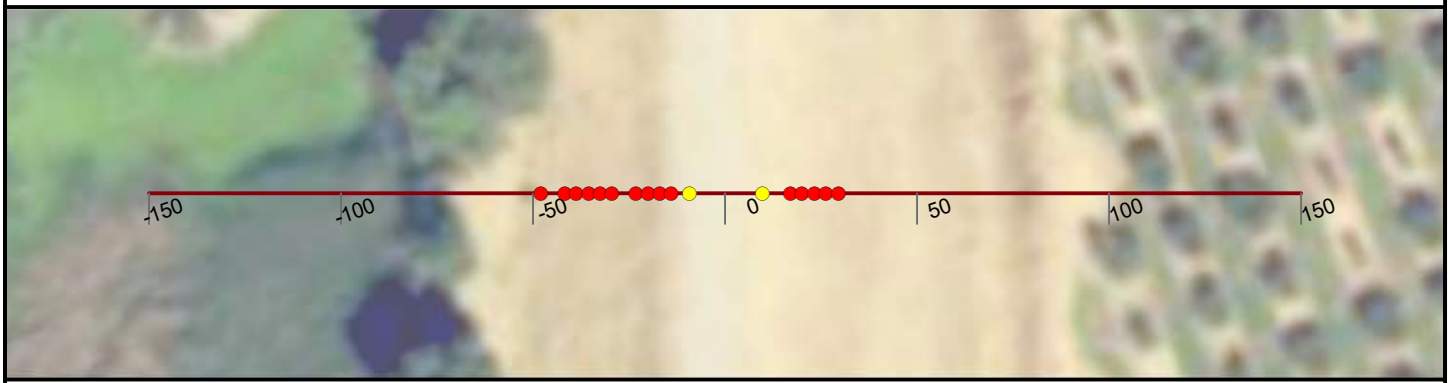
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Cross Section: Yankee Slough 45+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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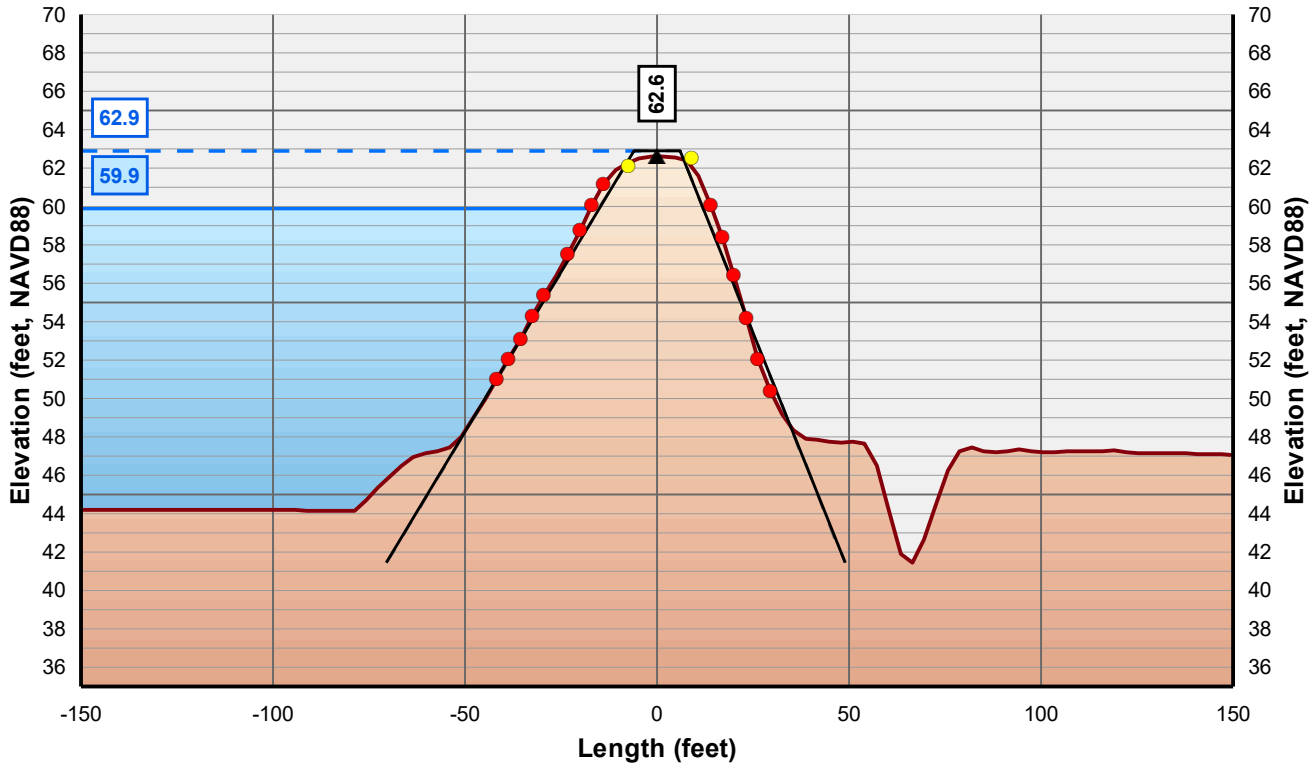
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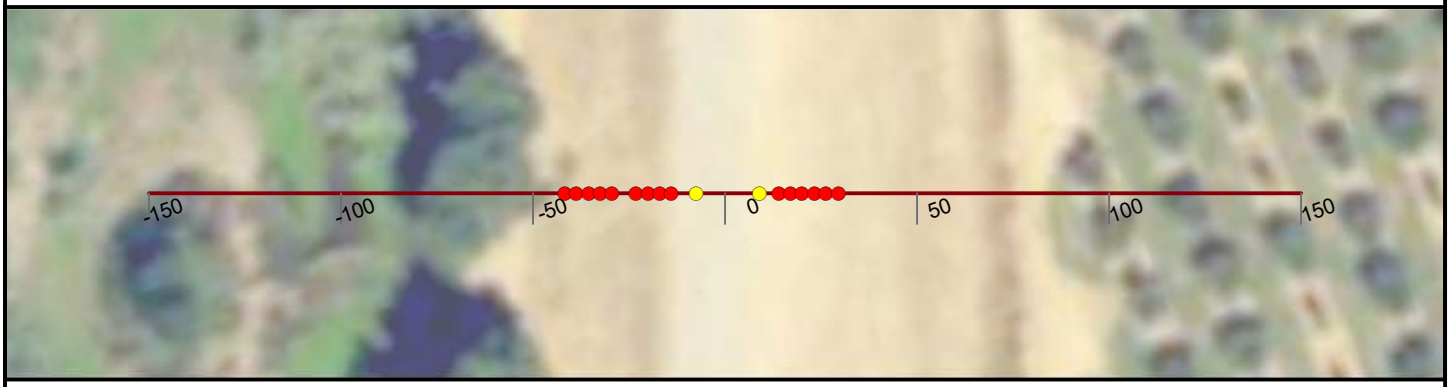
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Cross Section: Yankee Slough 46+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

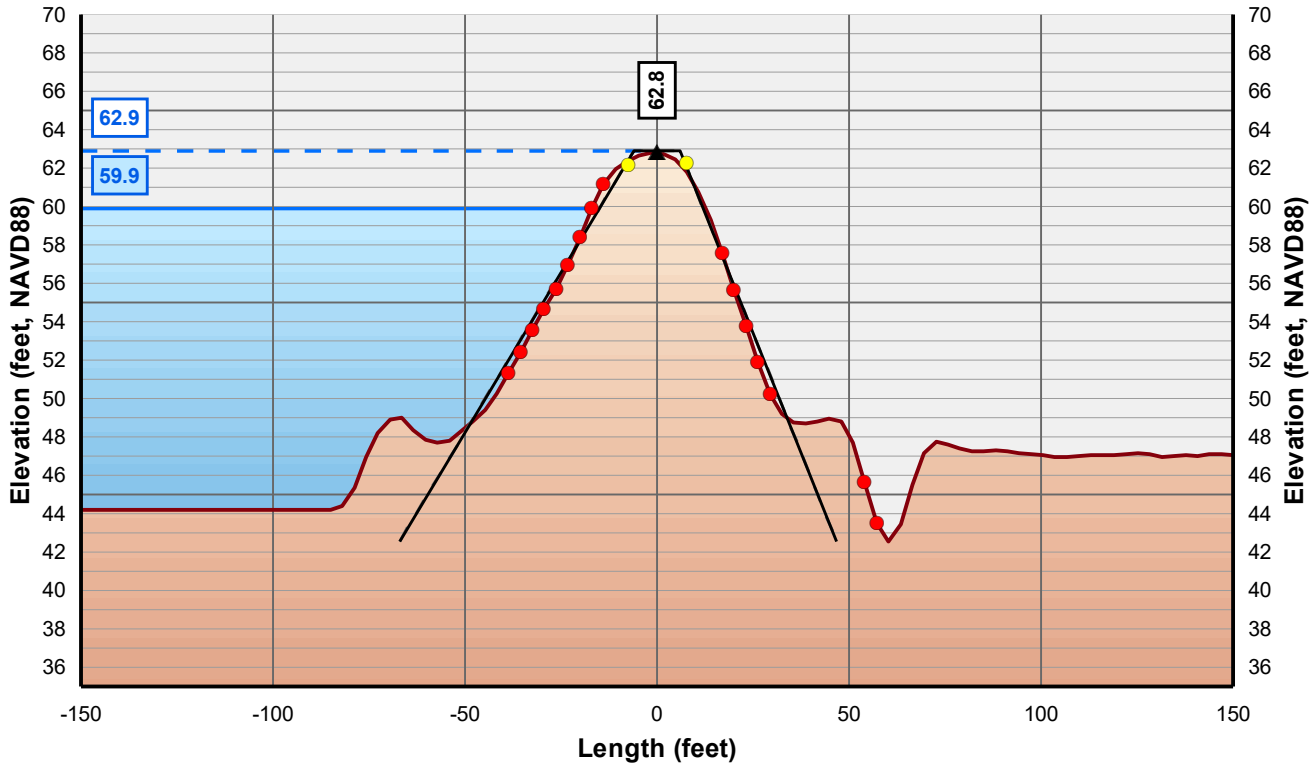
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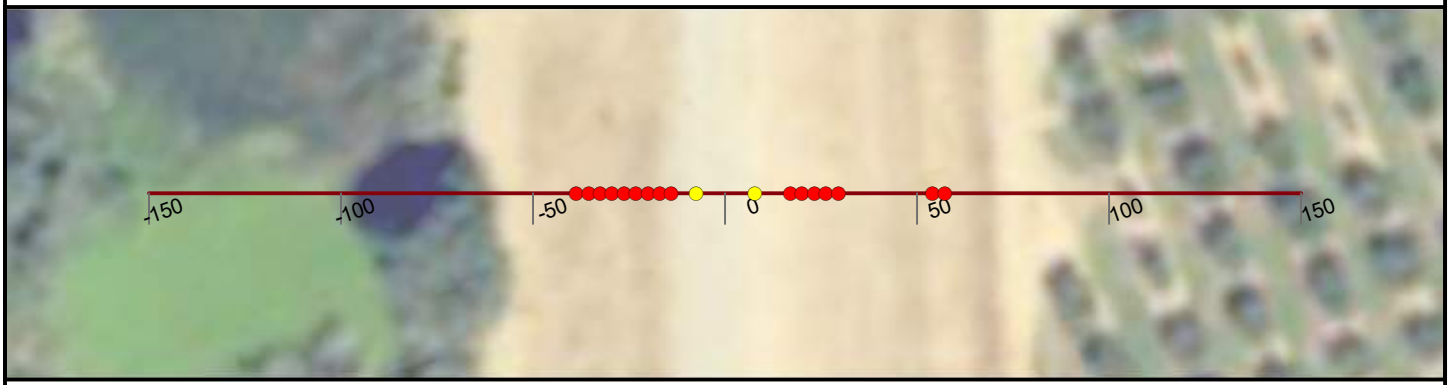
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Cross Section: Yankee Slough 47+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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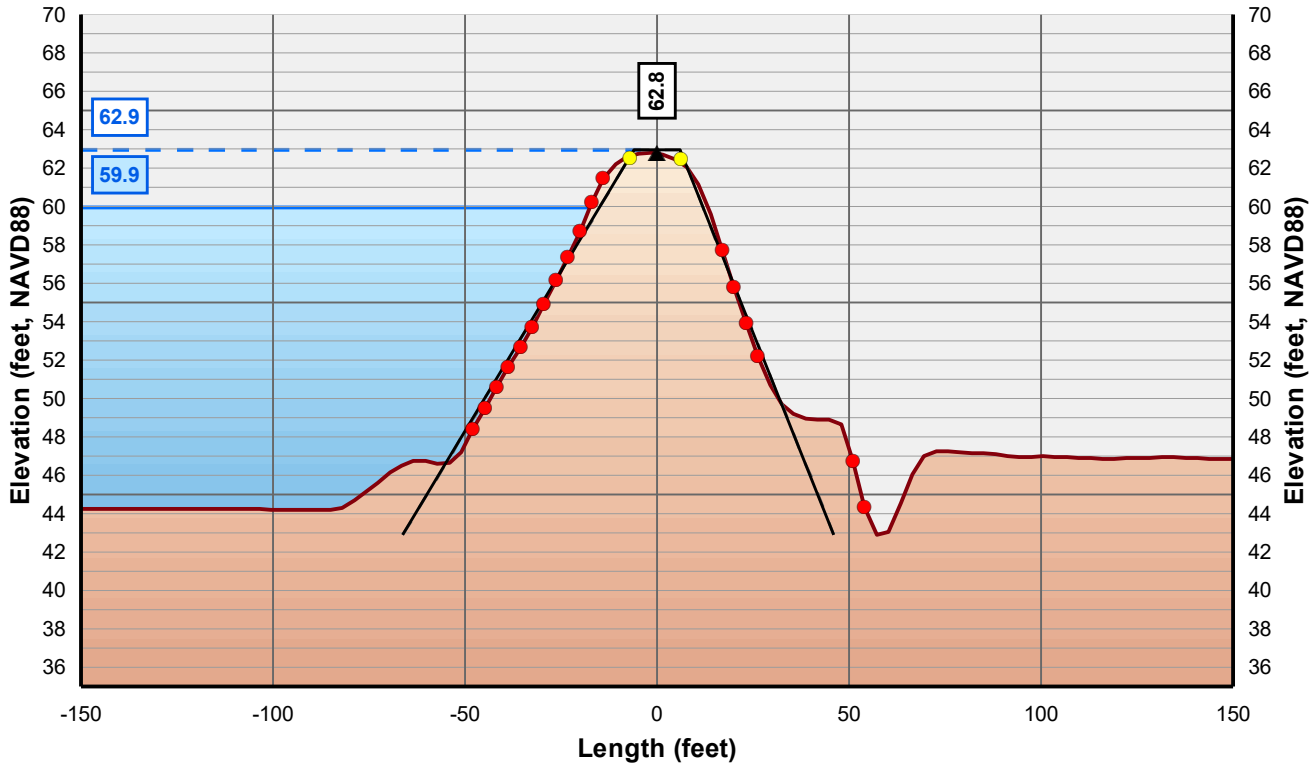
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3301 C Street, Bldg 100-B
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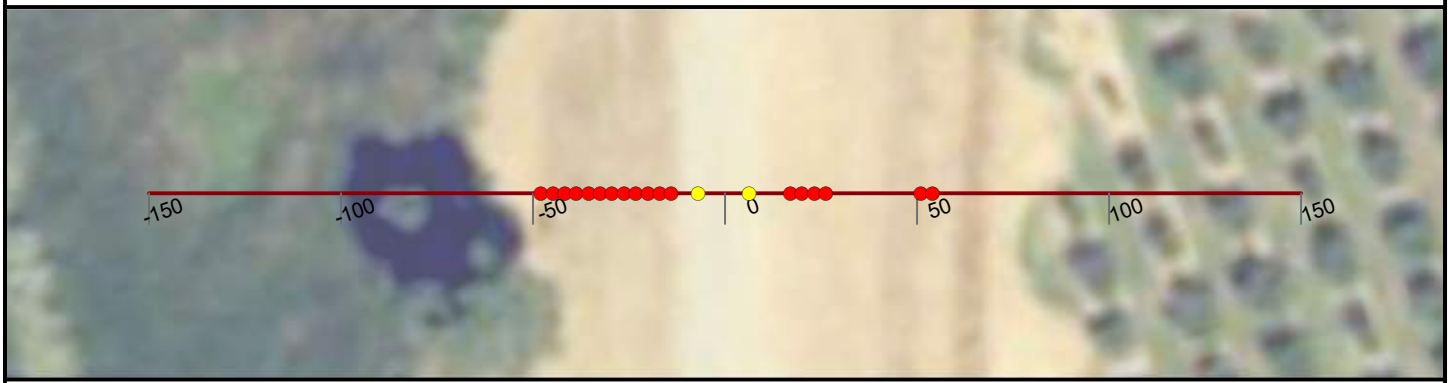
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Cross Section: Yankee Slough 48+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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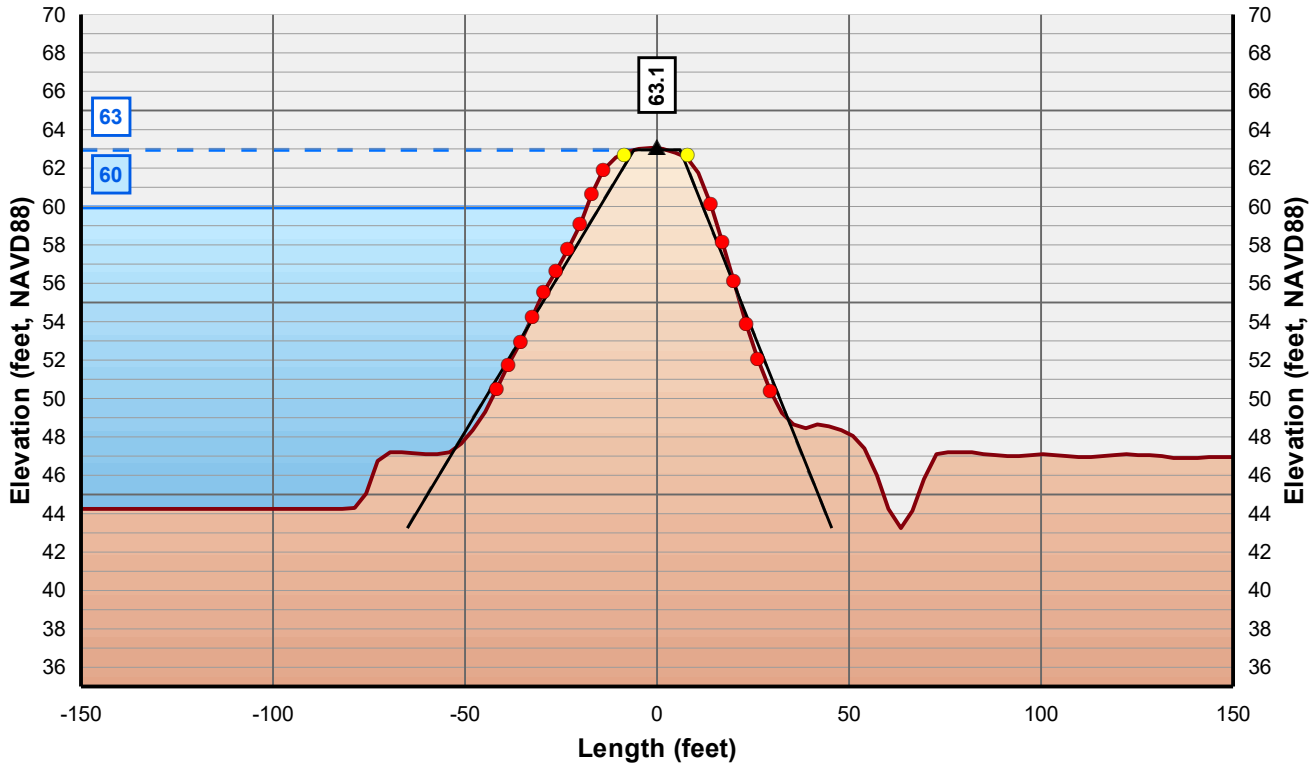
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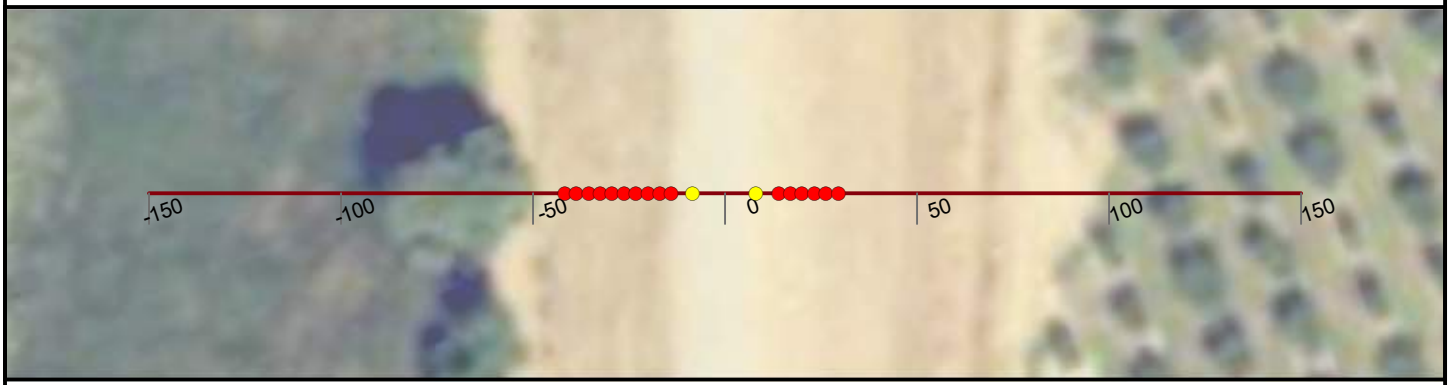
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Cross Section: Yankee Slough 49+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

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AUGUST, 2019

NORTH

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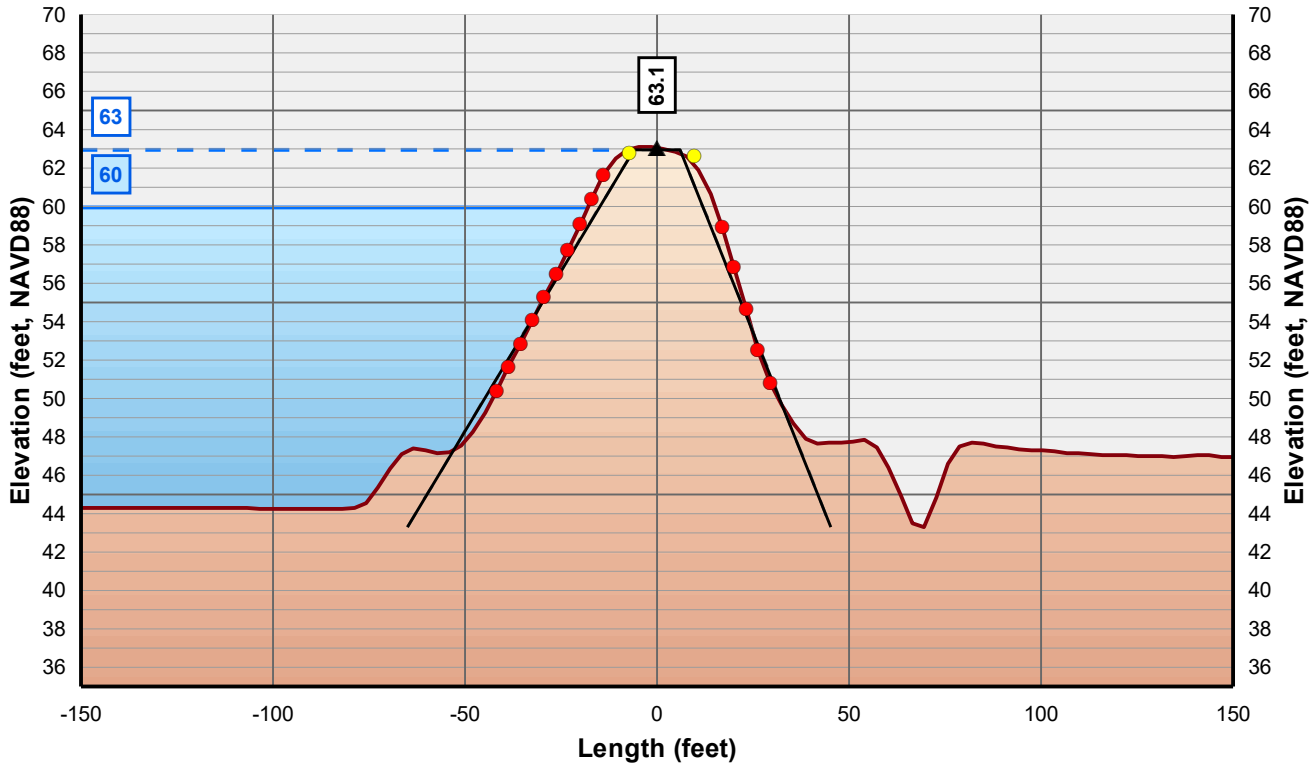
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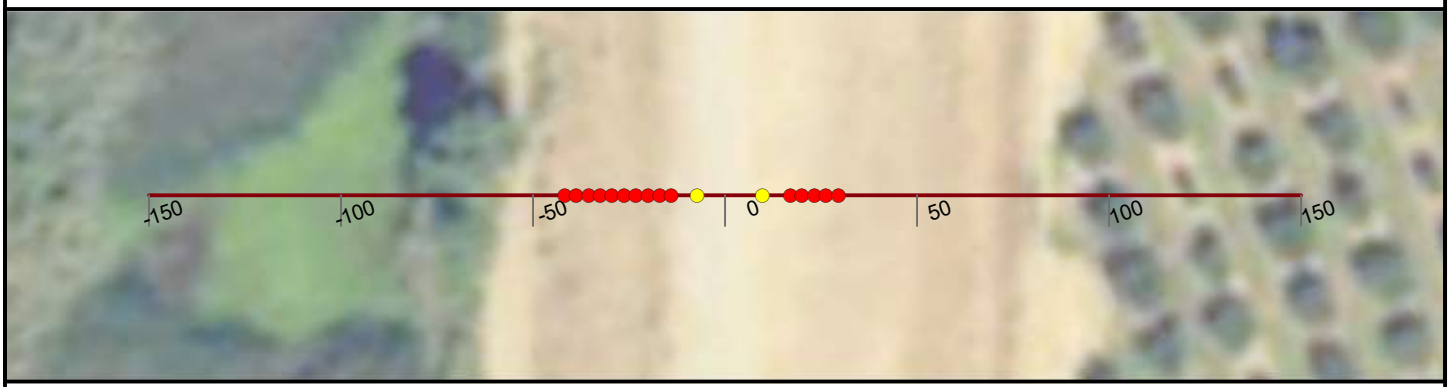
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Cross Section: Yankee Slough 50+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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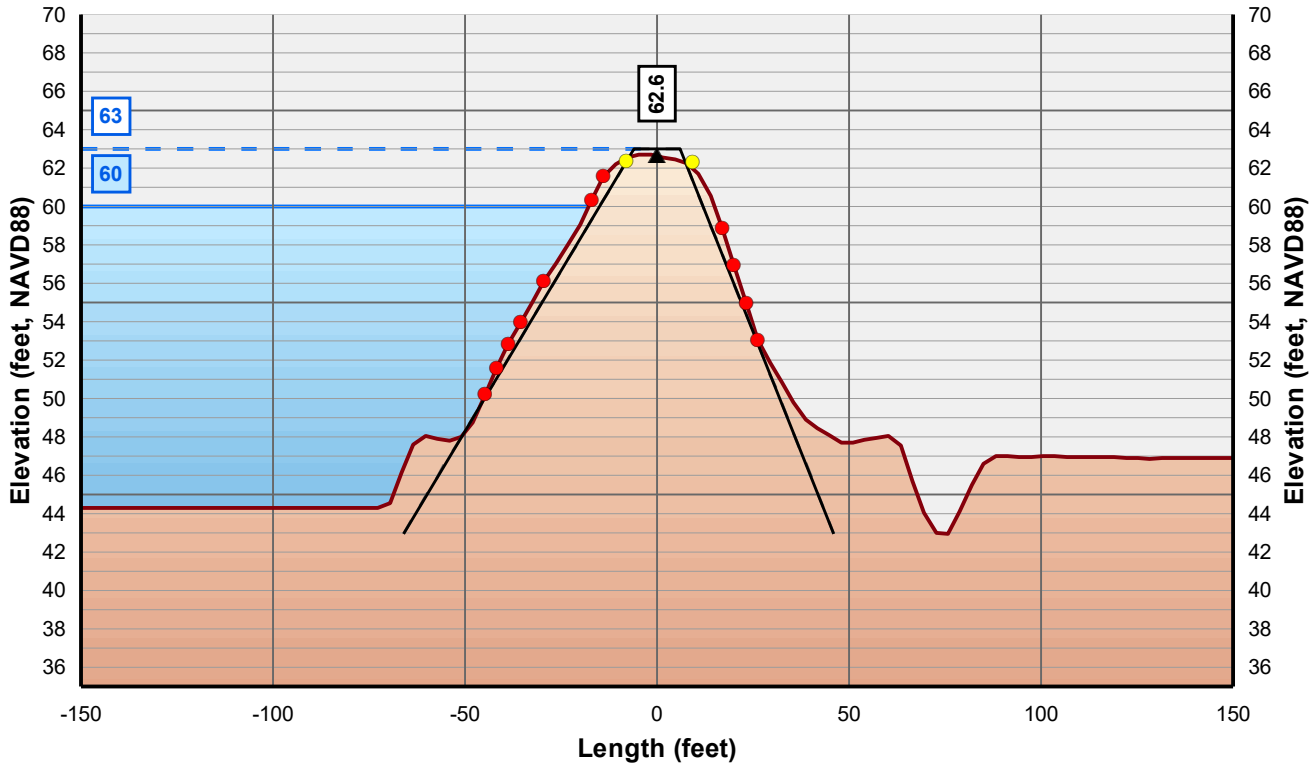
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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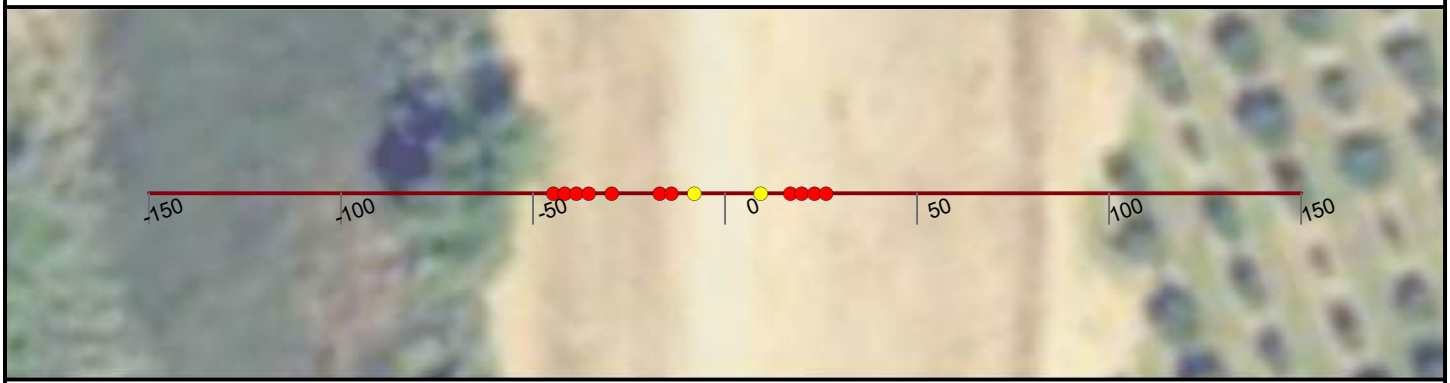
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Cross Section: Yankee Slough 51+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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AUGUST, 2019

NORTH

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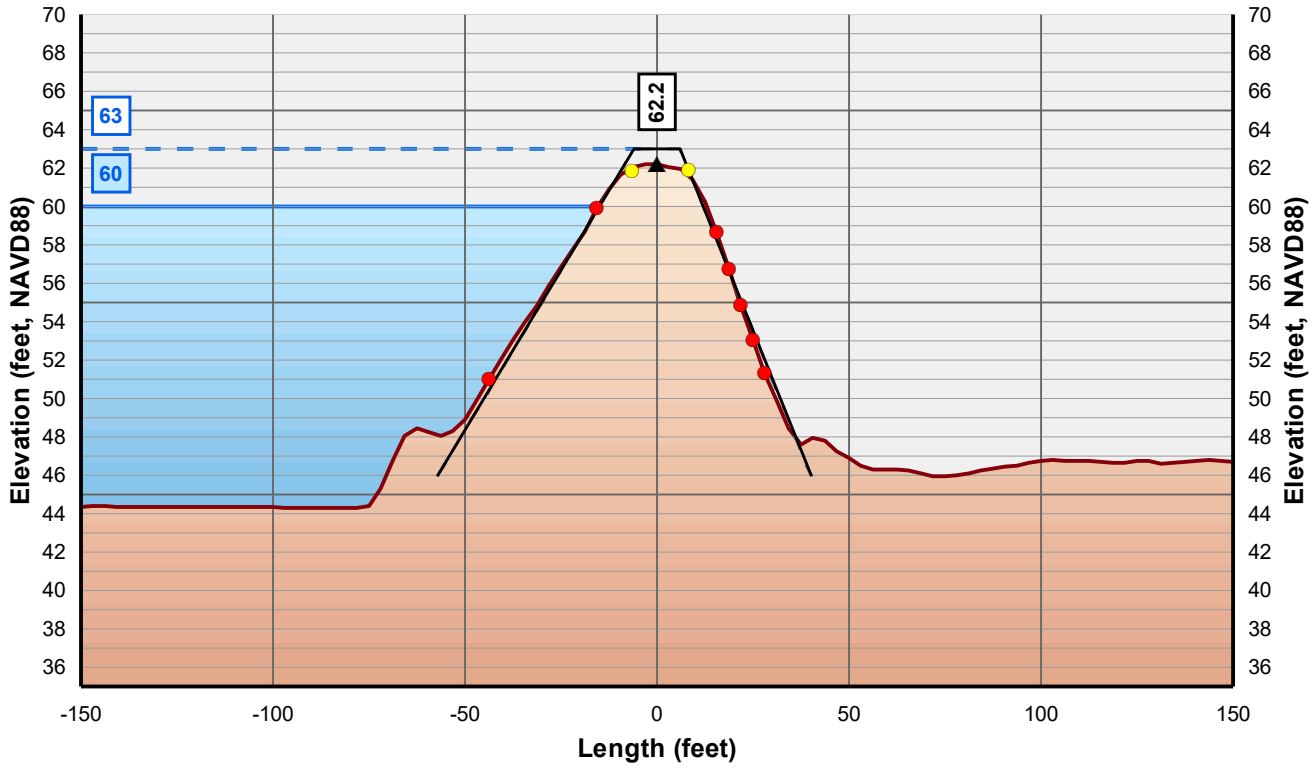
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

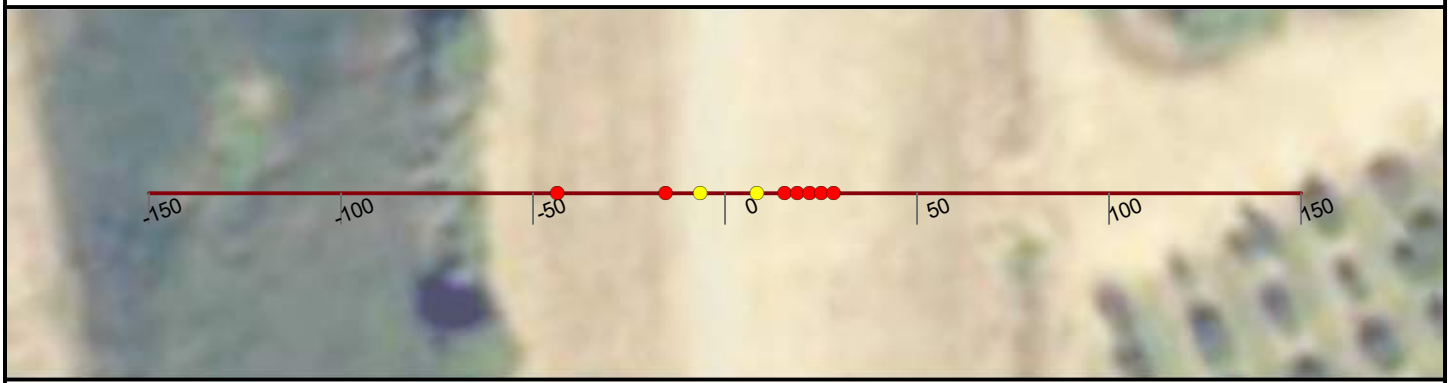
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Cross Section: Yankee Slough 52+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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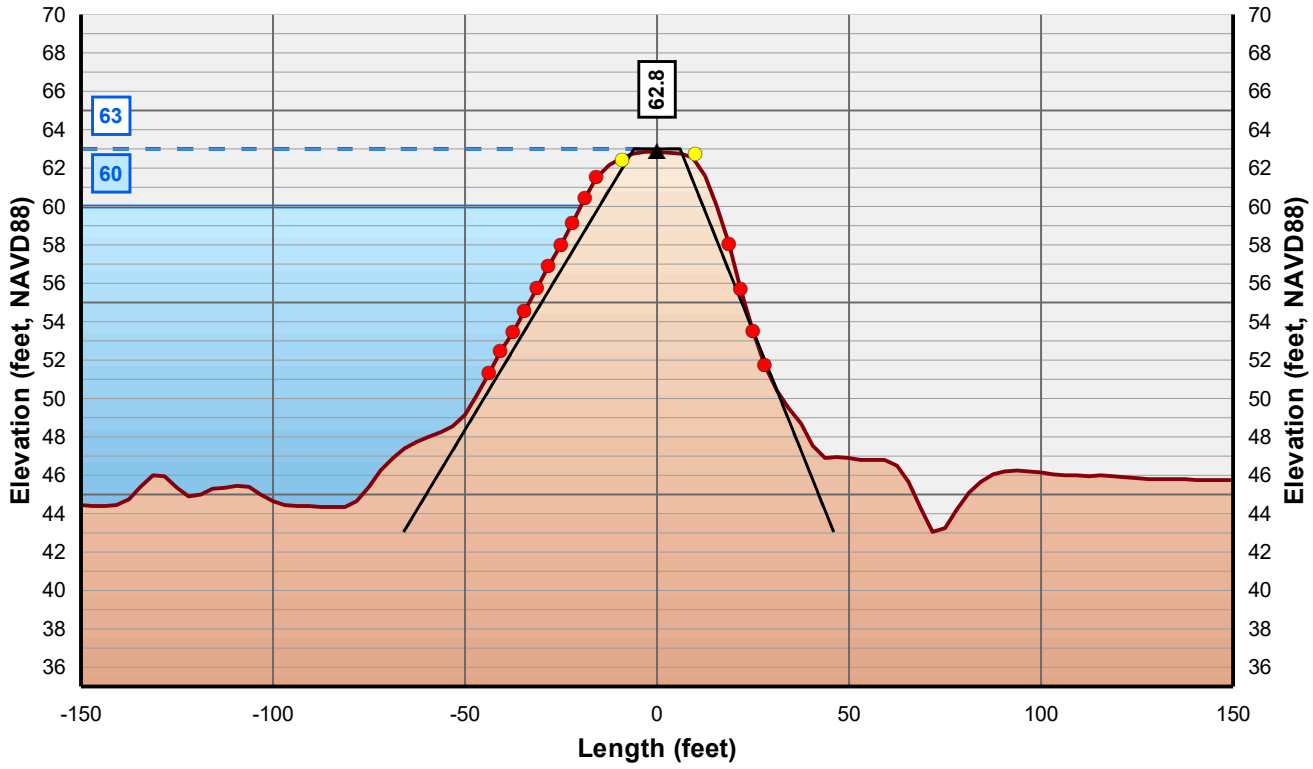
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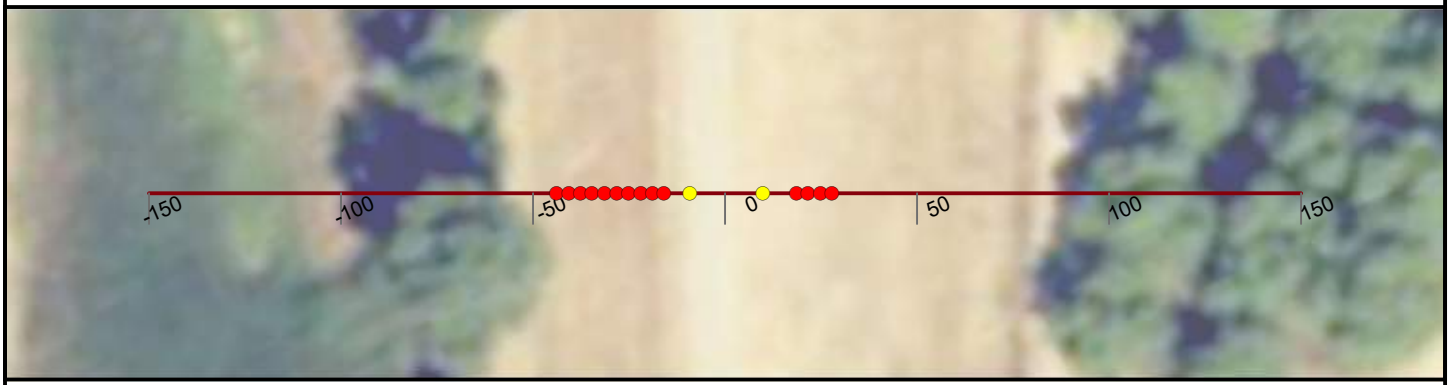
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Cross Section: Yankee Slough 53+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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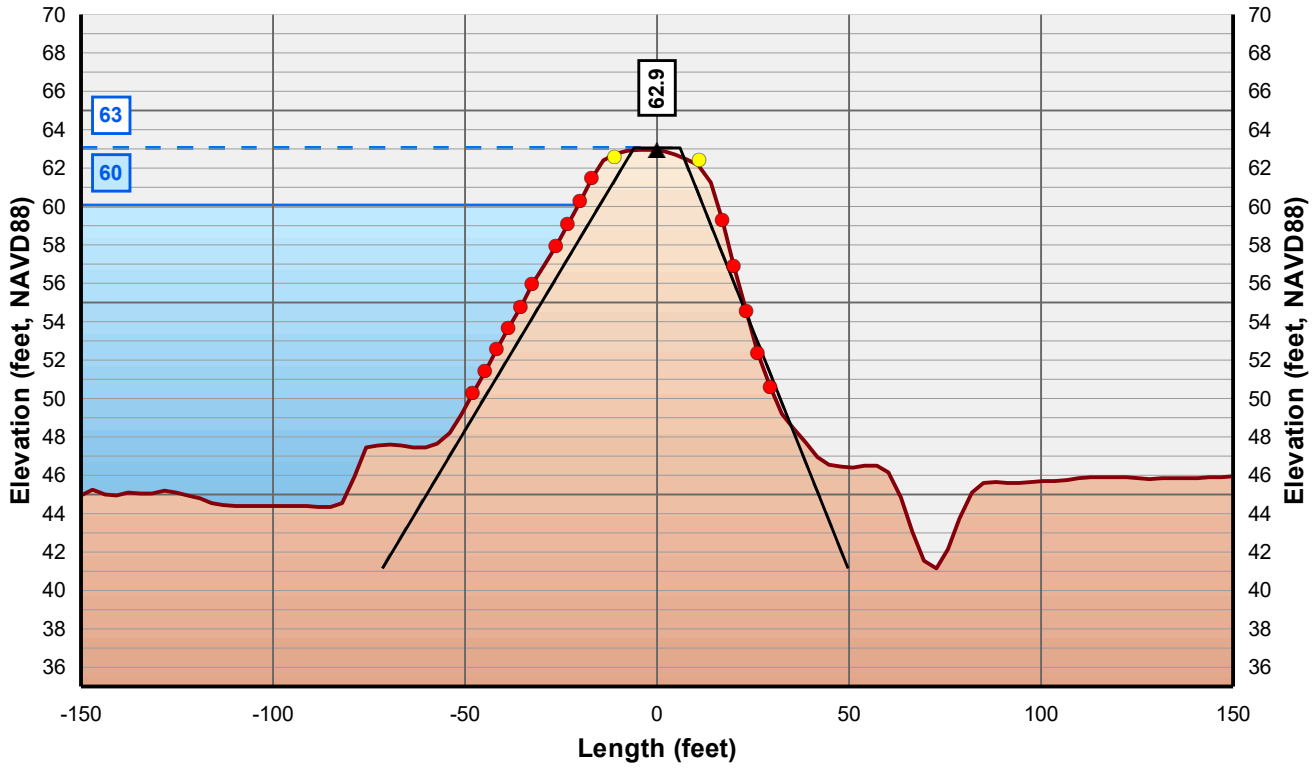
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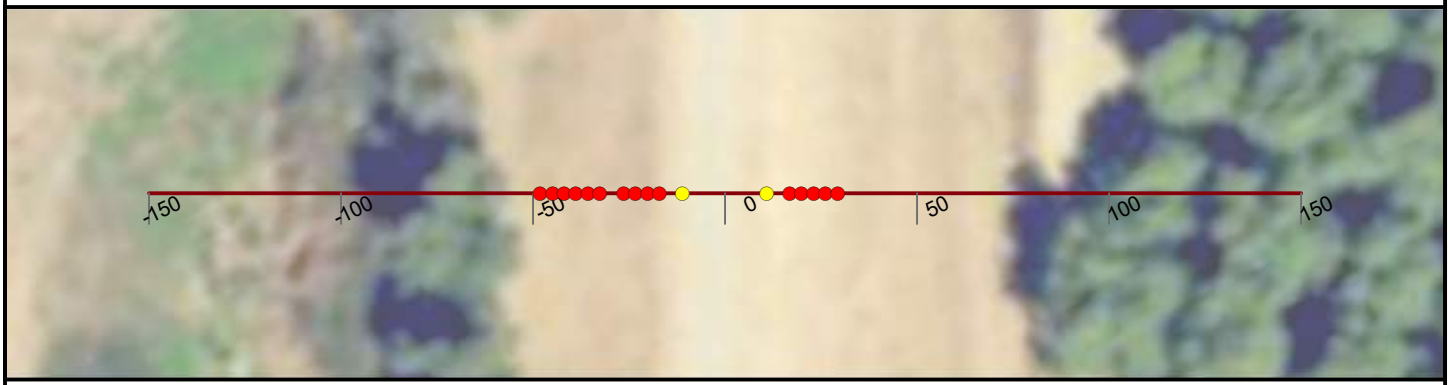
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Cross Section: Yankee Slough 54+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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YANKEE SLOUGH LEVEE

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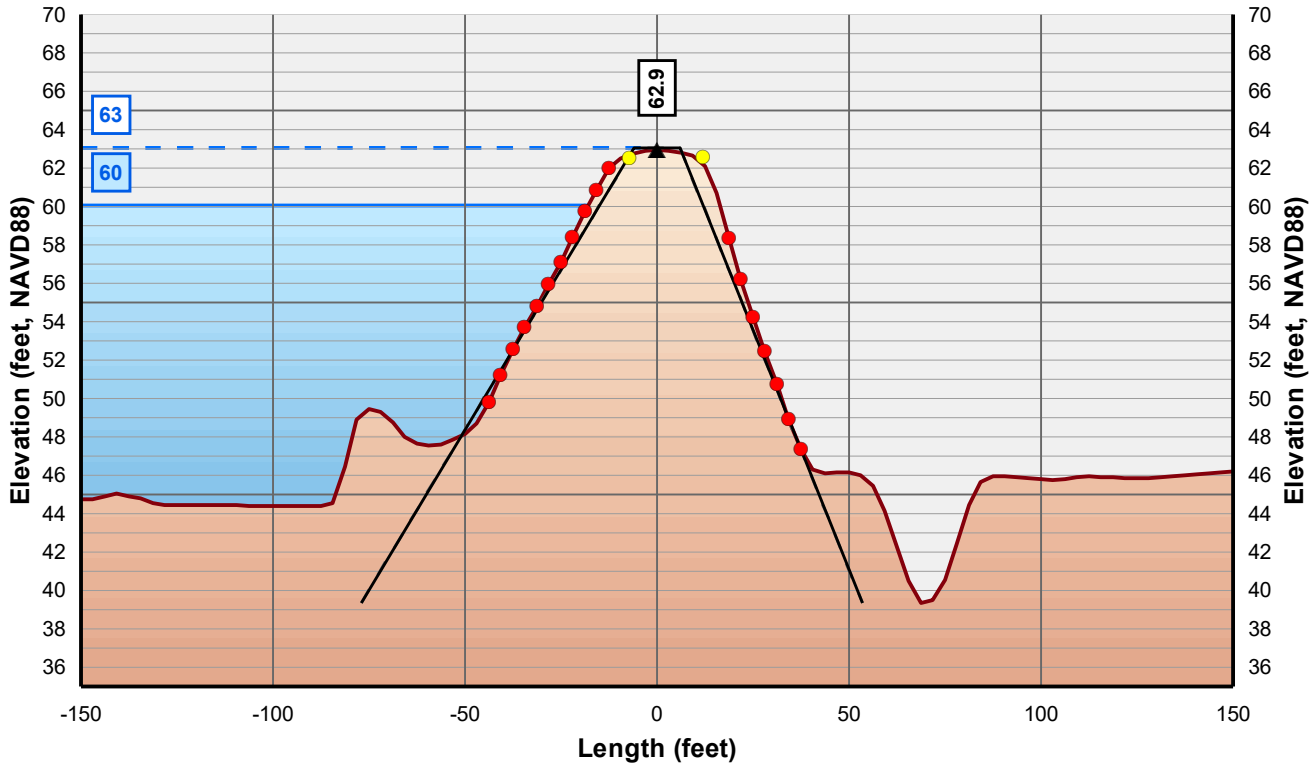
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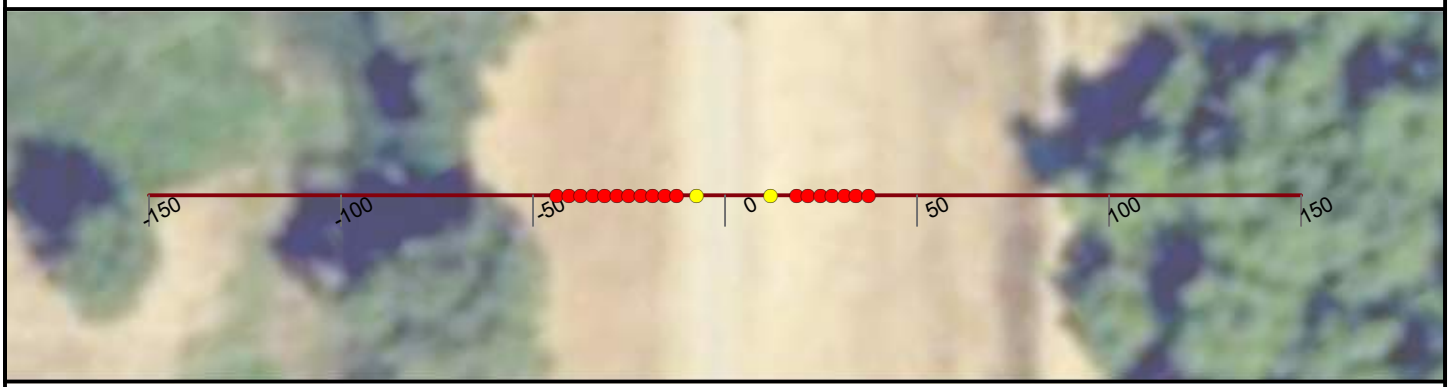
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Cross Section: Yankee Slough 55+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
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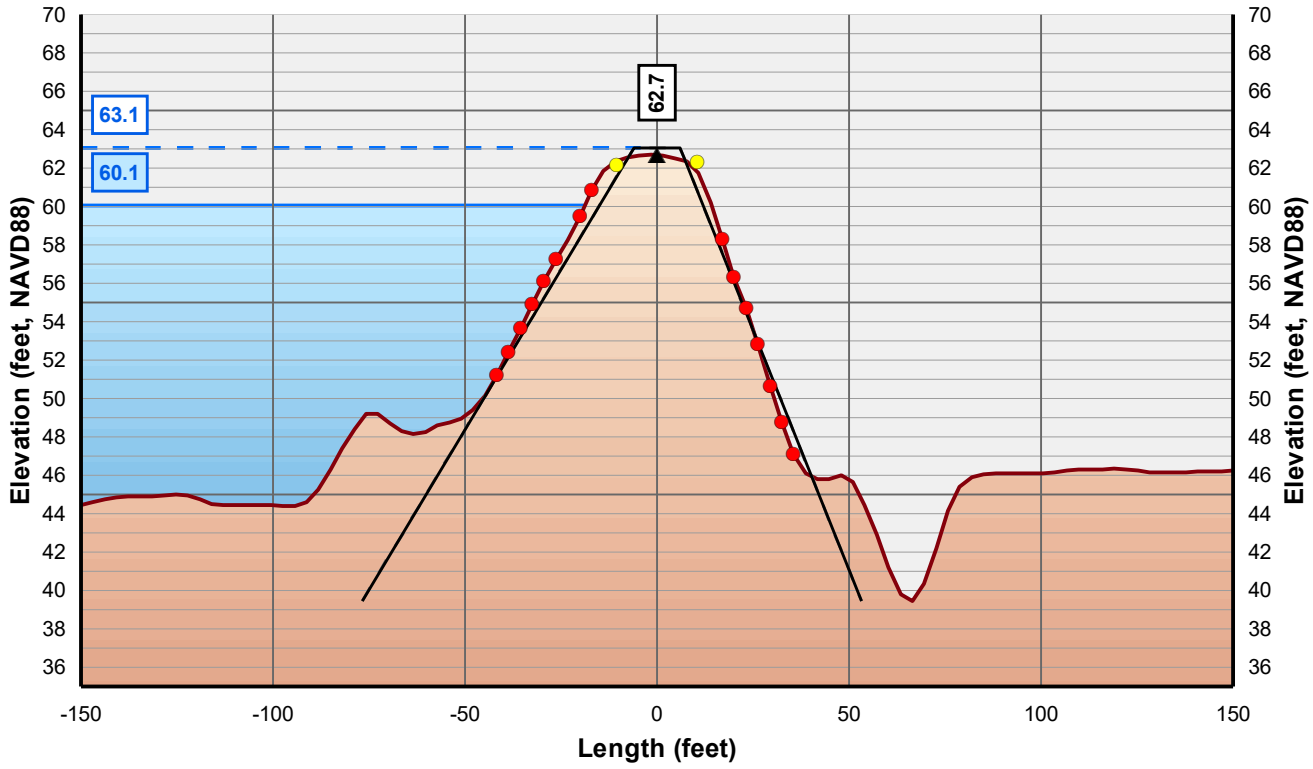
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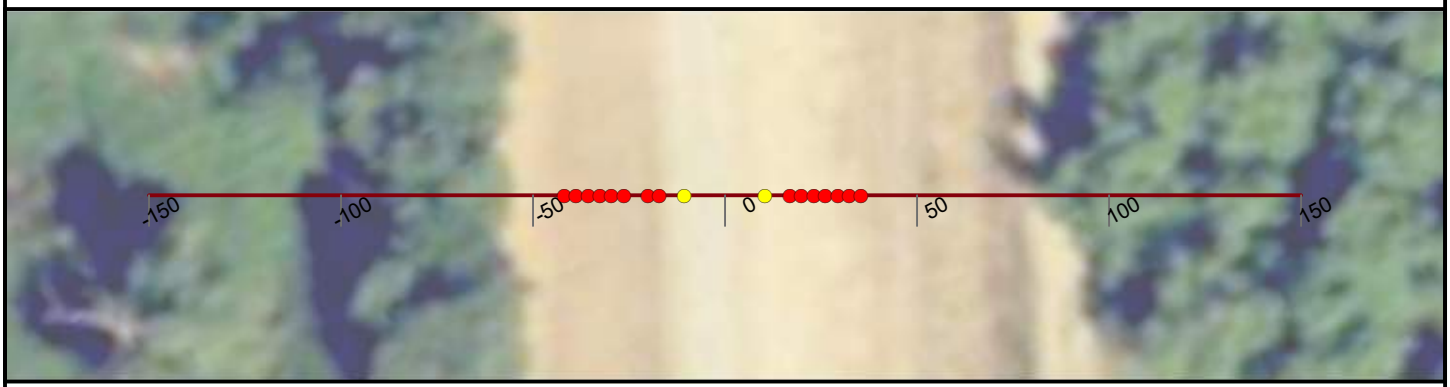
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Cross Section: Yankee Slough 56+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

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- Water Surface Elevation



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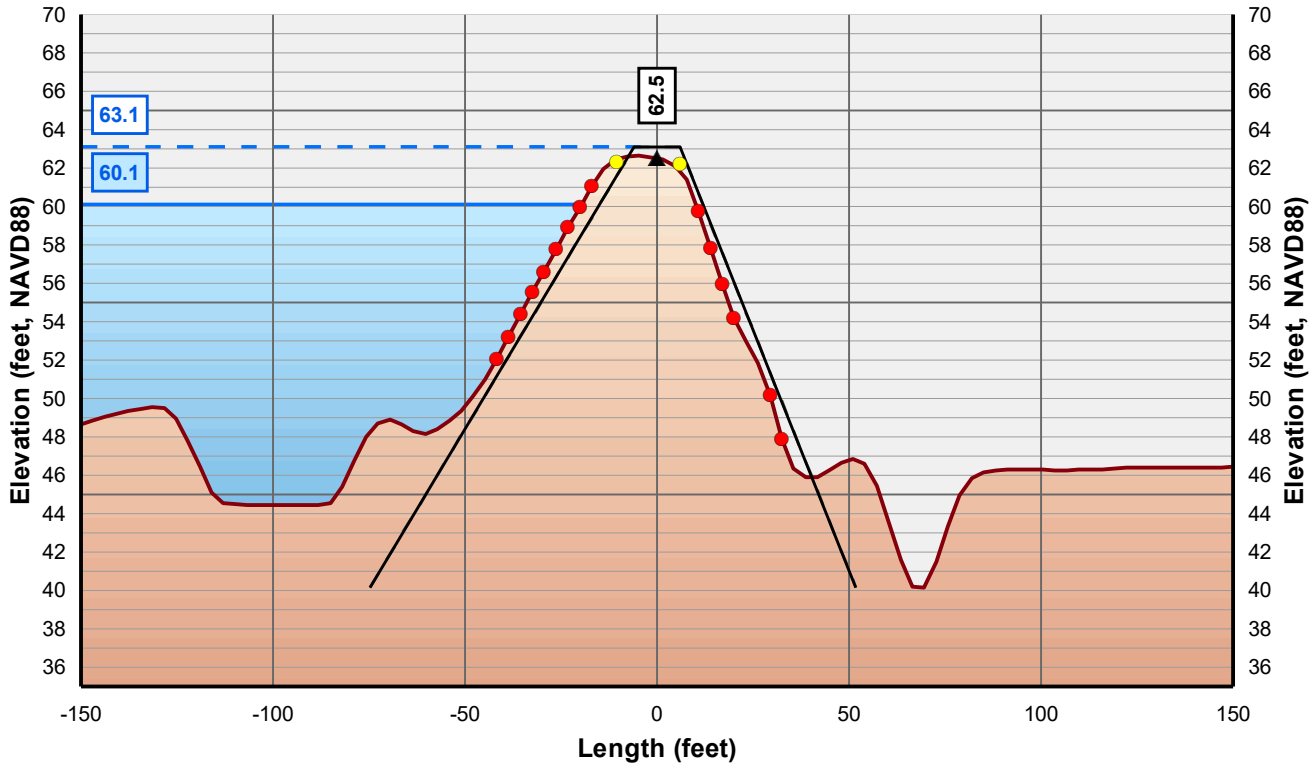
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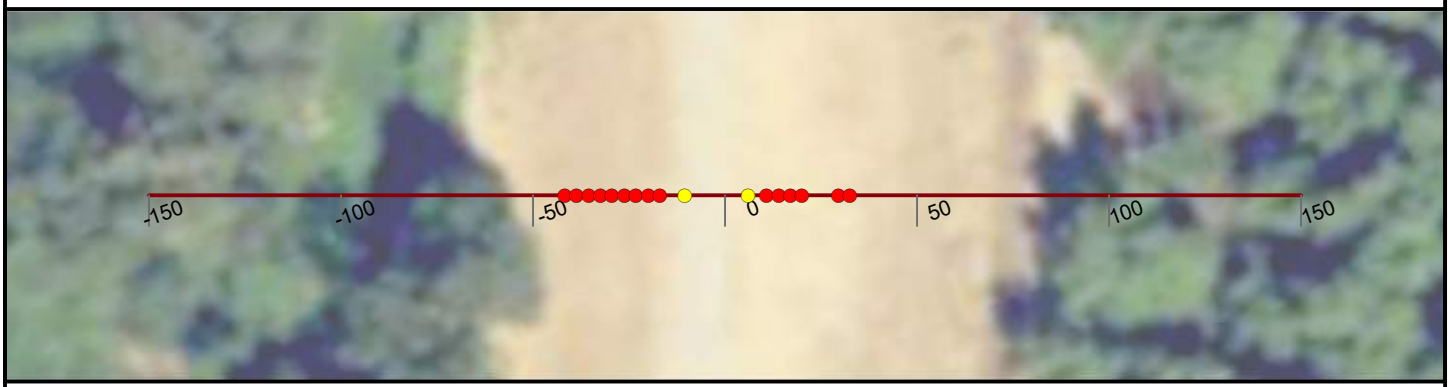
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Cross Section: Yankee Slough 57+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

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- Crown Point
- Issue Point
- Existing Levee
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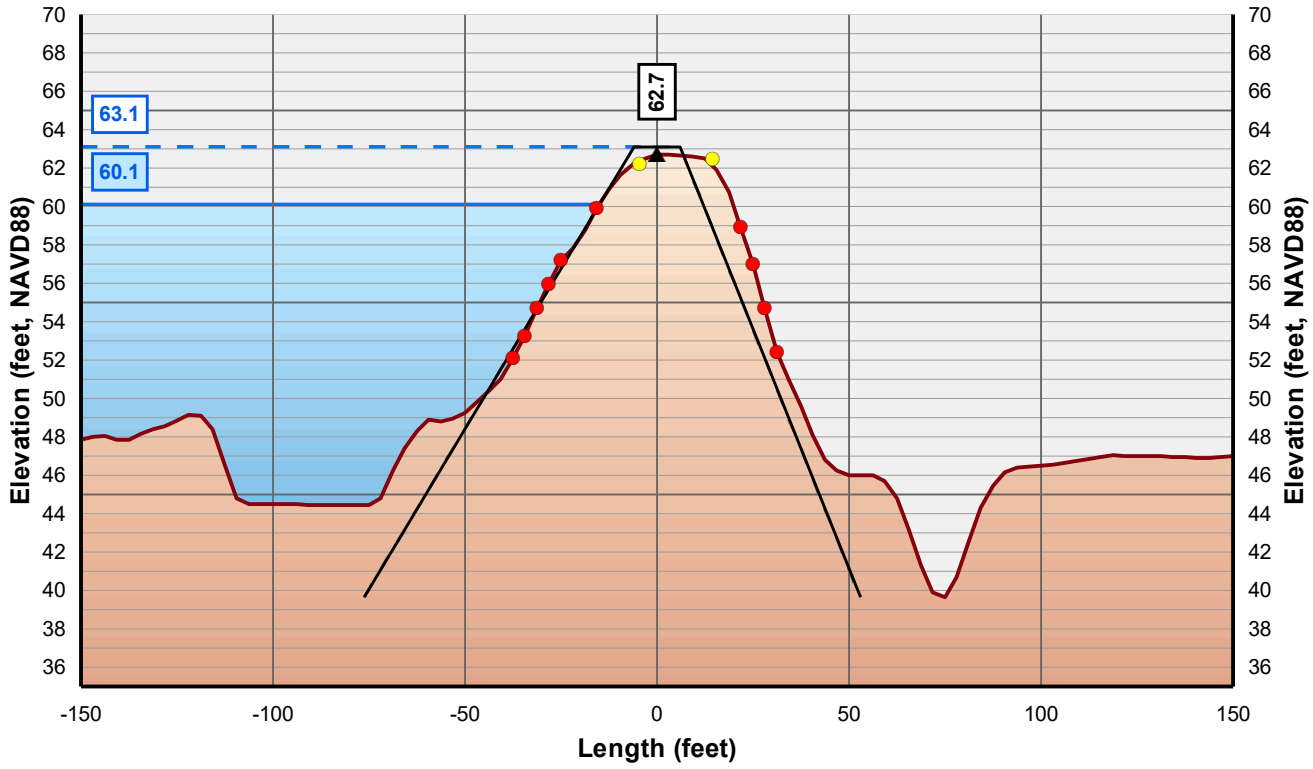
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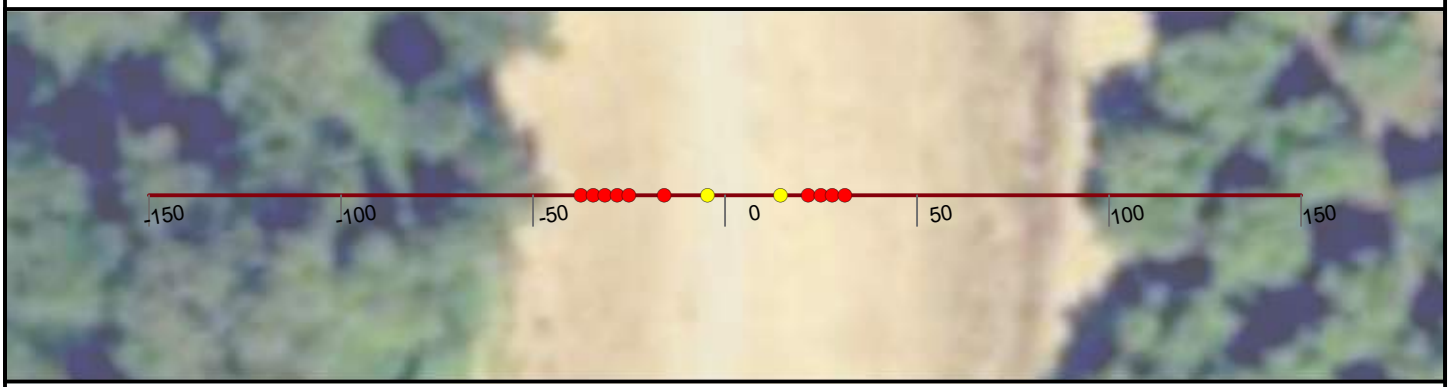
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Cross Section: Yankee Slough 58+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
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- Existing Levee
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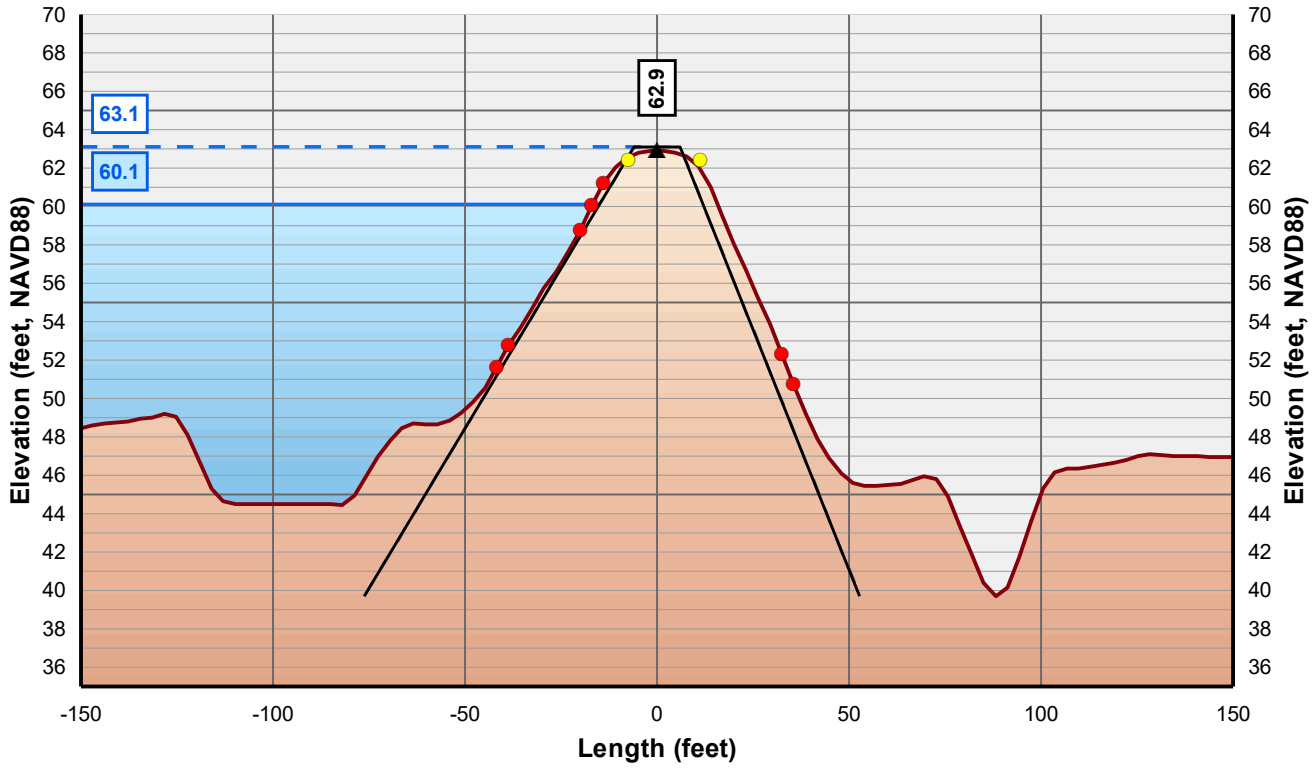
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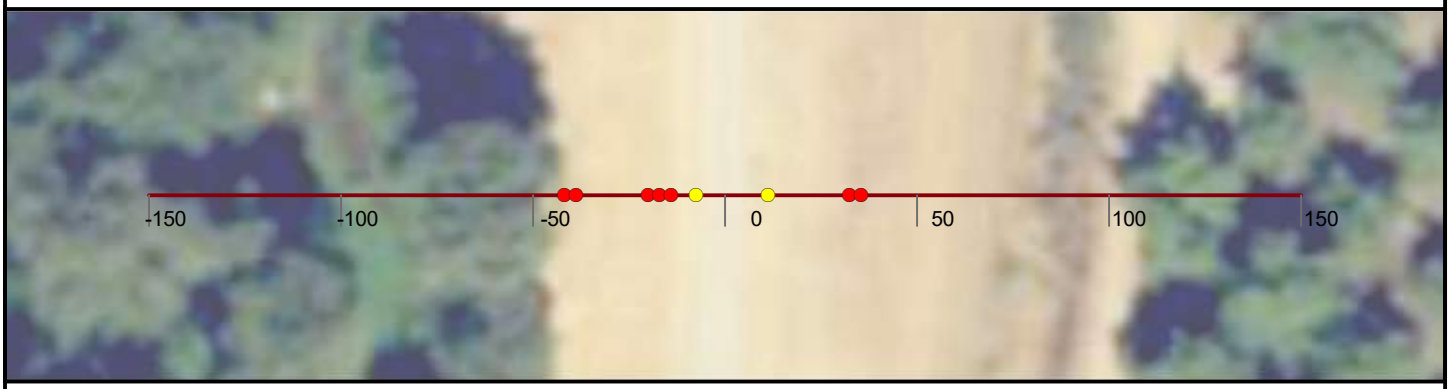
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Cross Section: Yankee Slough 59+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

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AUGUST, 2019

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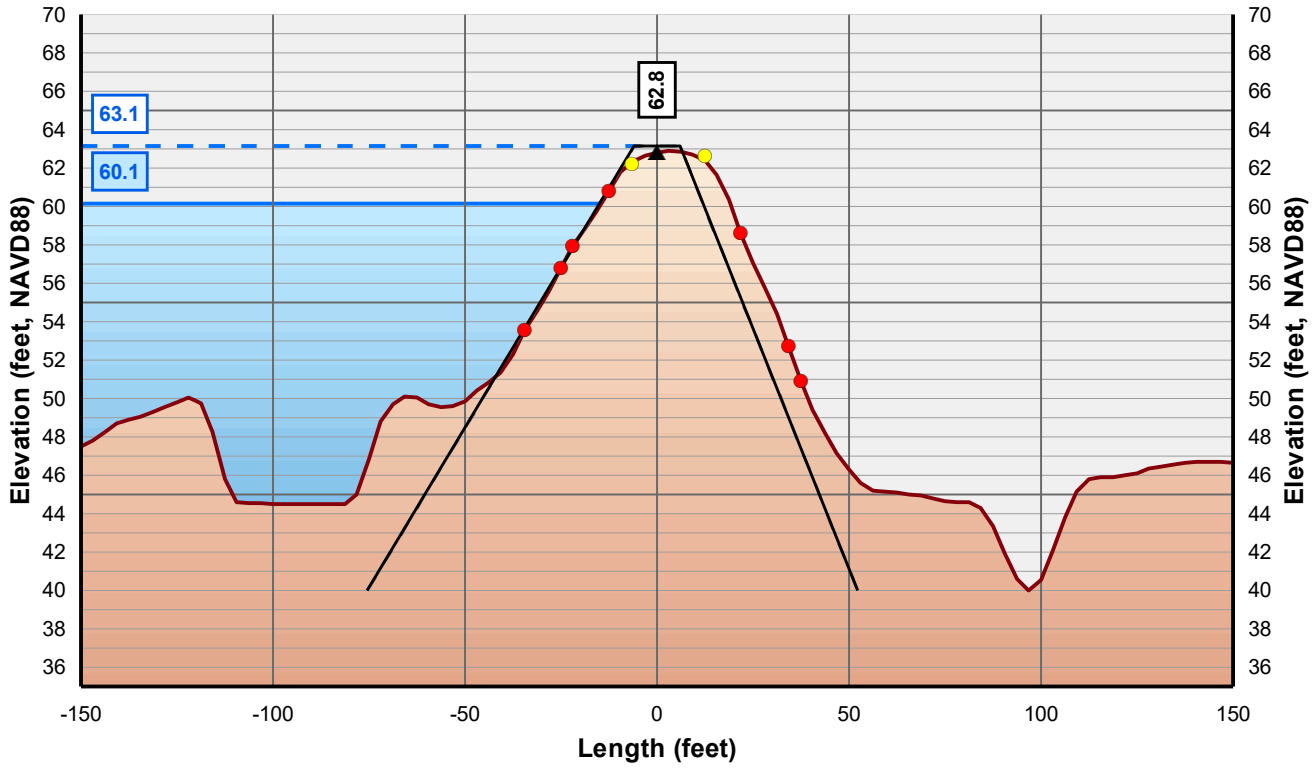
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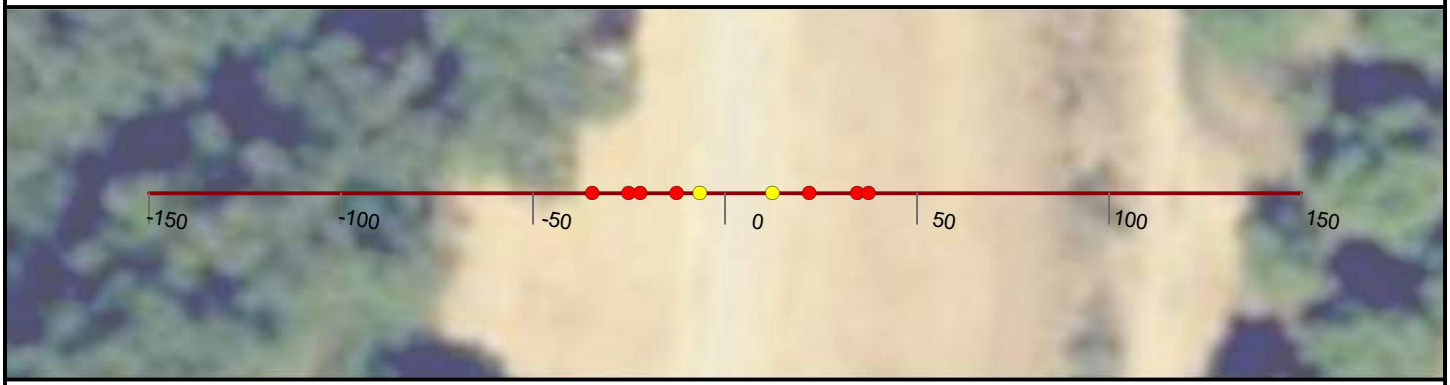
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Cross Section: Yankee Slough 60+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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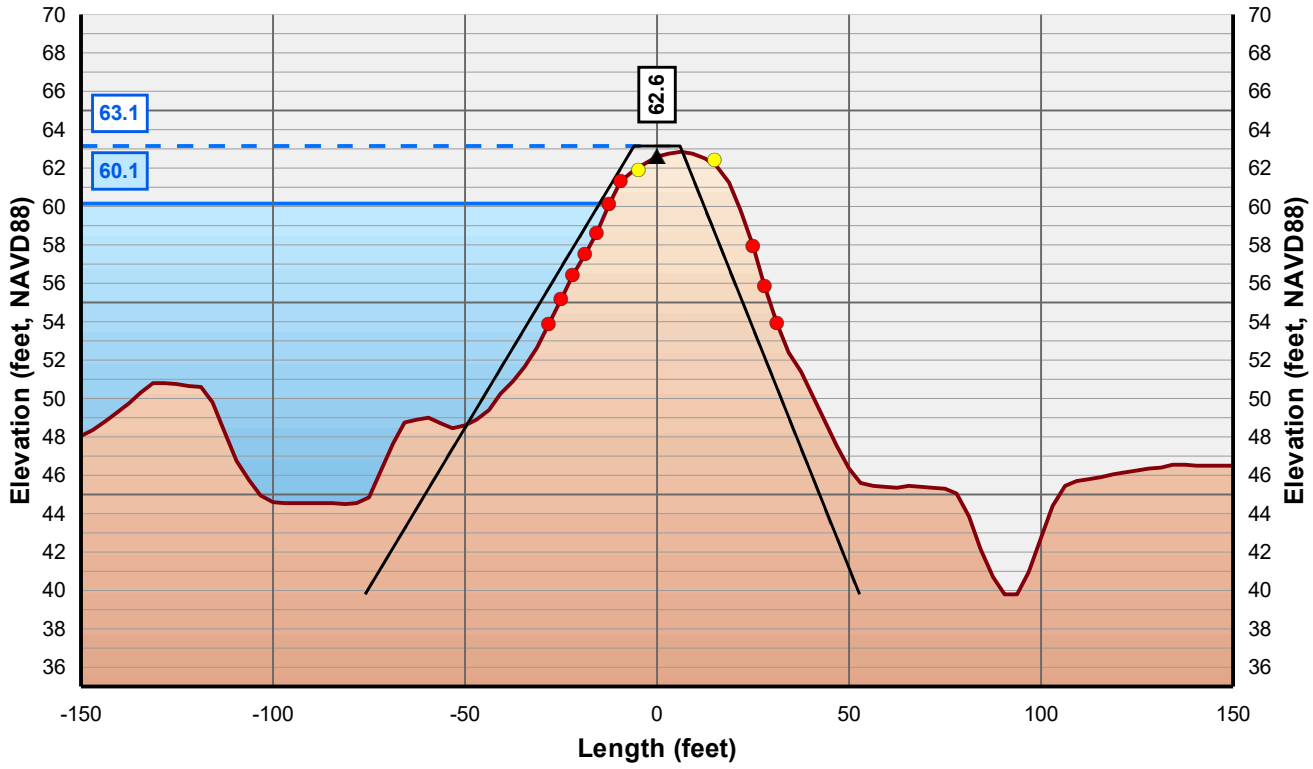
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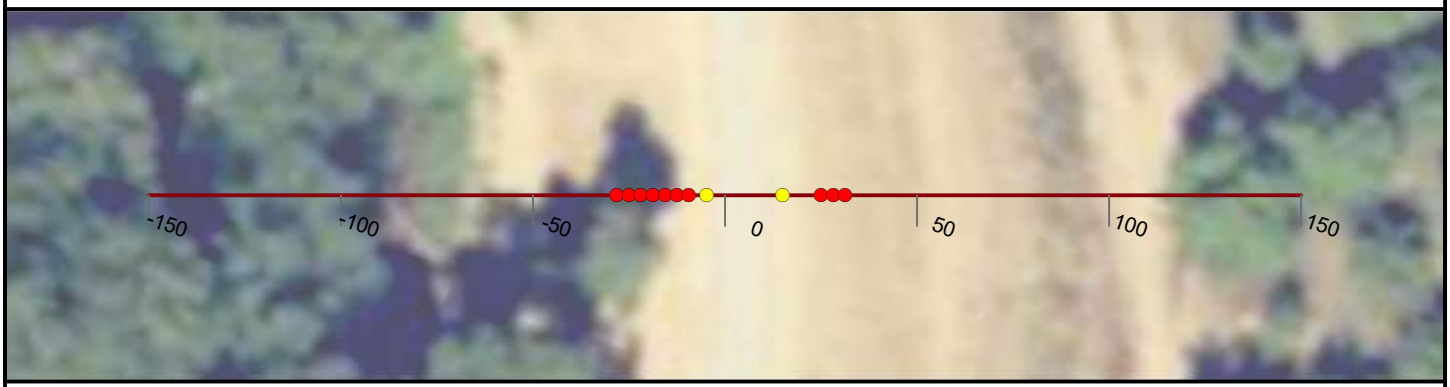
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Cross Section: Yankee Slough 61+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
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- Existing Levee
- Theoretical Levee Prism Preliminary
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FEASIBILITY STUDY

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NORTH

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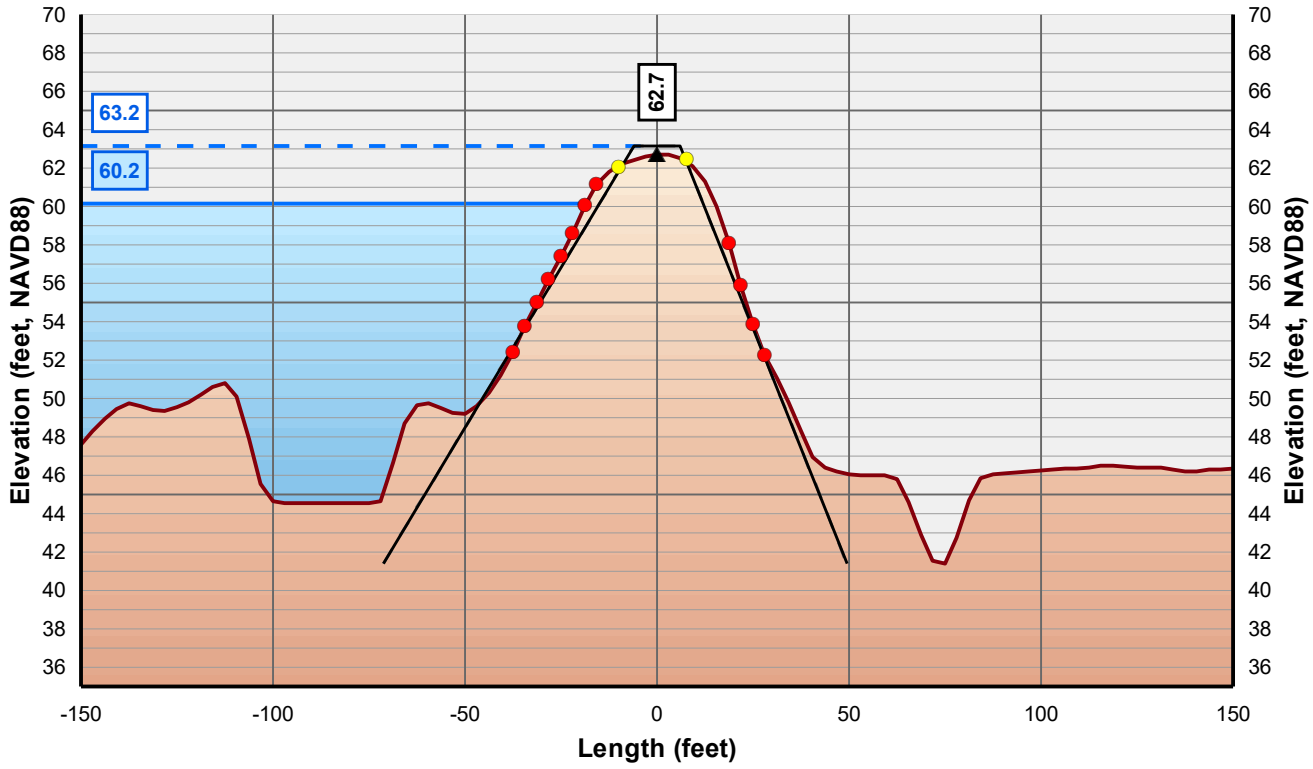
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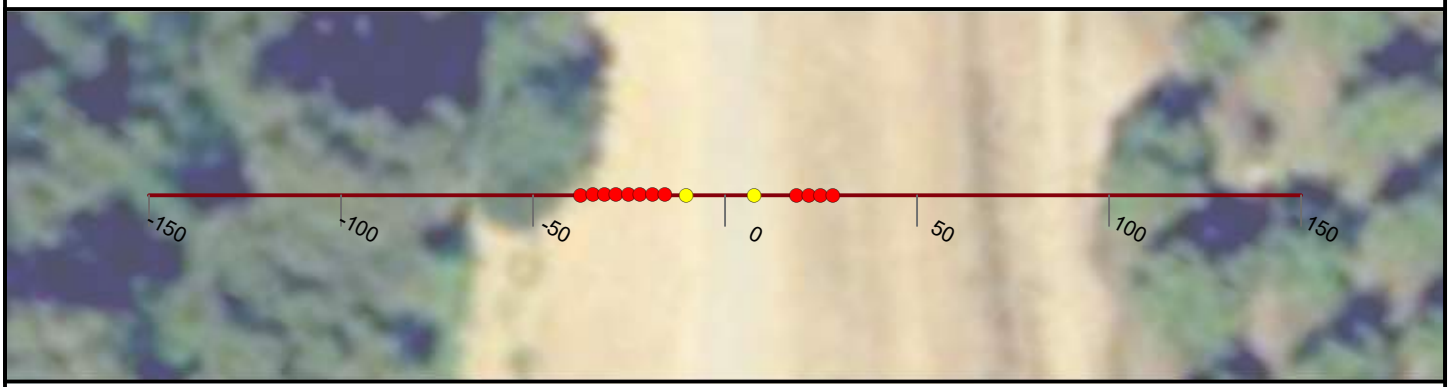
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Cross Section: Yankee Slough 62+00



Horizontal Scale: 1 inch = 50 Feet
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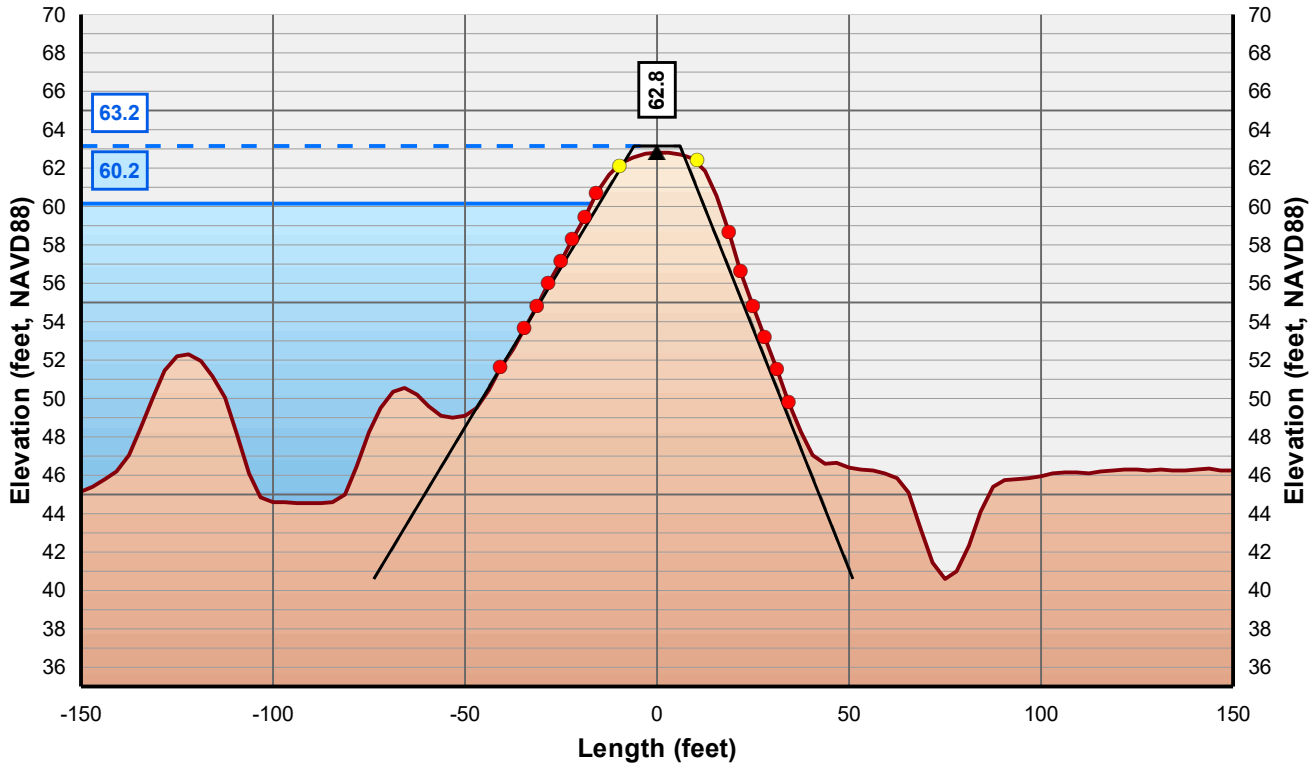
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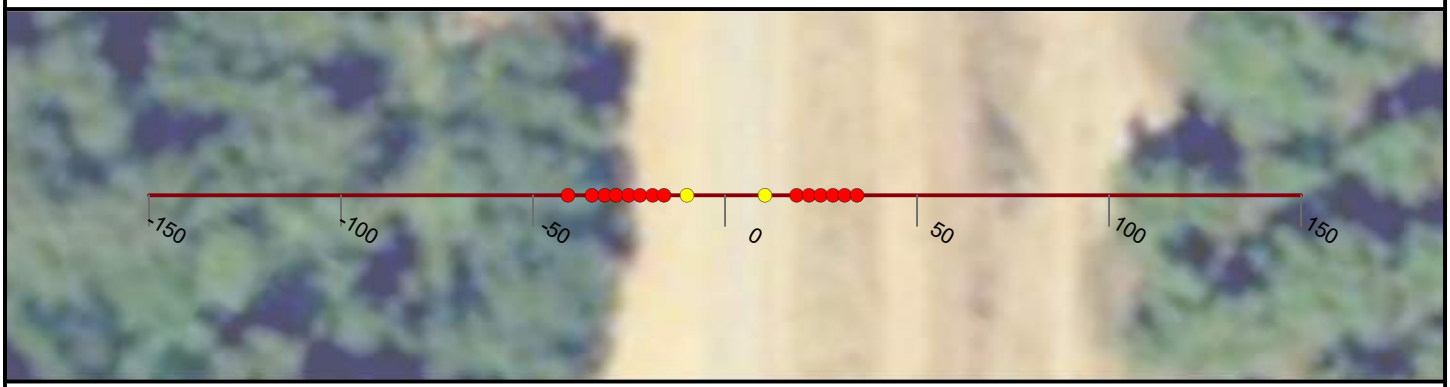
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Cross Section: Yankee Slough 63+00



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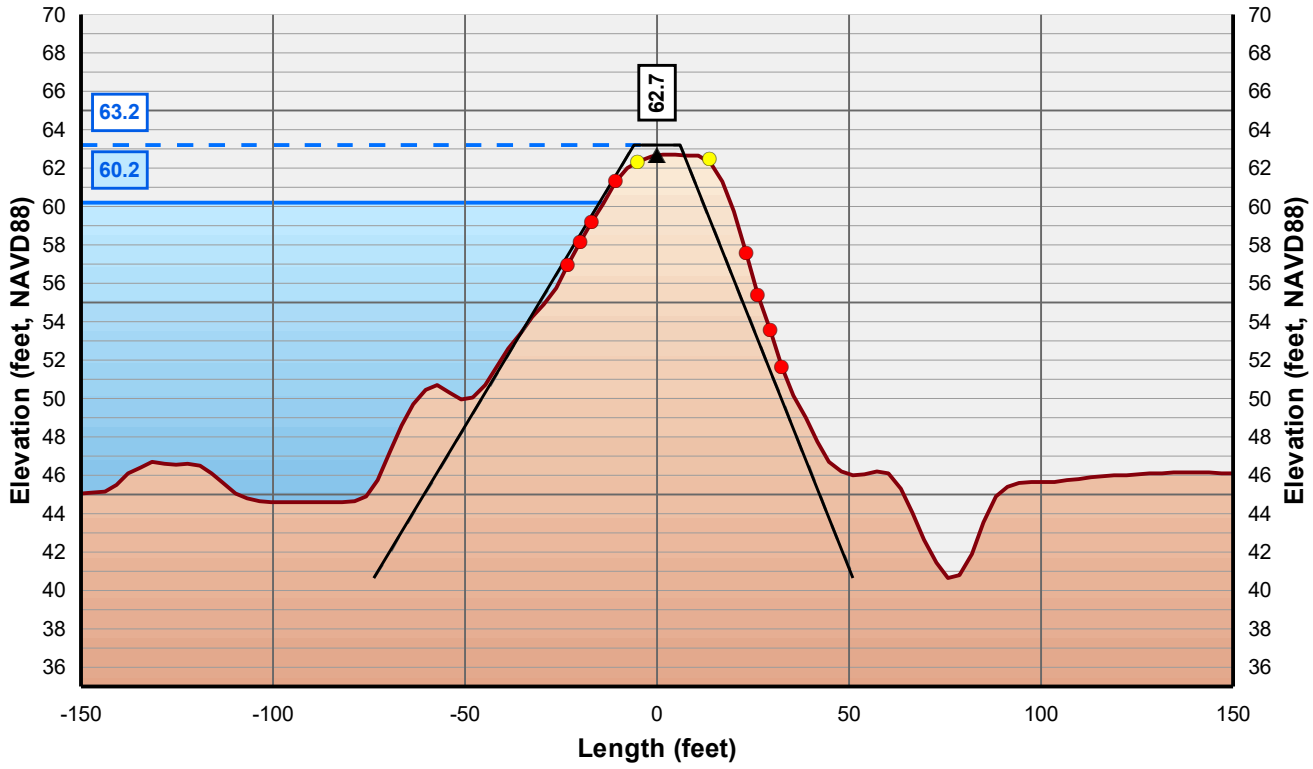
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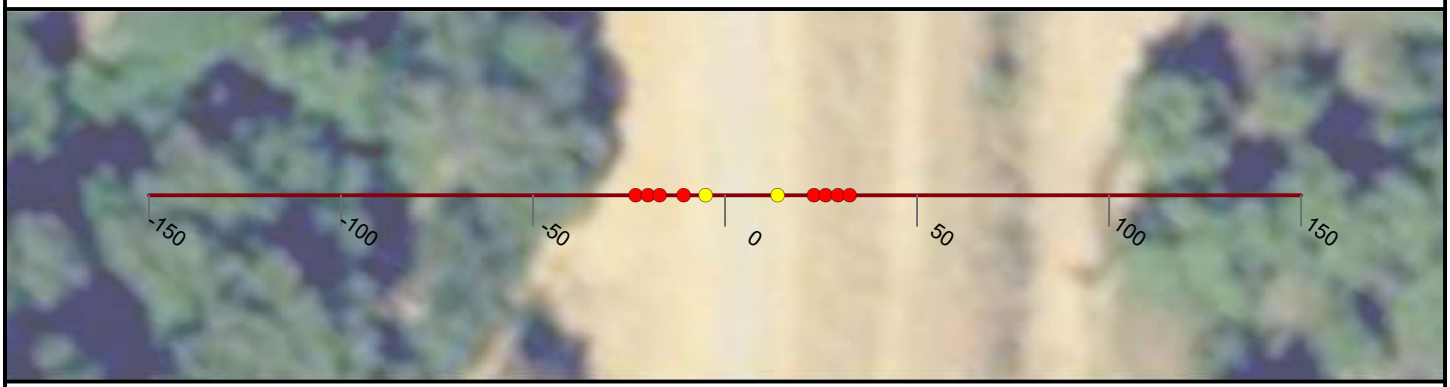
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Cross Section: Yankee Slough 64+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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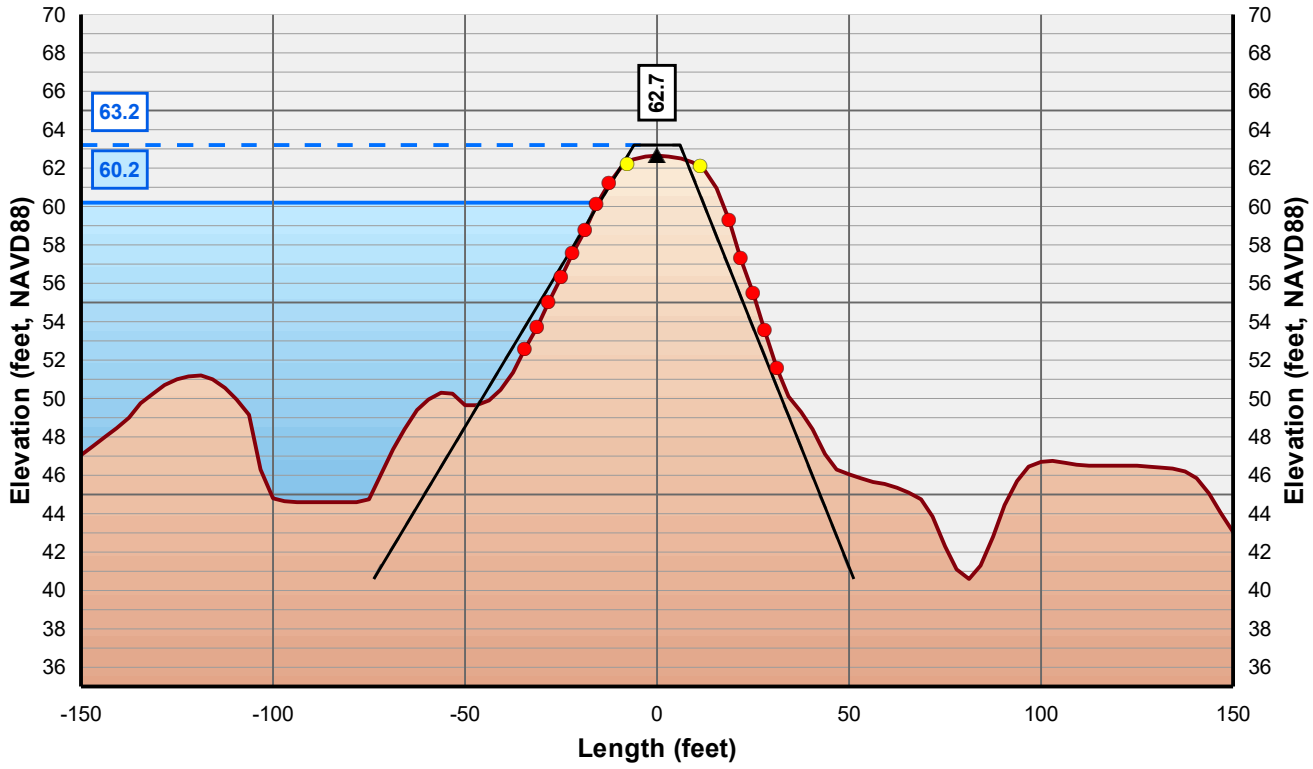
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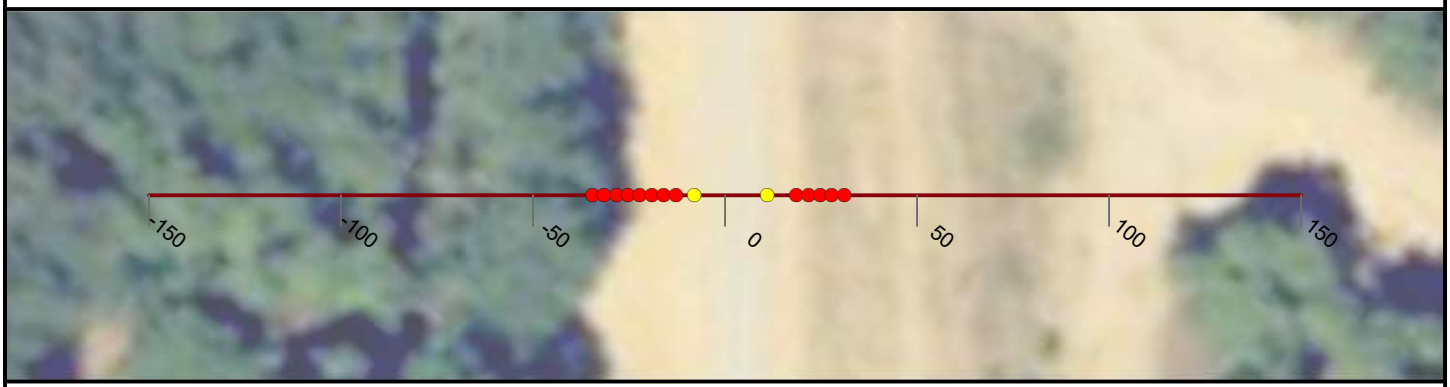
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Cross Section: Yankee Slough 65+00



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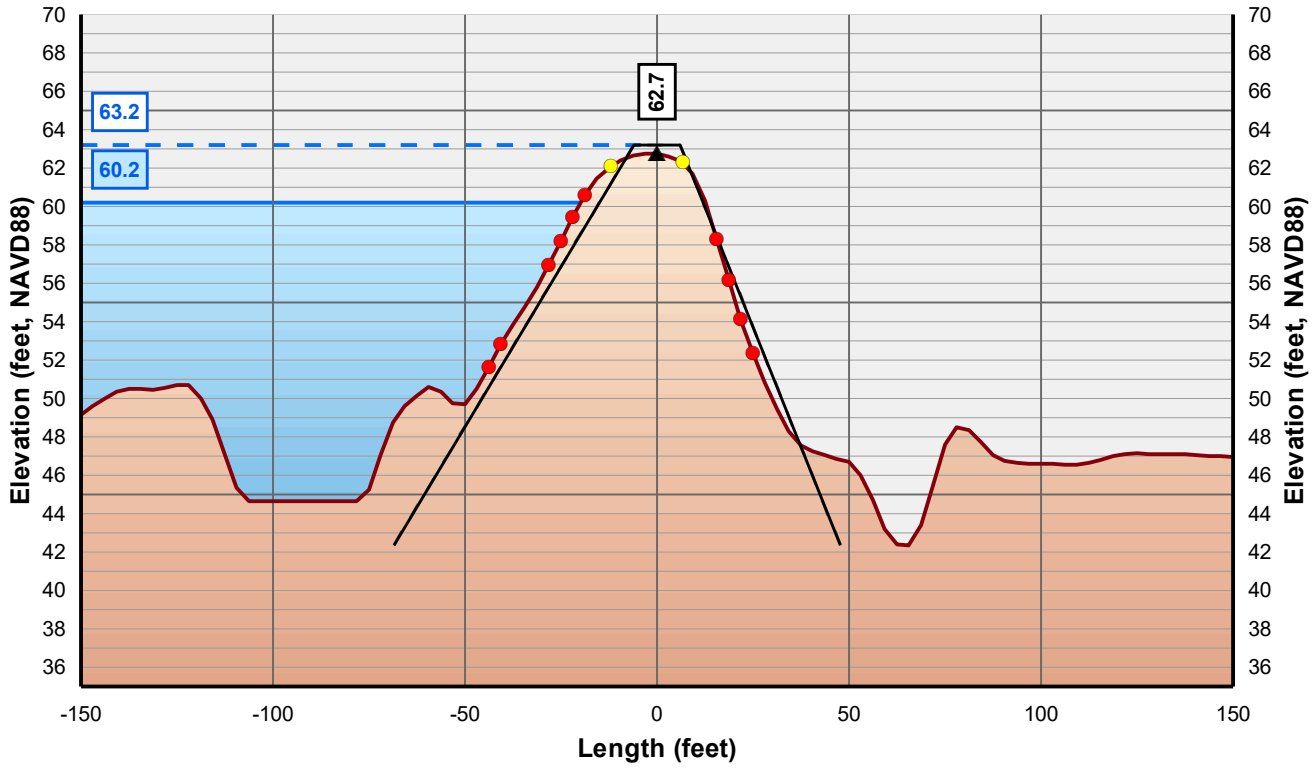
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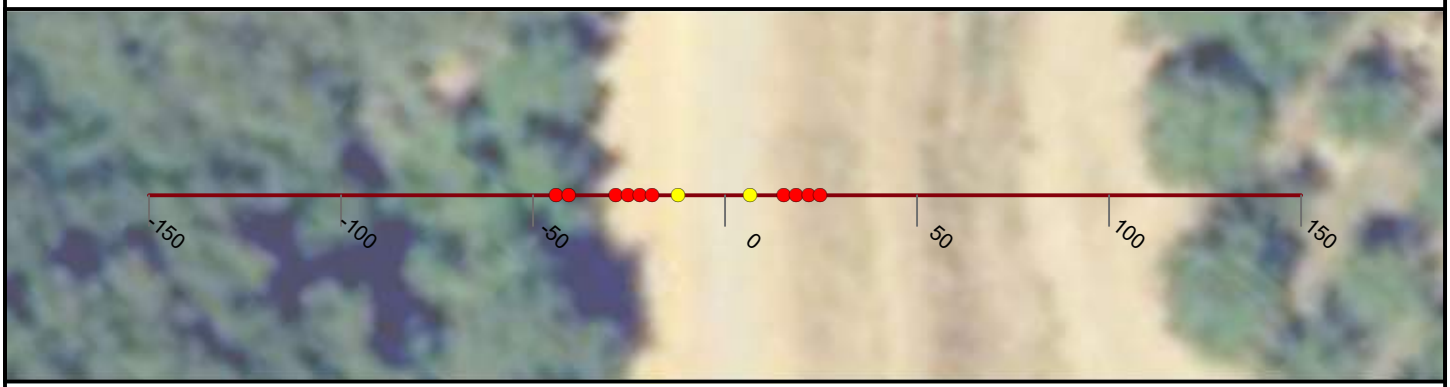
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Cross Section: Yankee Slough 66+00



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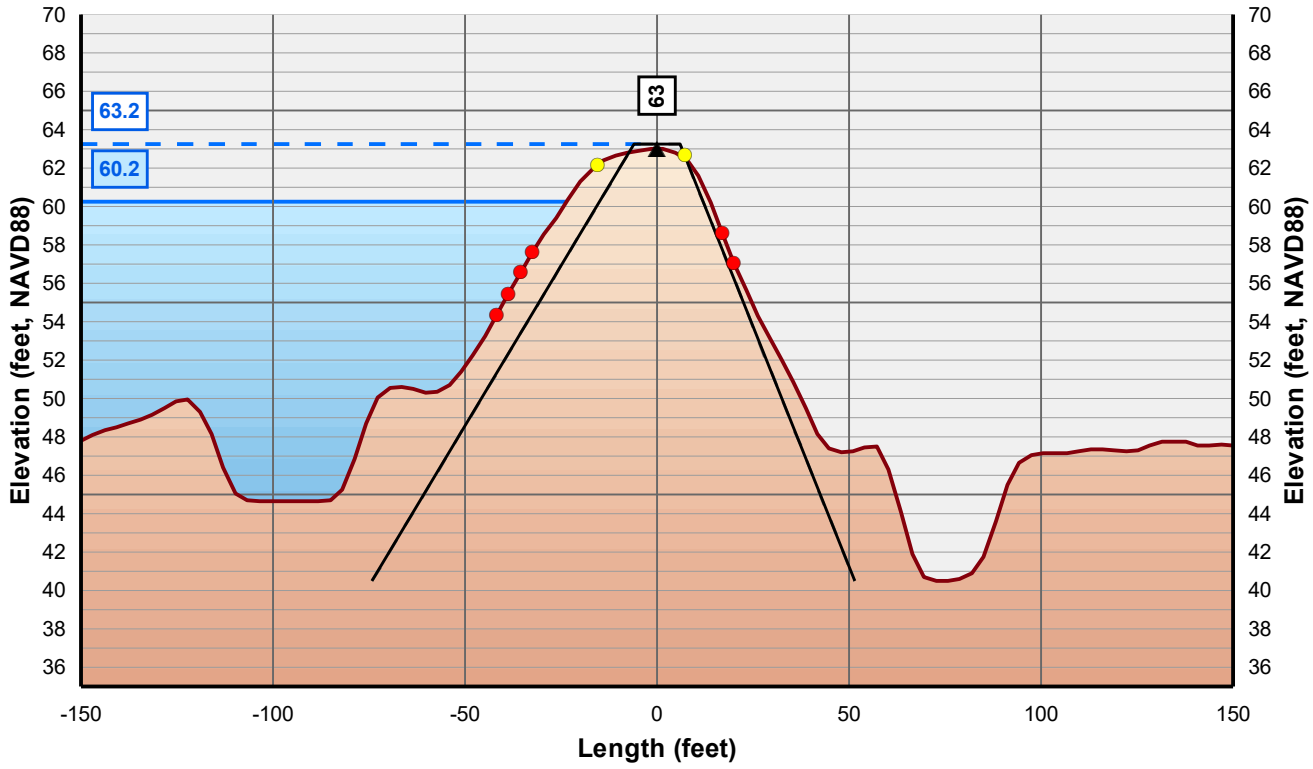
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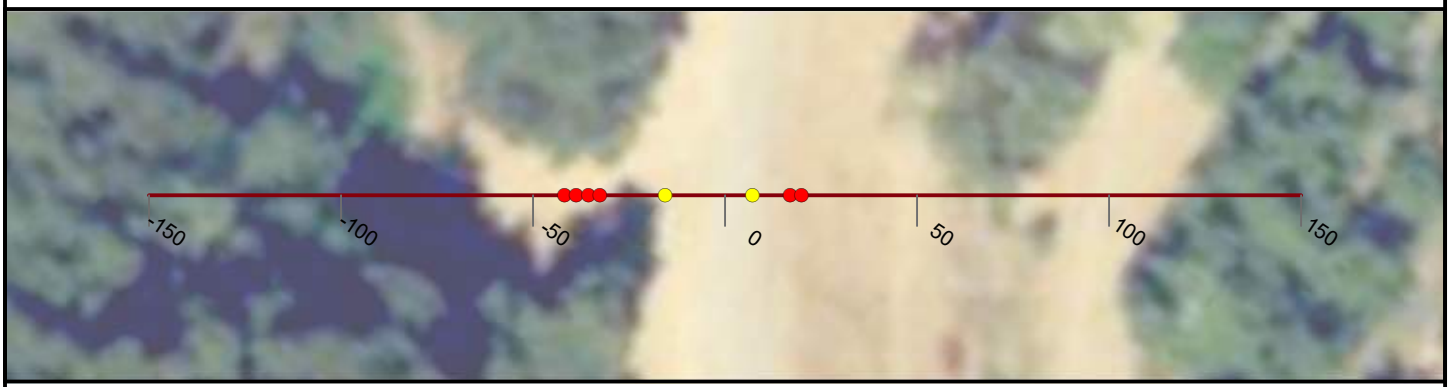
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Cross Section: Yankee Slough 67+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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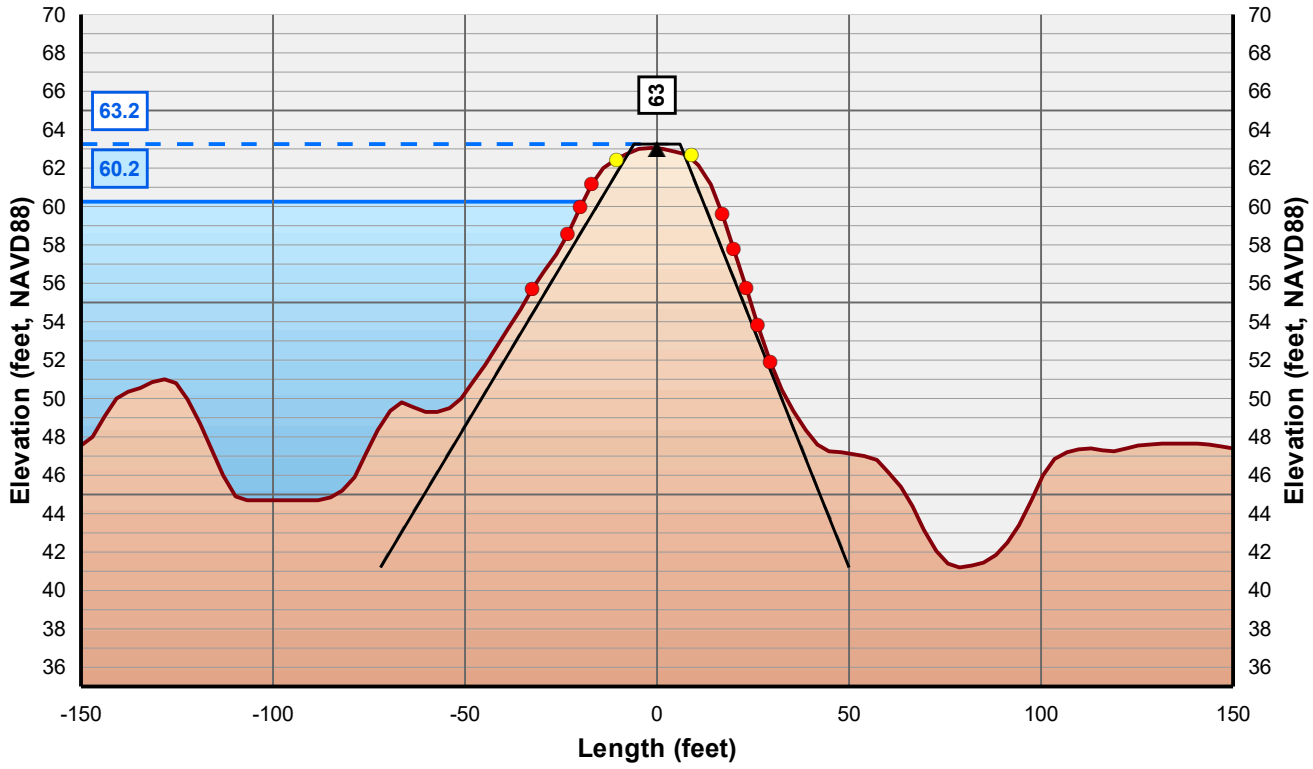
FEET

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3301 C Street, Bldg 100-B
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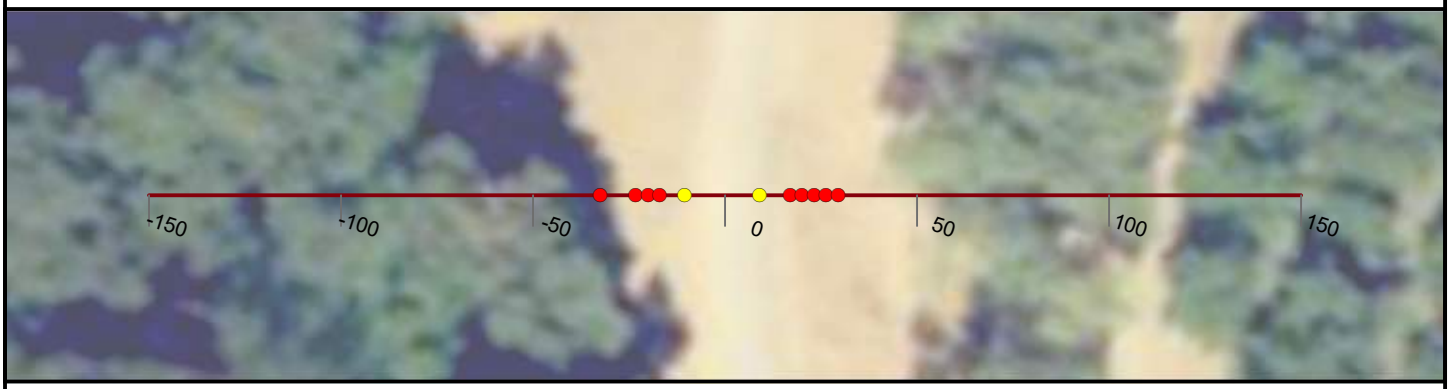
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Cross Section: Yankee Slough 68+00



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

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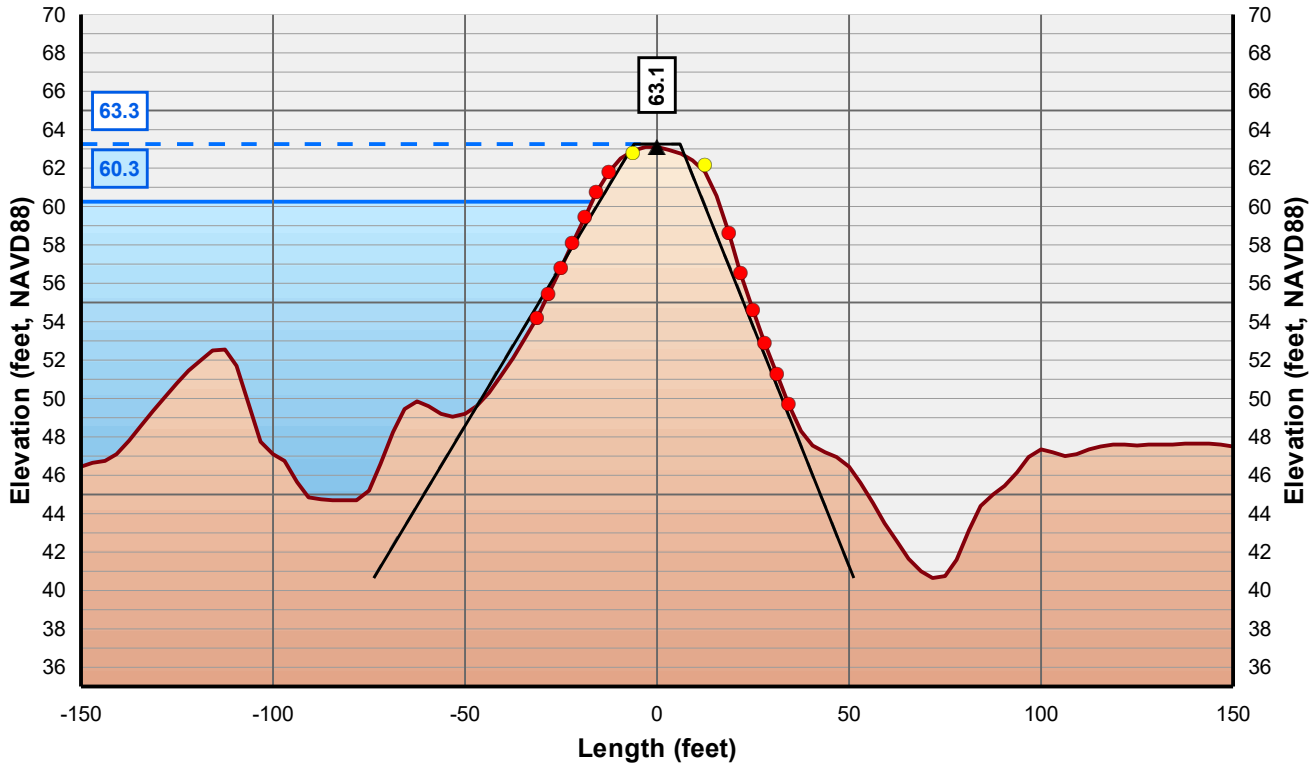
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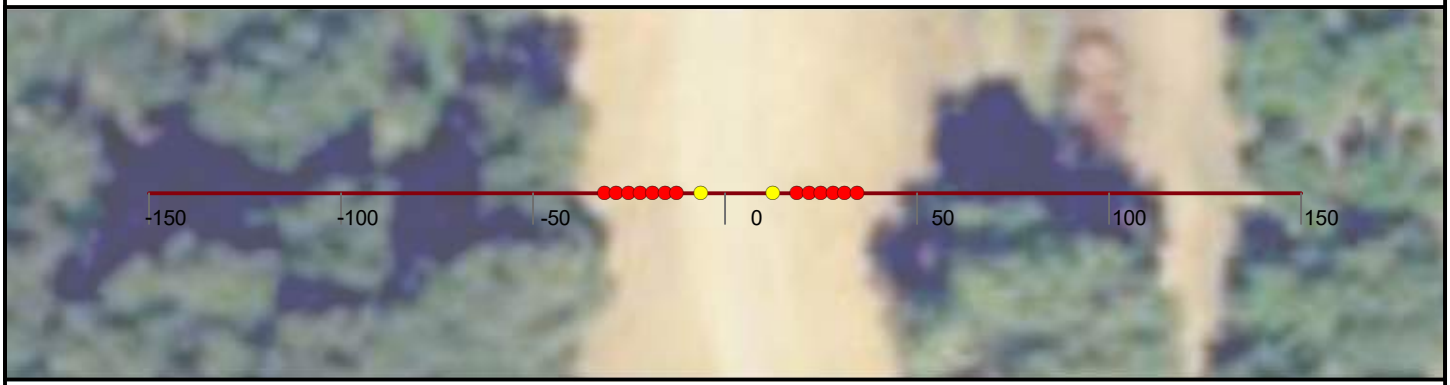
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Cross Section: Yankee Slough 69+00



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

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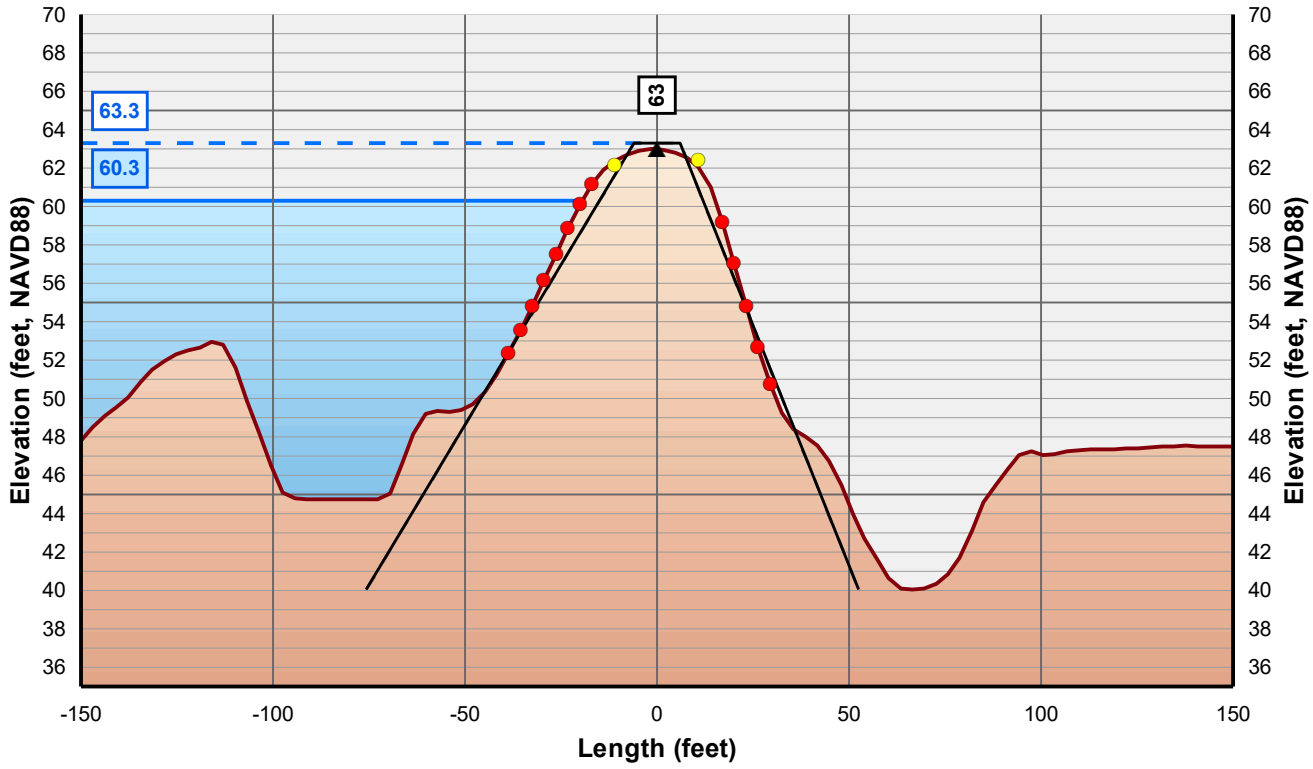
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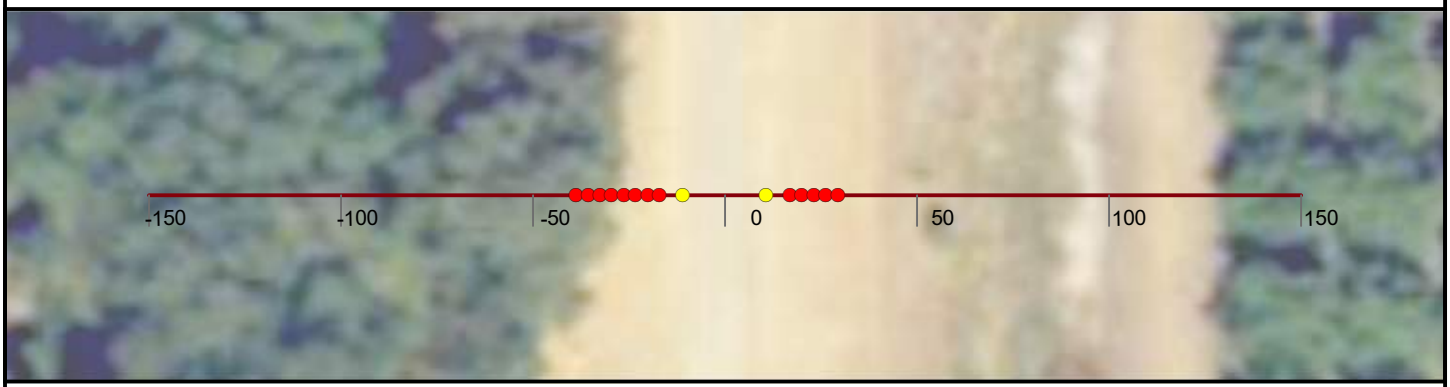
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Cross Section: Yankee Slough 70+00



Horizontal Scale: 1 inch = 50 Feet
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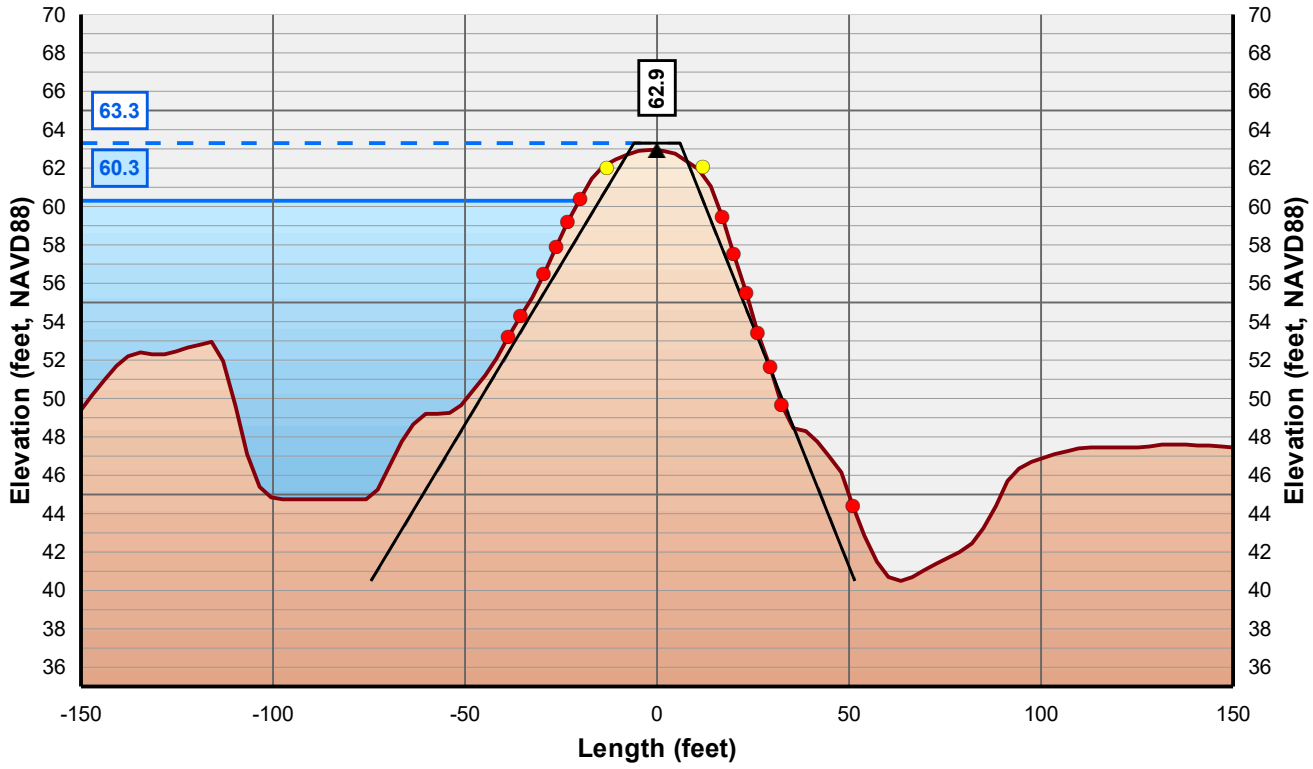
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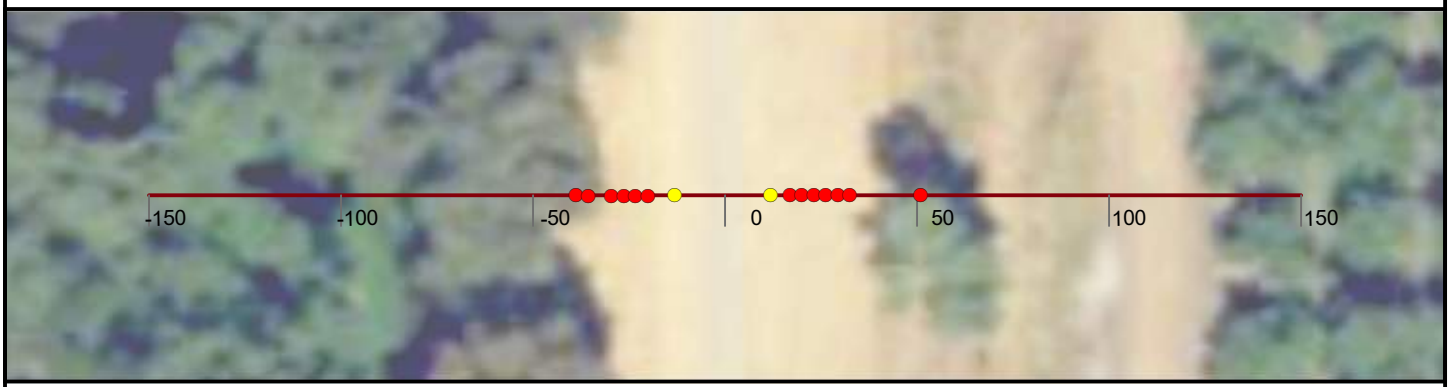
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Cross Section: Yankee Slough 71+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

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AUGUST, 2019

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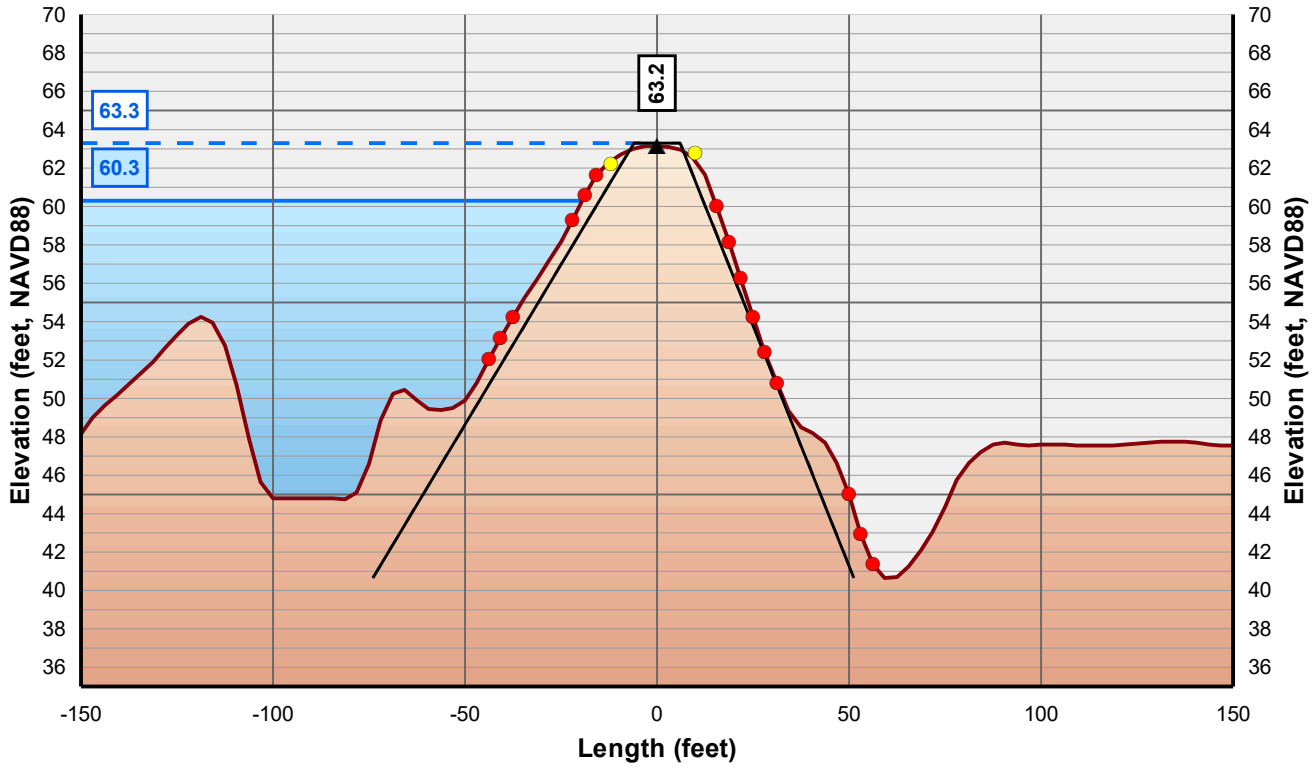
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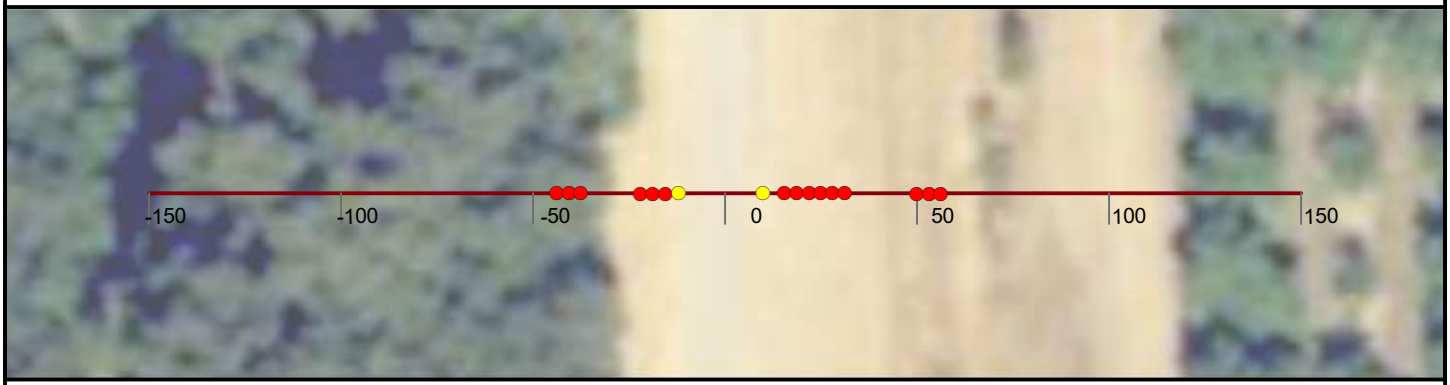
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Cross Section: Yankee Slough 72+00



Horizontal Scale: 1 inch = 50 Feet
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Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

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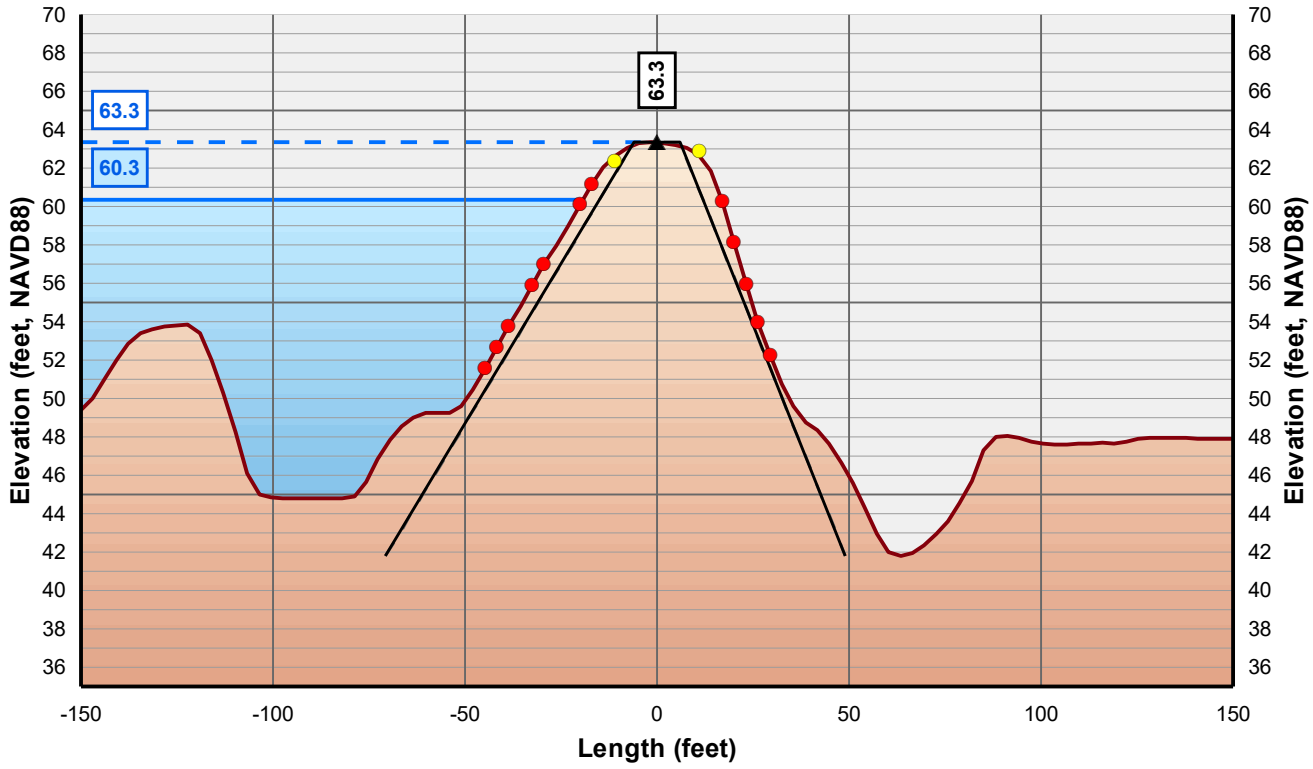
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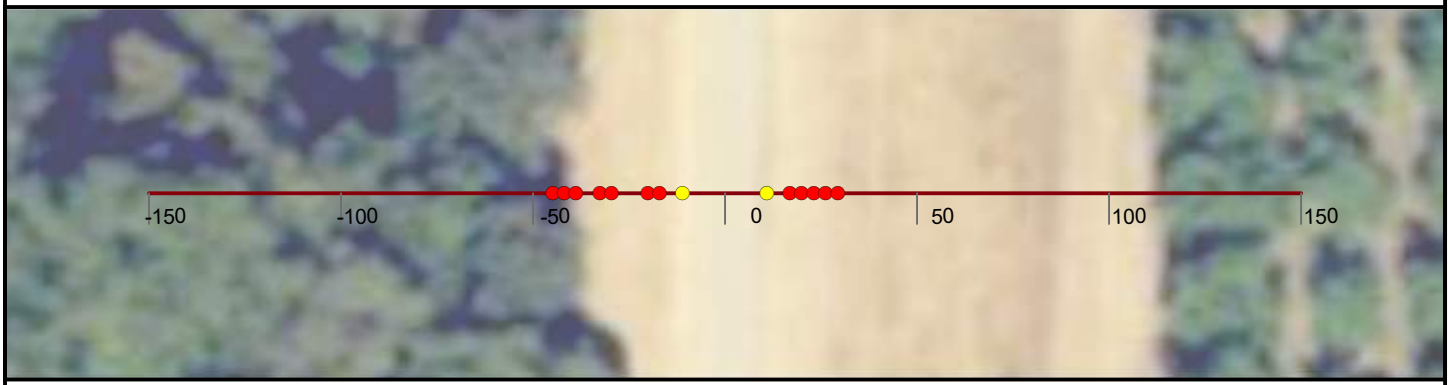
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Cross Section: Yankee Slough 73+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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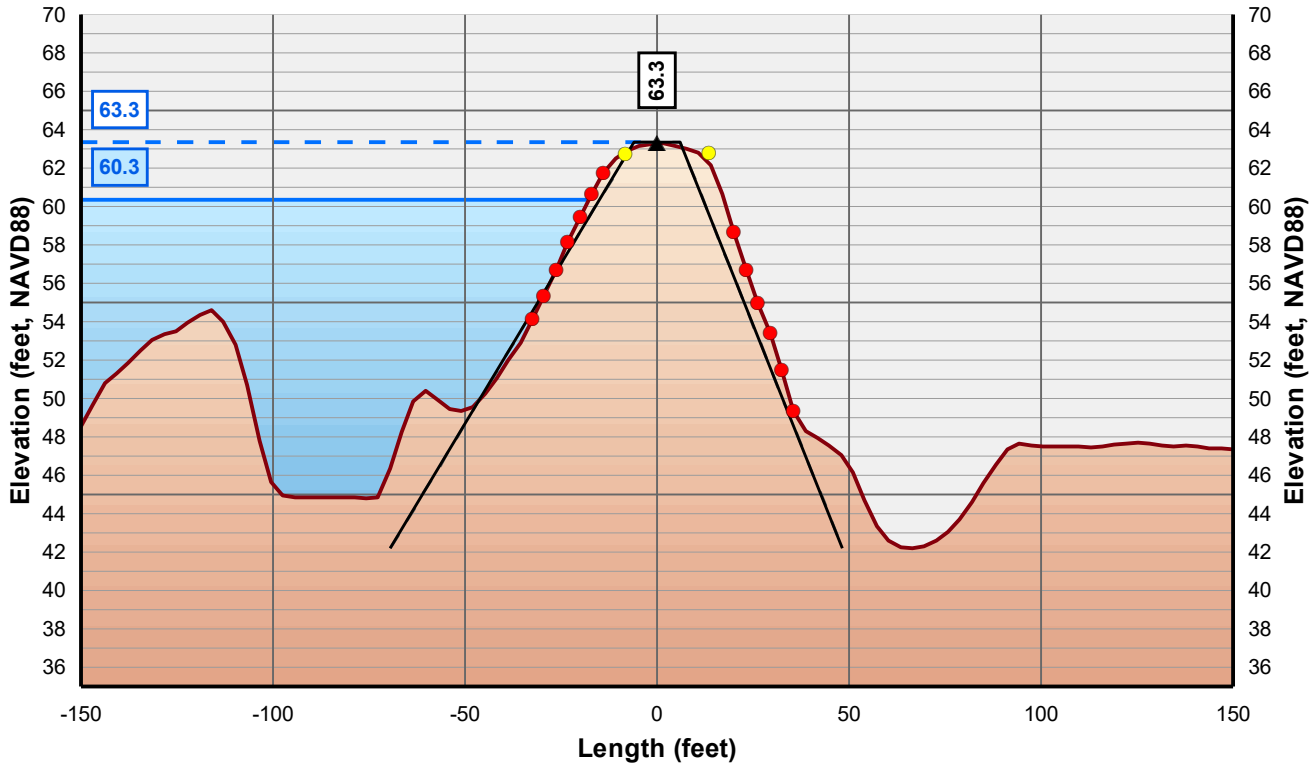
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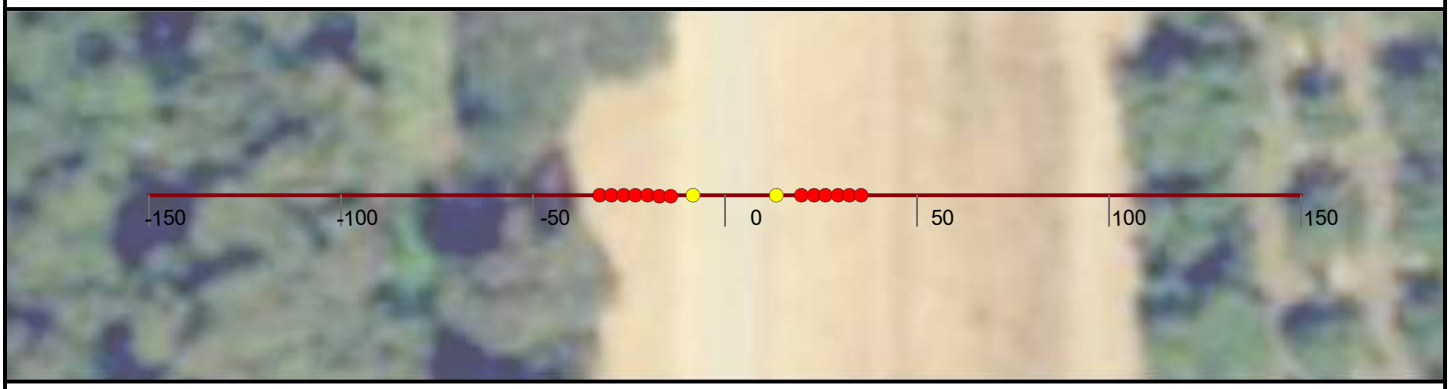
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Cross Section: Yankee Slough 74+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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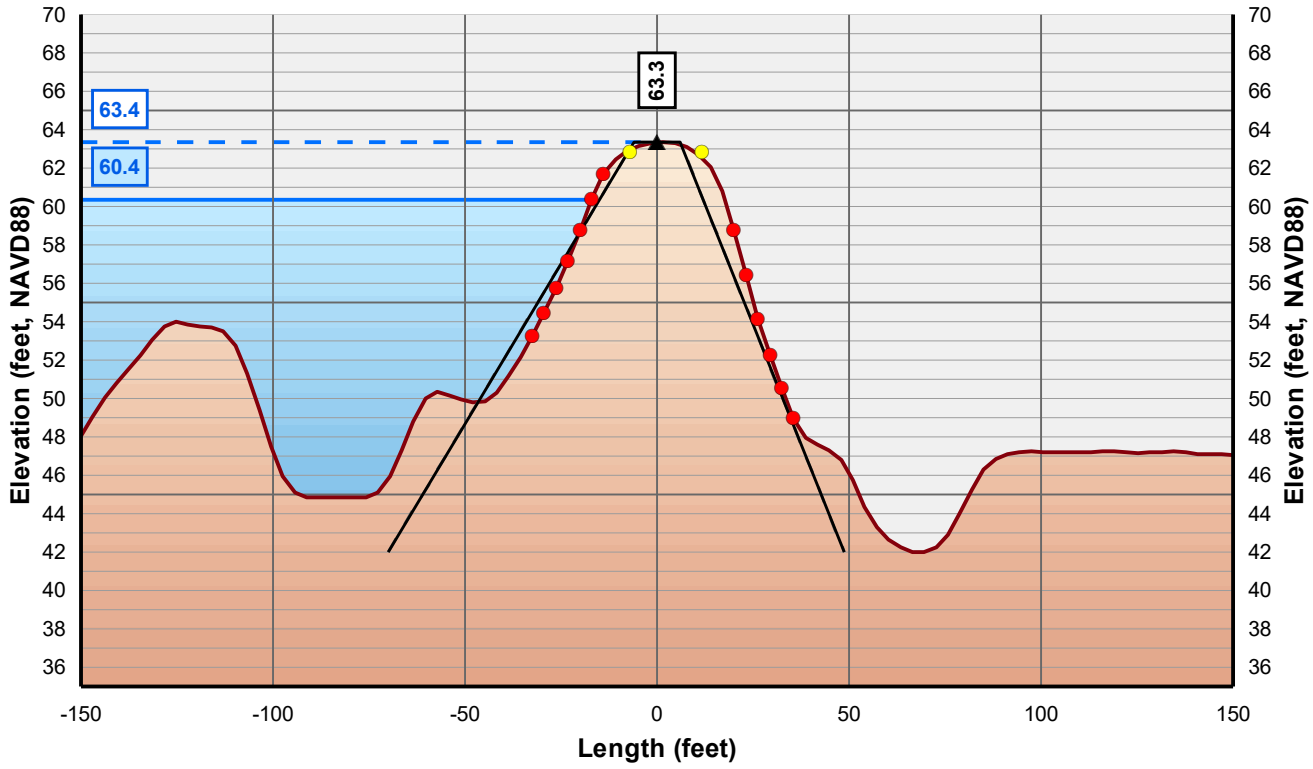
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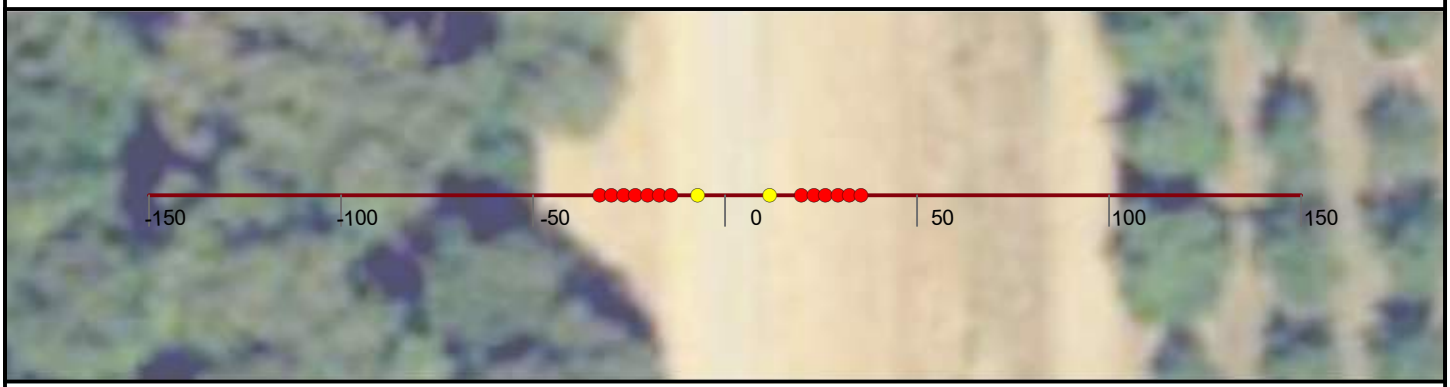
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Cross Section: Yankee Slough 75+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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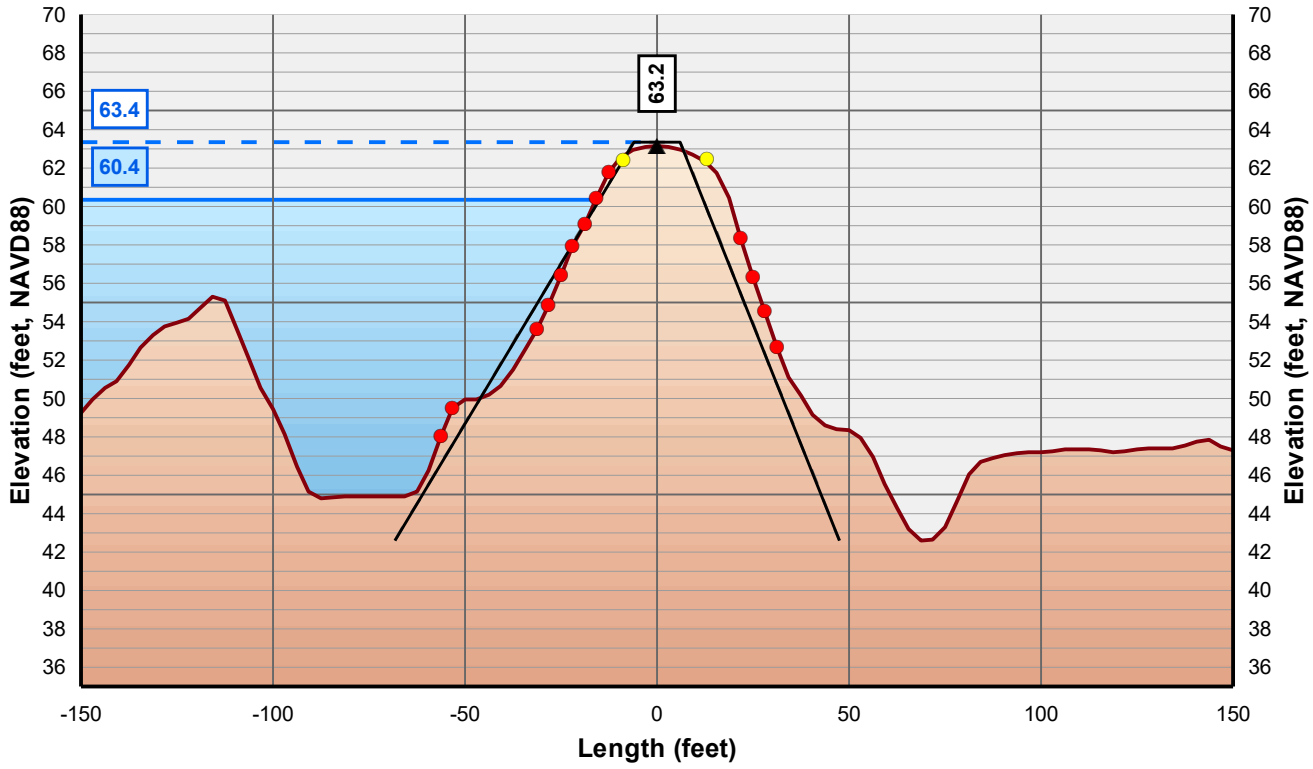
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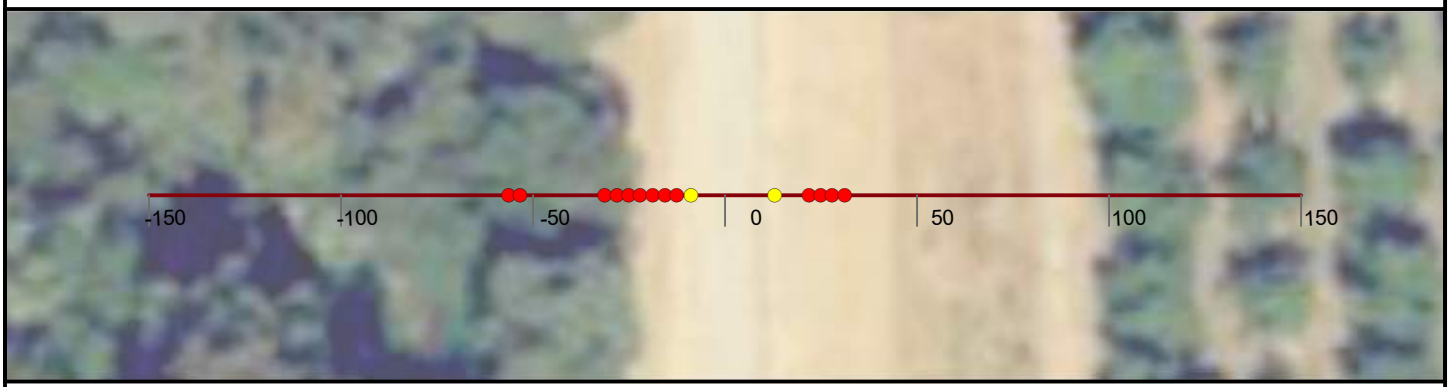
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Cross Section: Yankee Slough 76+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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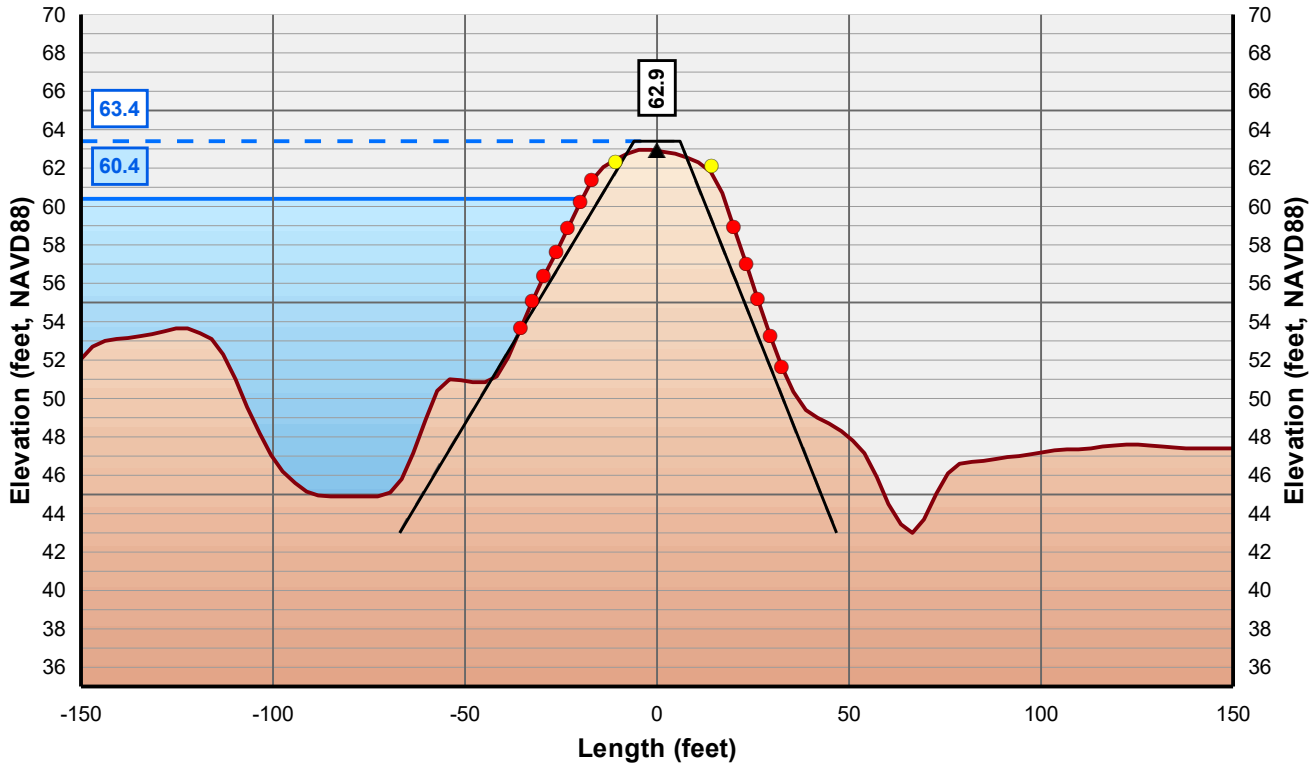
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Cross Section: Yankee Slough 77+00



Horizontal Scale: 1 inch = 50 Feet
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Control Line
Crown Point
Issue Point
Existing Levee
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Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

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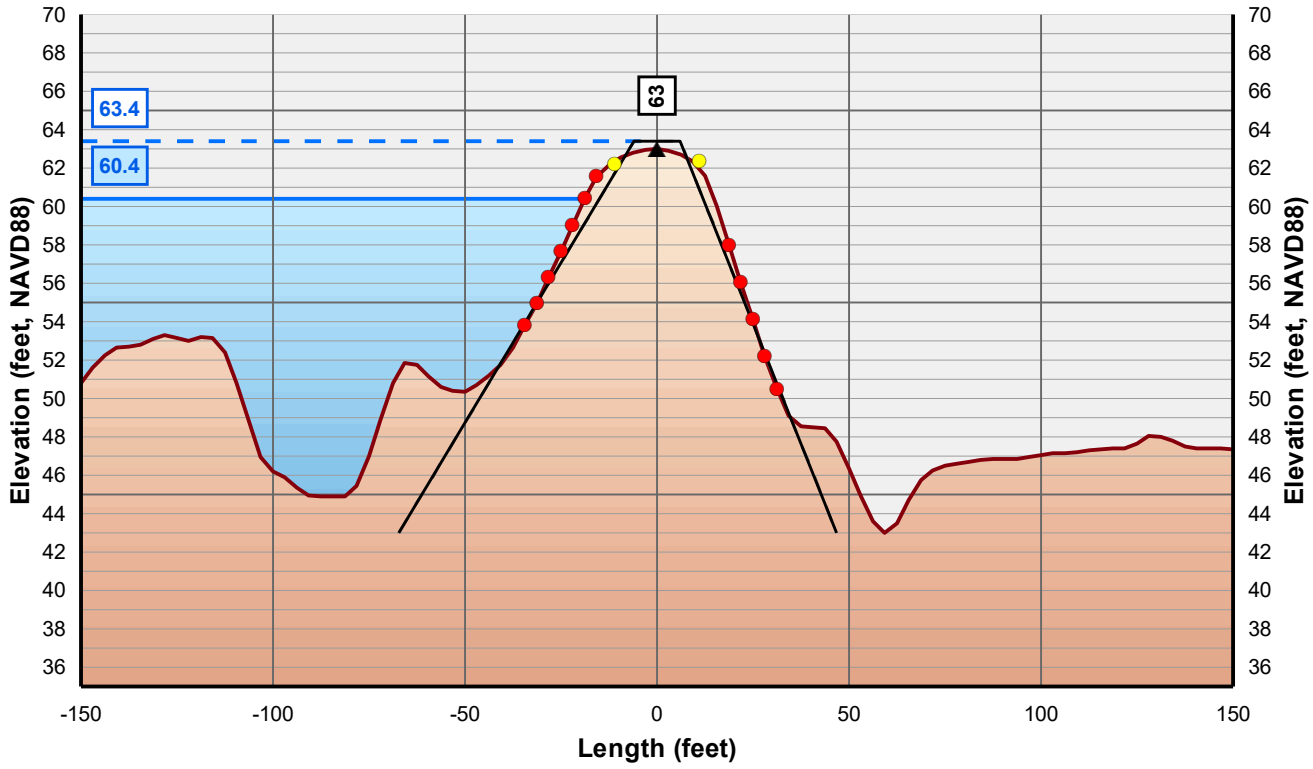
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Cross Section: Yankee Slough 78+00



Horizontal Scale: 1 inch = 50 Feet
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AUGUST, 2019

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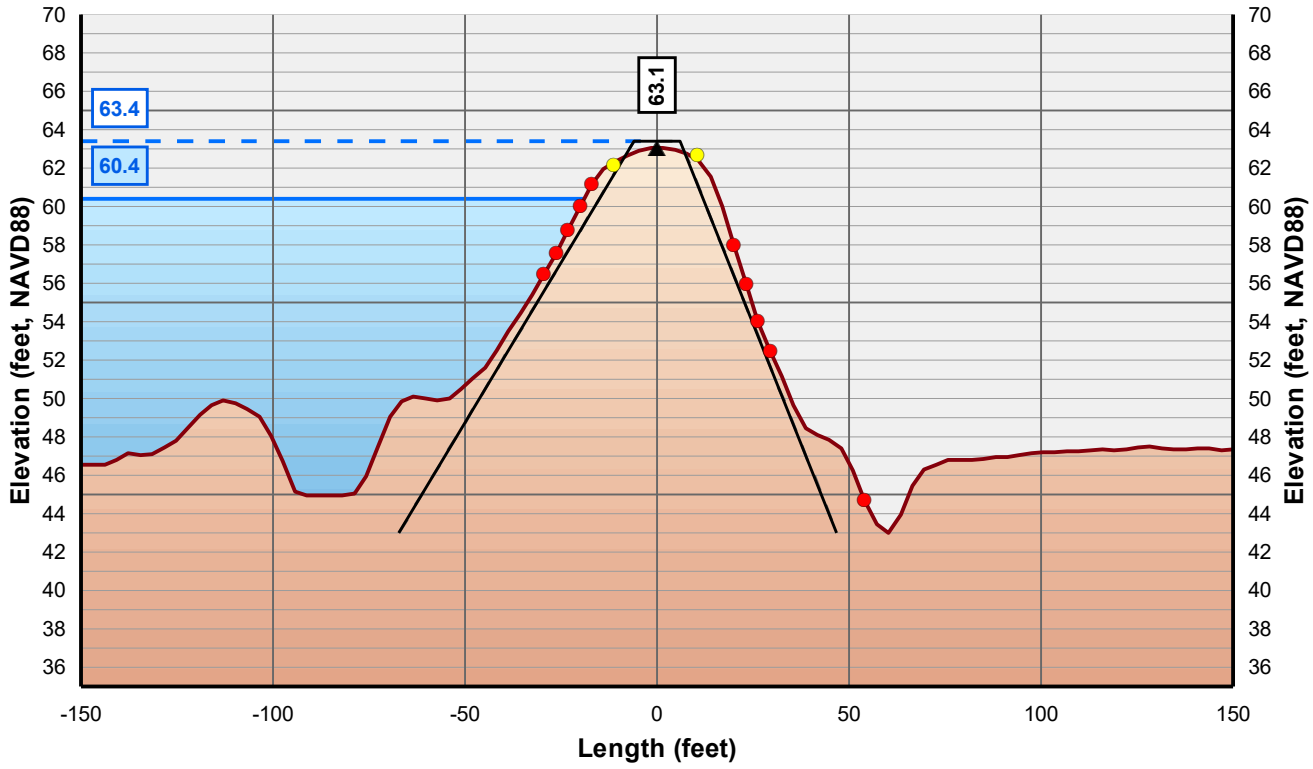
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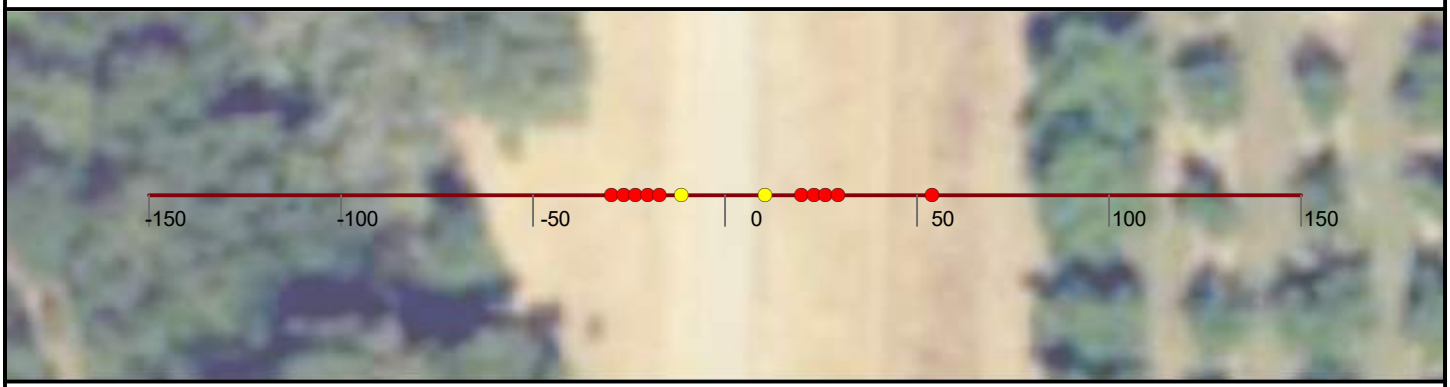
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Cross Section: Yankee Slough 79+00



Horizontal Scale: 1 inch = 50 Feet
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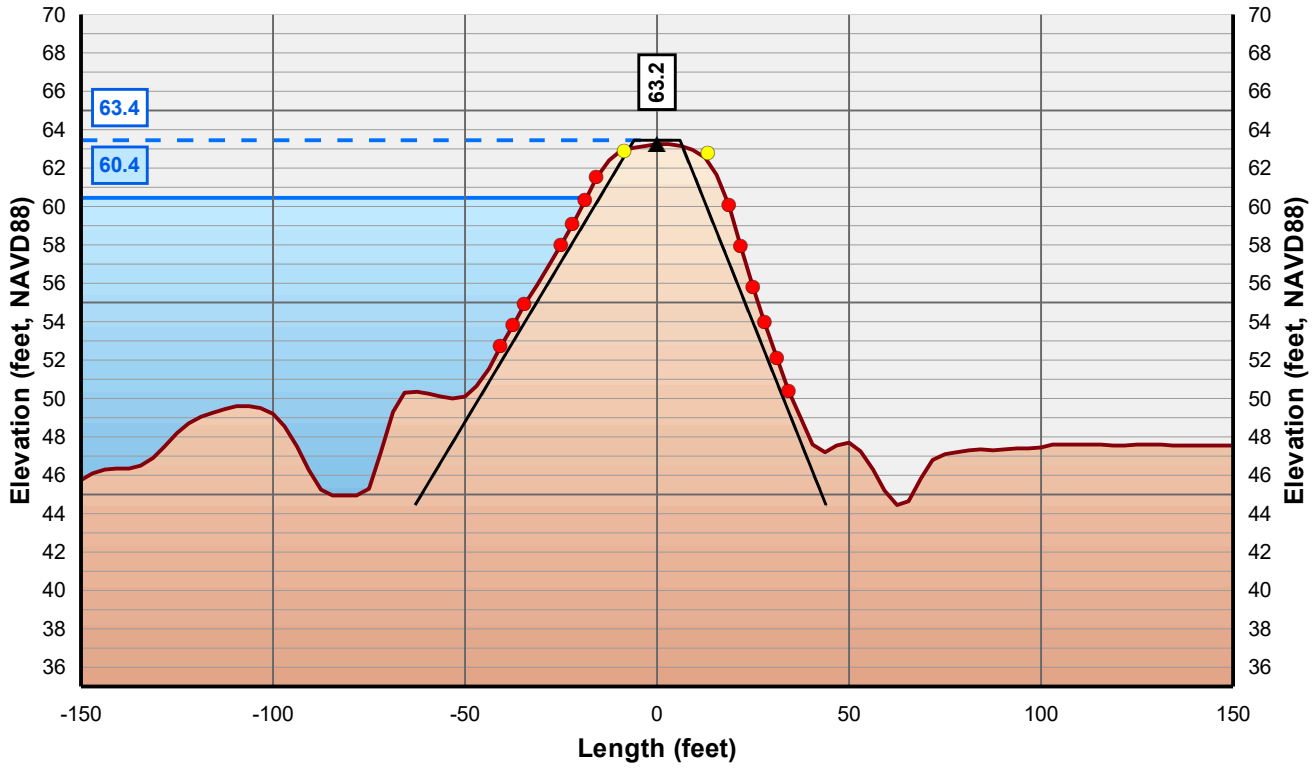
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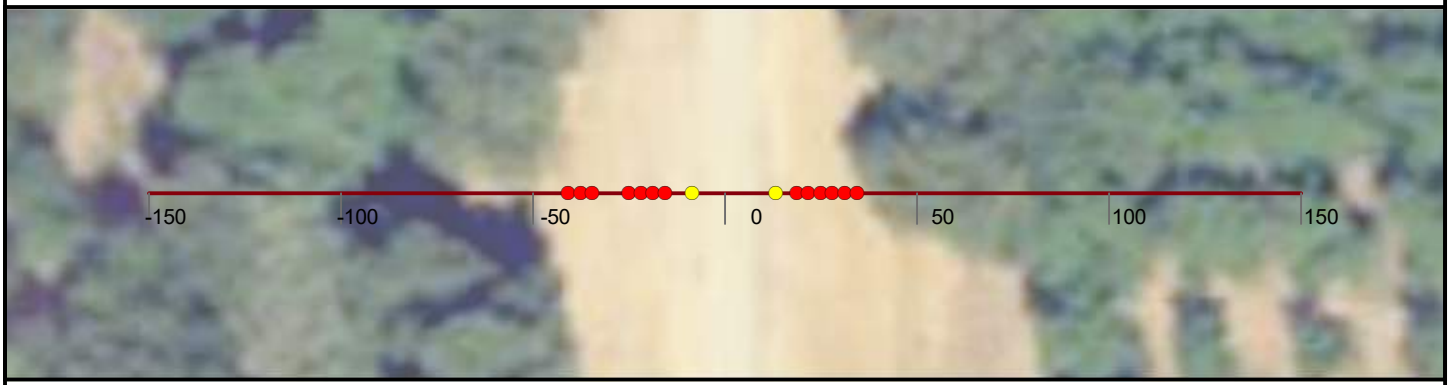
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Cross Section: Yankee Slough 80+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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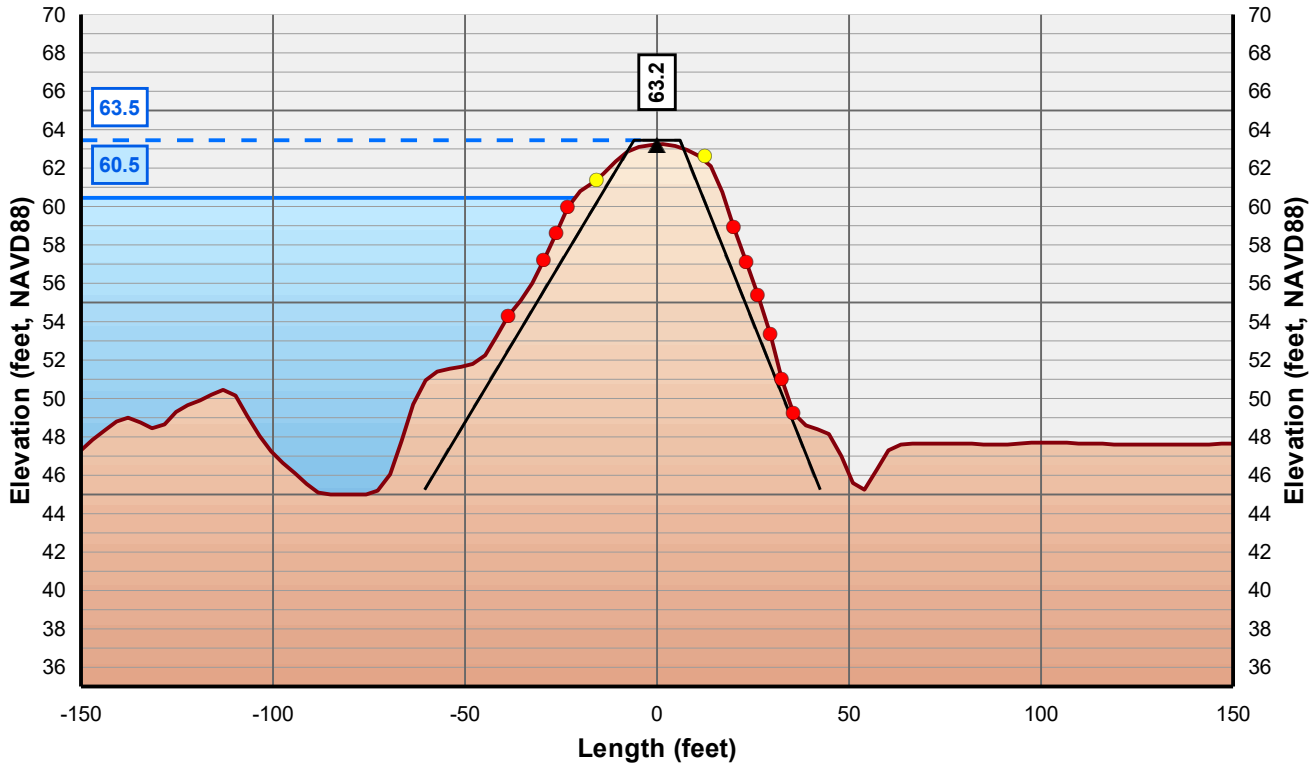
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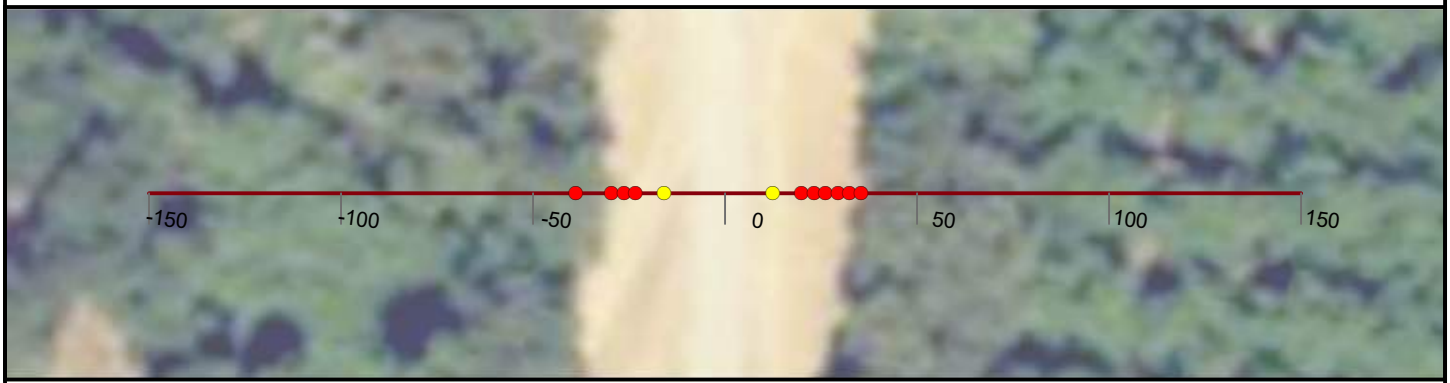
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Cross Section: Yankee Slough 81+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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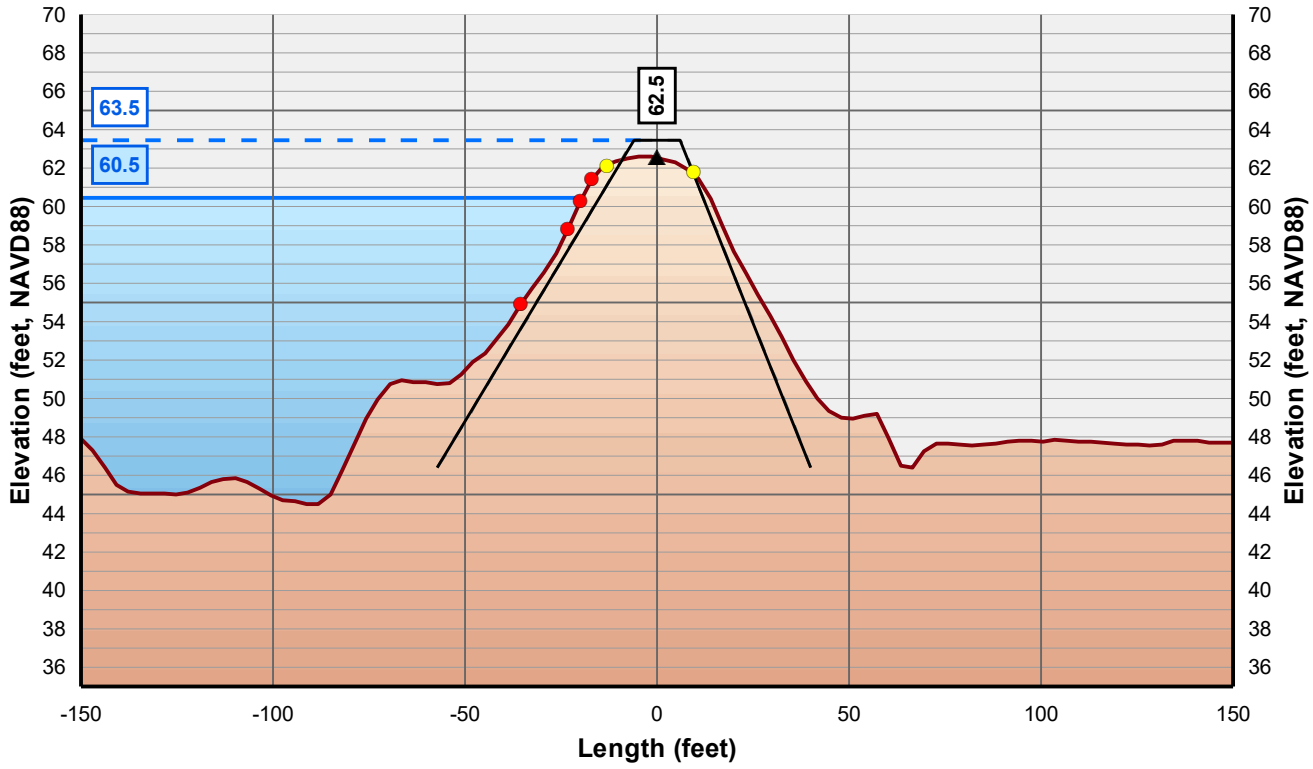
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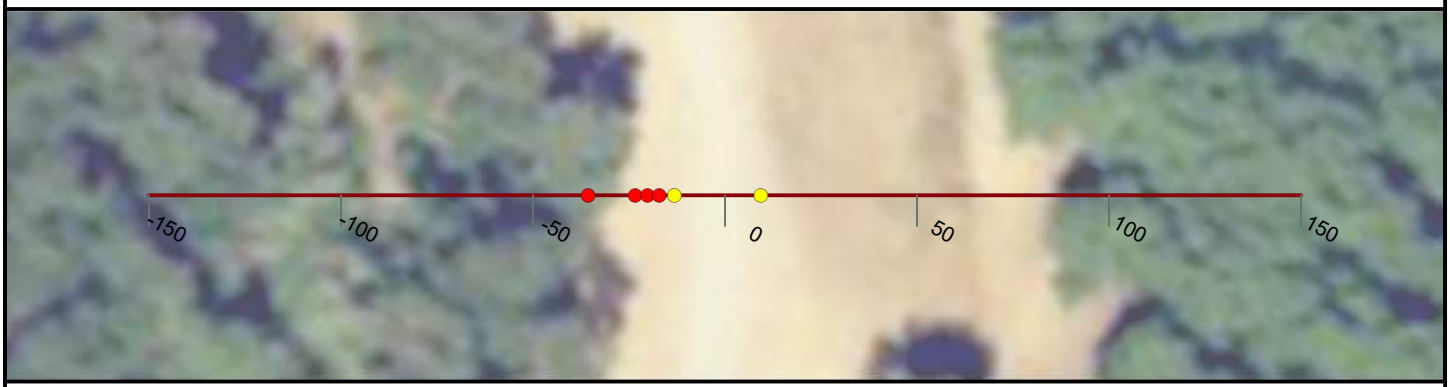
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Cross Section: Yankee Slough 82+00



Horizontal Scale: 1 inch = 50 Feet
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AUGUST, 2019

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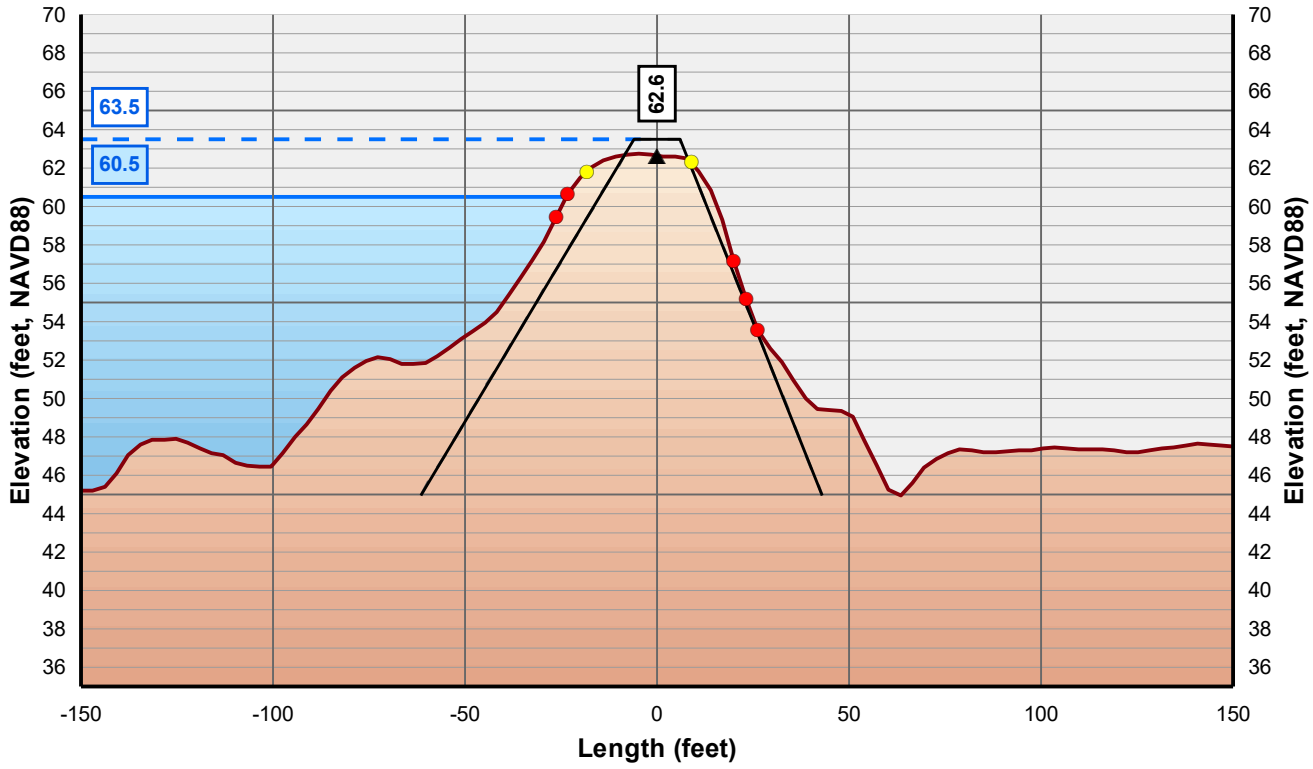
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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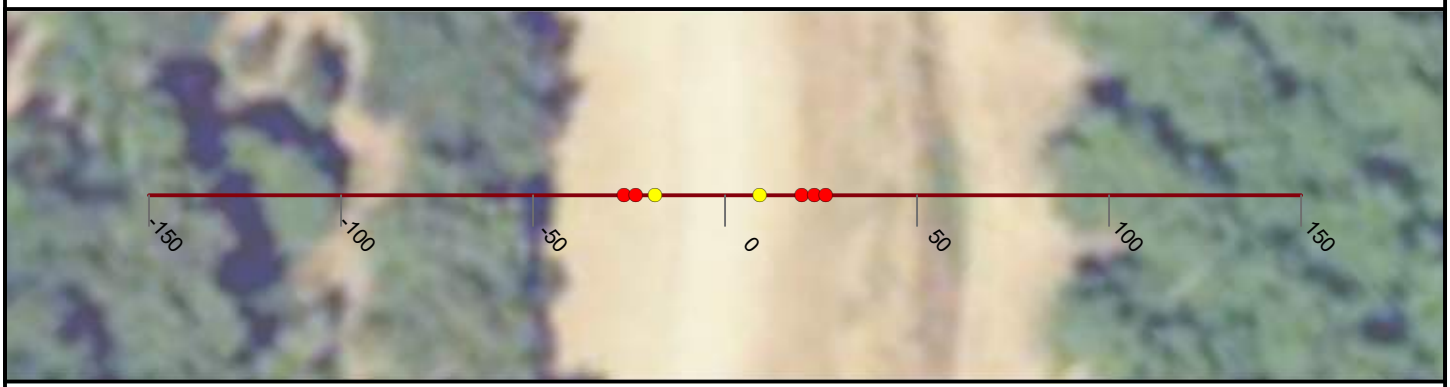
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Cross Section: Yankee Slough 83+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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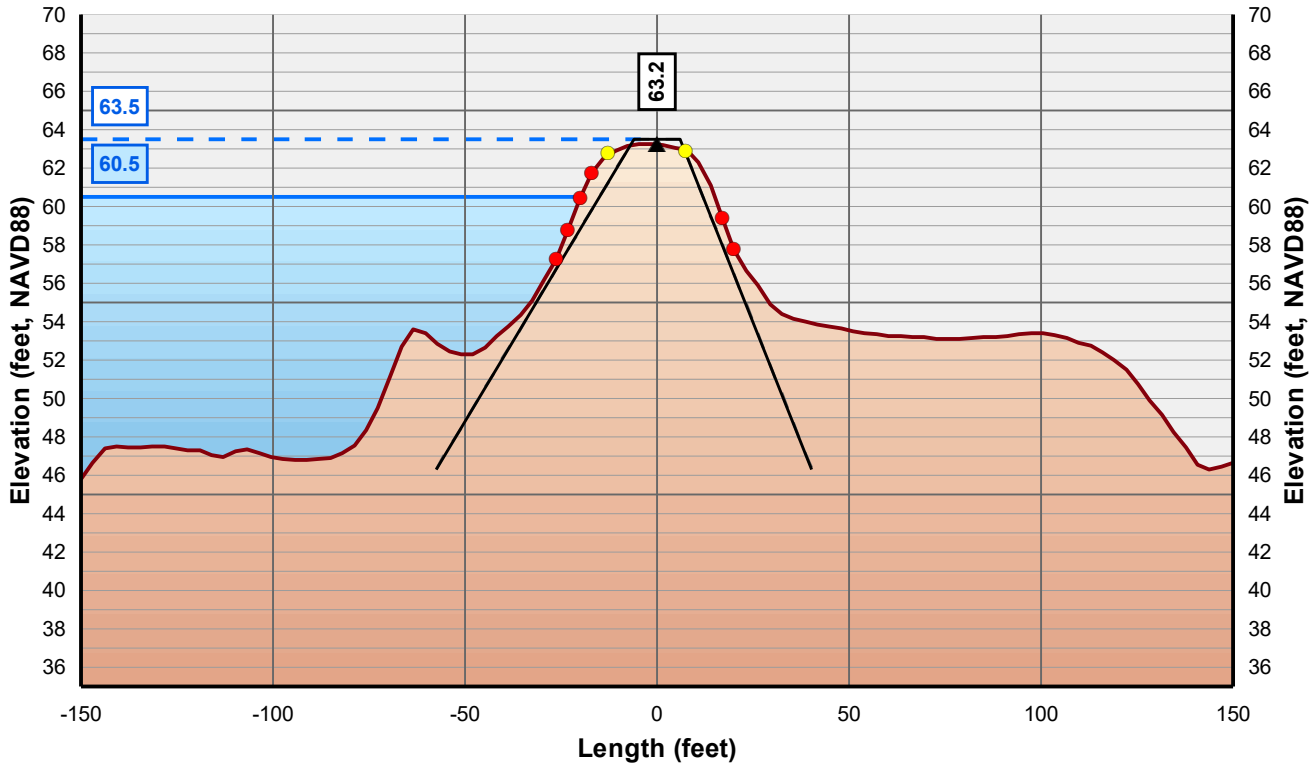
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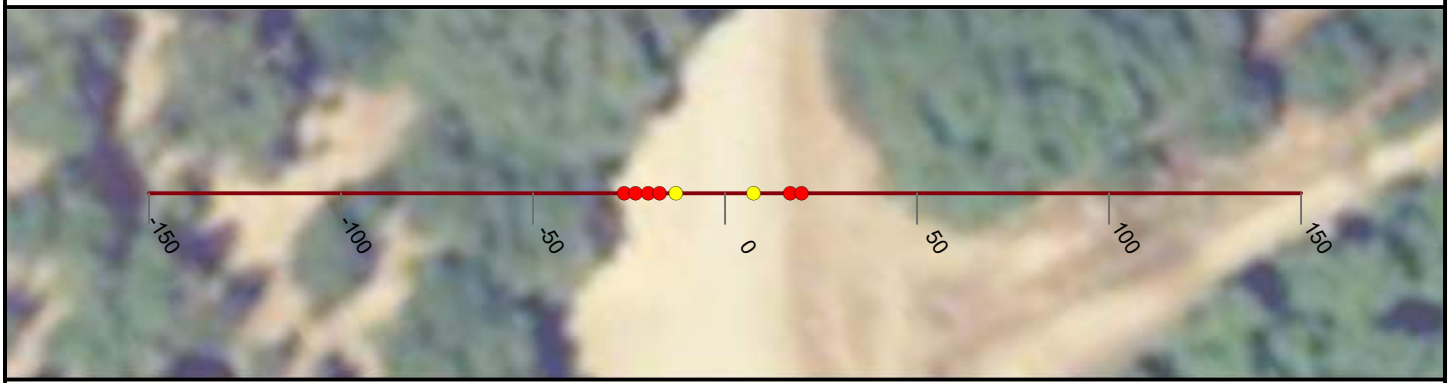
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Cross Section: Yankee Slough 84+00



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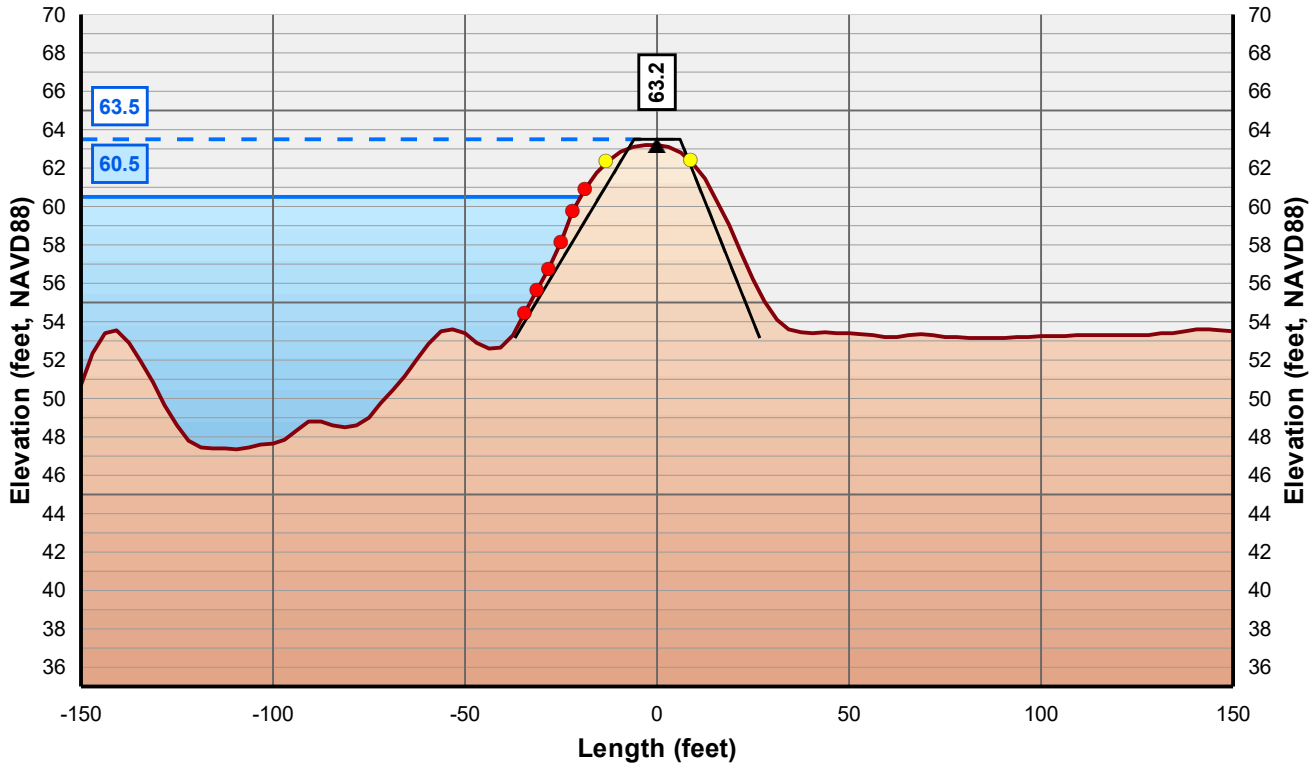
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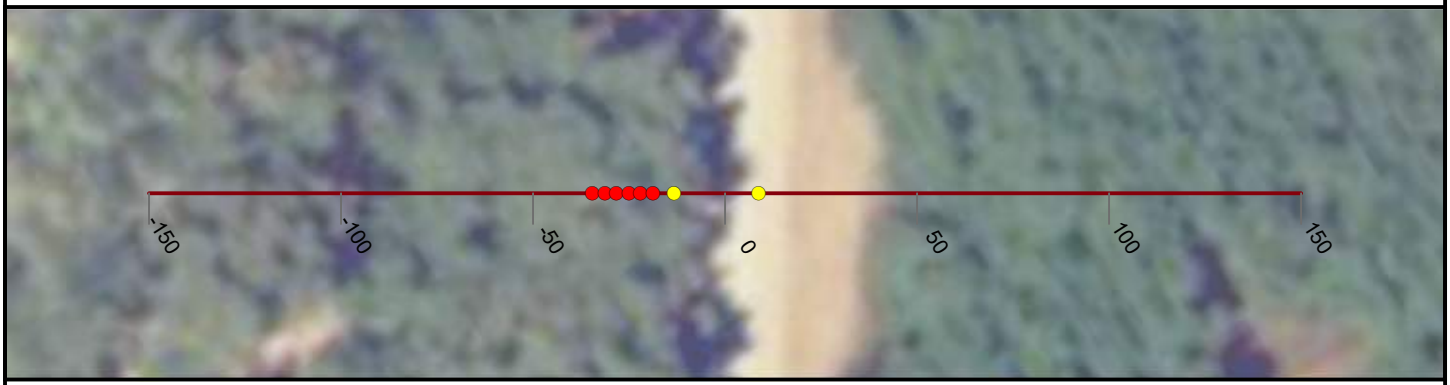
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Cross Section: Yankee Slough 85+00



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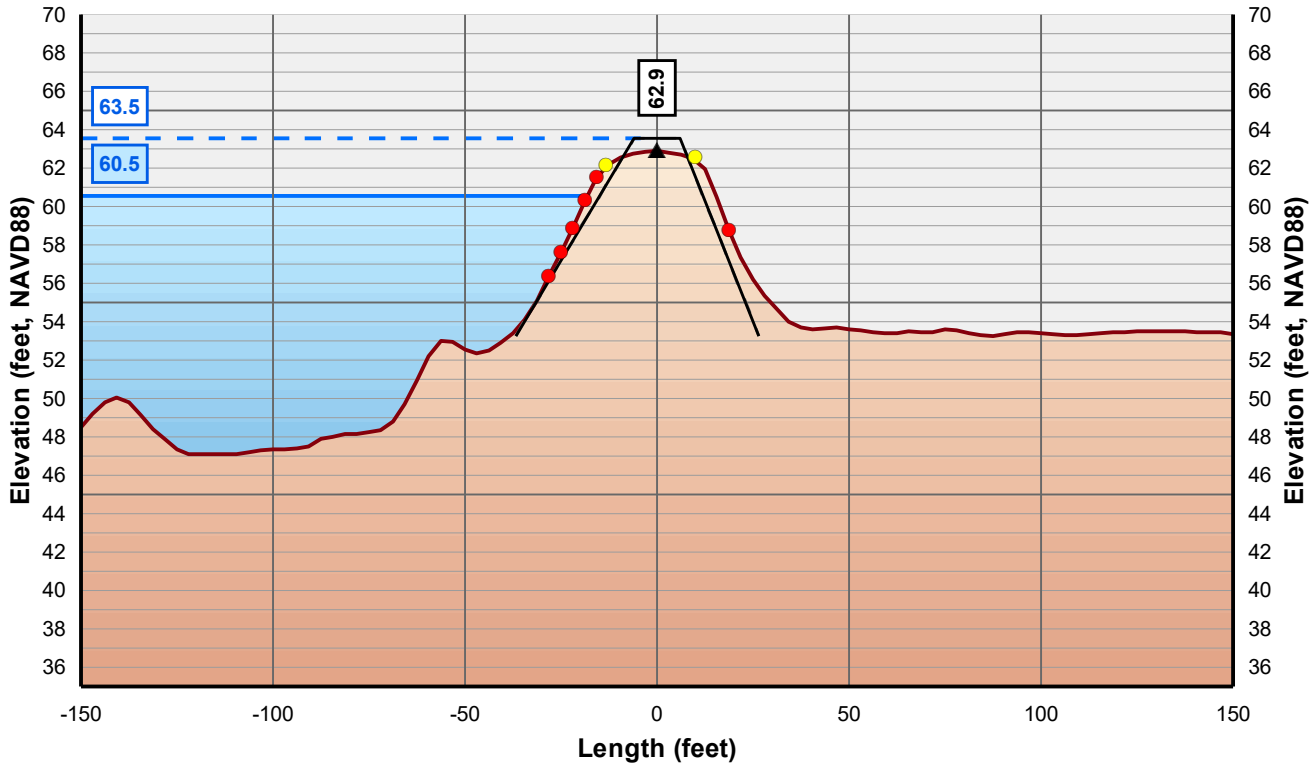
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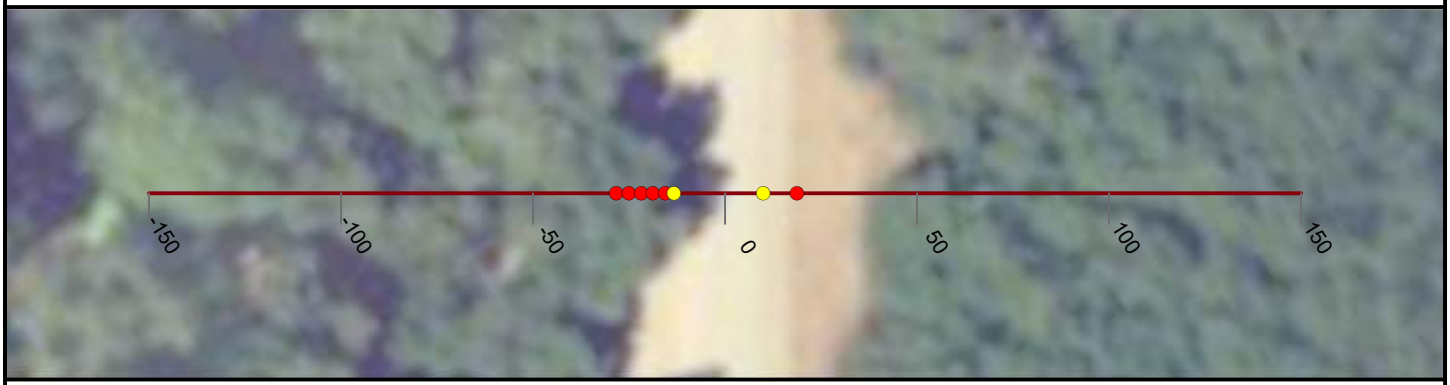
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Cross Section: Yankee Slough 86+00



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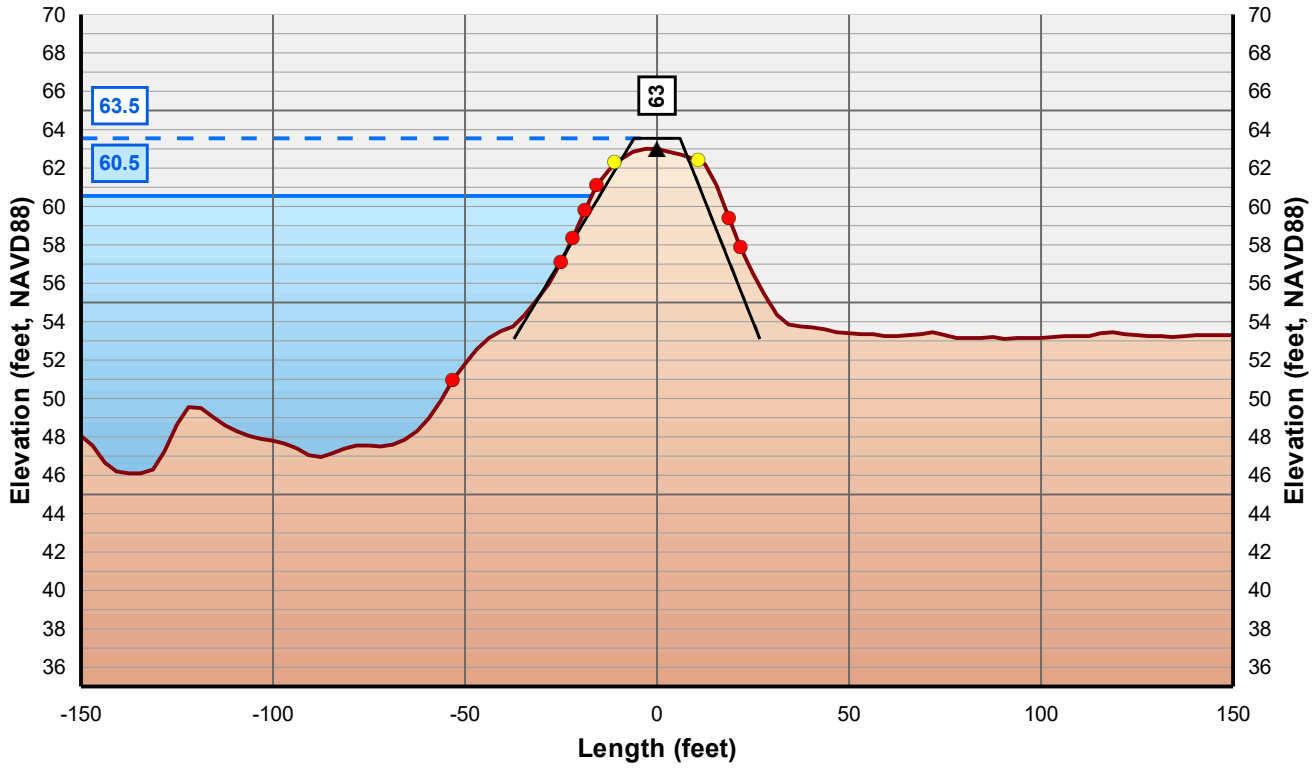
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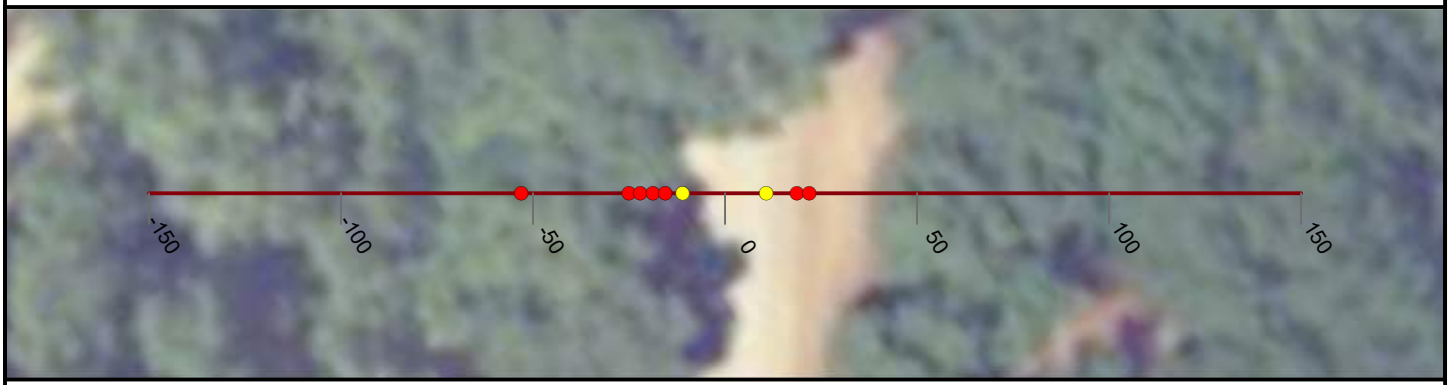
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Cross Section: Yankee Slough 87+00



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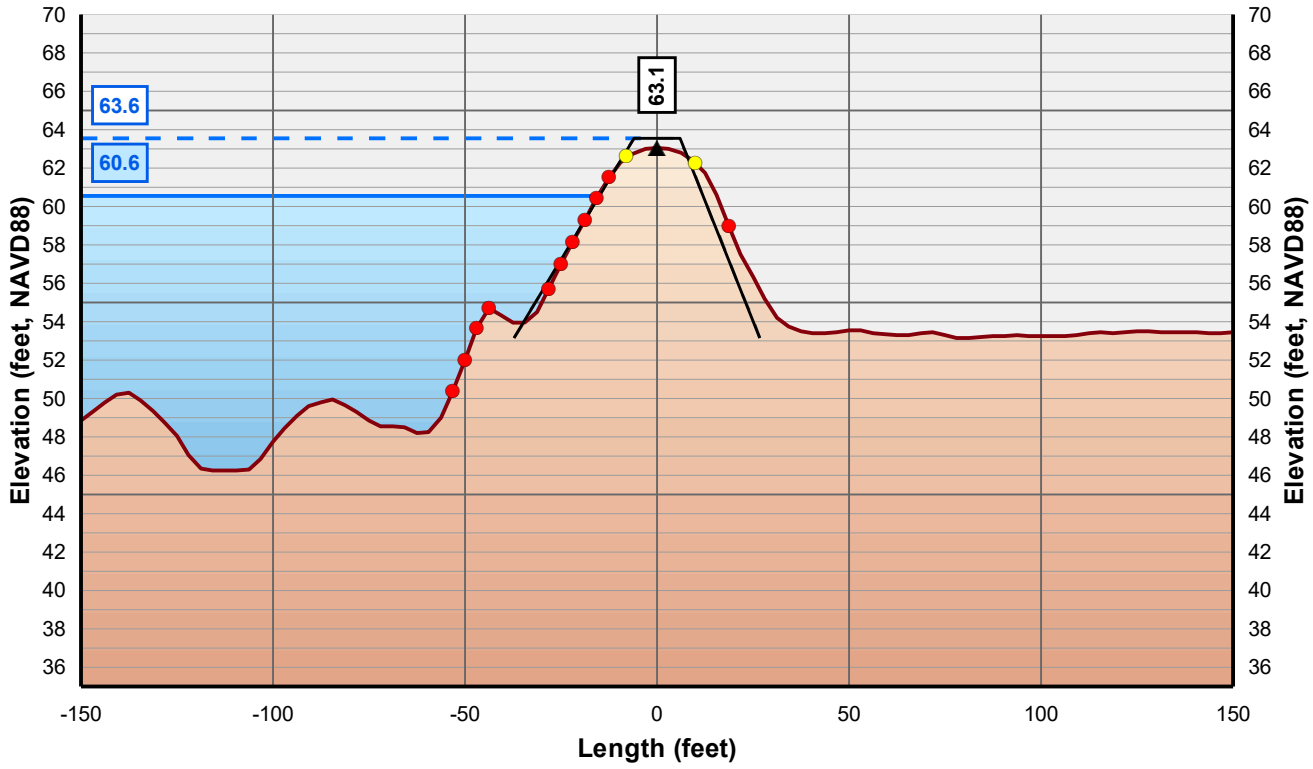
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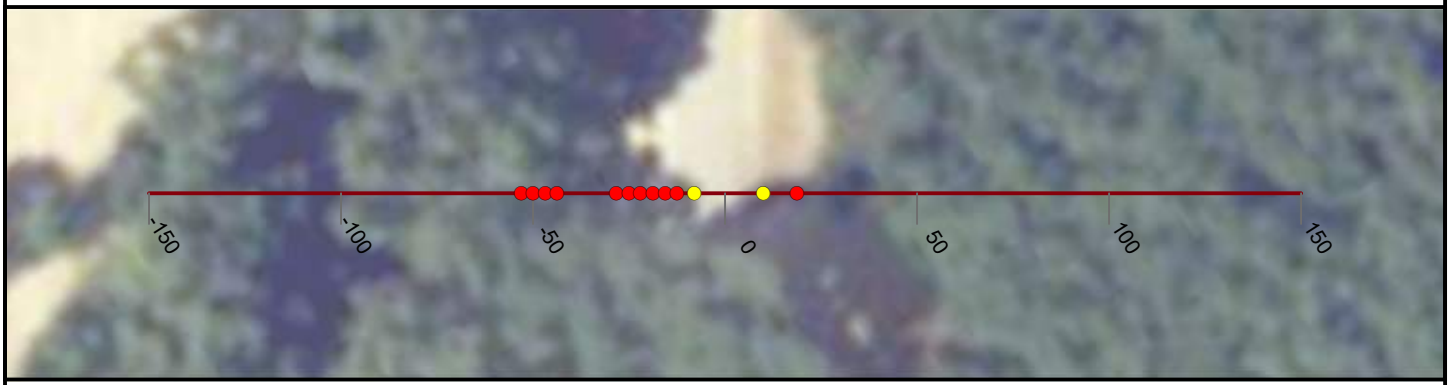
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Cross Section: Yankee Slough 88+00



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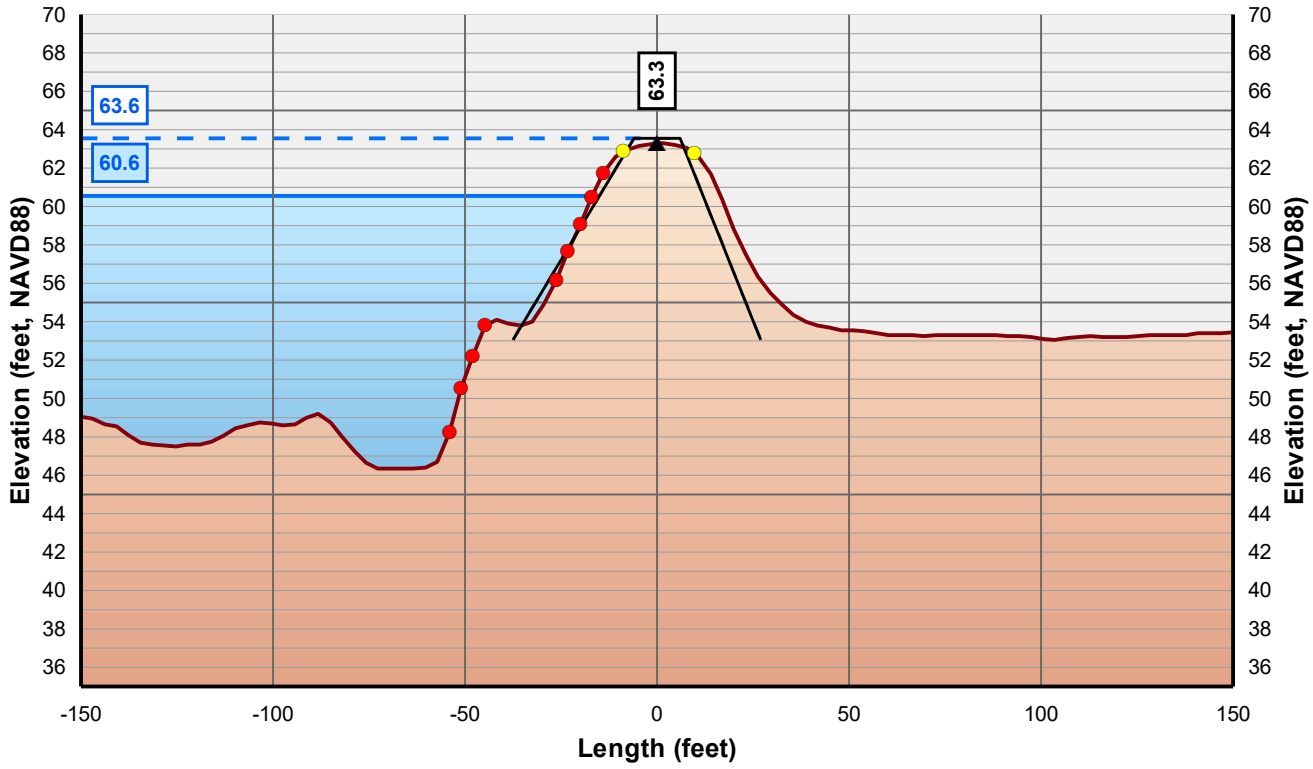
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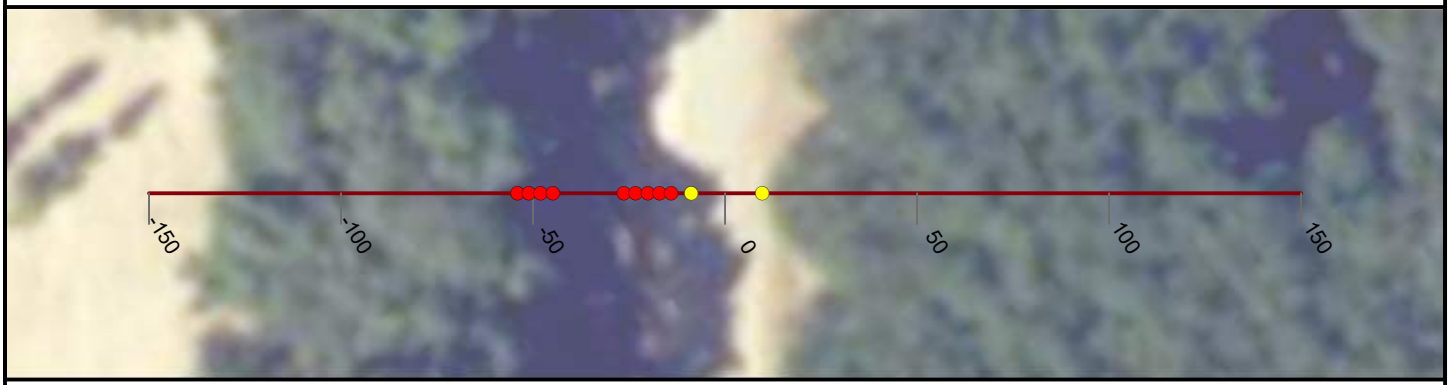
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Cross Section: Yankee Slough 89+00



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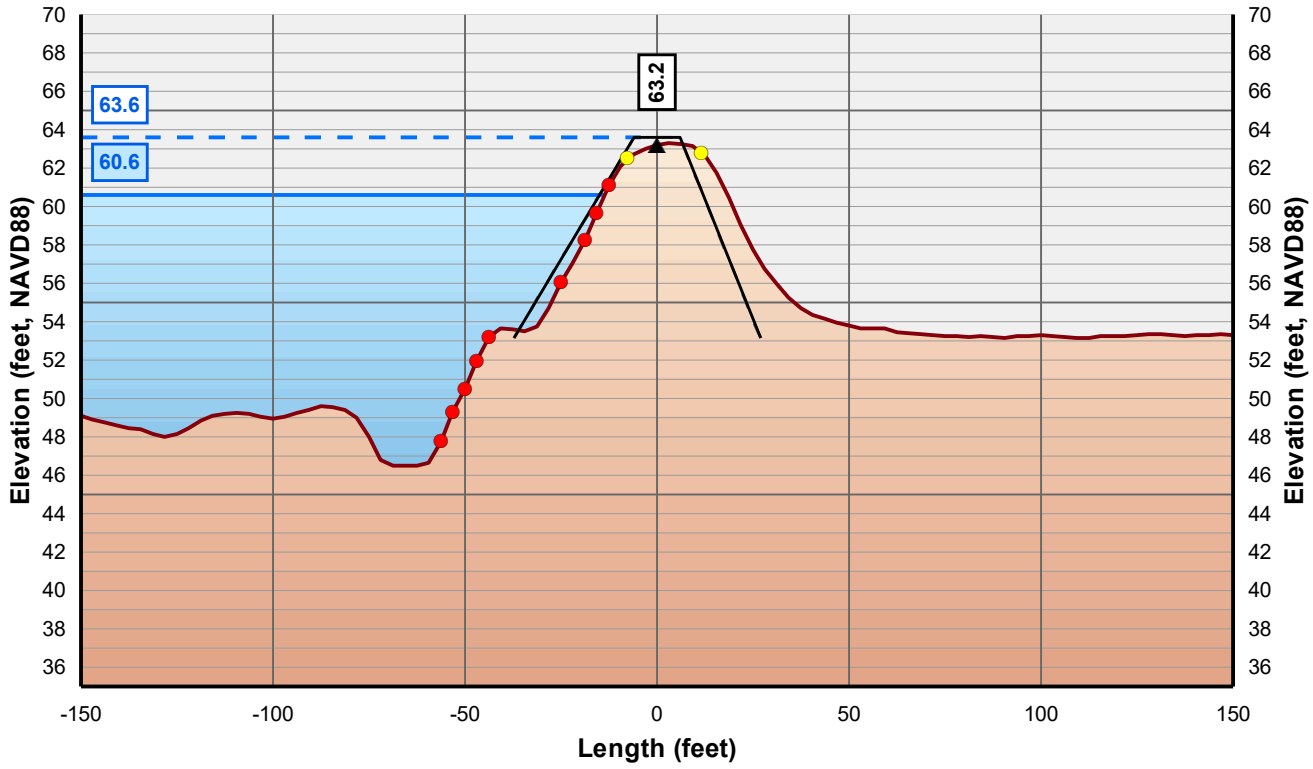
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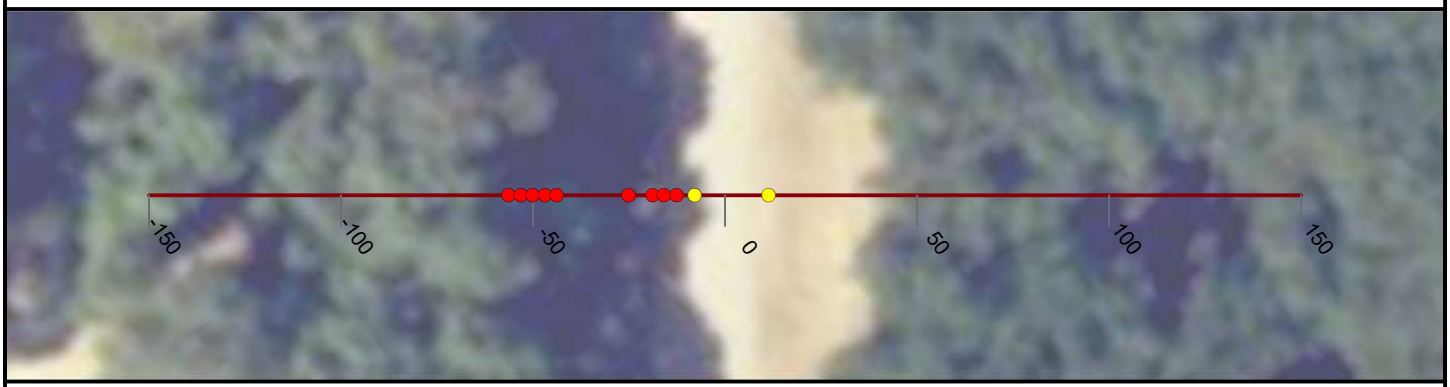
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Cross Section: Yankee Slough 90+00



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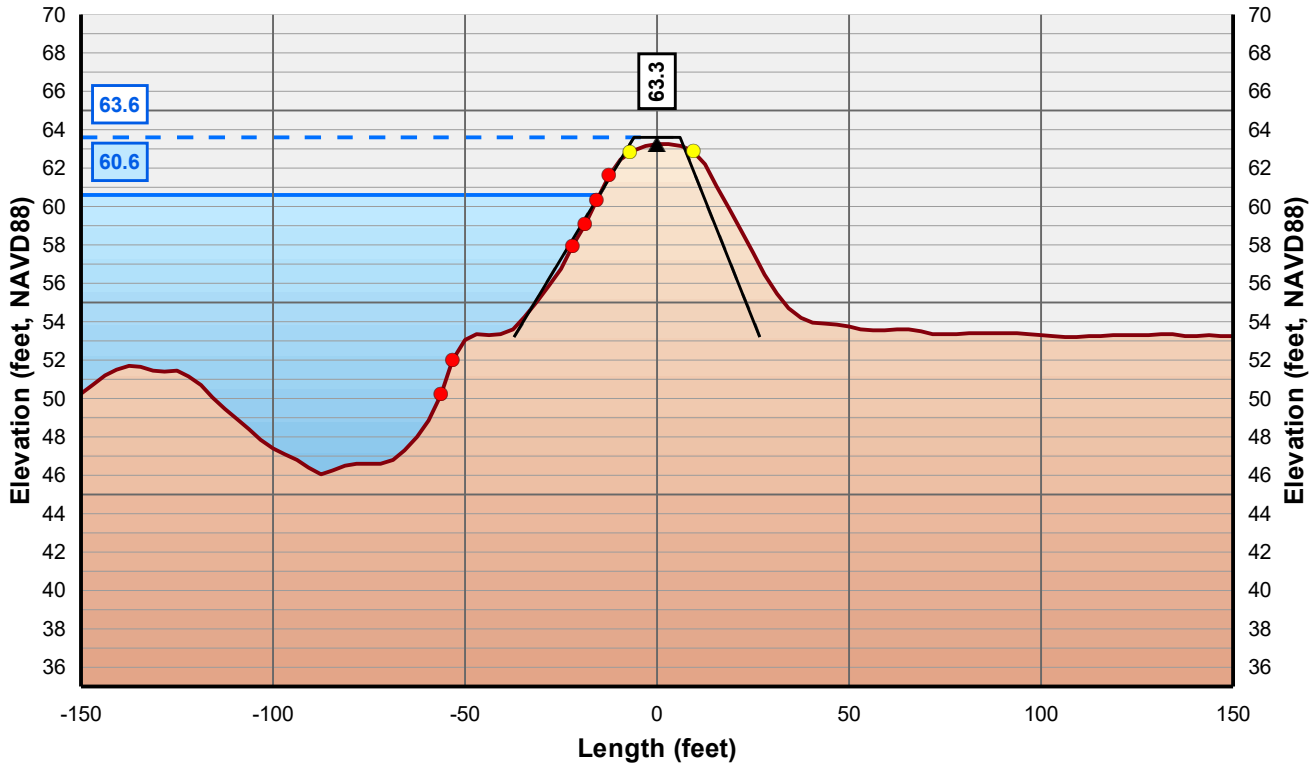
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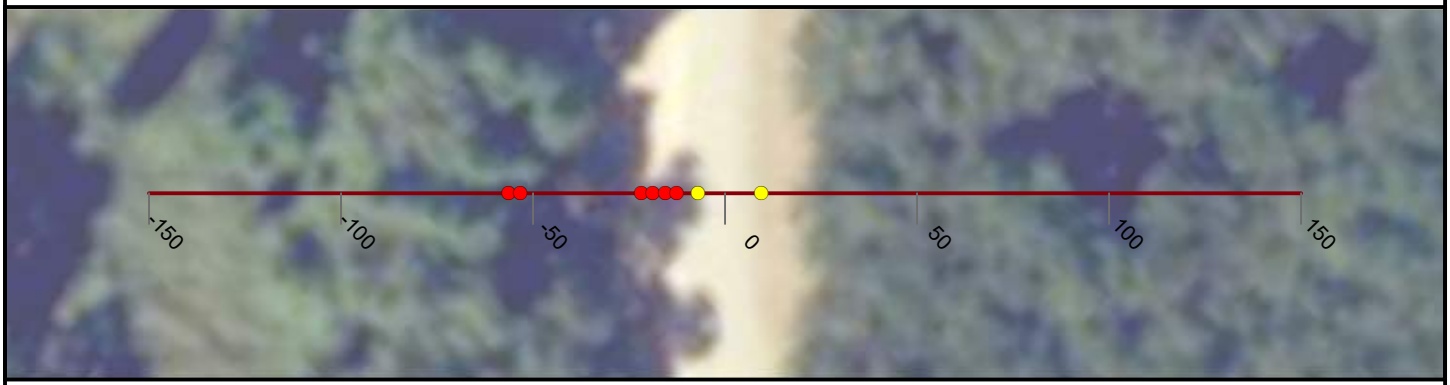
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Cross Section: Yankee Slough 91+00



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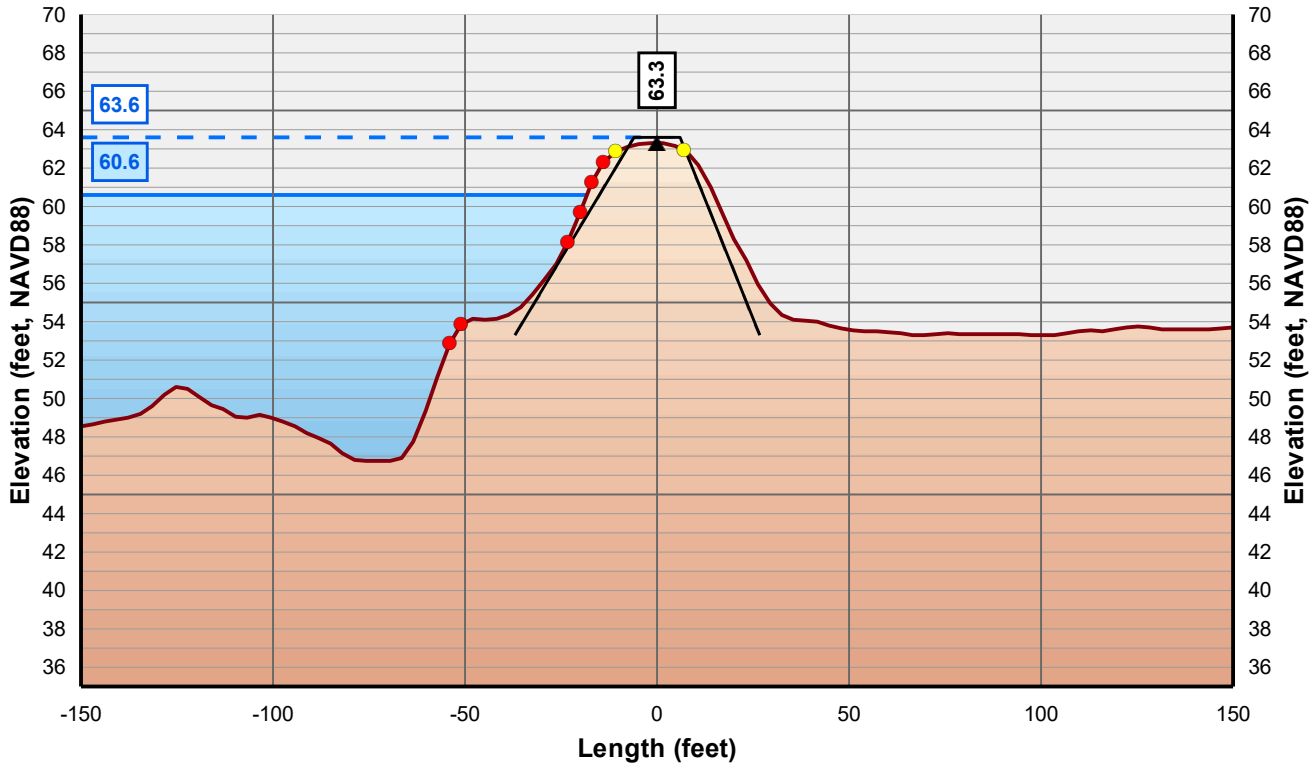
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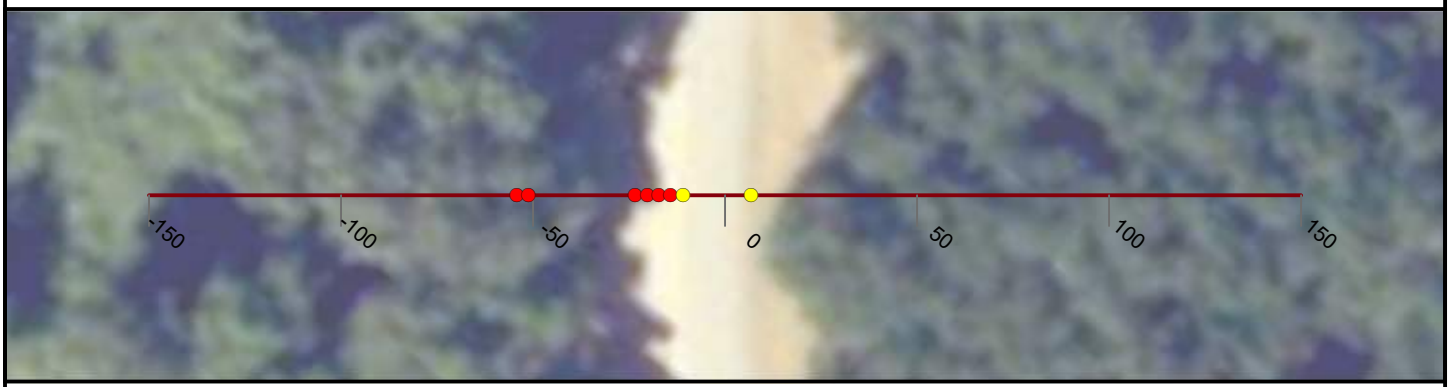
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Cross Section: Yankee Slough 92+00



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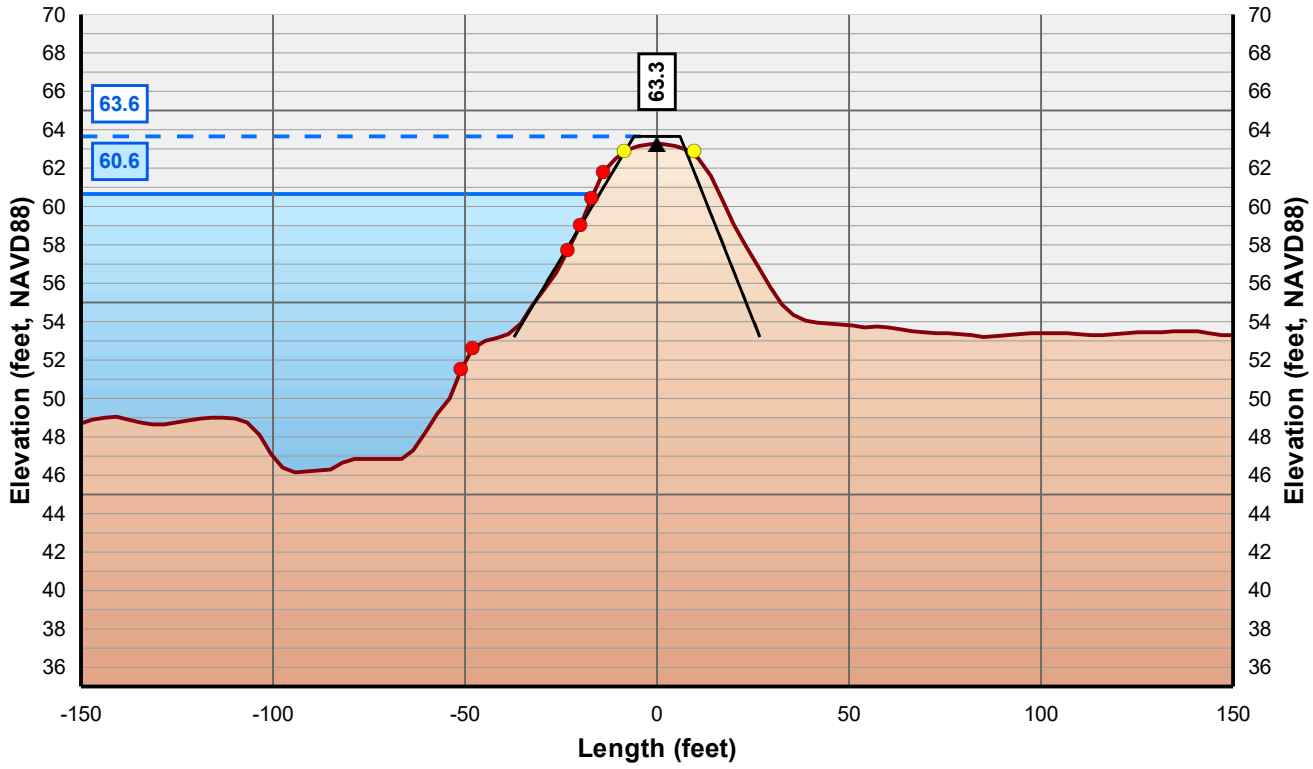
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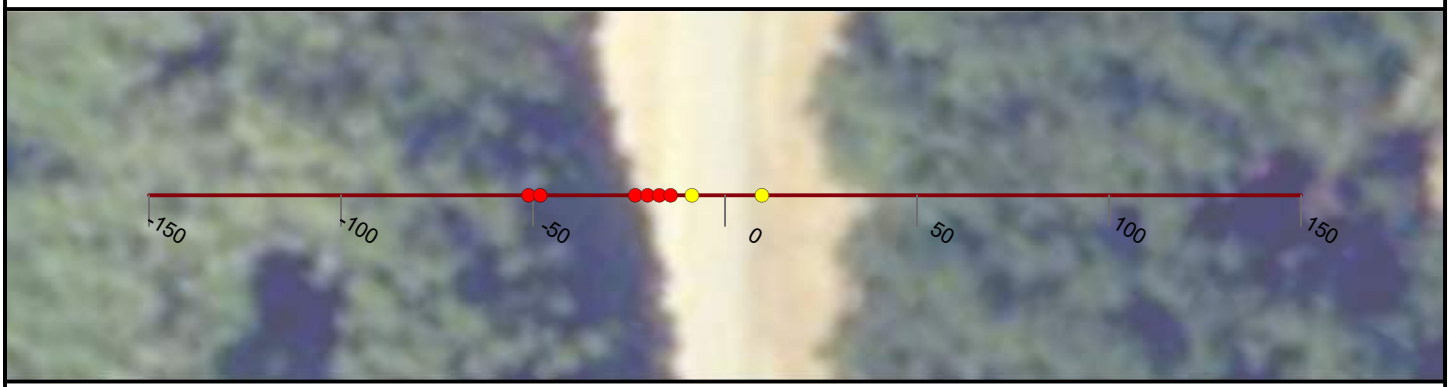
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Cross Section: Yankee Slough 93+00



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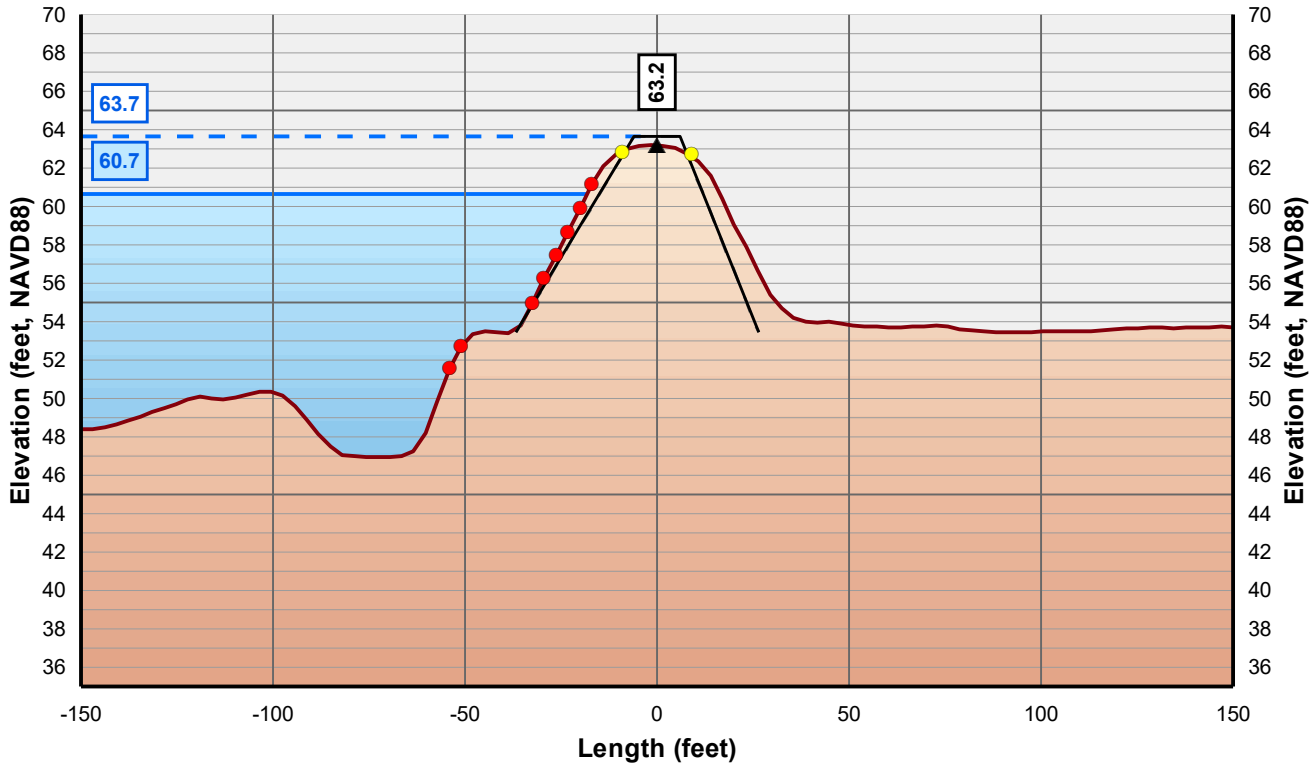
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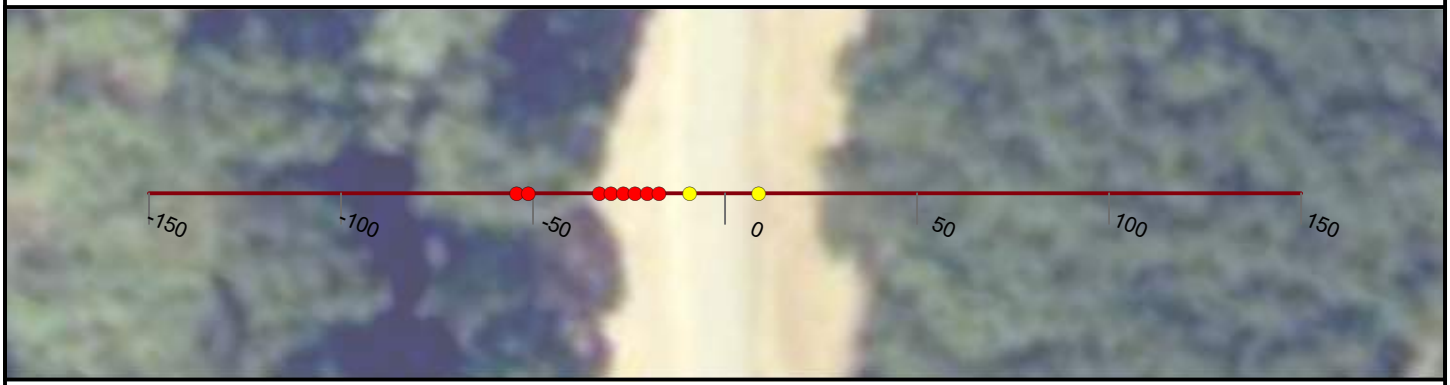
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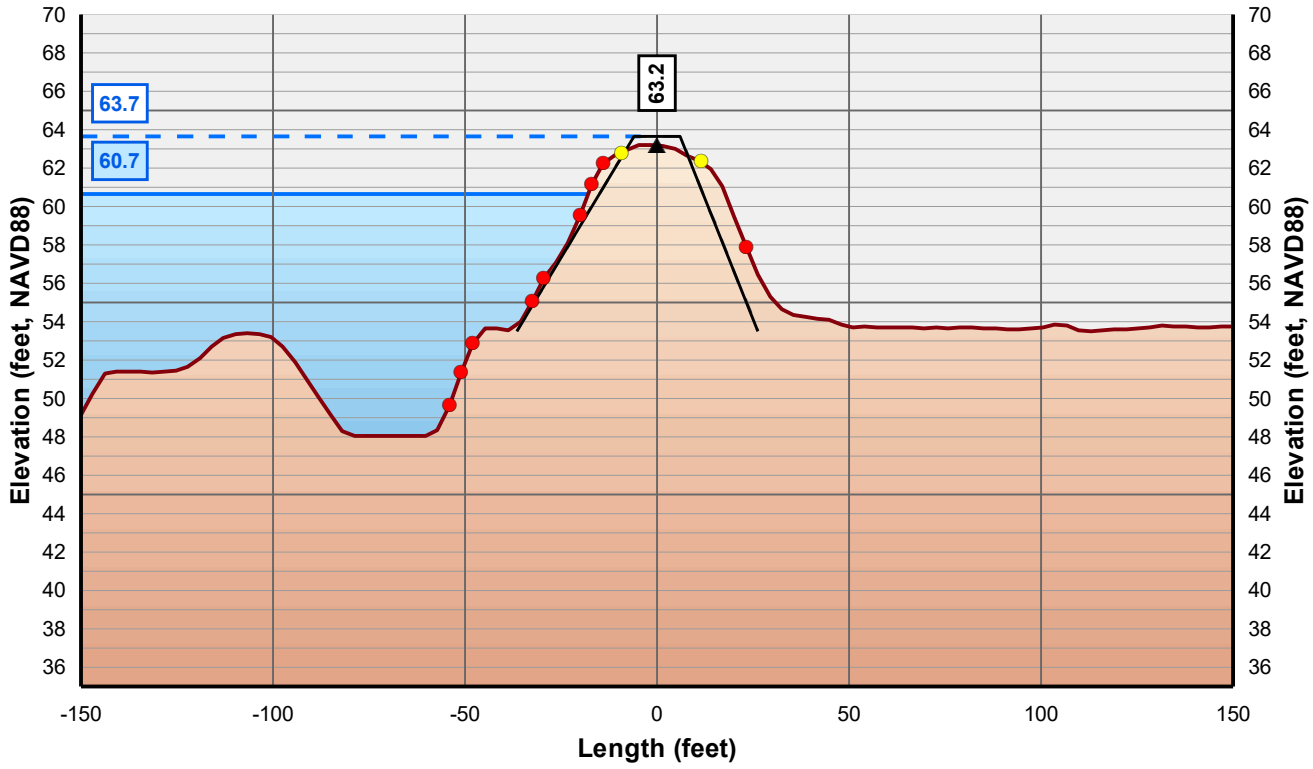
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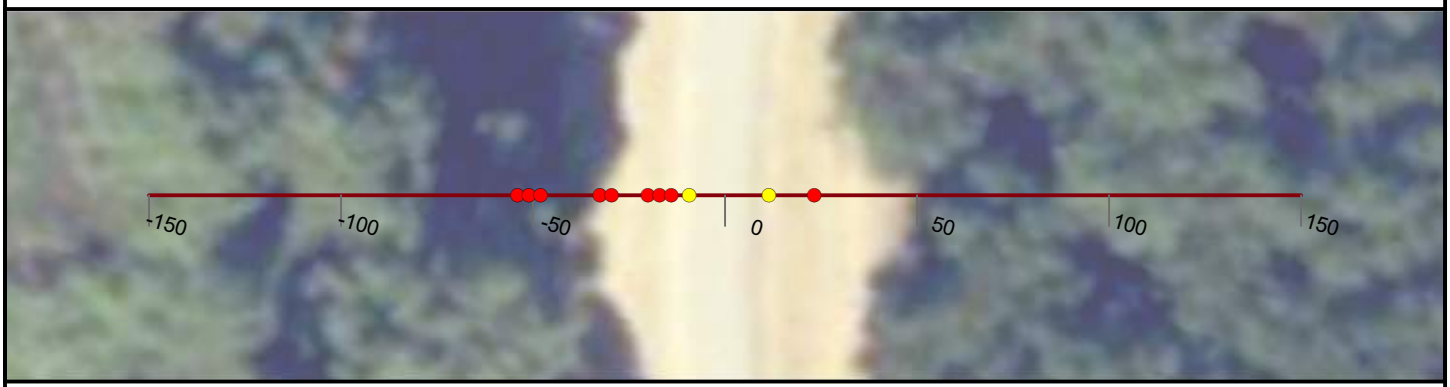
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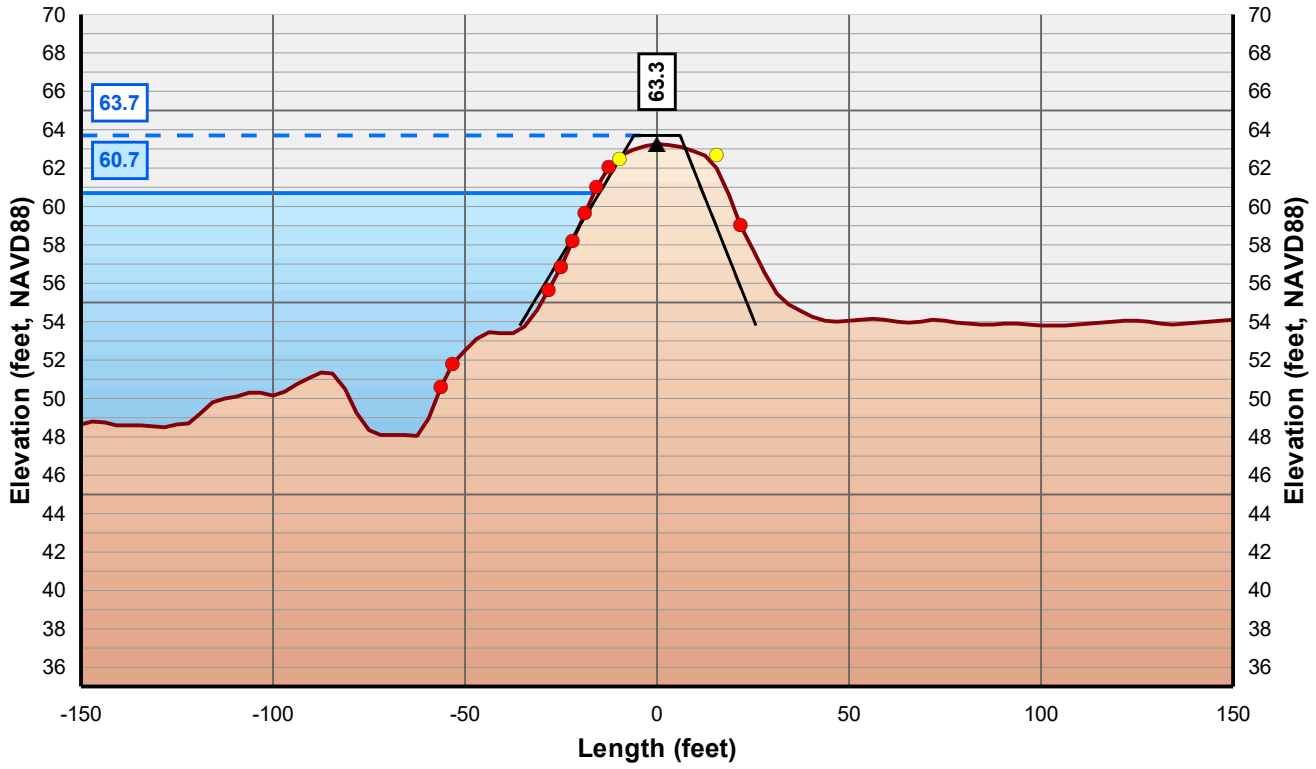
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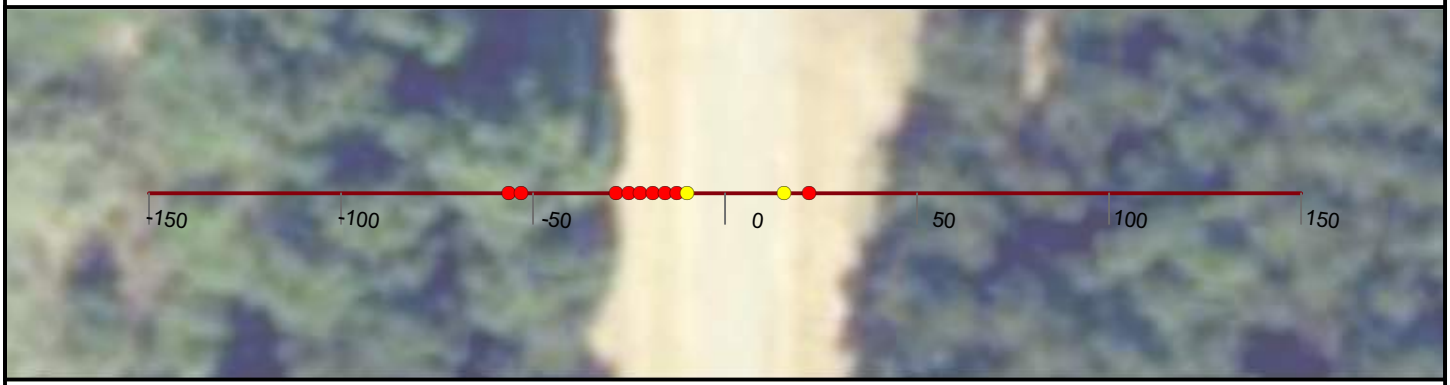
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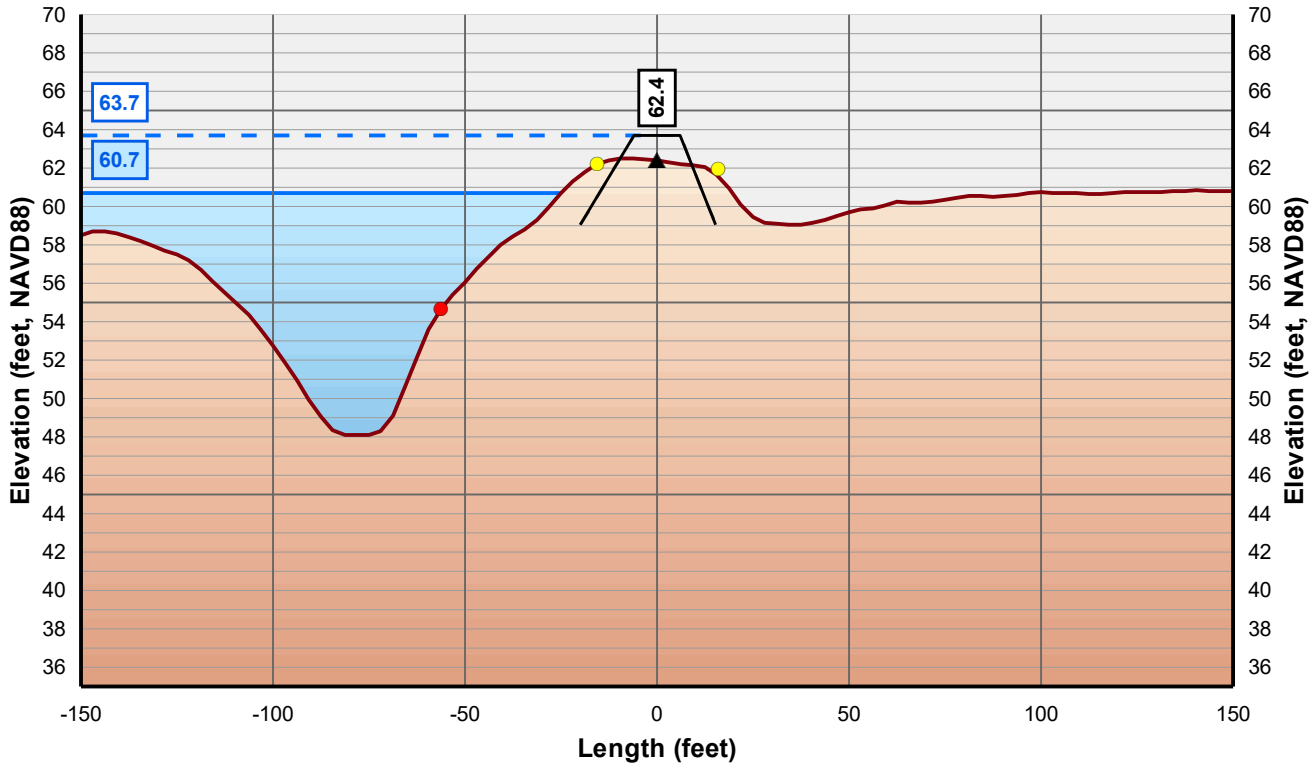
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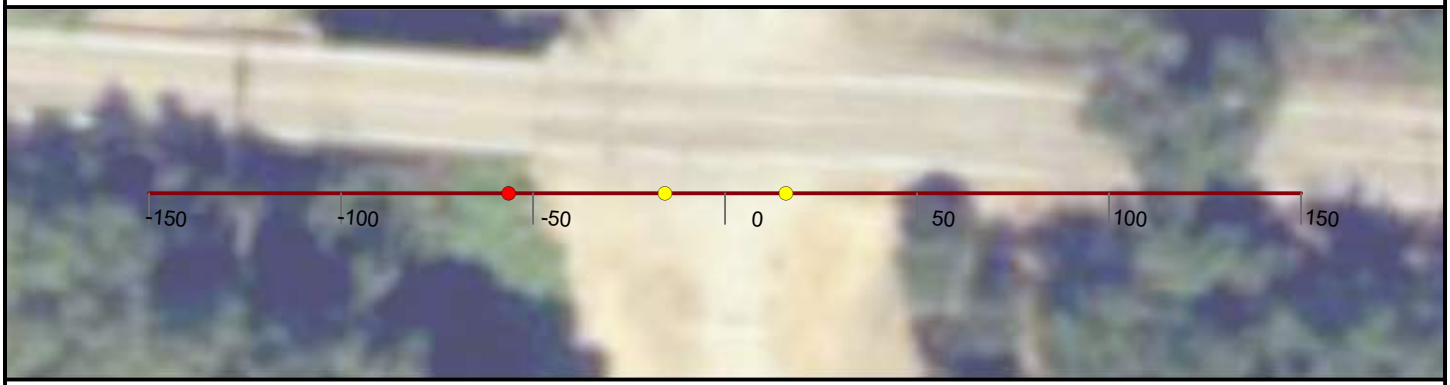
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NORTH

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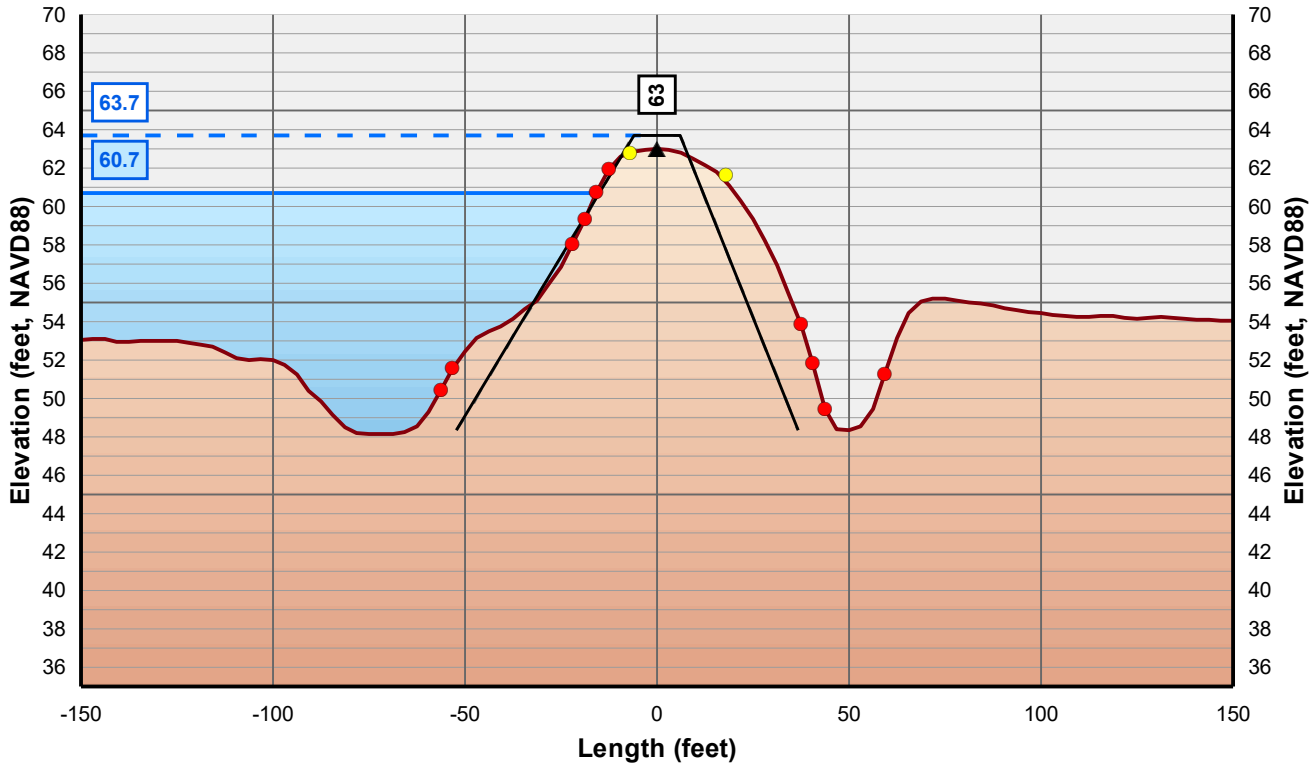
FEET

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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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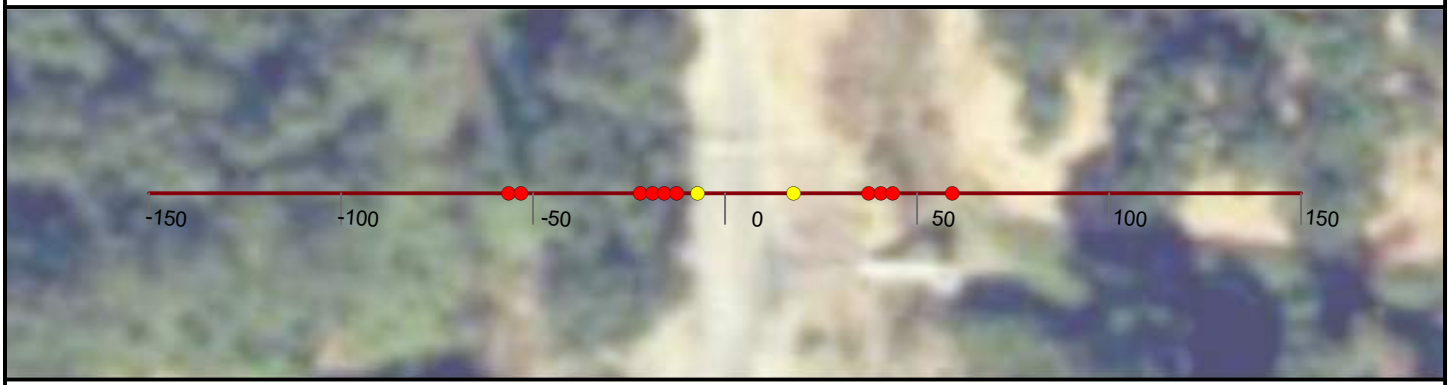
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Cross Section: Yankee Slough 98+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

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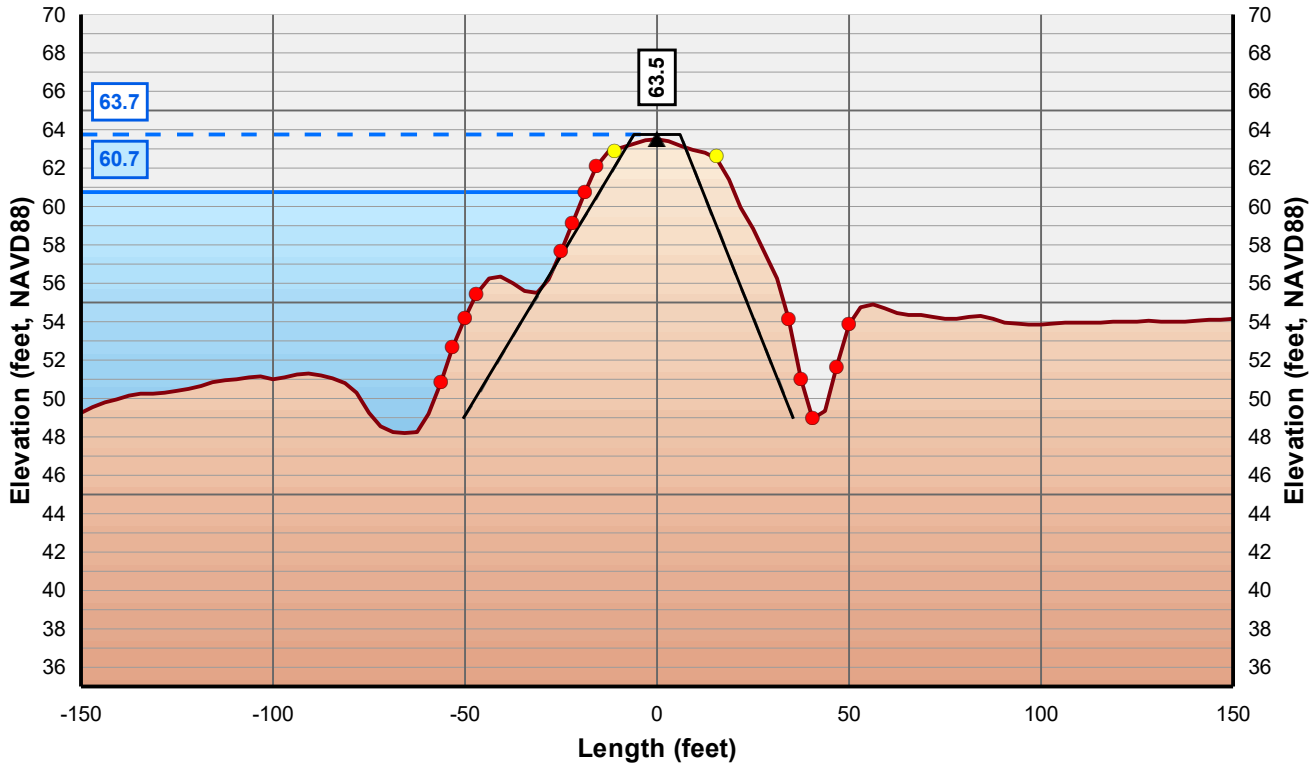
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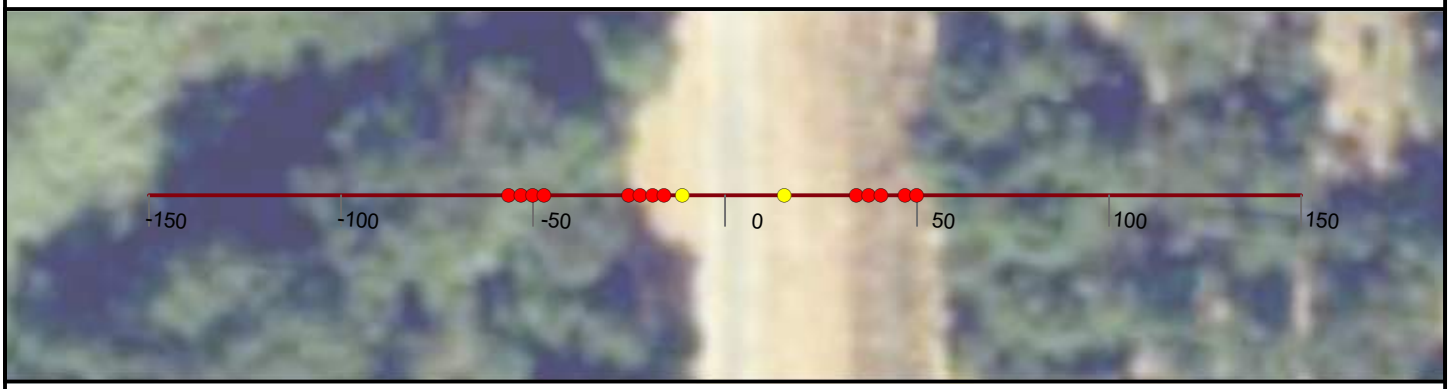
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Cross Section: Yankee Slough 99+00



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FEASIBILITY STUDY

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AUGUST, 2019

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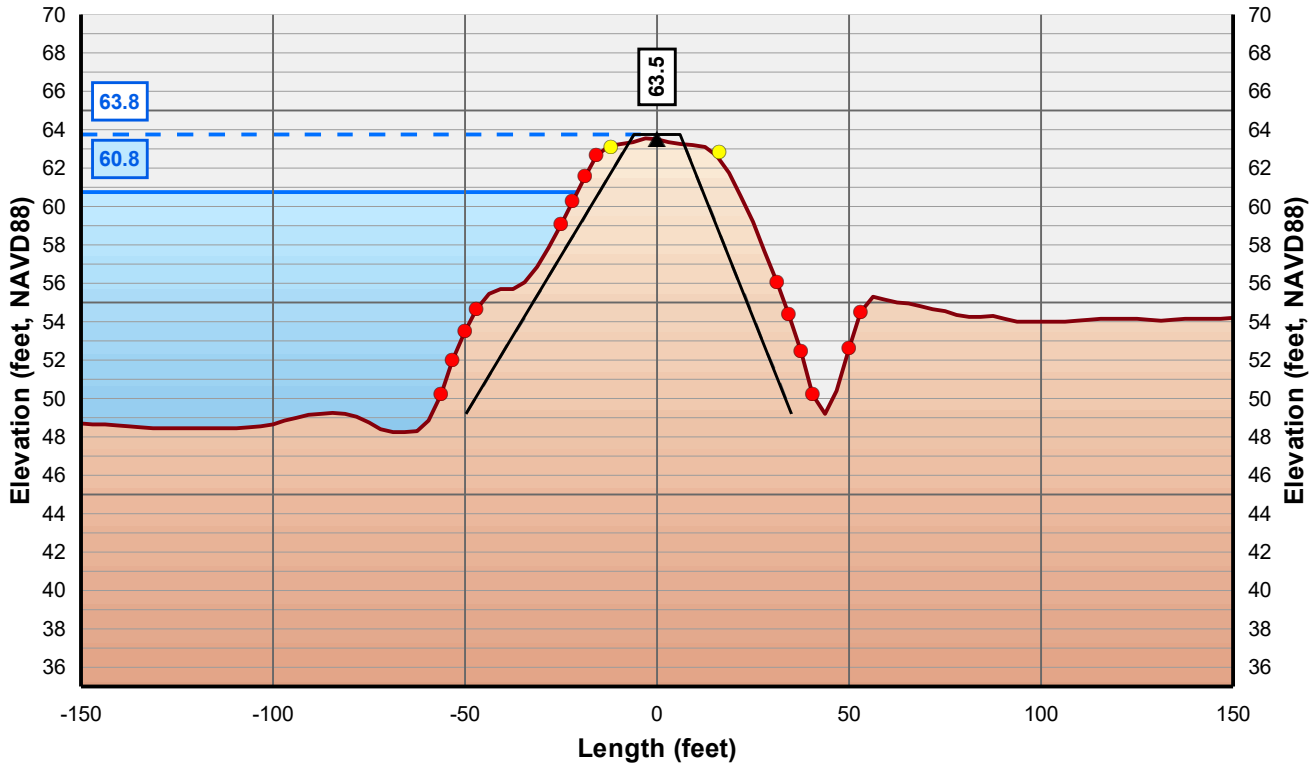
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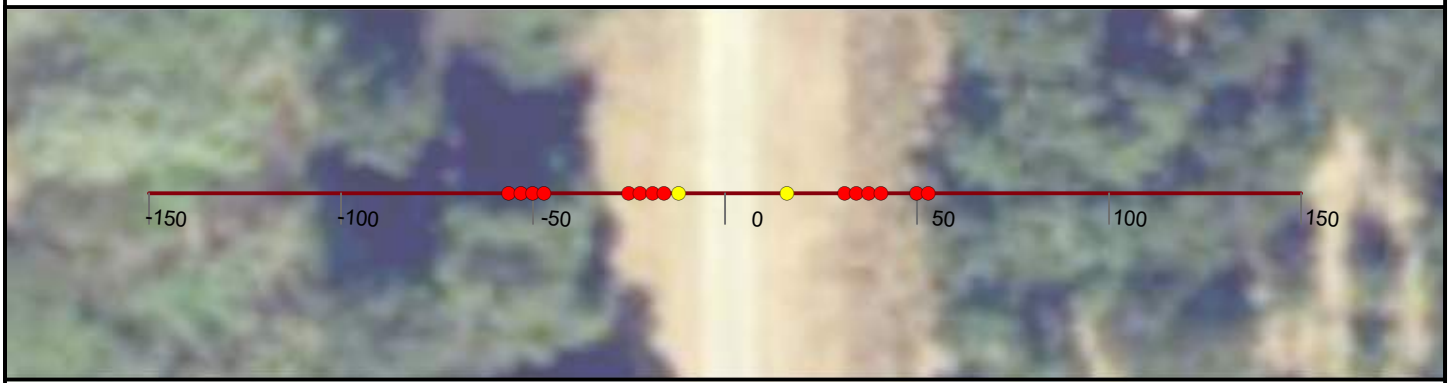
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Cross Section: Yankee Slough 100+00



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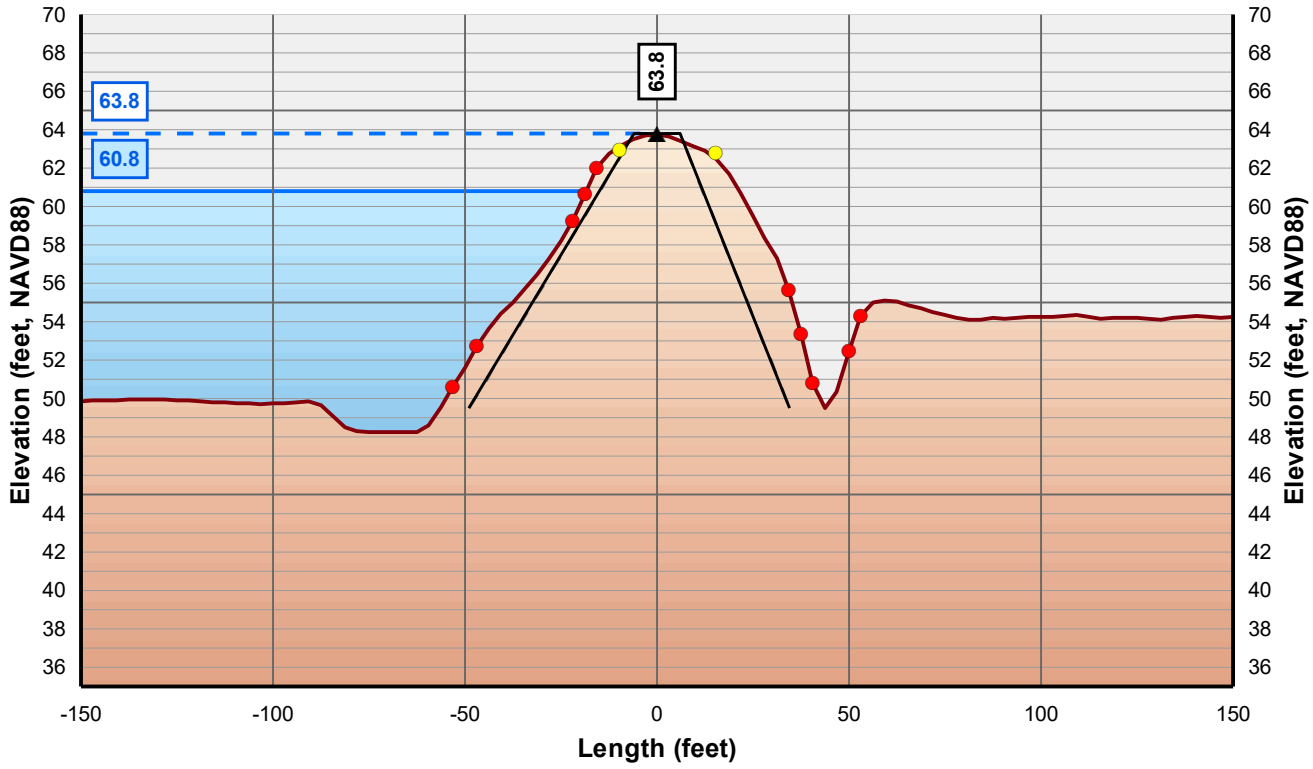
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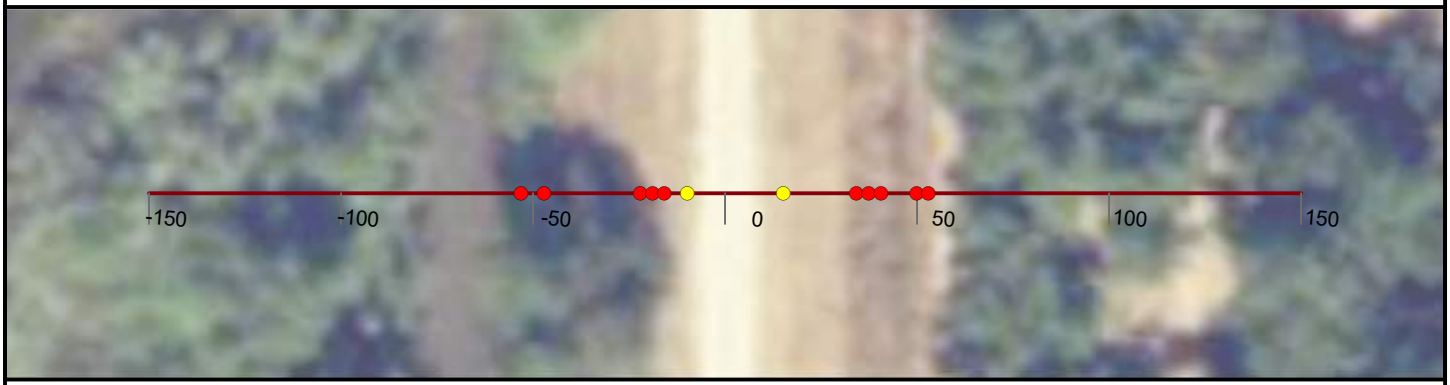
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Cross Section: Yankee Slough 101+00



Horizontal Scale: 1 inch = 50 Feet
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▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



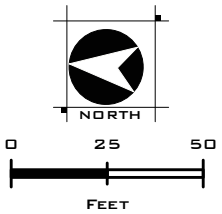
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AUGUST, 2019

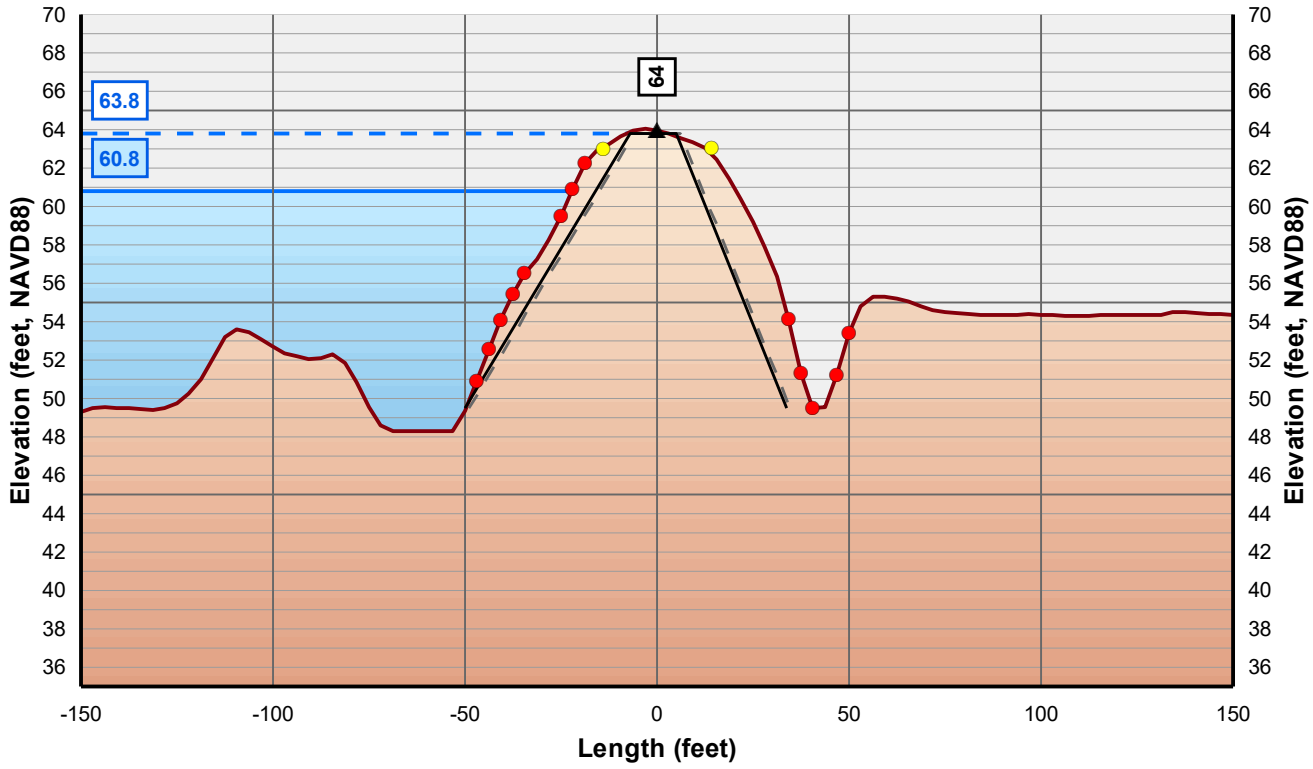


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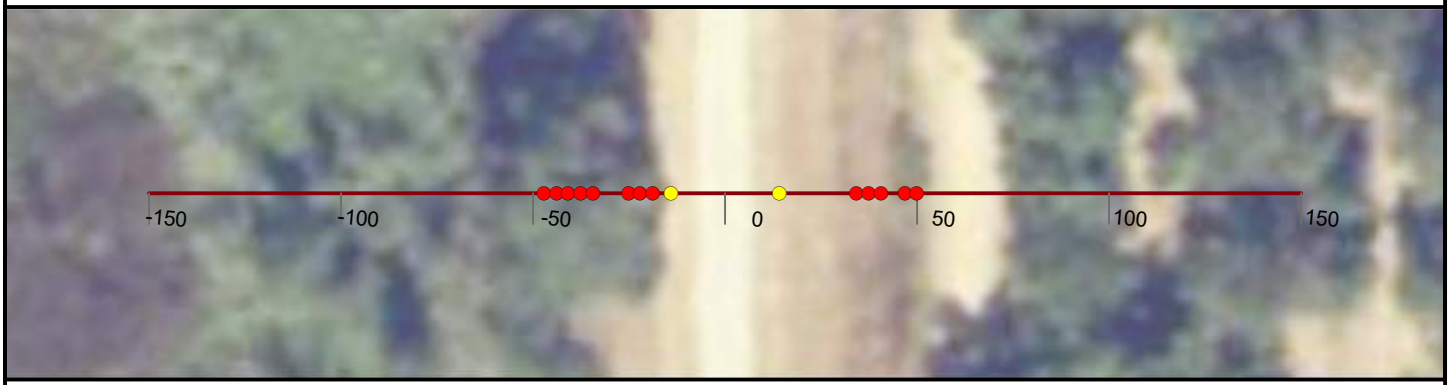
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Cross Section: Yankee Slough 102+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

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- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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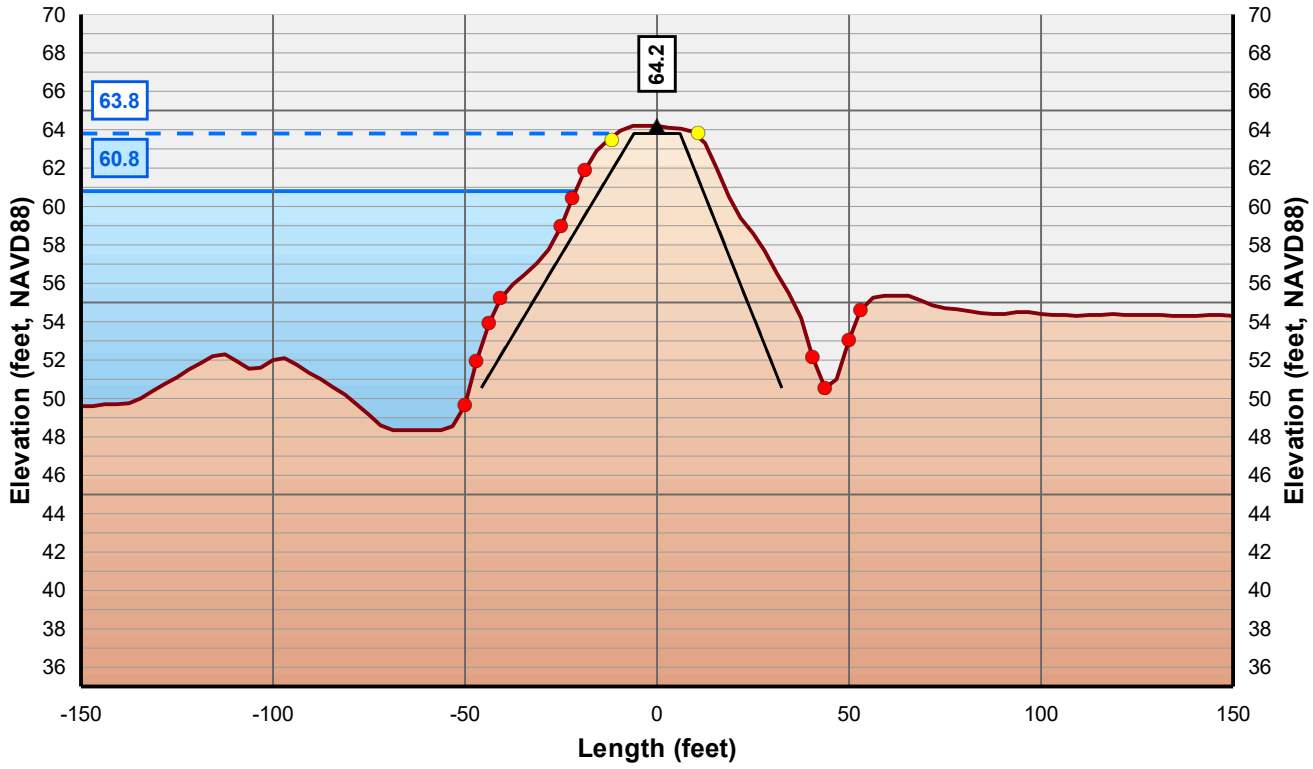
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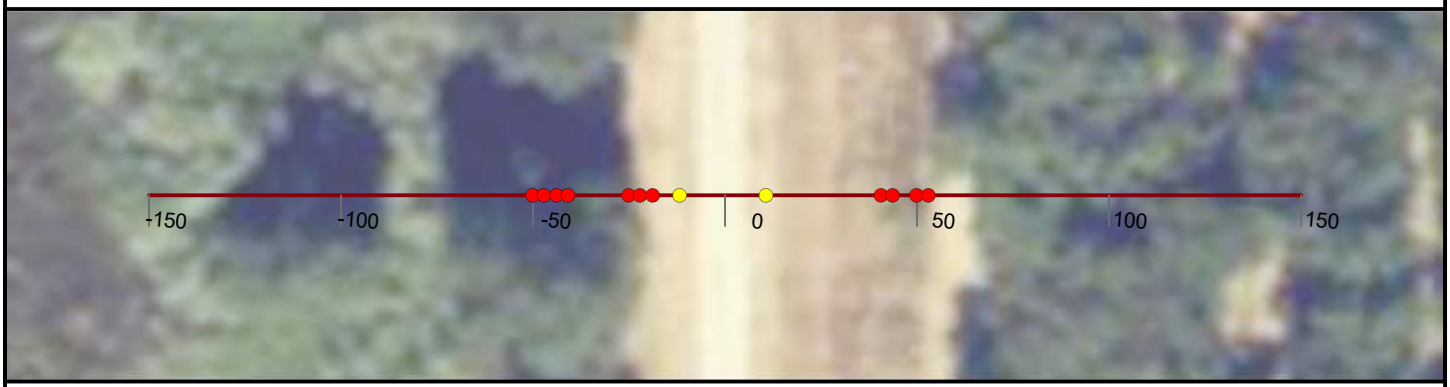
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Cross Section: Yankee Slough 103+00



Horizontal Scale: 1 inch = 50 Feet
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FEASIBILITY STUDY

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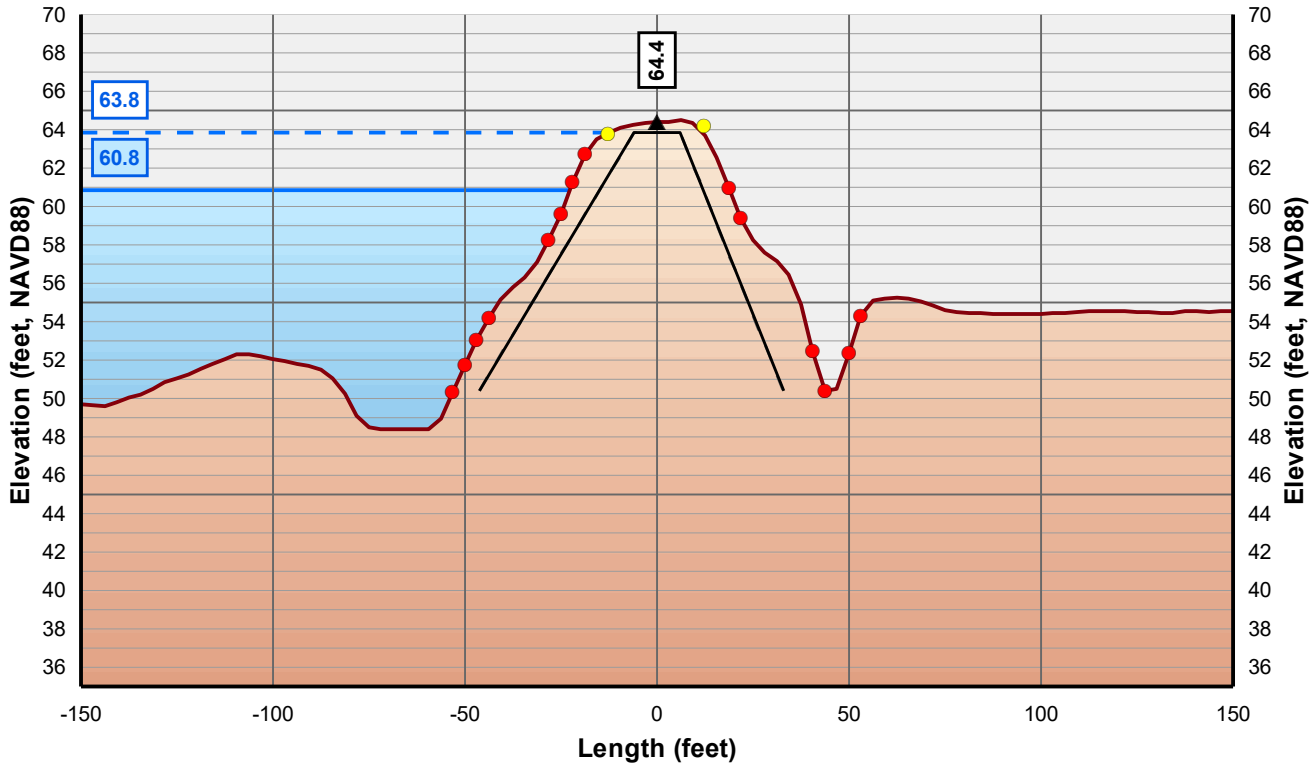
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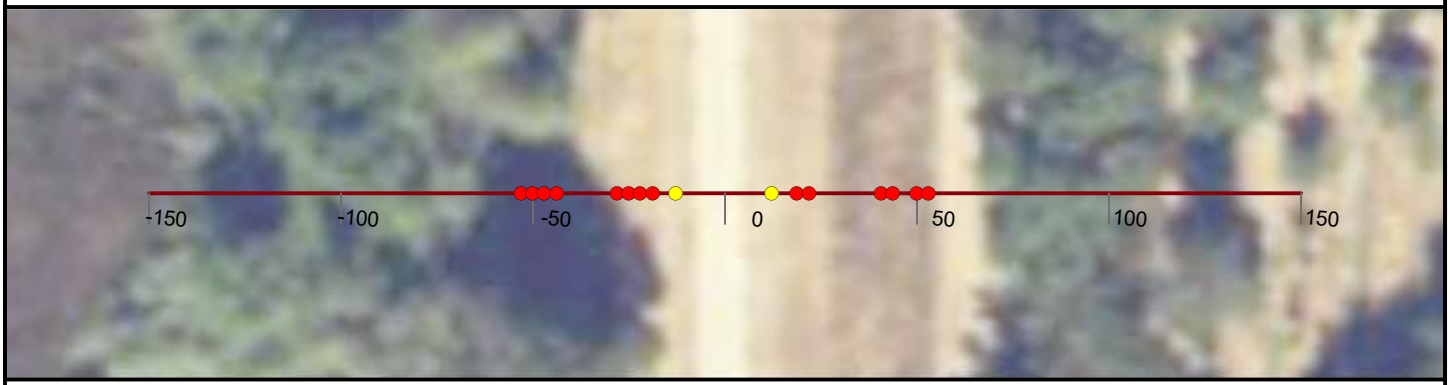
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Cross Section: Yankee Slough 104+00



Horizontal Scale: 1 inch = 50 Feet
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▲ Control Line
● Crown Point
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Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY
YANKEE SLOUGH LEVEE
CALIFORNIA
AUGUST, 2019

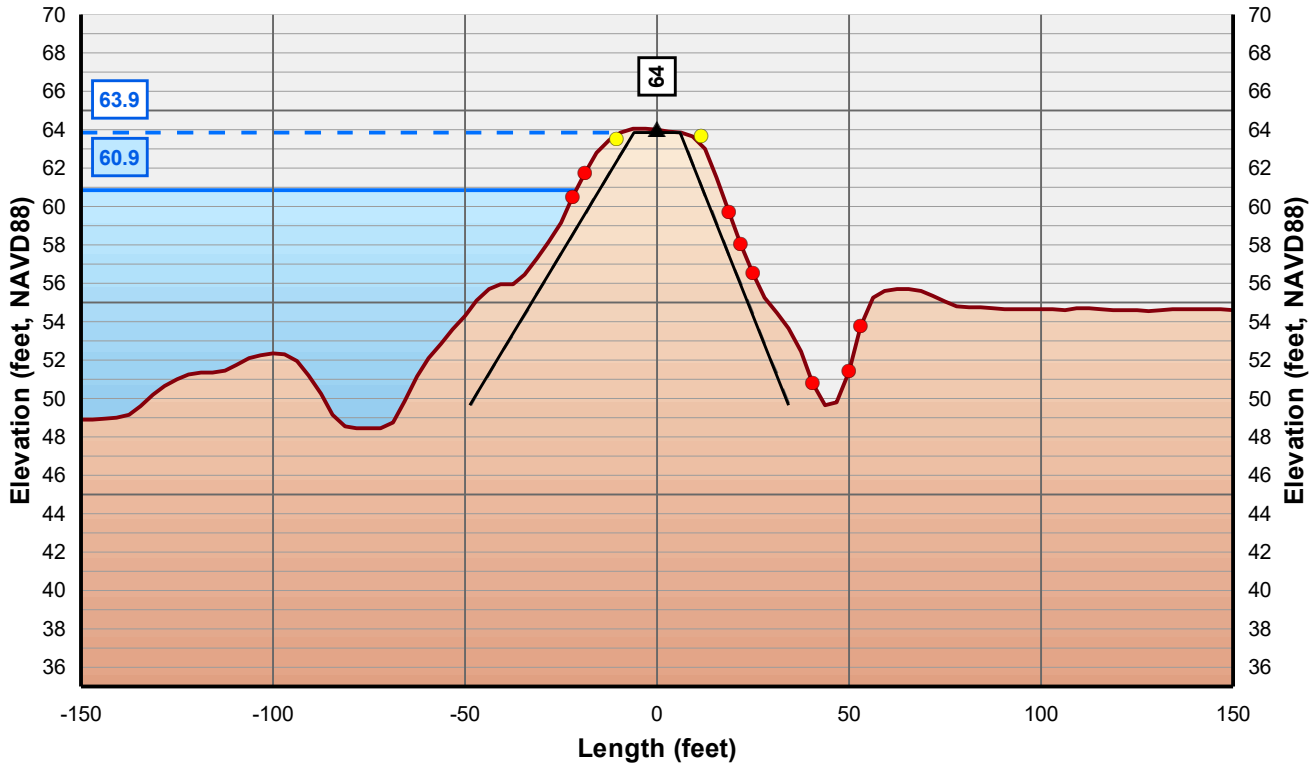
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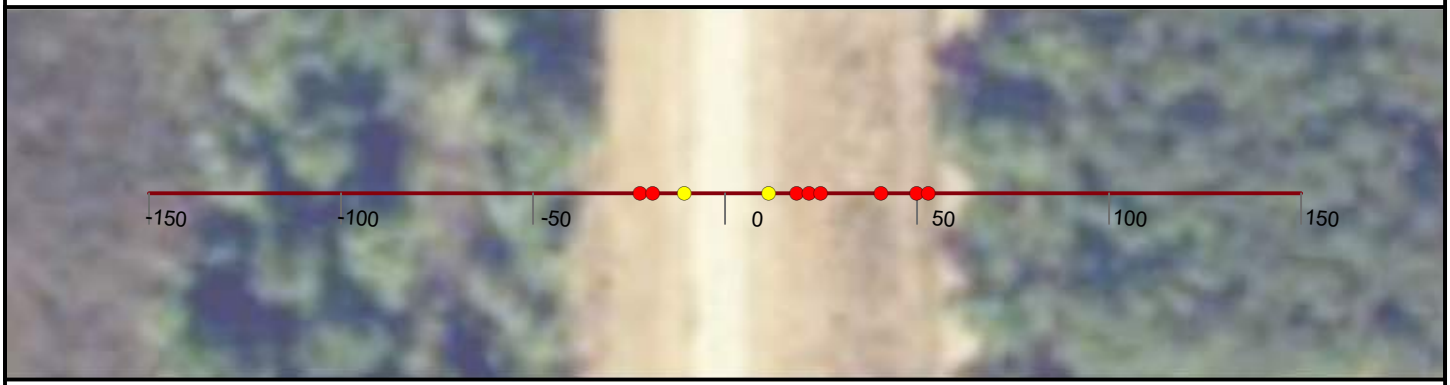
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Cross Section: Yankee Slough 105+00



Horizontal Scale: 1 inch = 50 Feet
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

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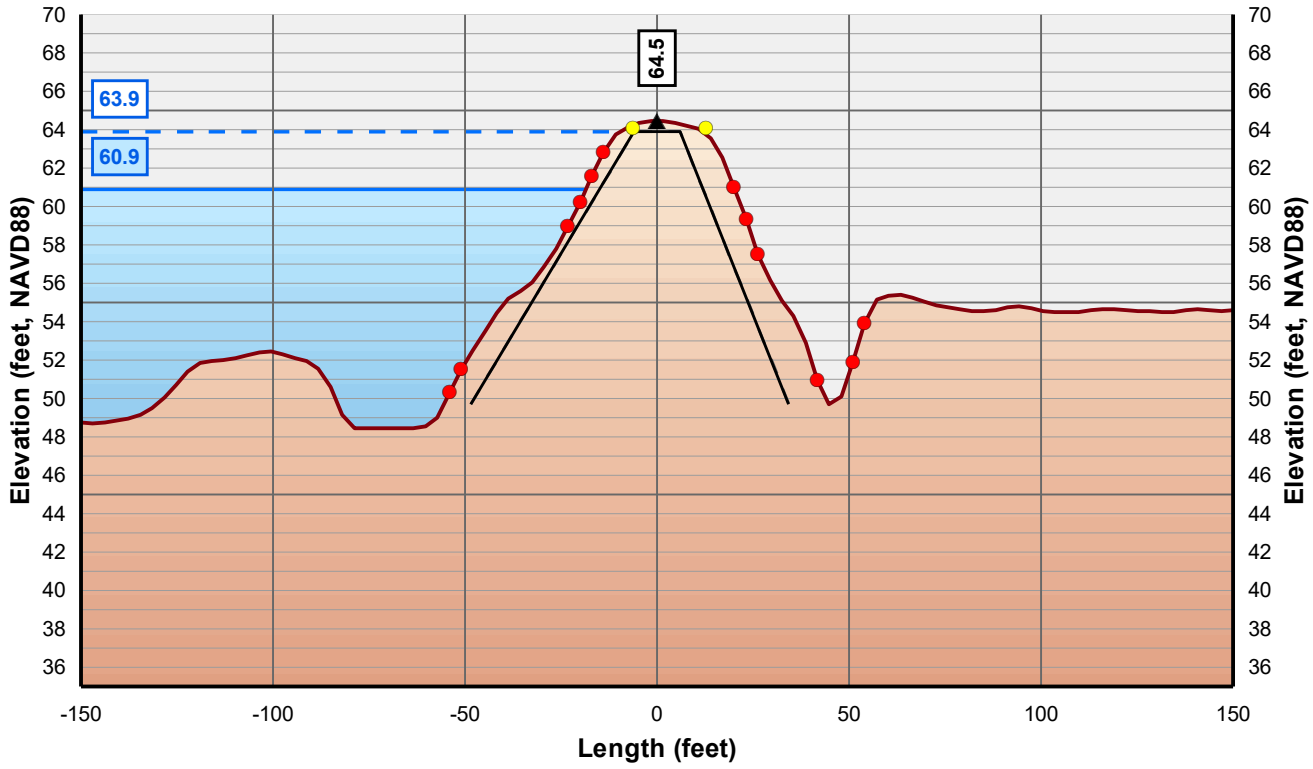
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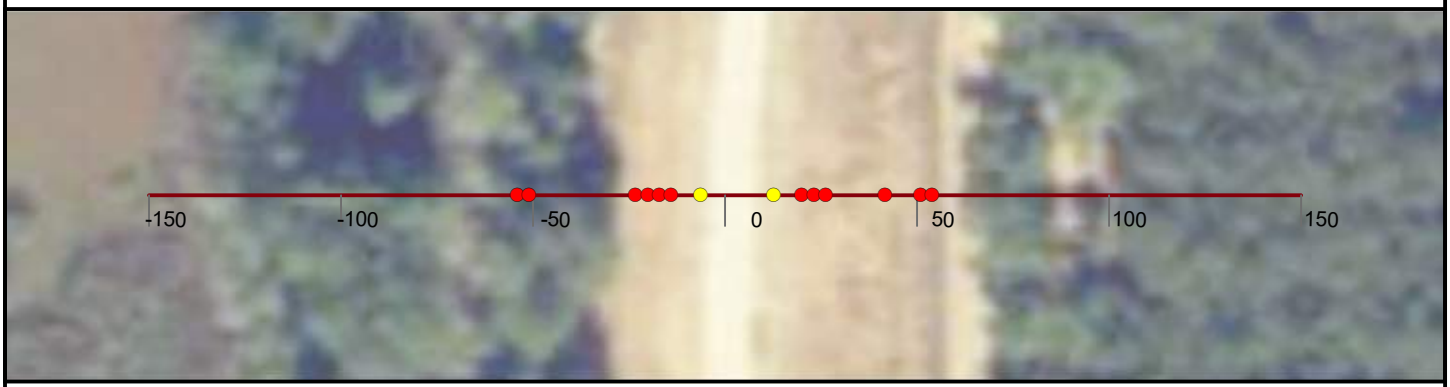
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Cross Section: Yankee Slough 106+00



Horizontal Scale: 1 inch = 50 Feet
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FEASIBILITY STUDY

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AUGUST, 2019

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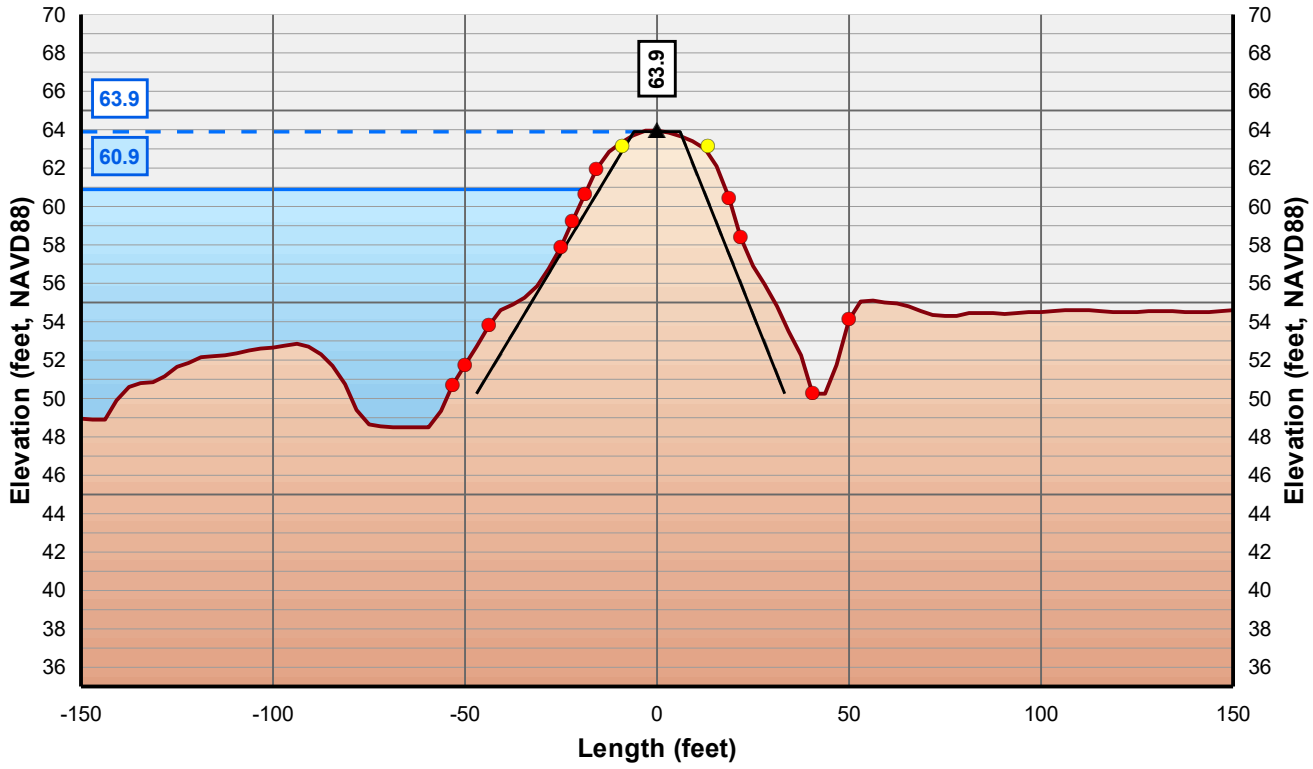
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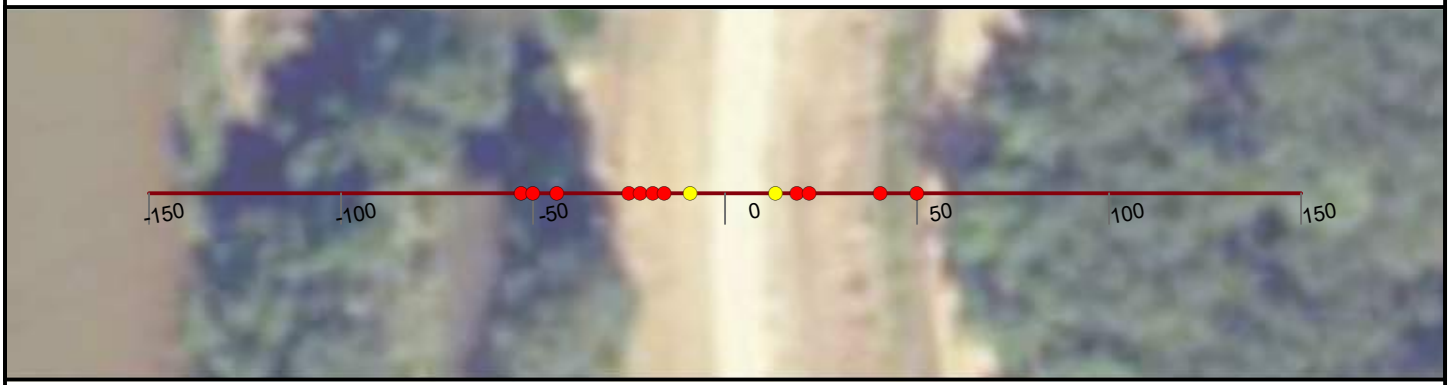
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Cross Section: Yankee Slough 107+00



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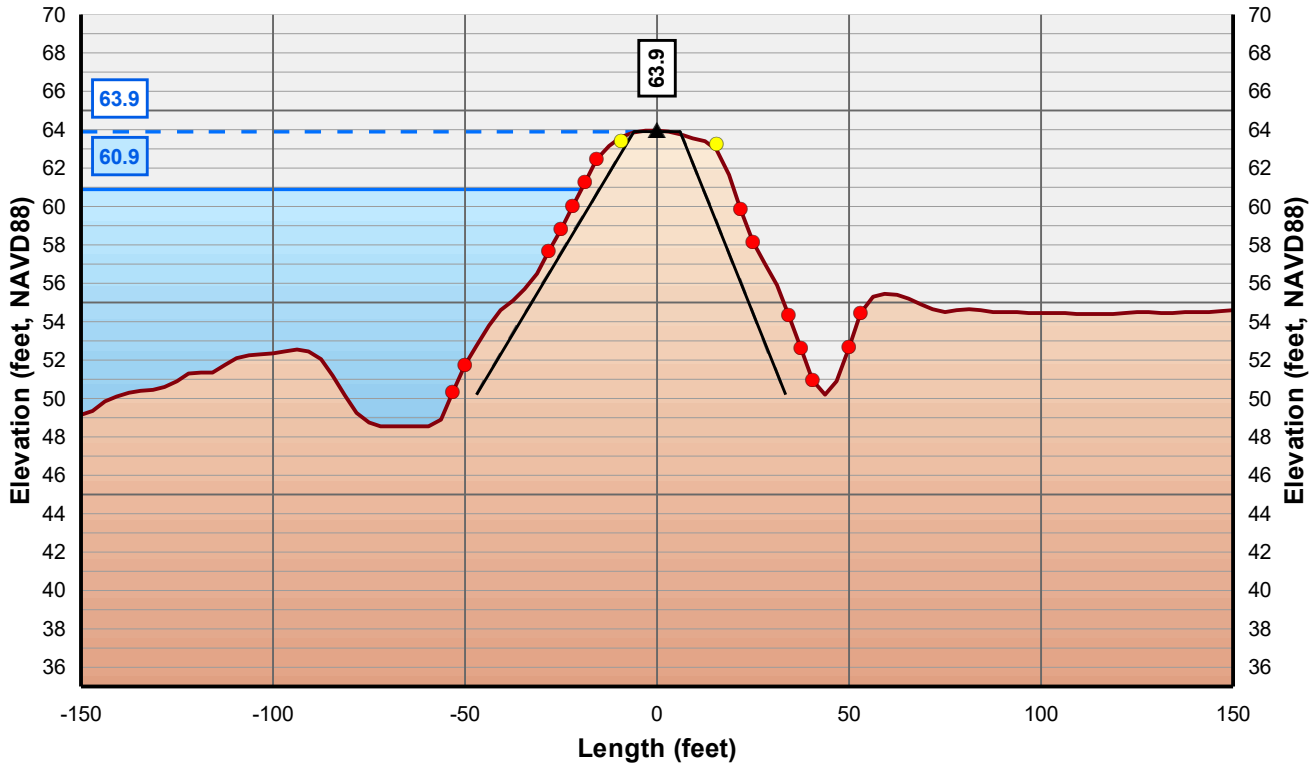
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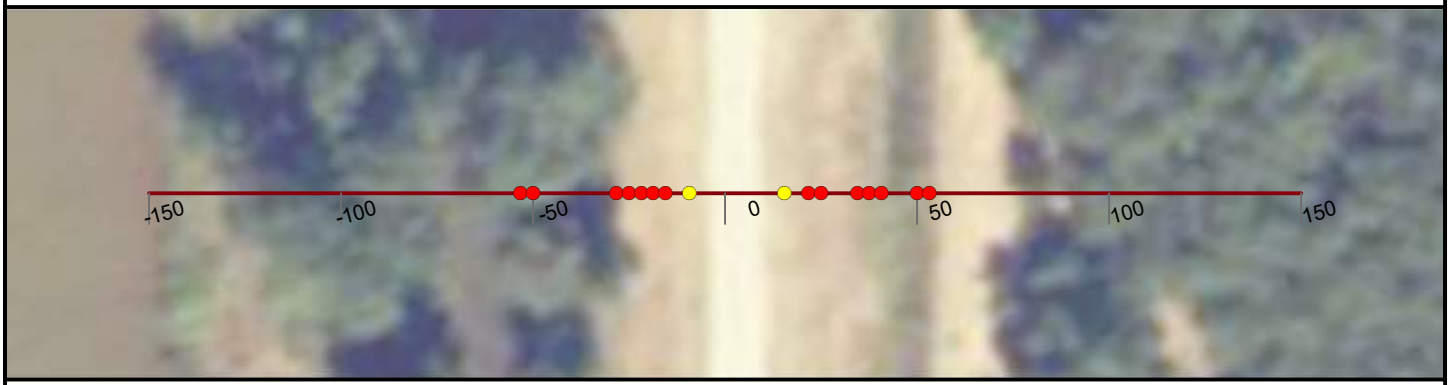
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Cross Section: Yankee Slough 108+00



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▲ Control Line
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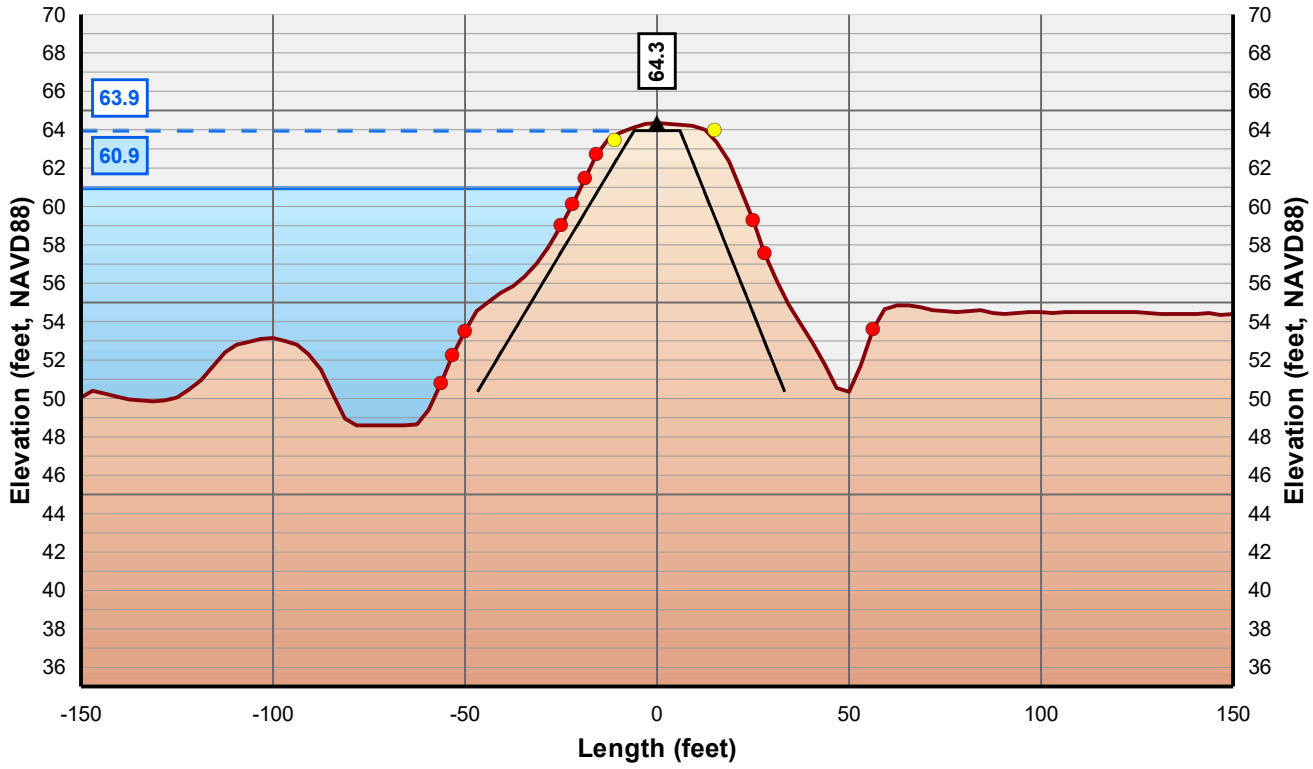
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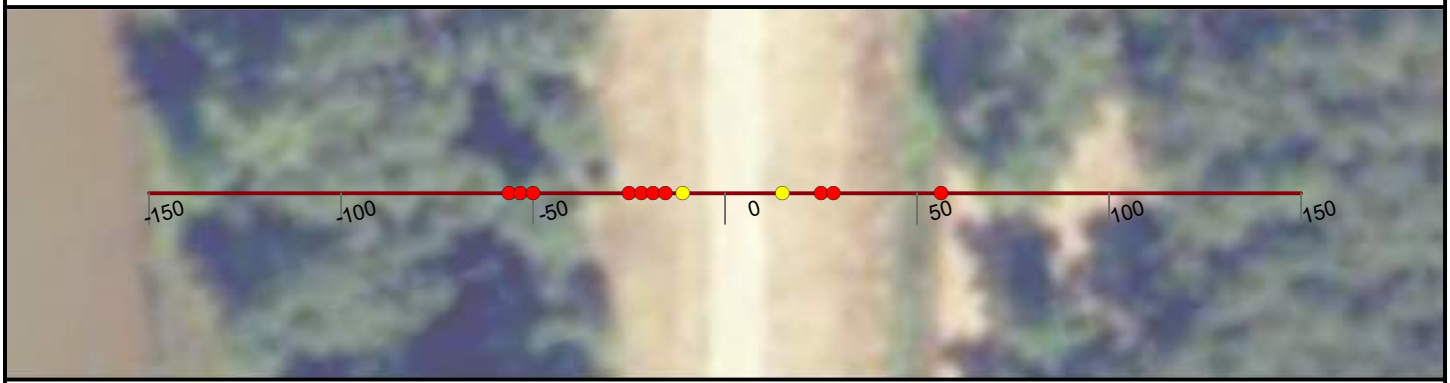
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Cross Section: Yankee Slough 109+00



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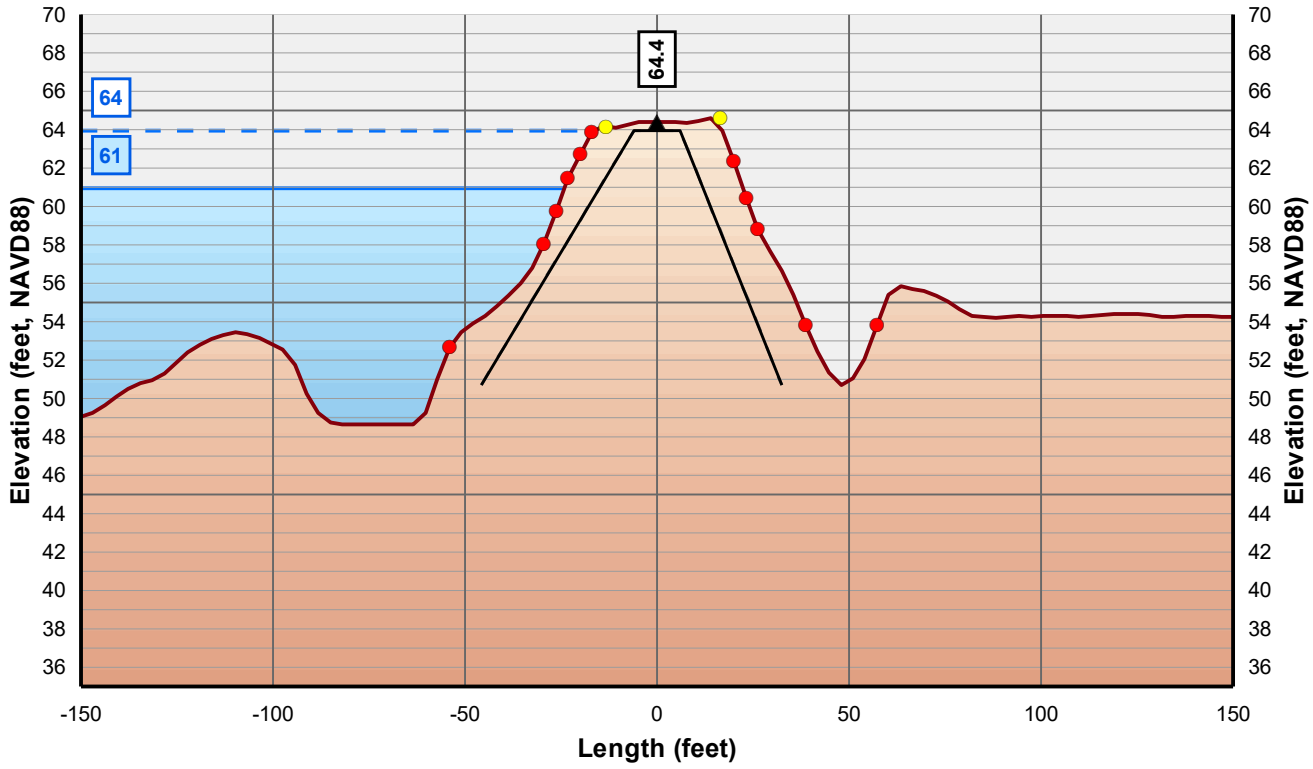
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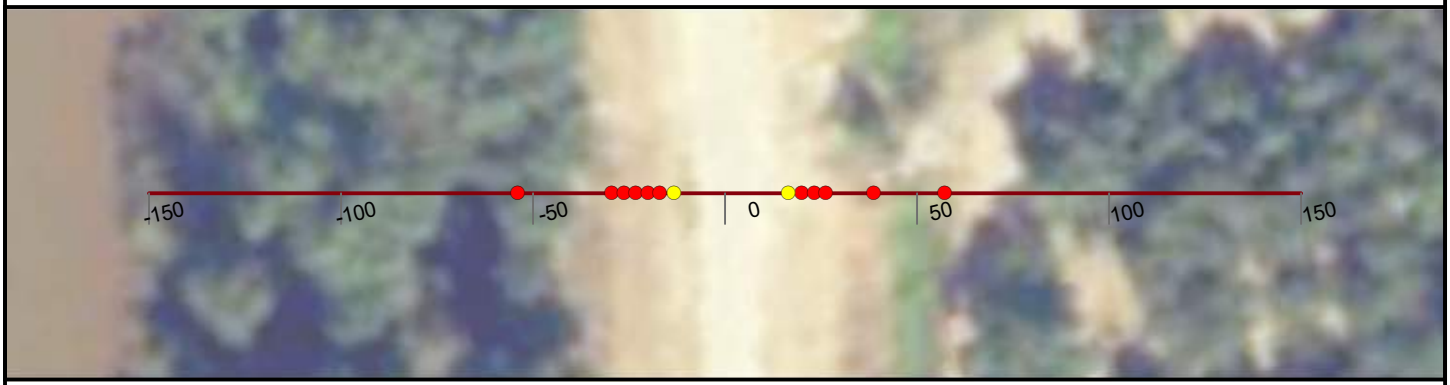
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Cross Section: Yankee Slough 110+00



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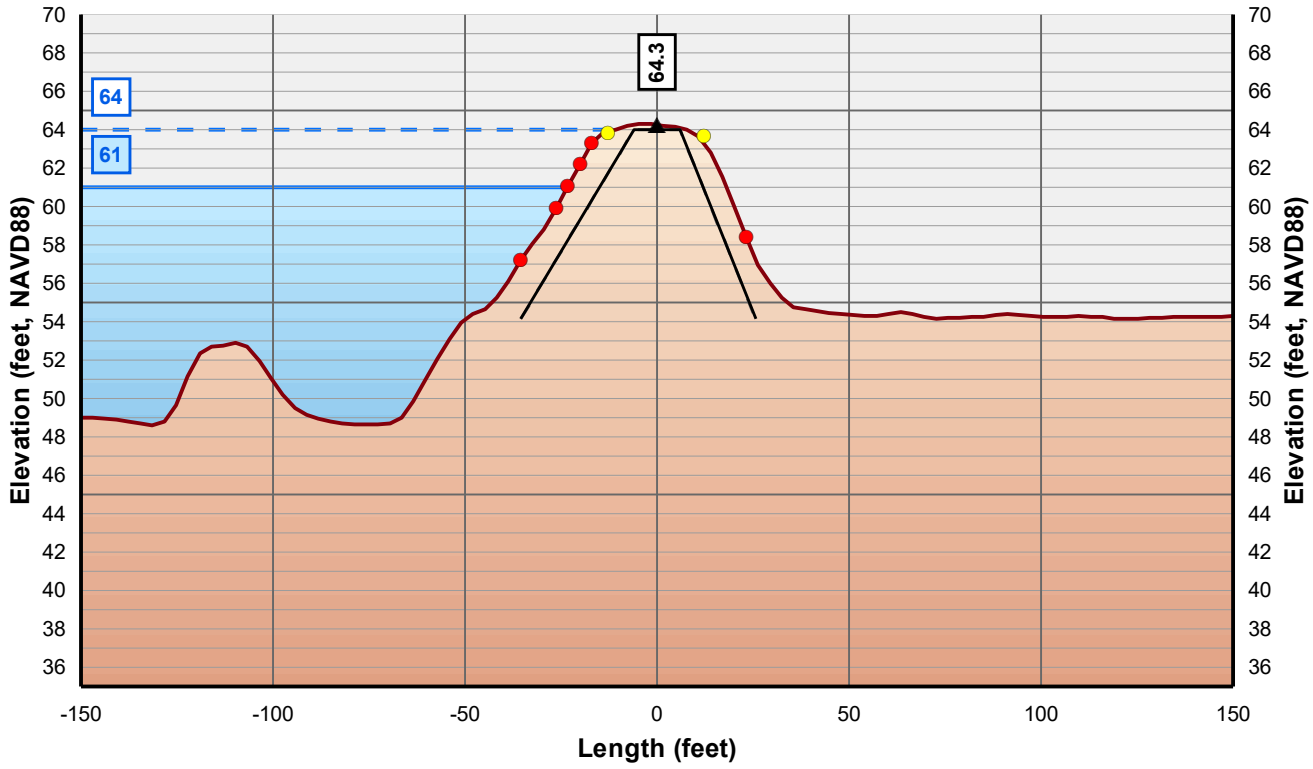
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Cross Section: Yankee Slough 111+00



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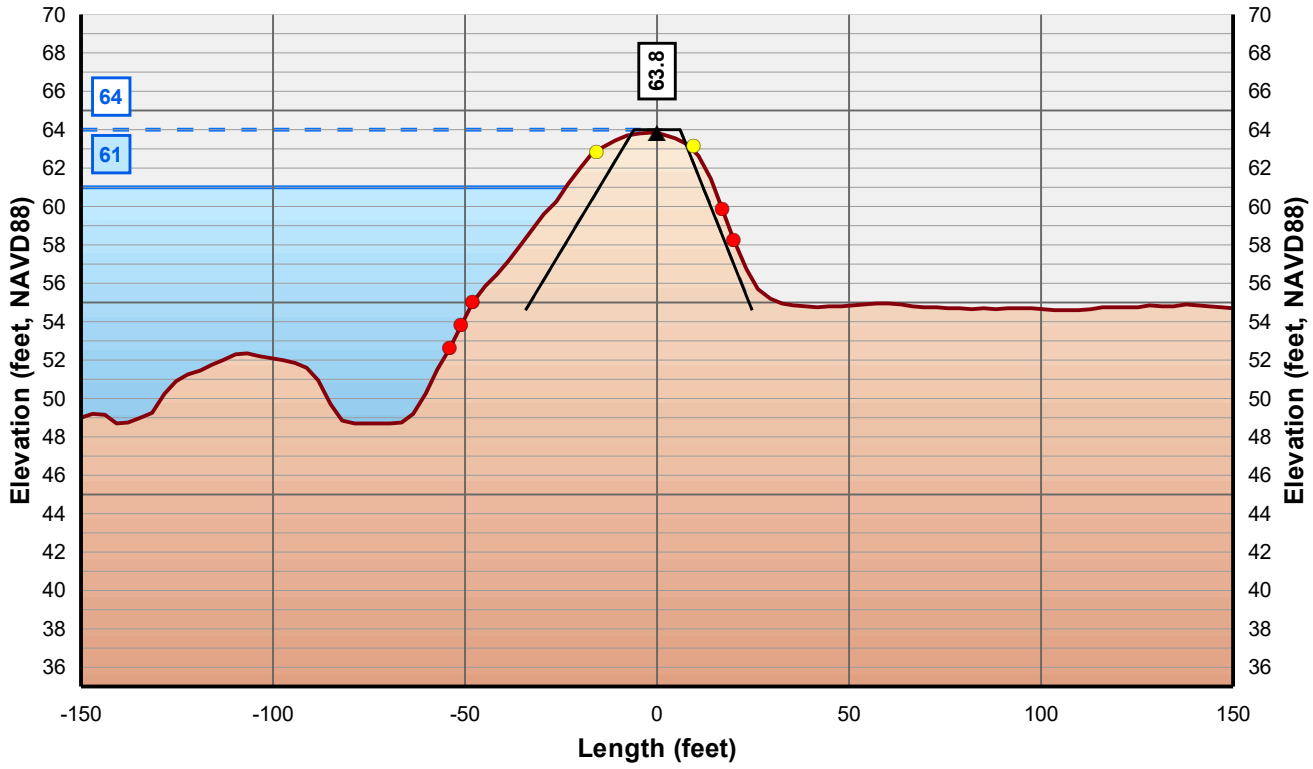
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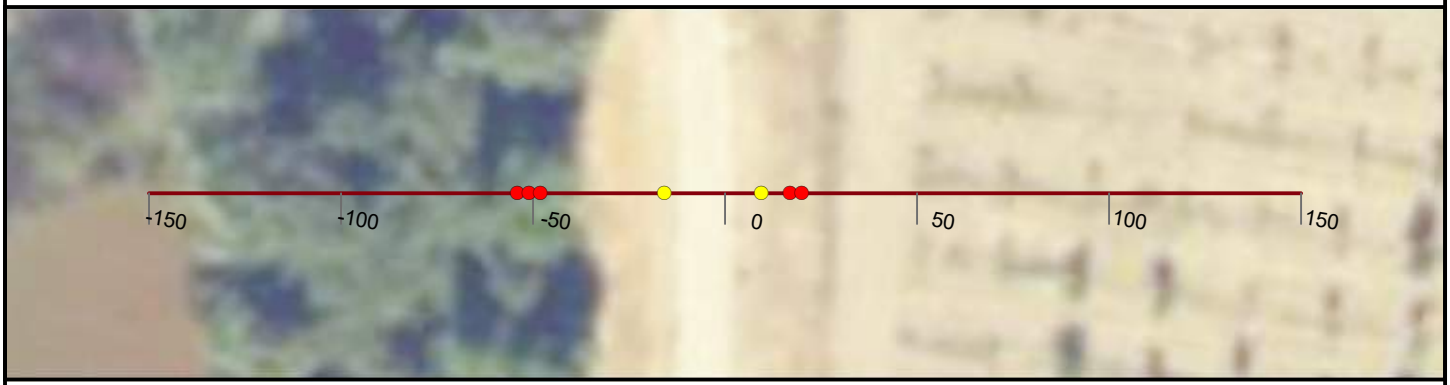
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Cross Section: Yankee Slough 112+00



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NORTH

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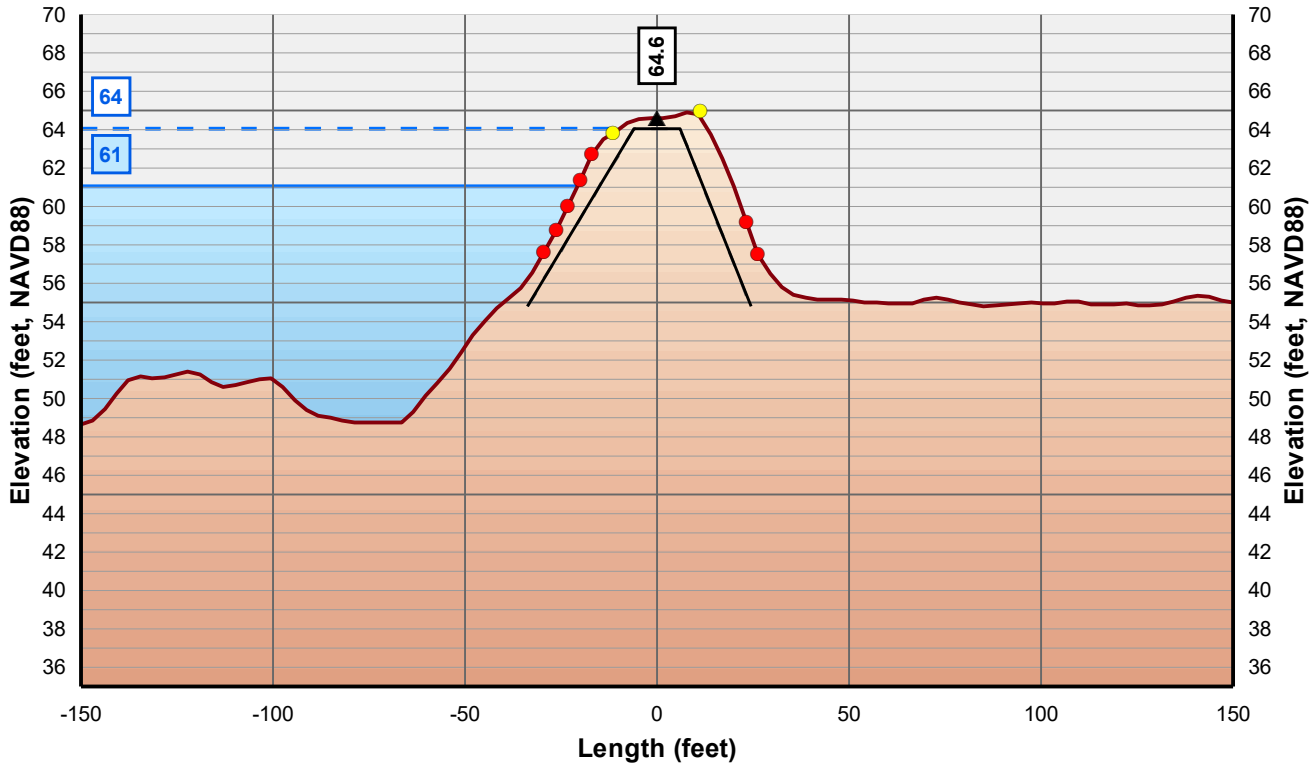
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

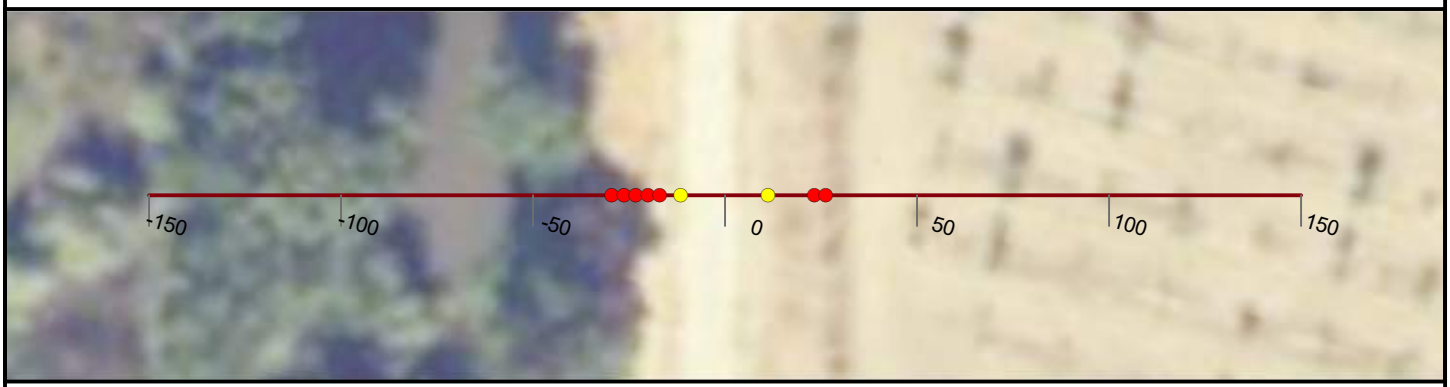
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Cross Section: Yankee Slough 113+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

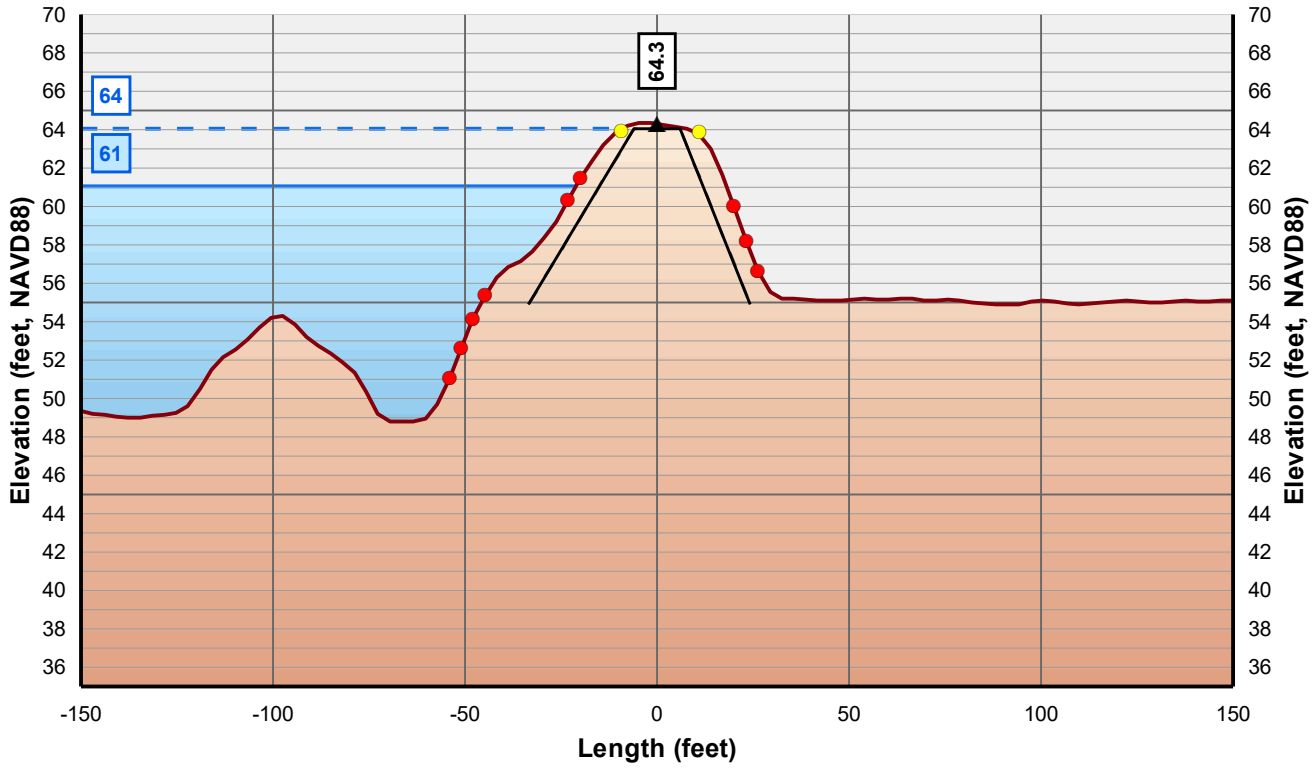
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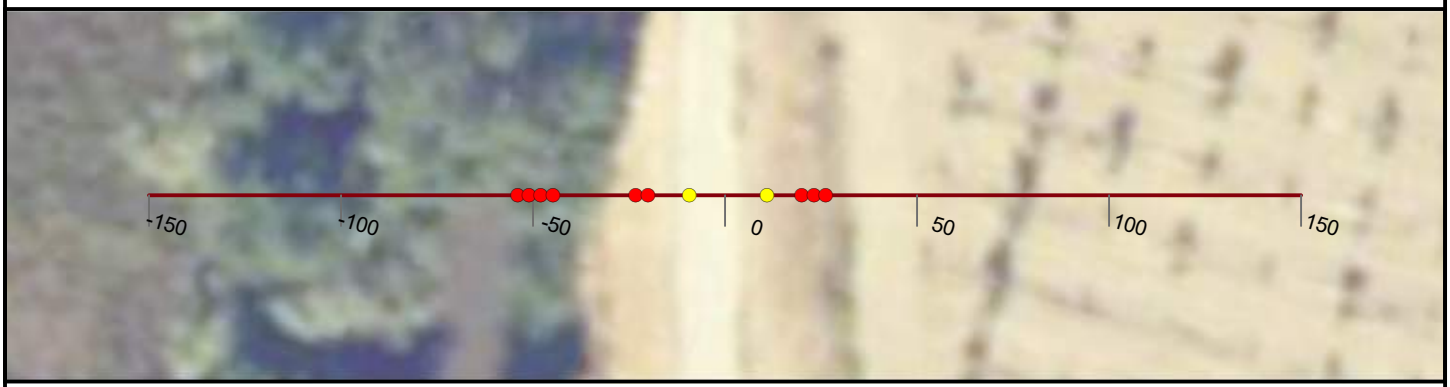
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Cross Section: Yankee Slough 114+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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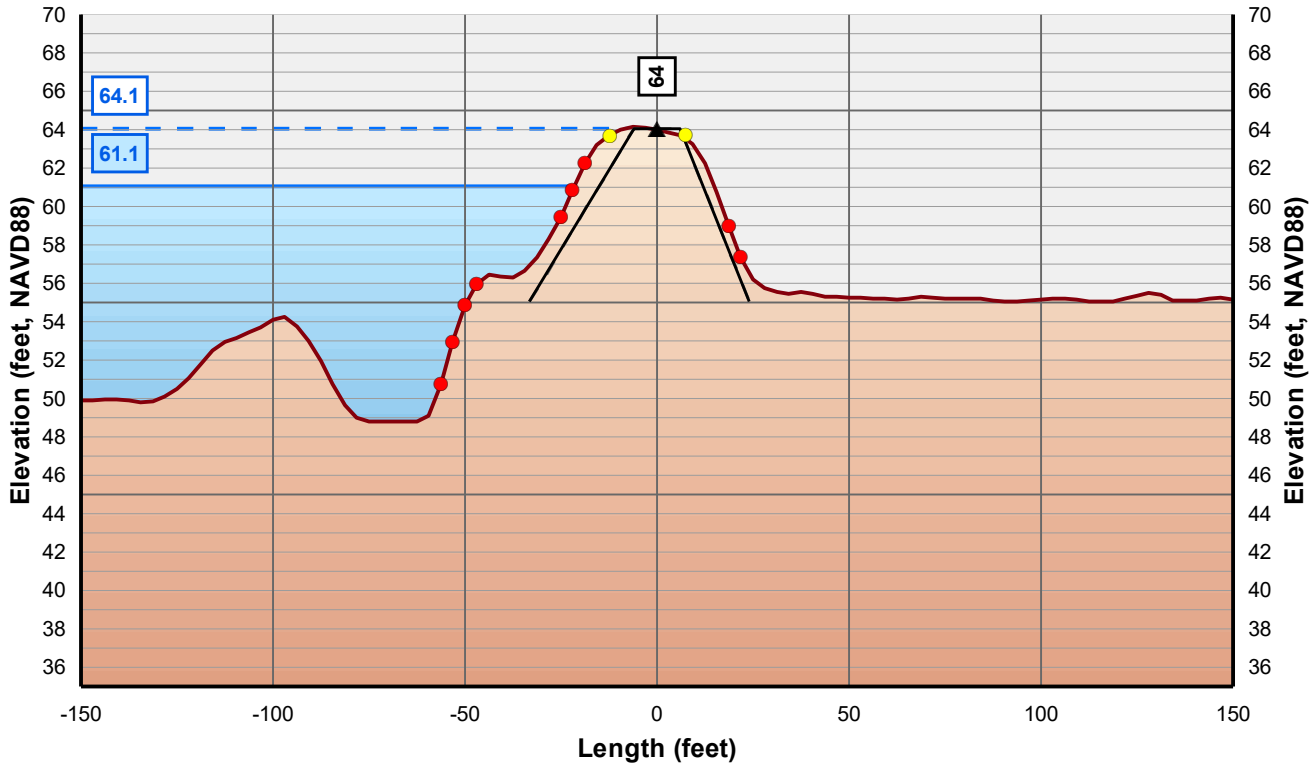
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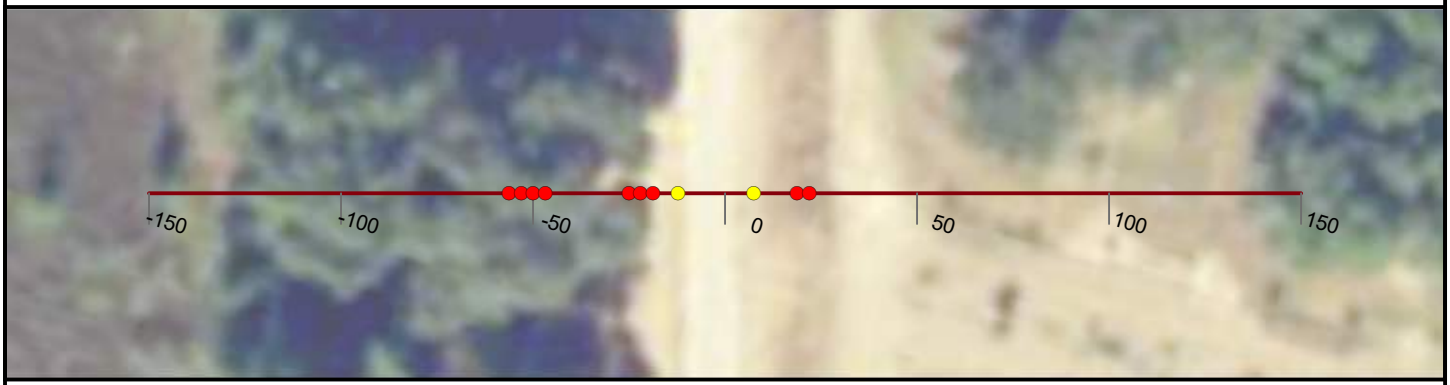
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Cross Section: Yankee Slough 115+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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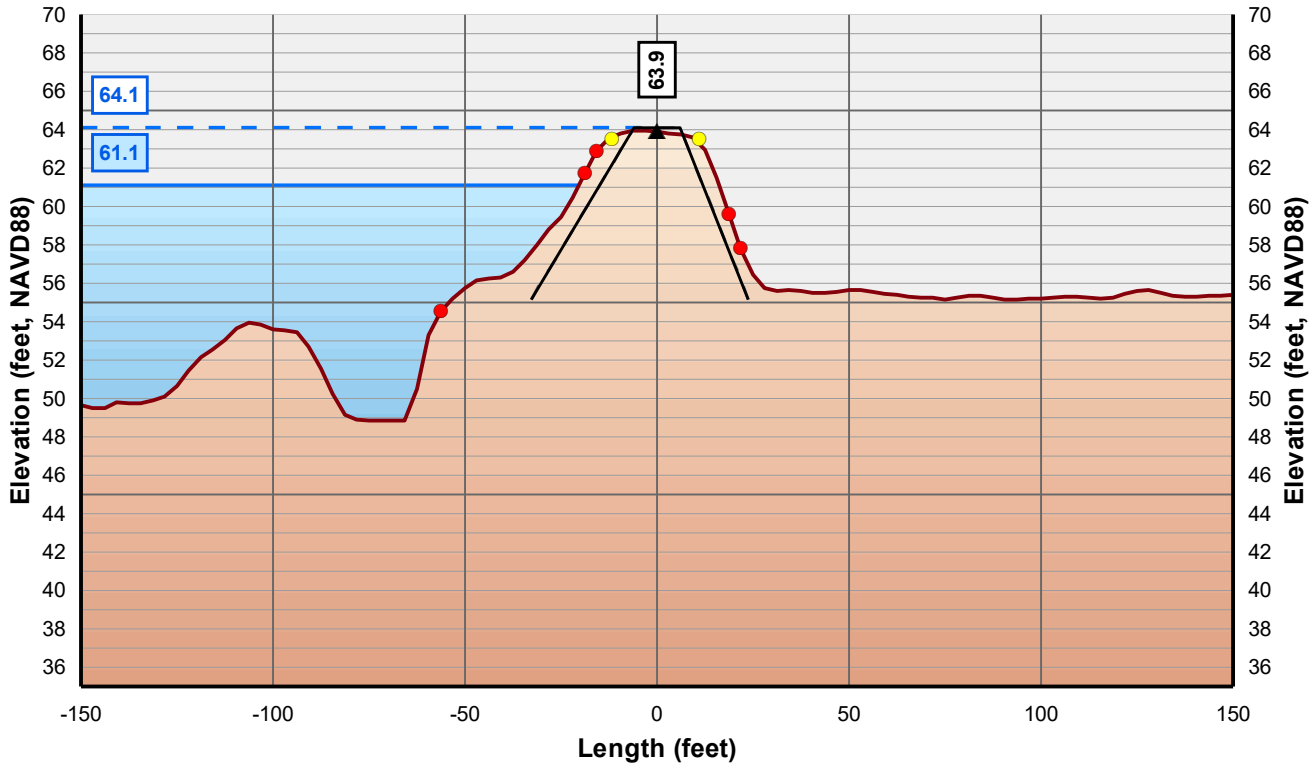
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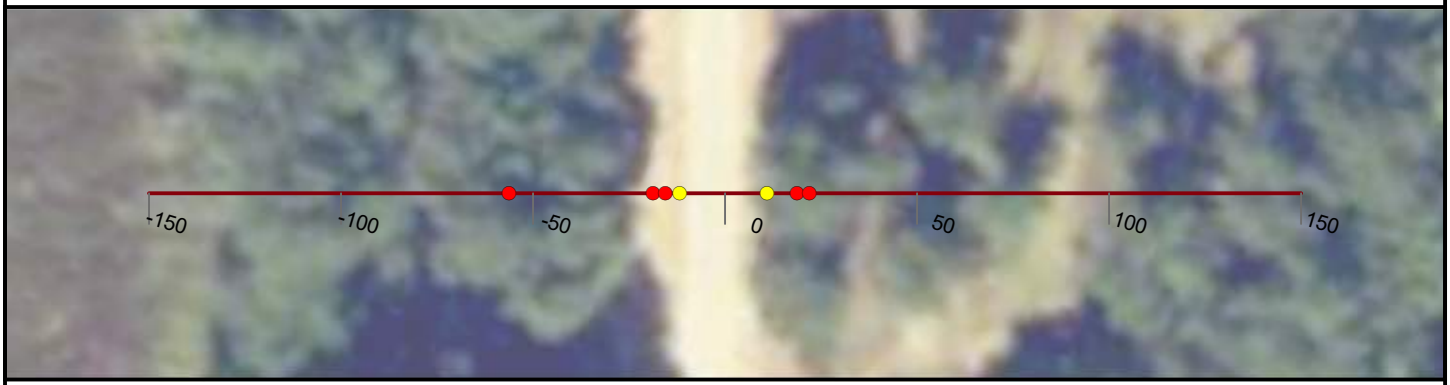
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Cross Section: Yankee Slough 116+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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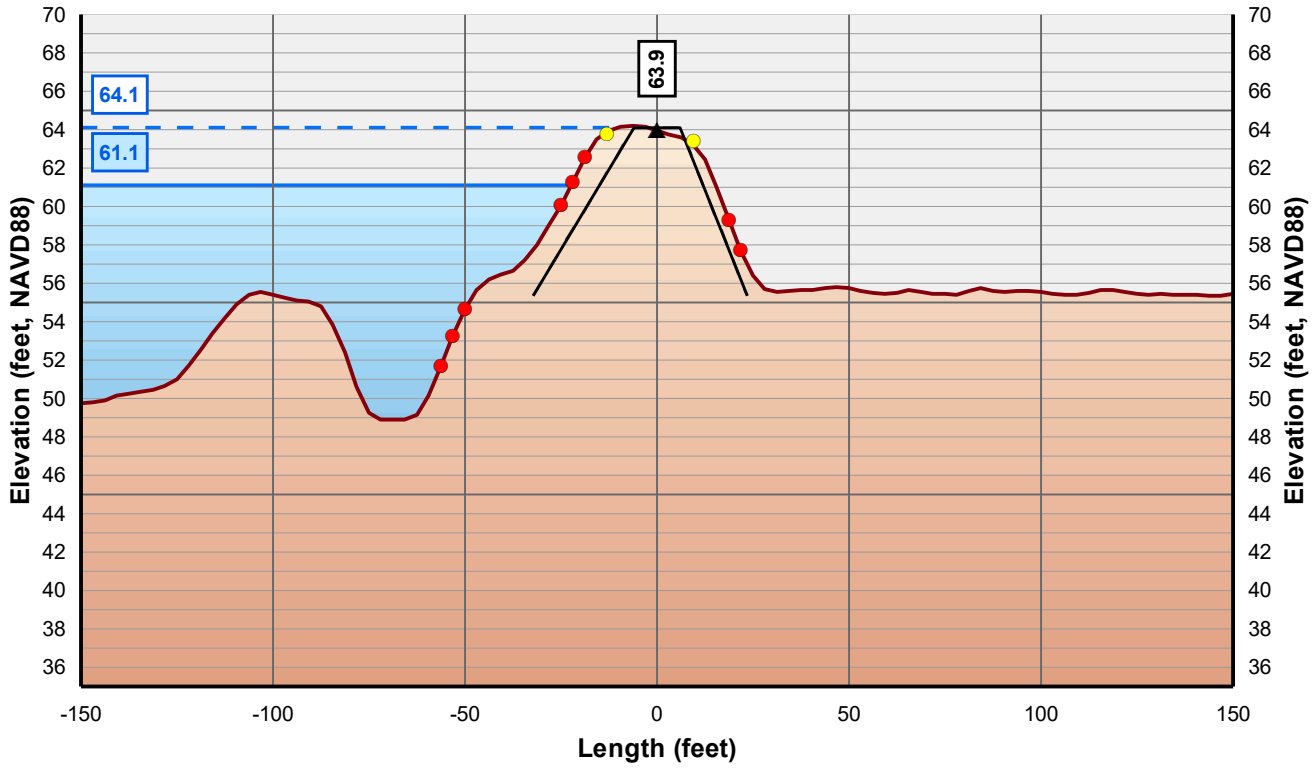
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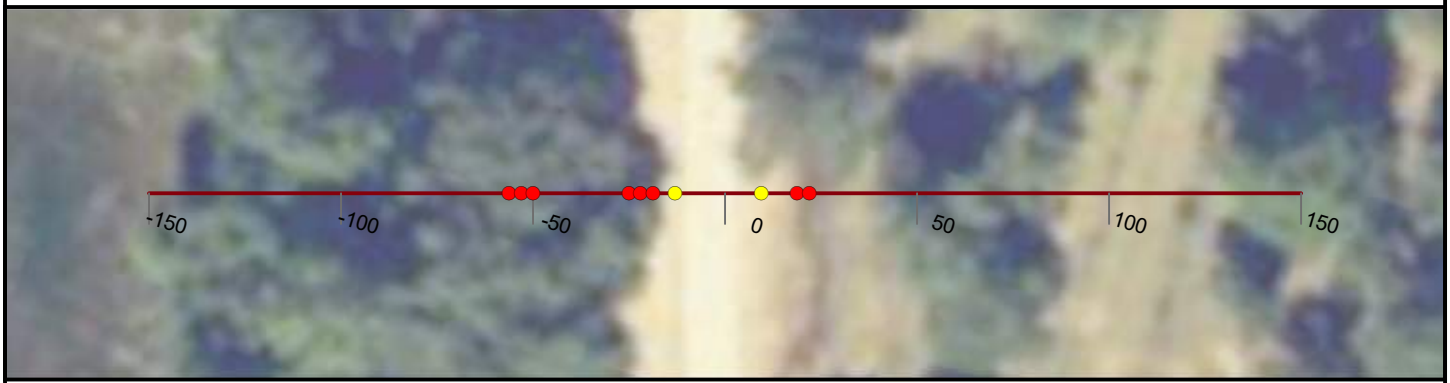
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Cross Section: Yankee Slough 117+00



Horizontal Scale: 1 inch = 50 Feet
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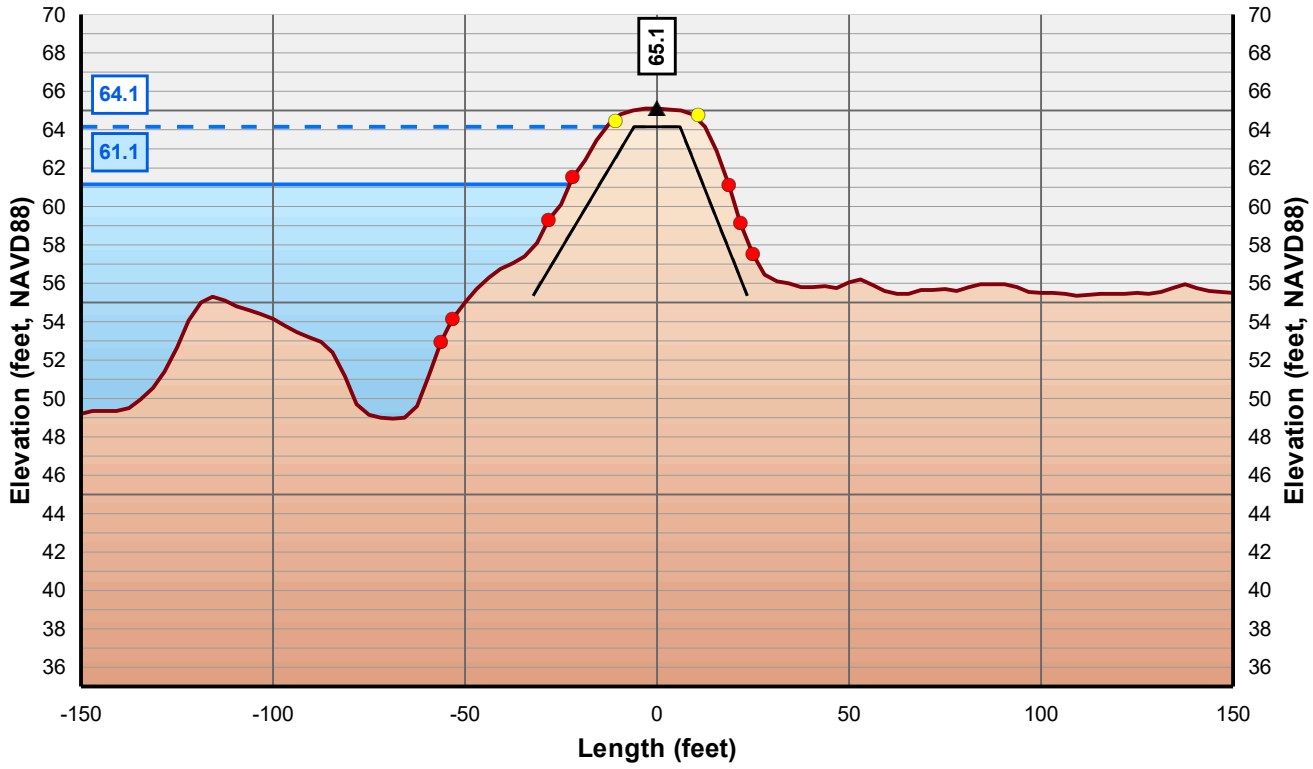
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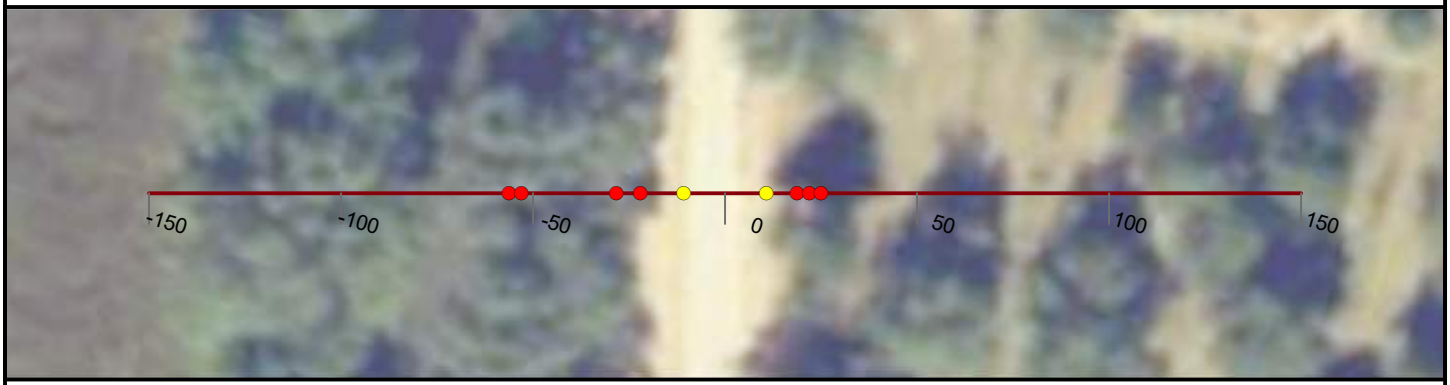
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Cross Section: Yankee Slough 118+00



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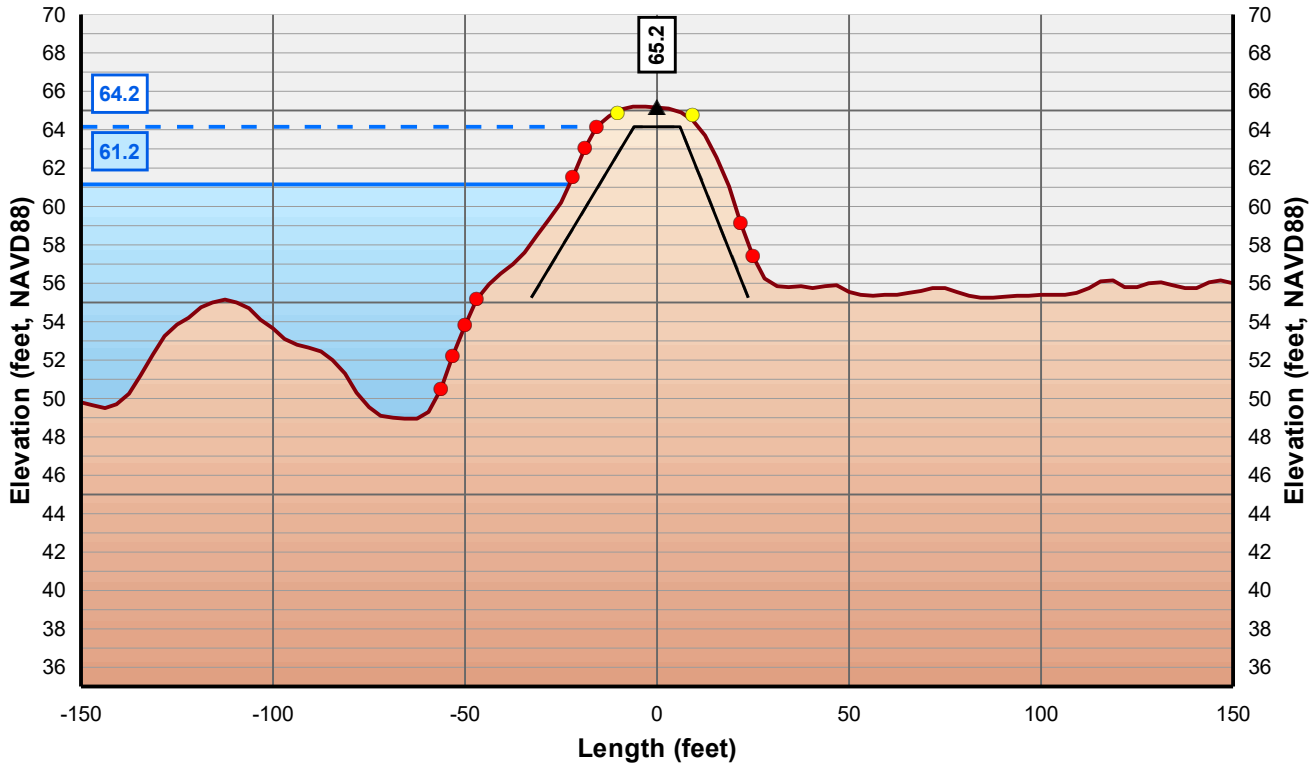
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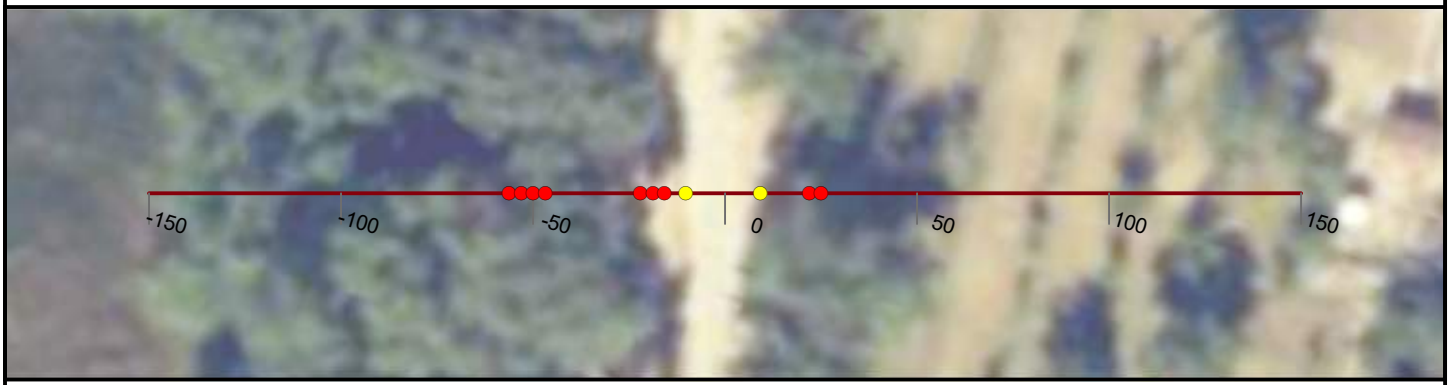
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Cross Section: Yankee Slough 119+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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- Issue Point
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- Theoretical Levee Prism Preliminary
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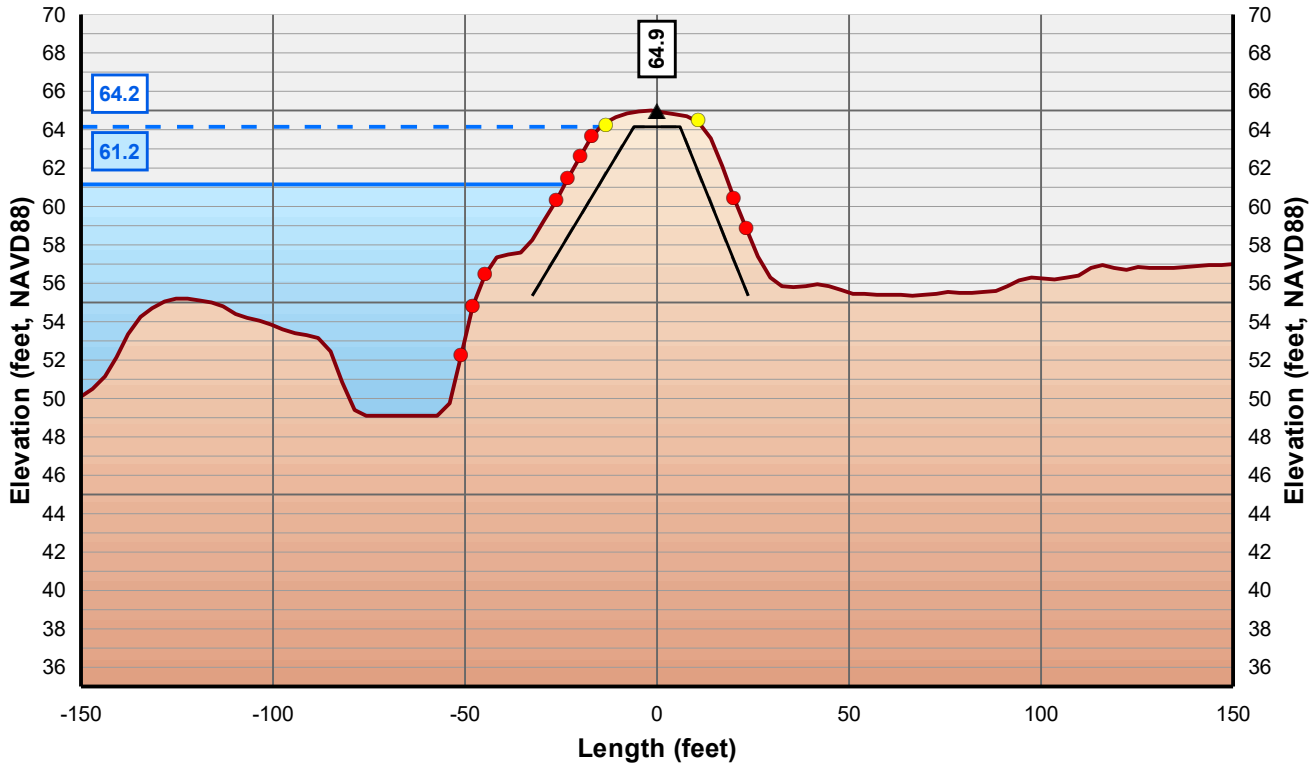
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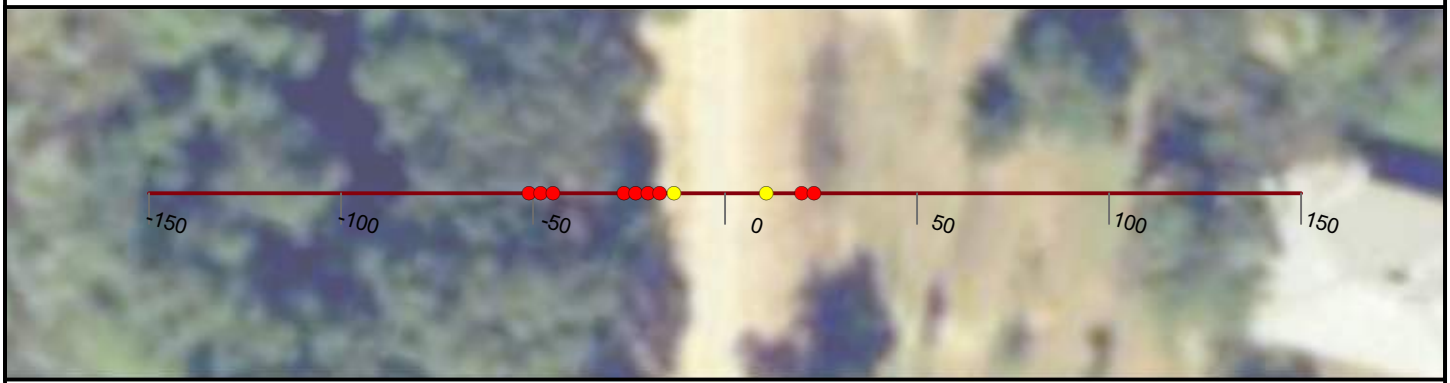
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Cross Section: Yankee Slough 120+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

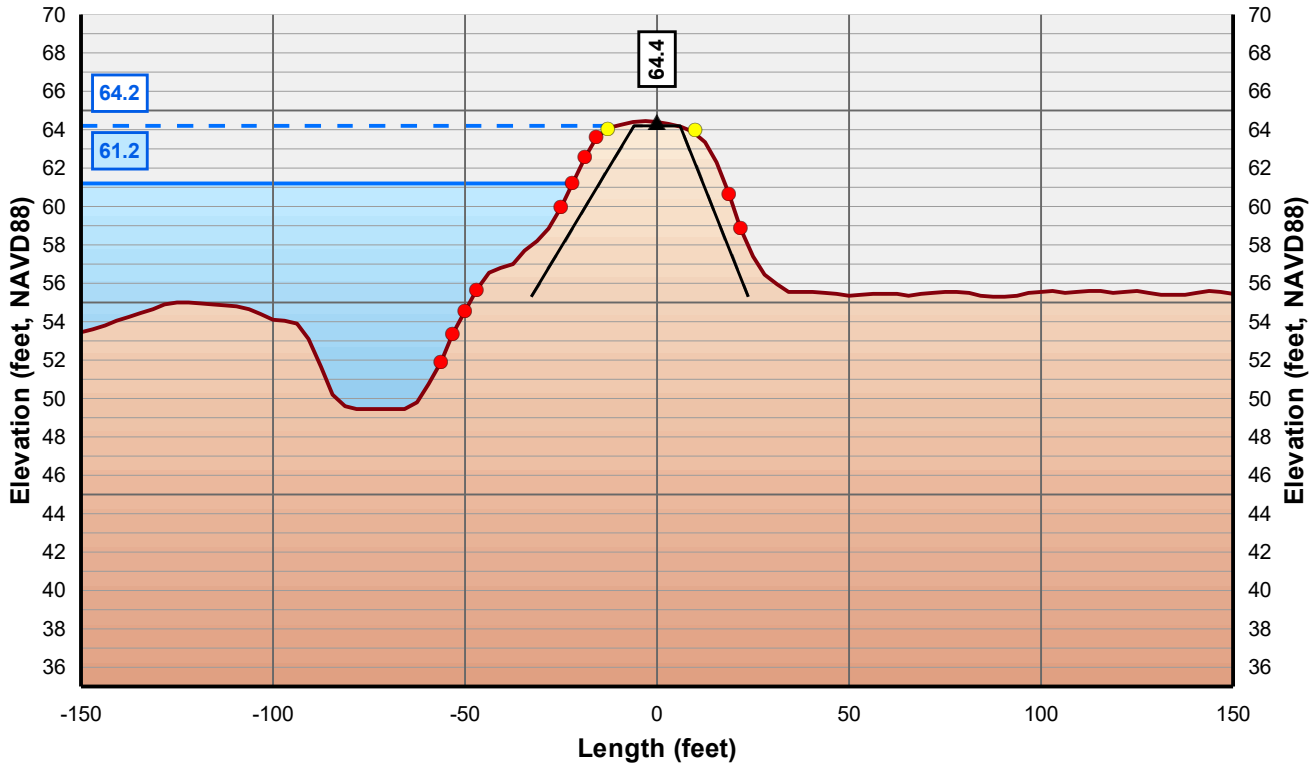
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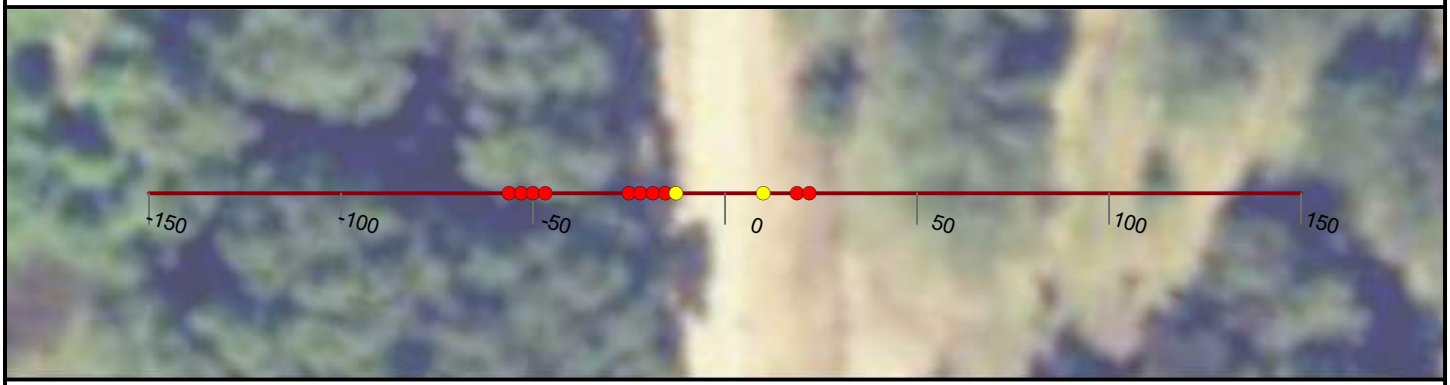
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Cross Section: Yankee Slough 121+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

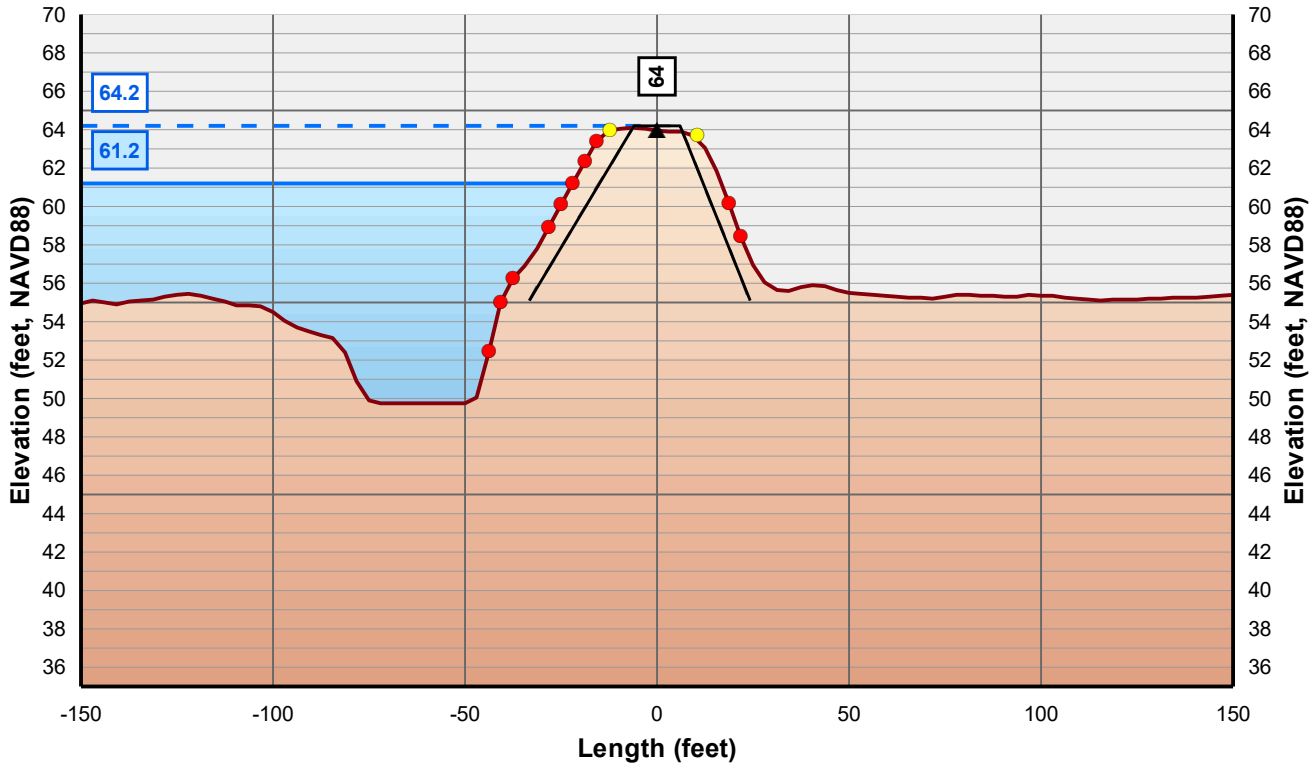
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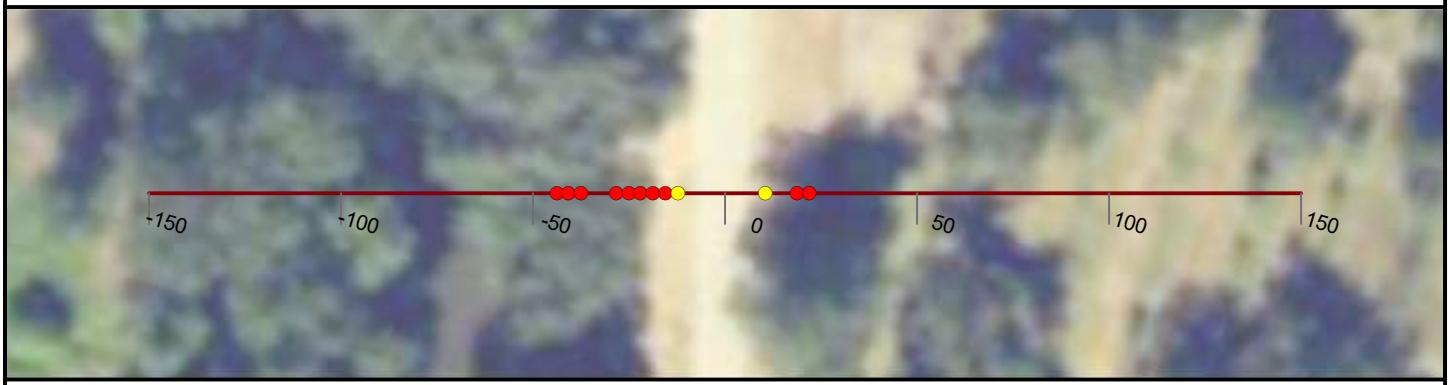
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Cross Section: Yankee Slough 122+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

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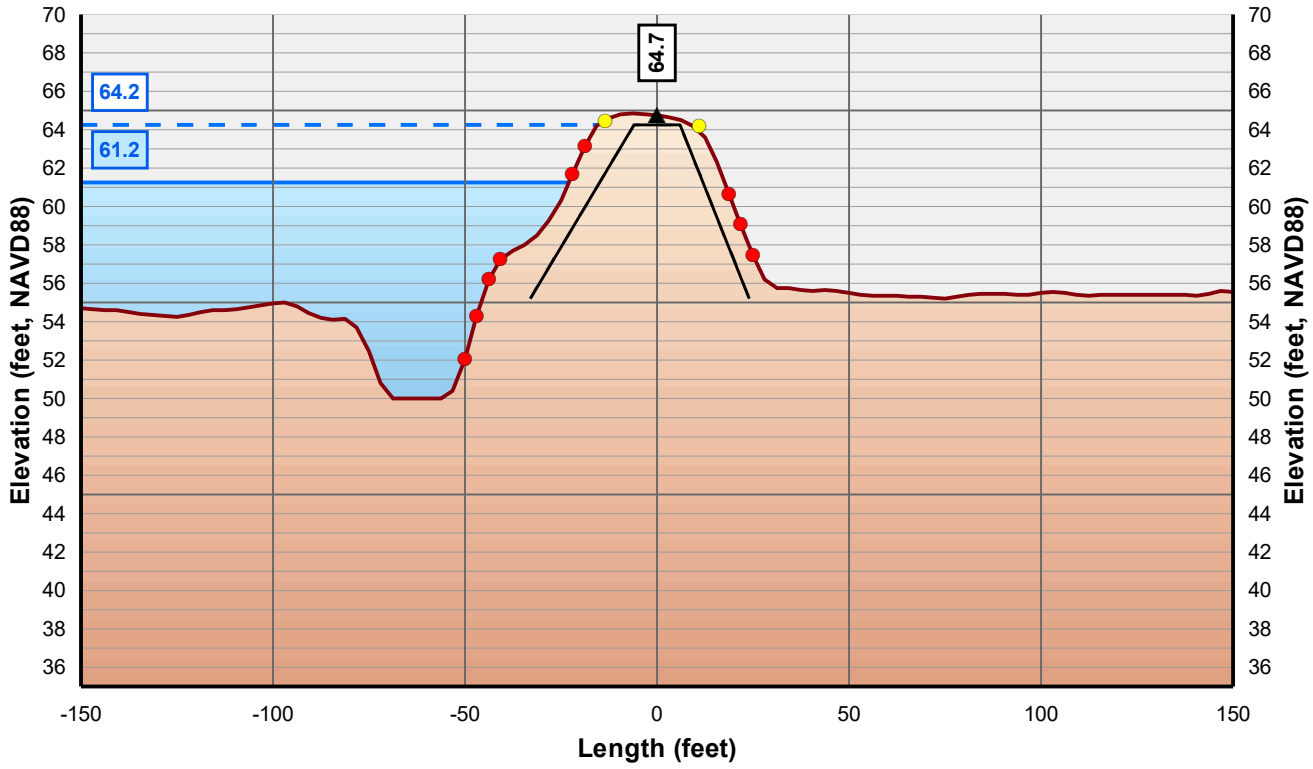
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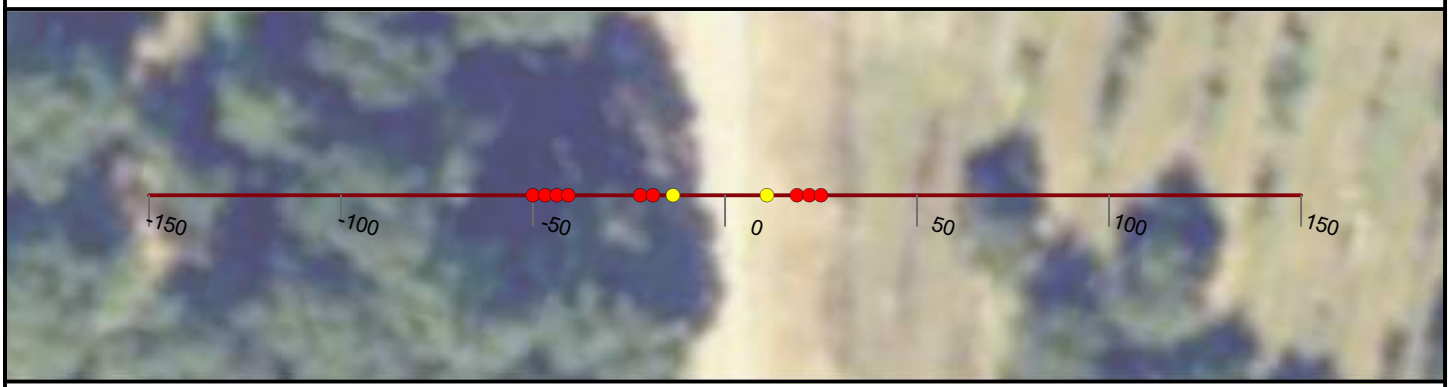
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Cross Section: Yankee Slough 123+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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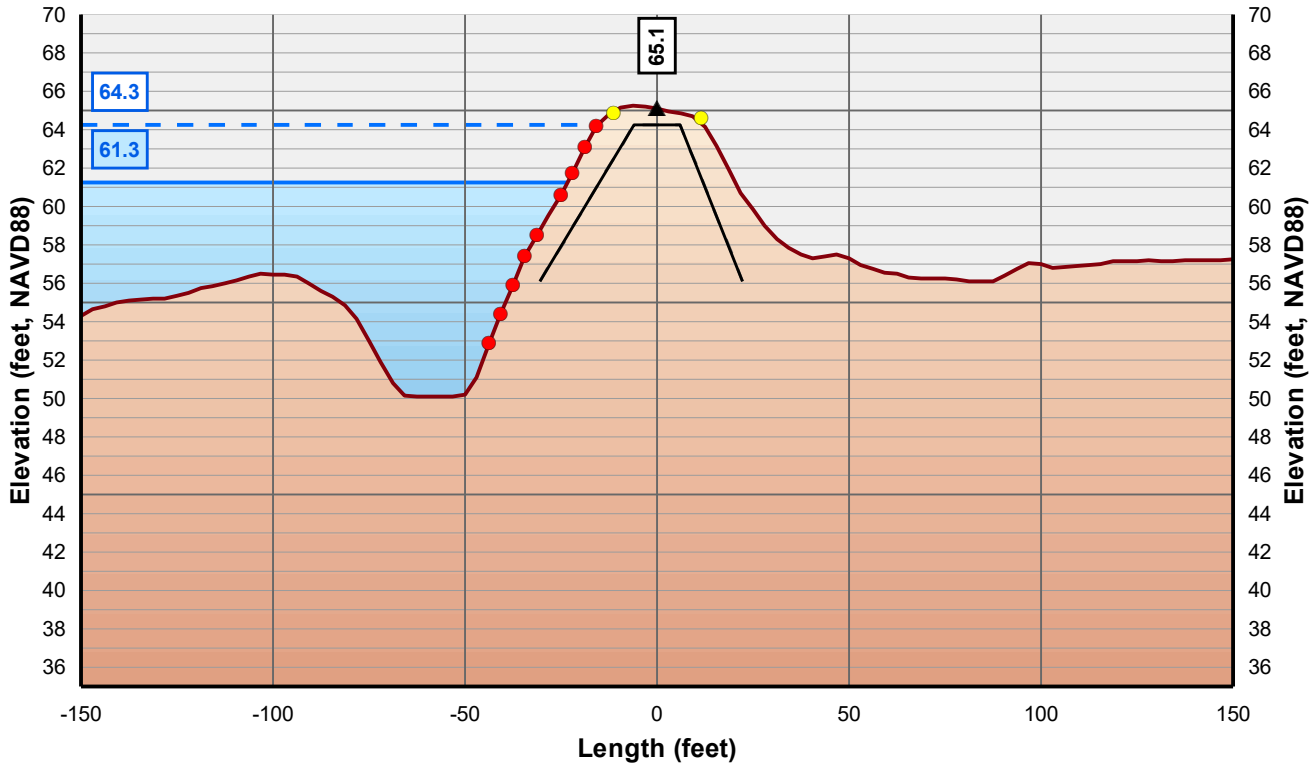
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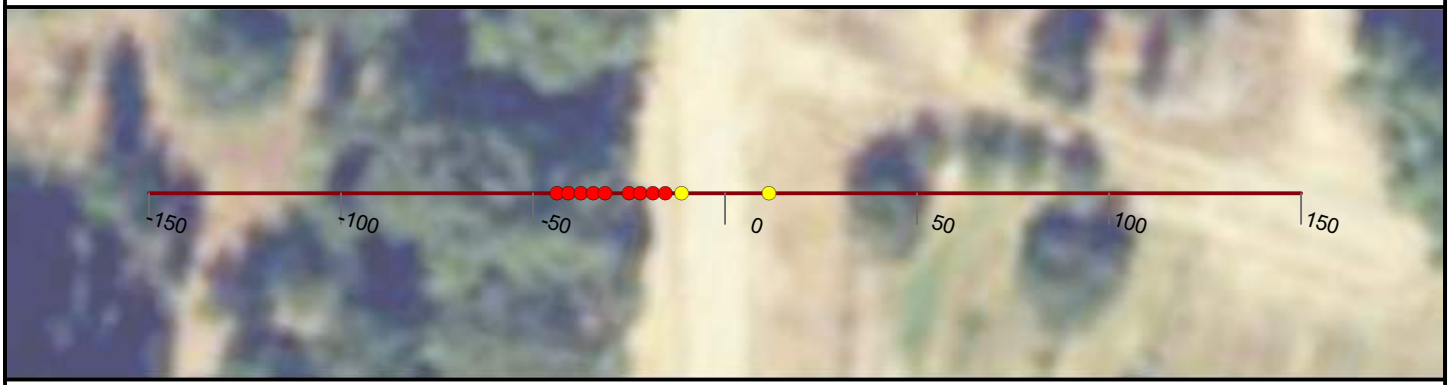
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Cross Section: Yankee Slough 124+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

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CALIFORNIA

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NORTH

0 25 50

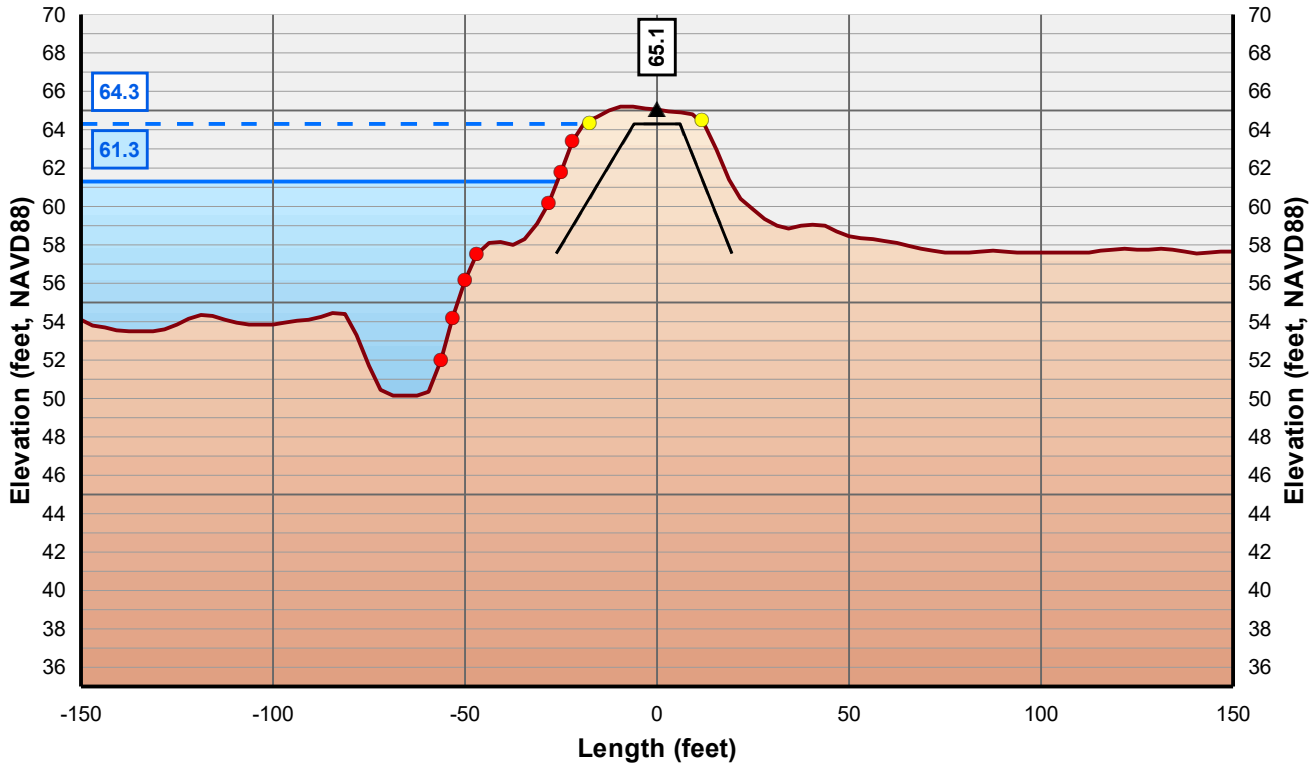
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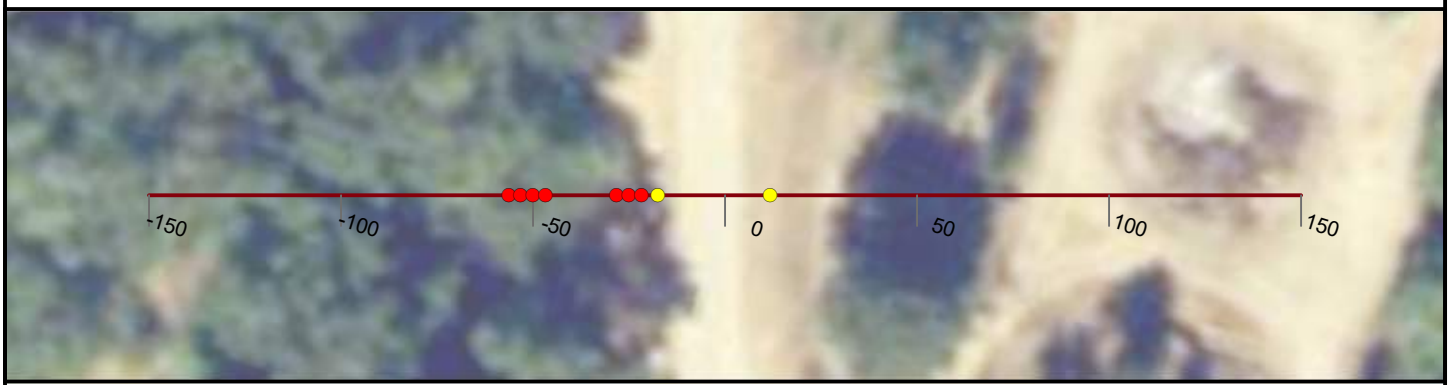
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Cross Section: Yankee Slough 125+00



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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

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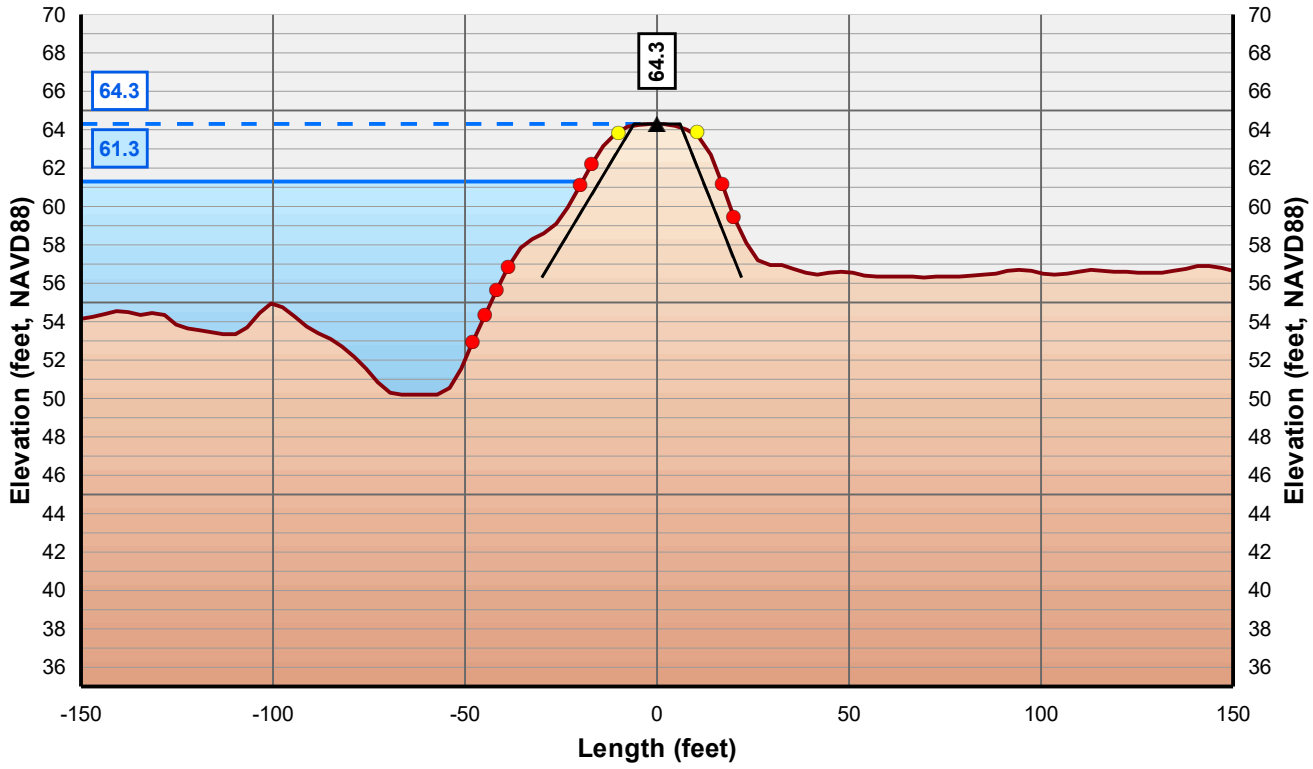
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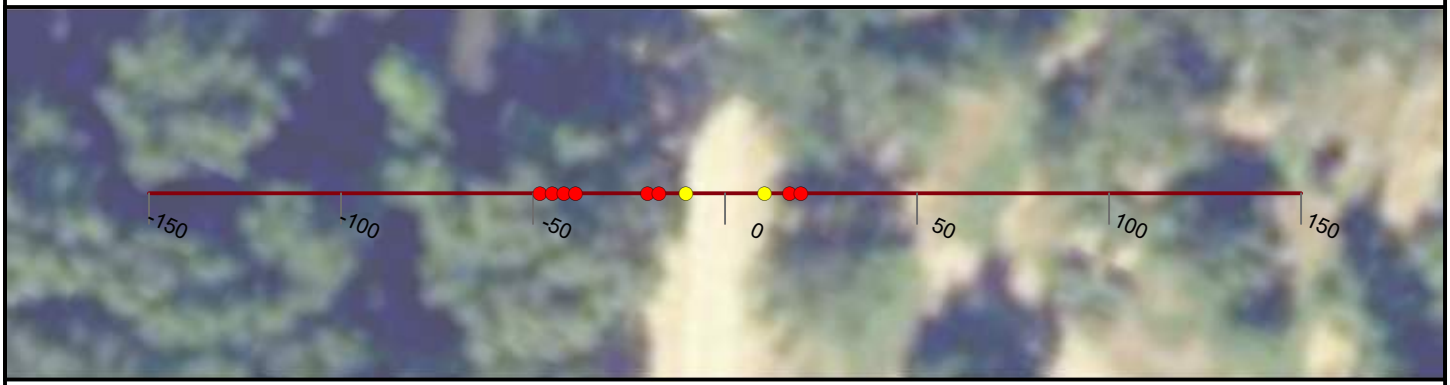
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Cross Section: Yankee Slough 126+00



Horizontal Scale: 1 inch = 50 Feet
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Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
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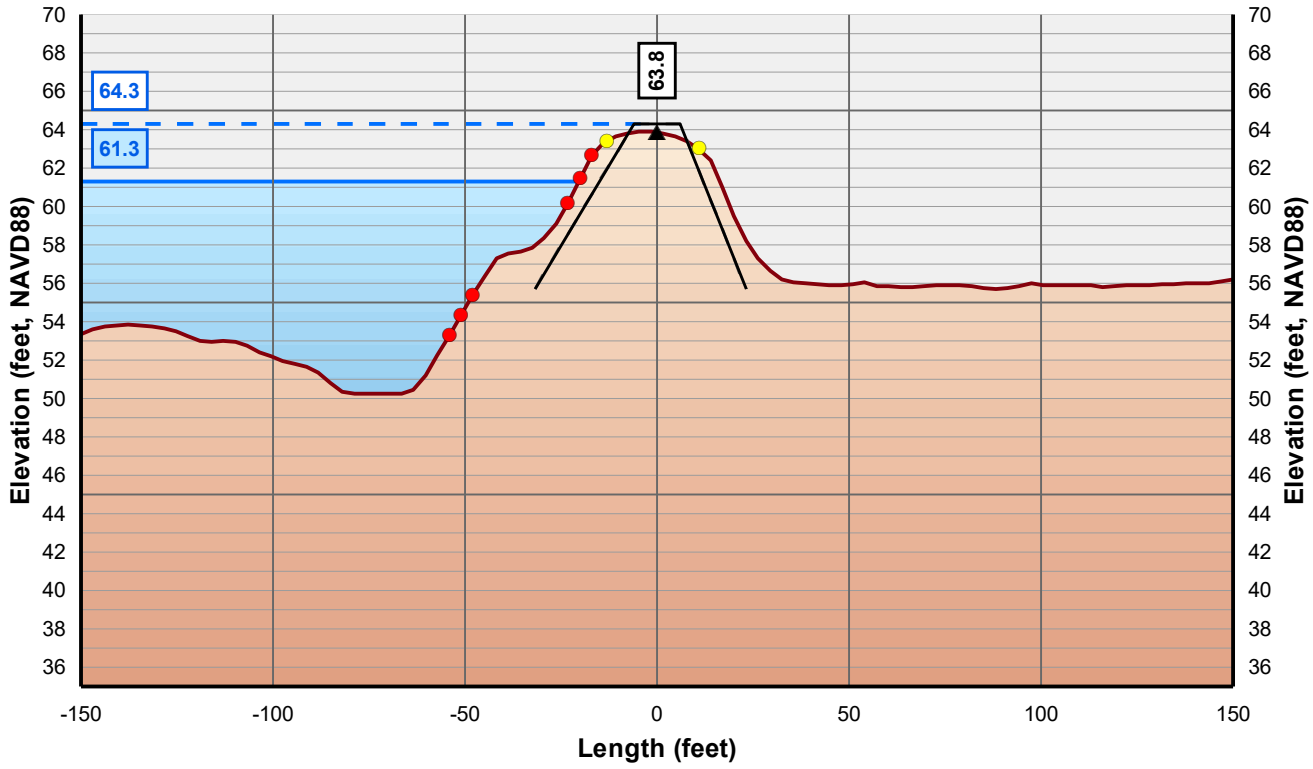
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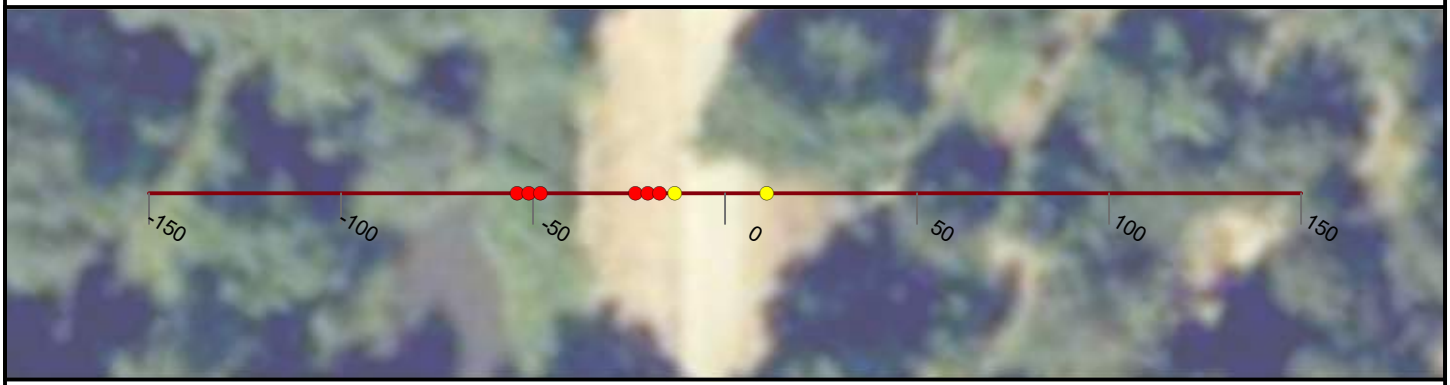
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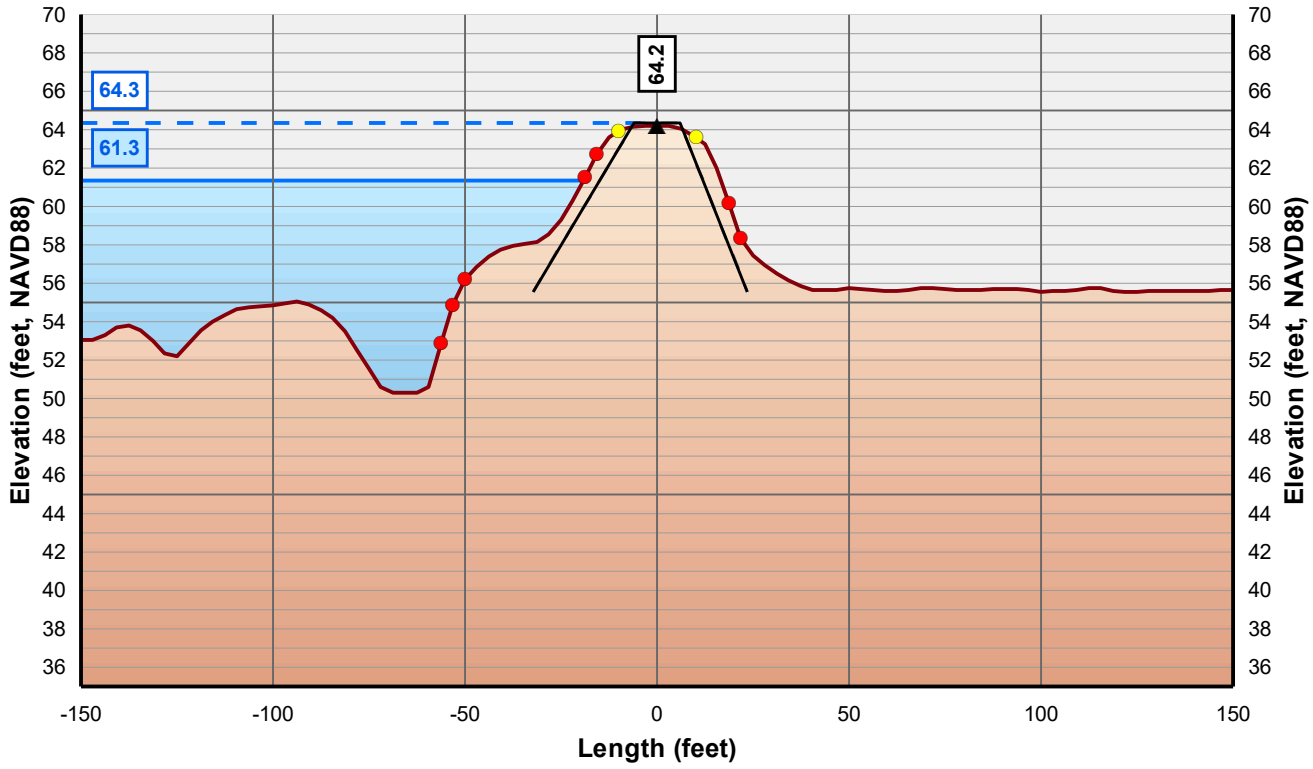
FEET

PRELIMINARY

WOOD RODGERS
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3301 C Street, Bldg 100-B
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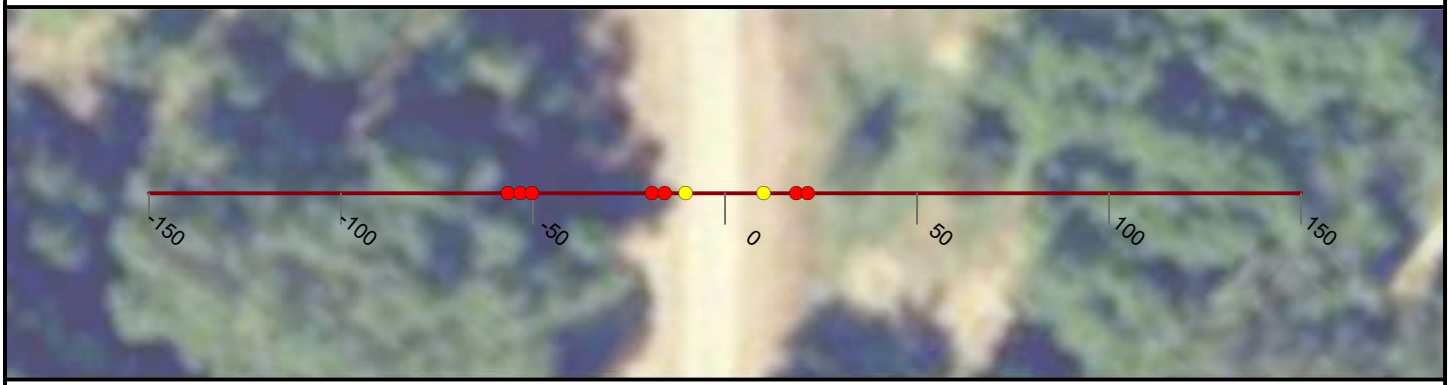
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Cross Section: Yankee Slough 128+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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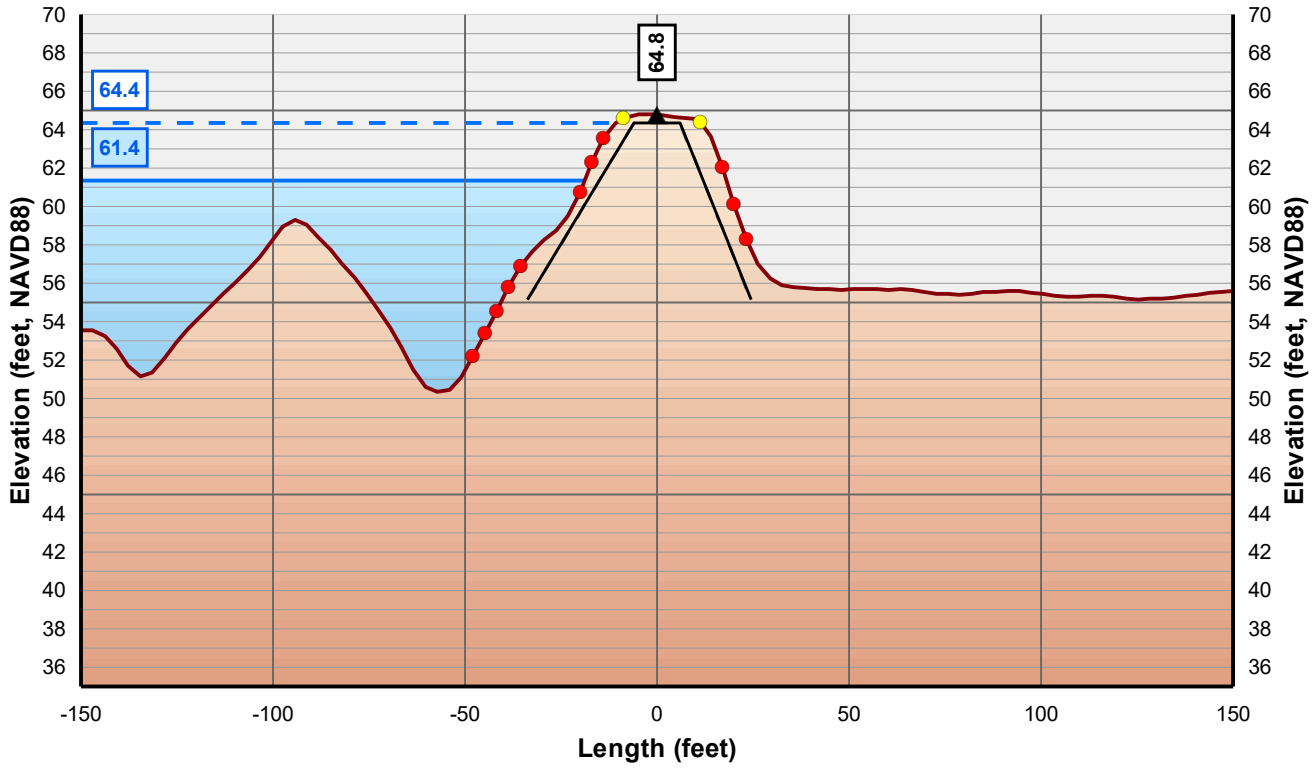
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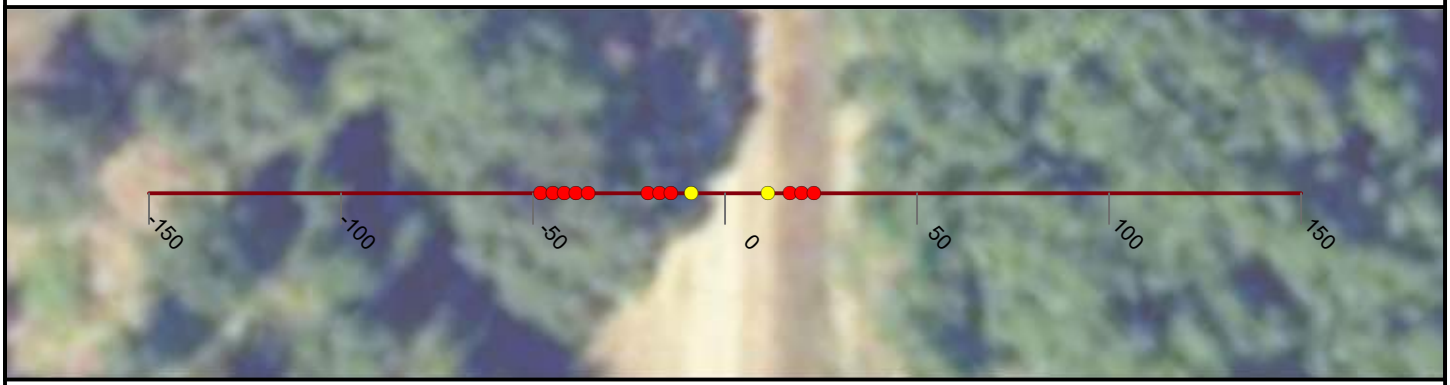
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Cross Section: Yankee Slough 129+00



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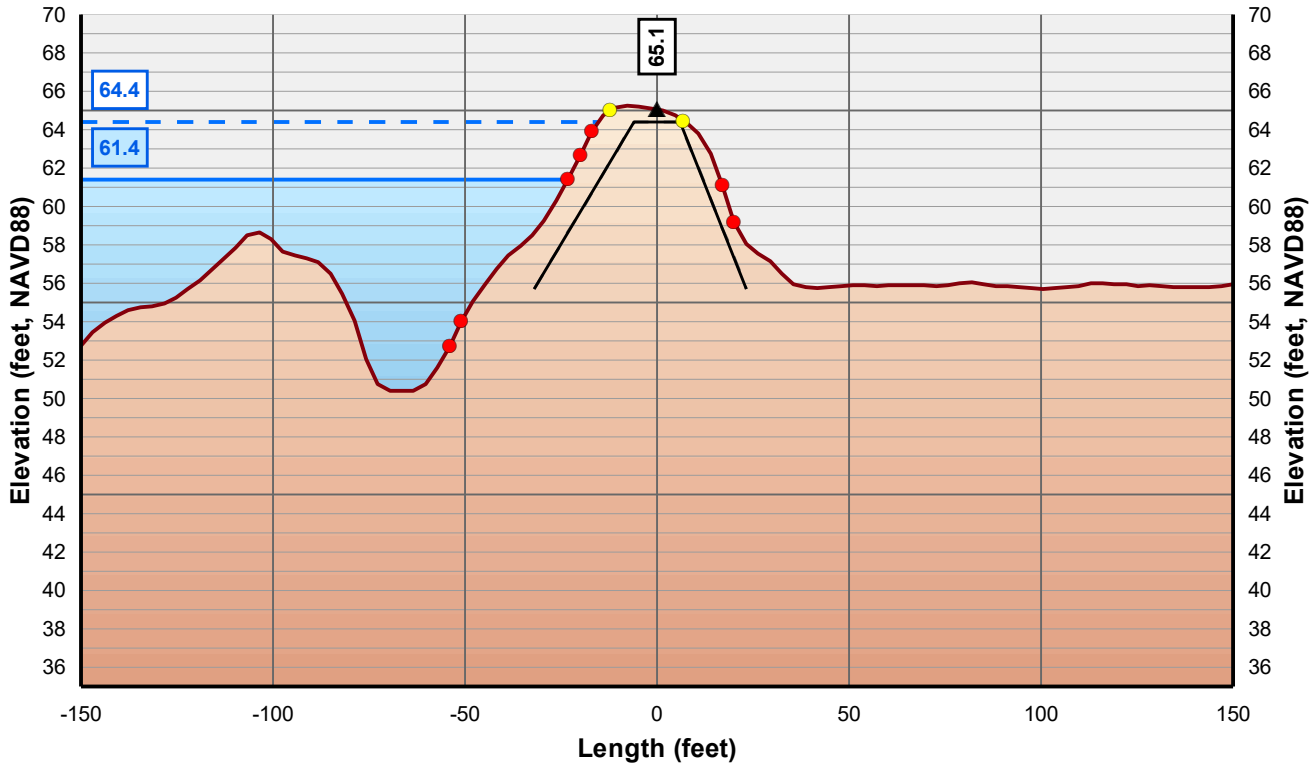
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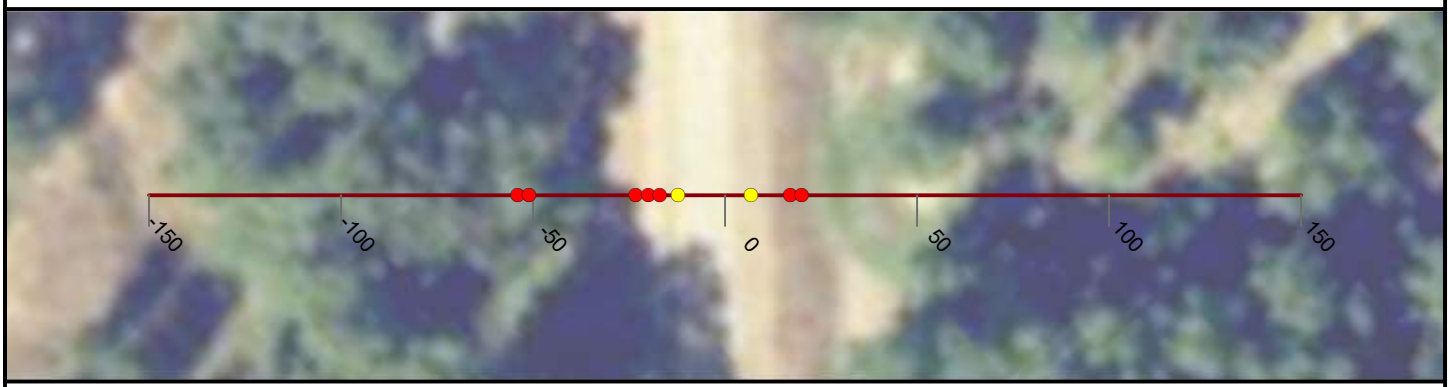
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Cross Section: Yankee Slough 130+00



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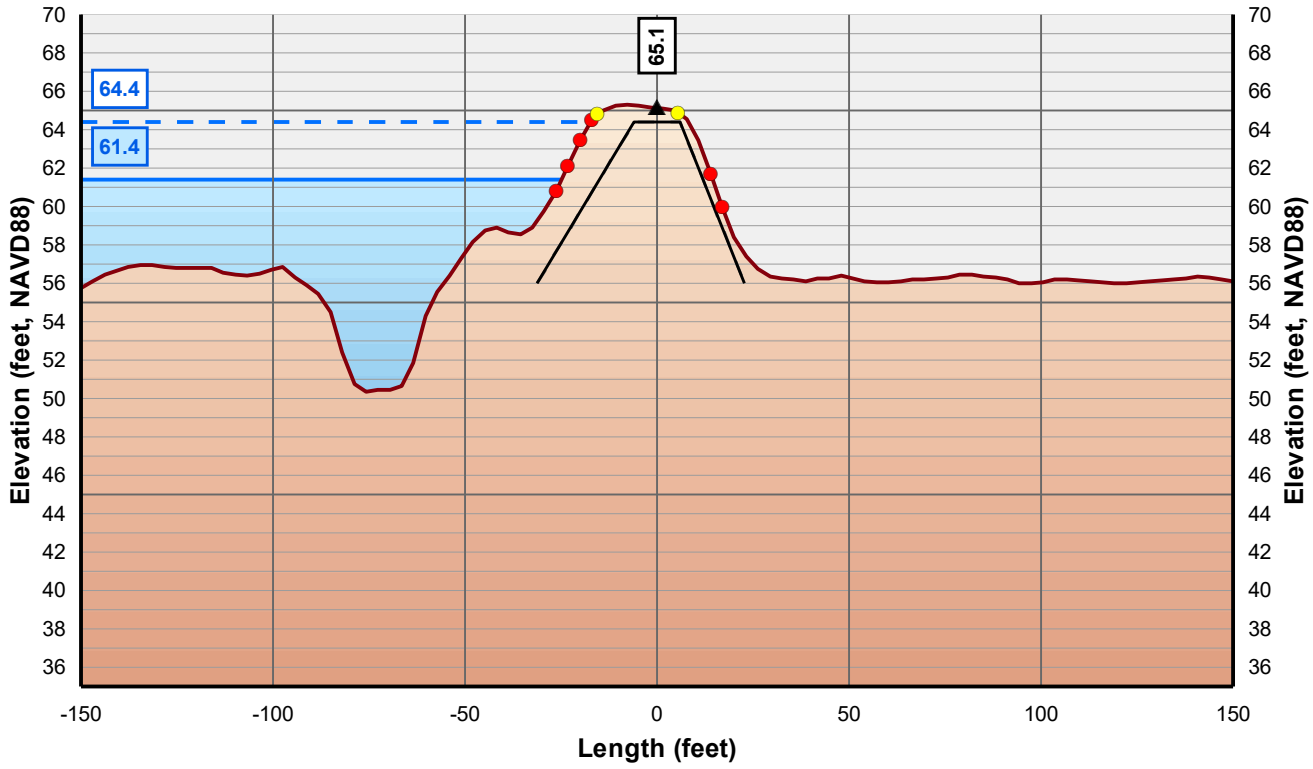
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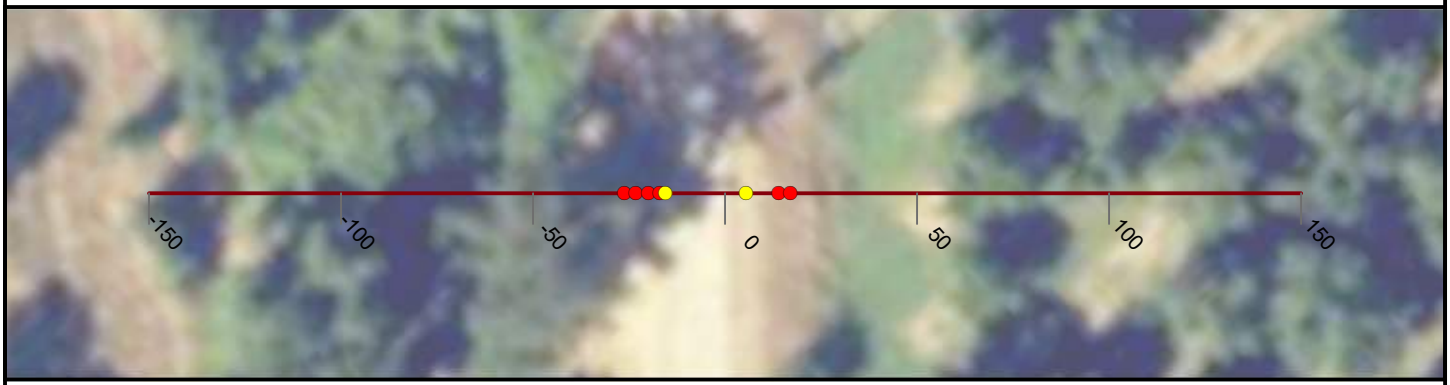
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Cross Section: Yankee Slough 131+00



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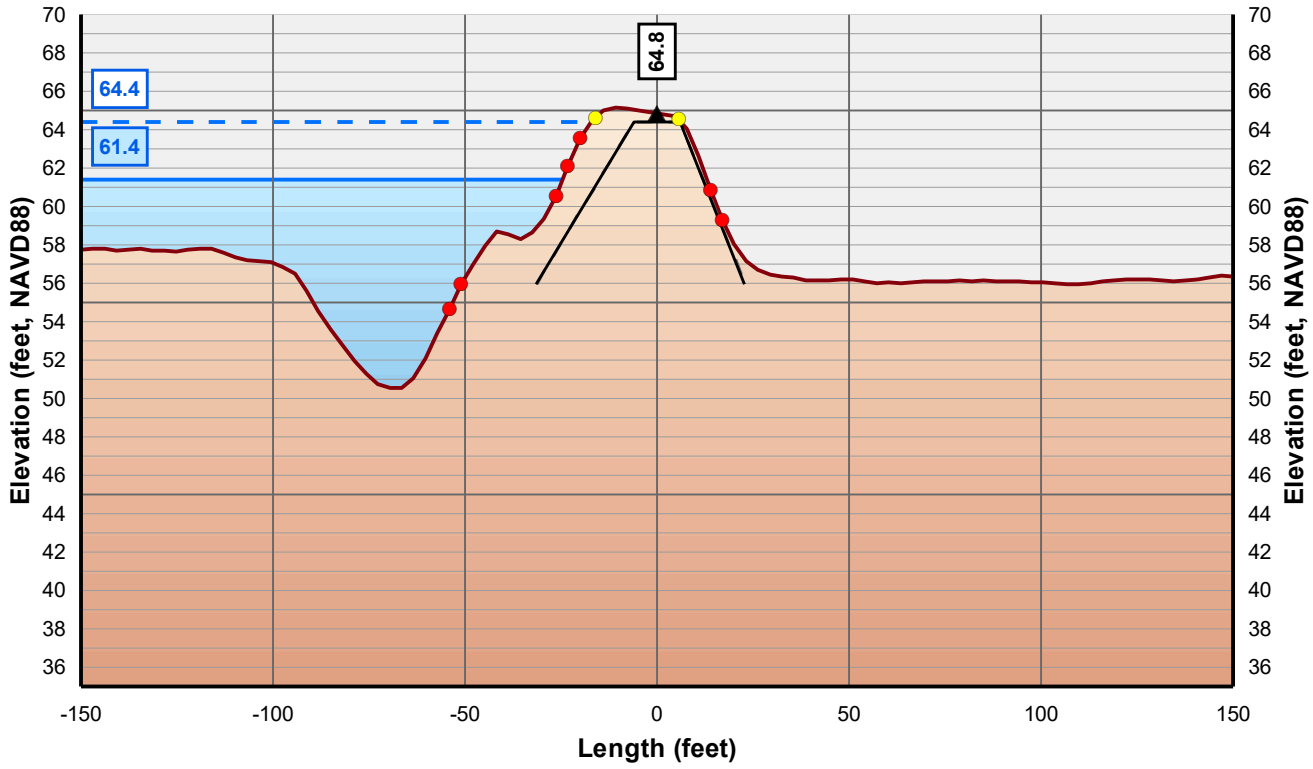
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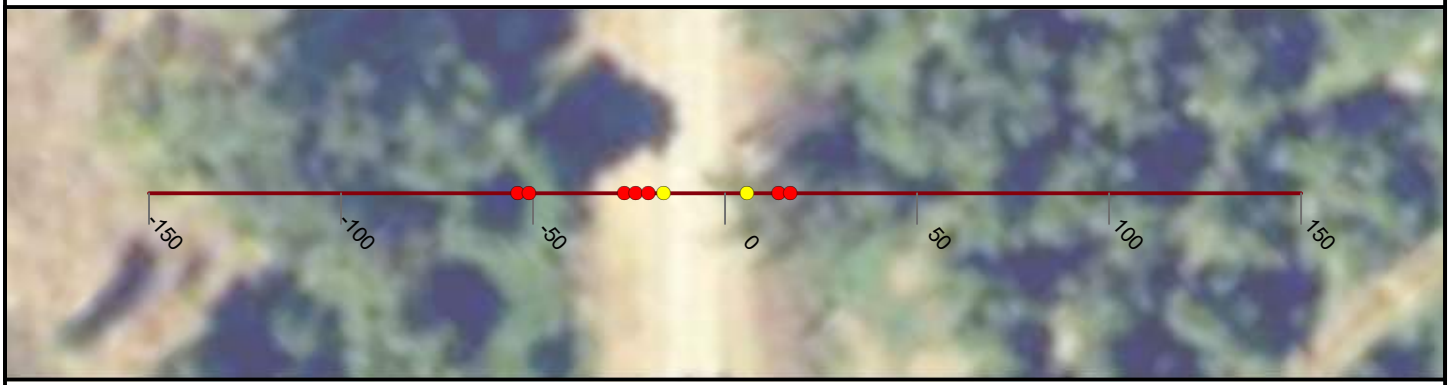
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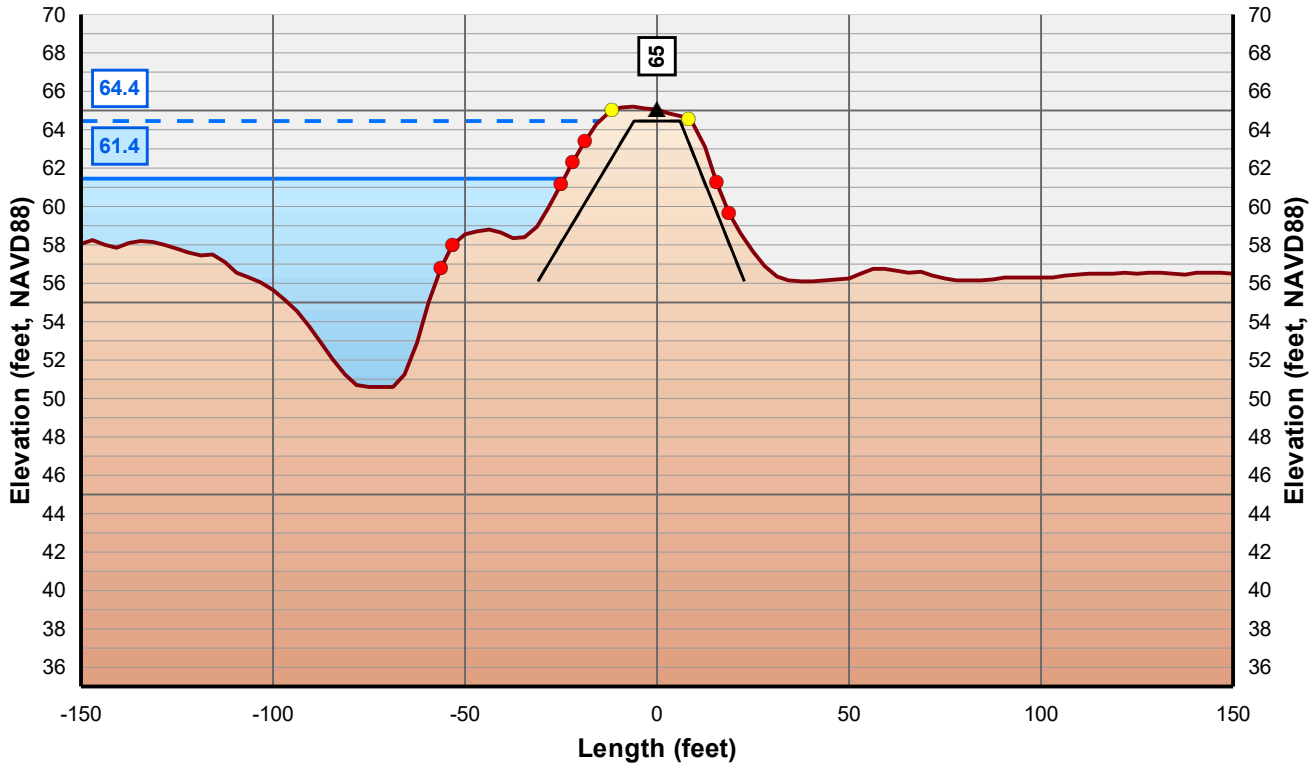
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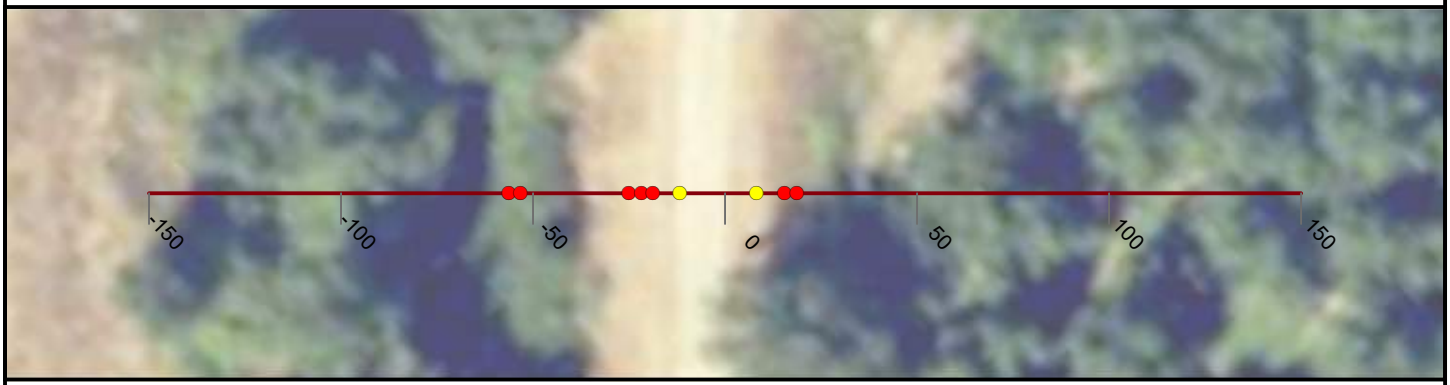
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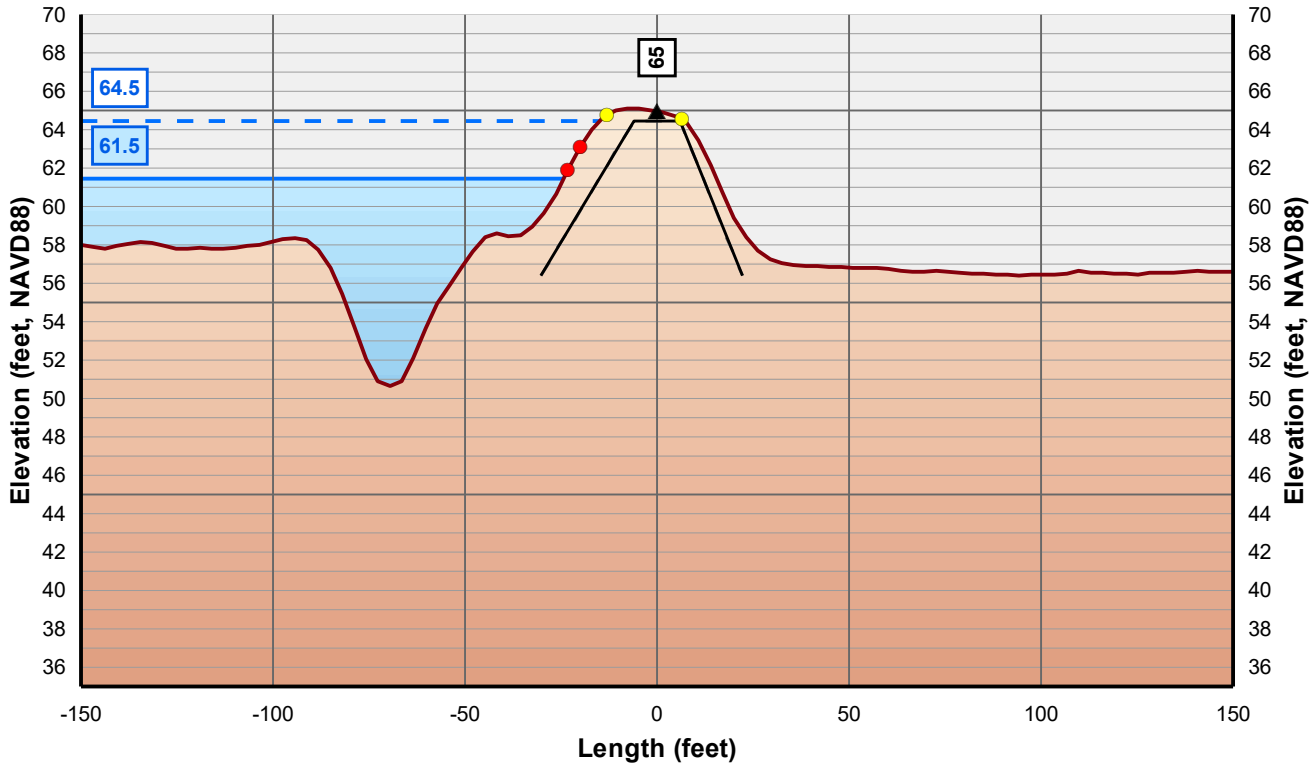
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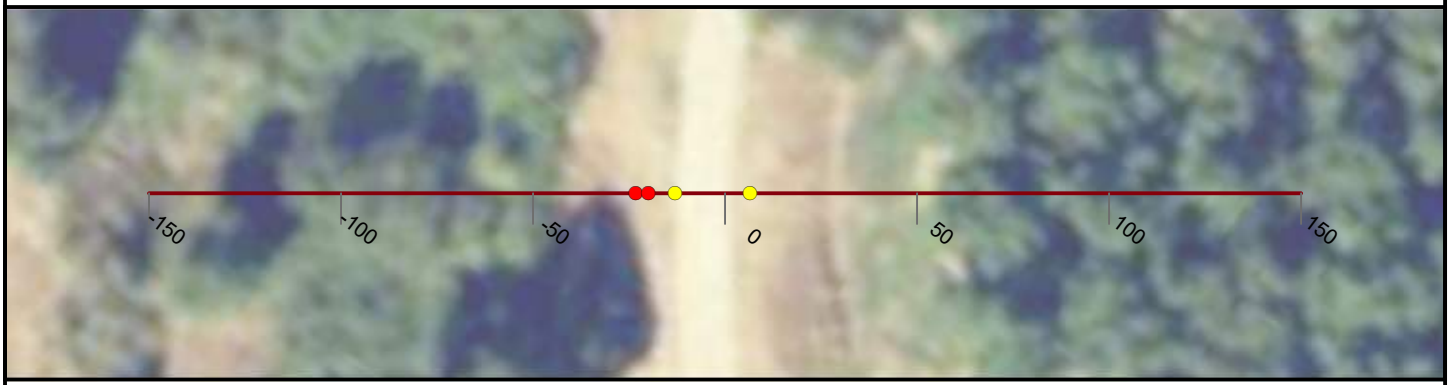
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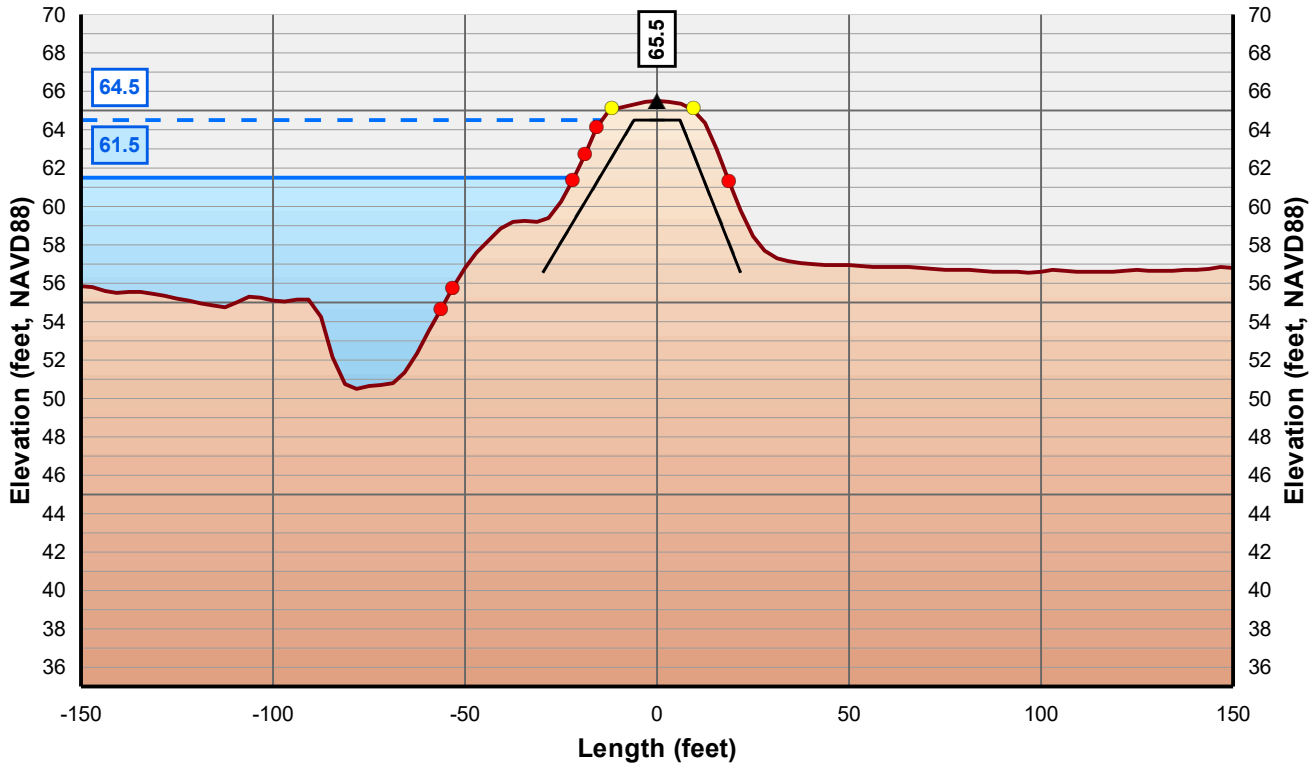
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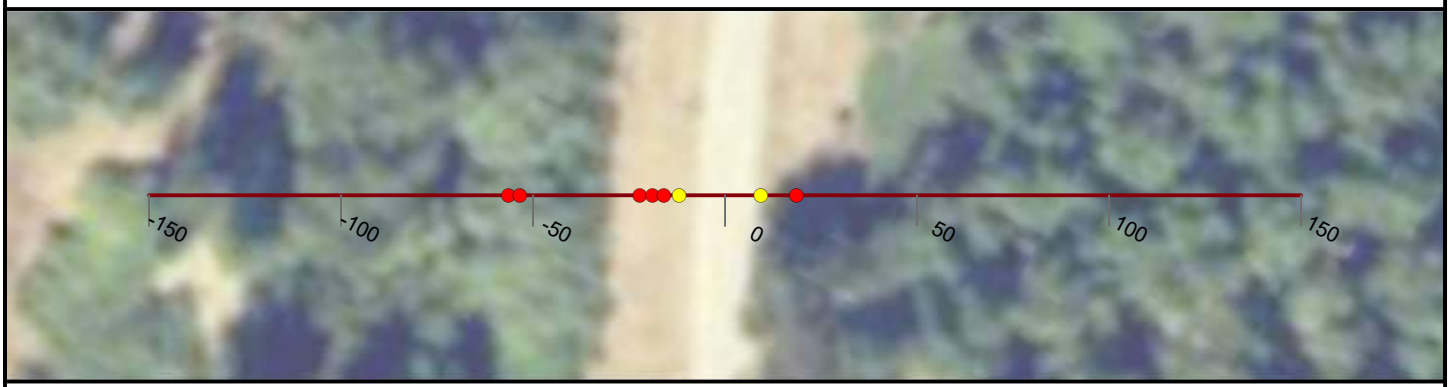
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Cross Section: Yankee Slough 135+00



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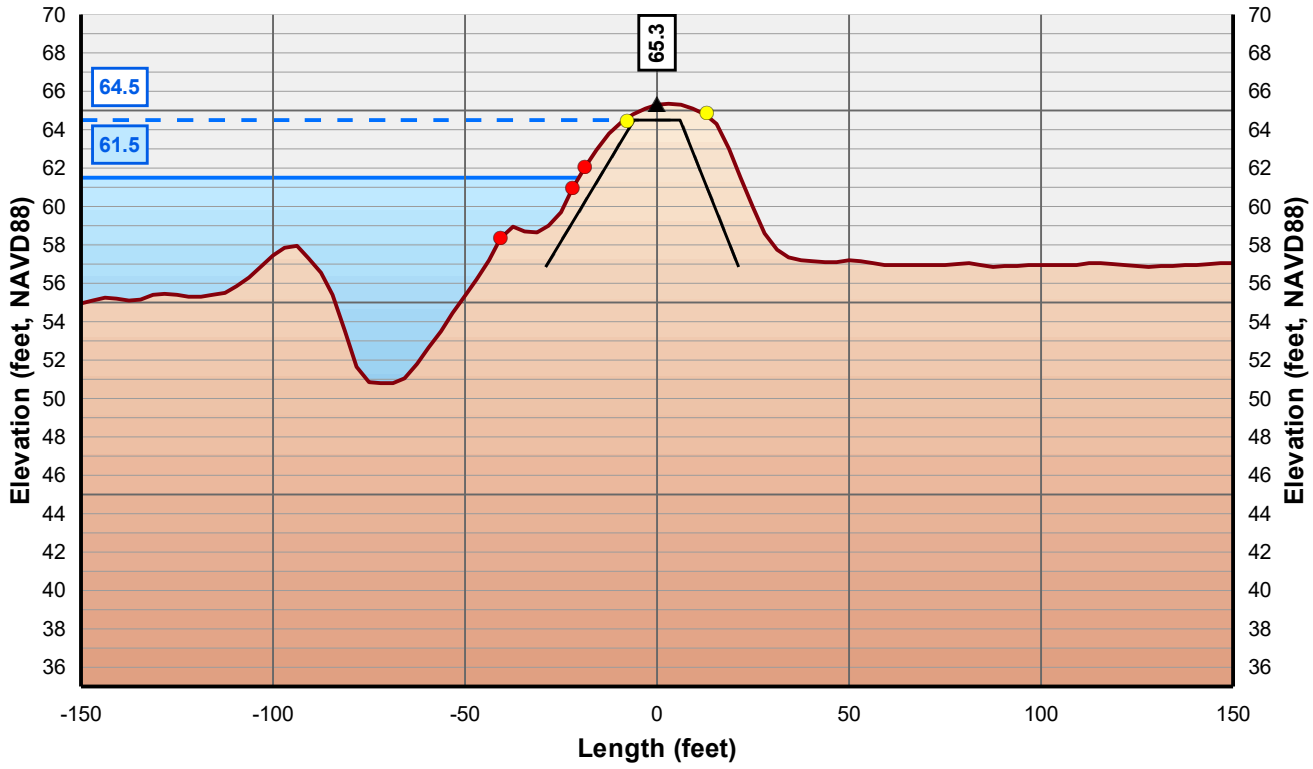
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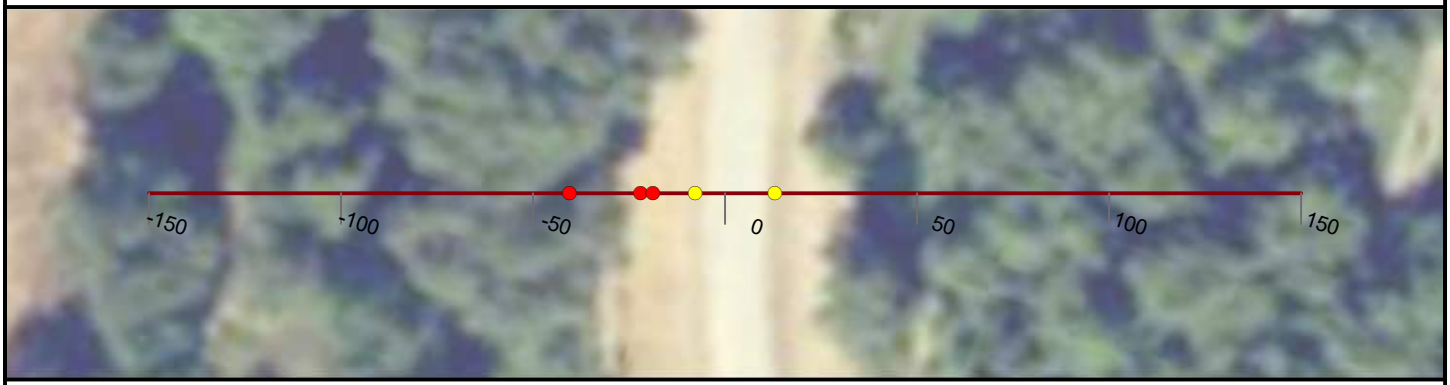
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Cross Section: Yankee Slough 136+00



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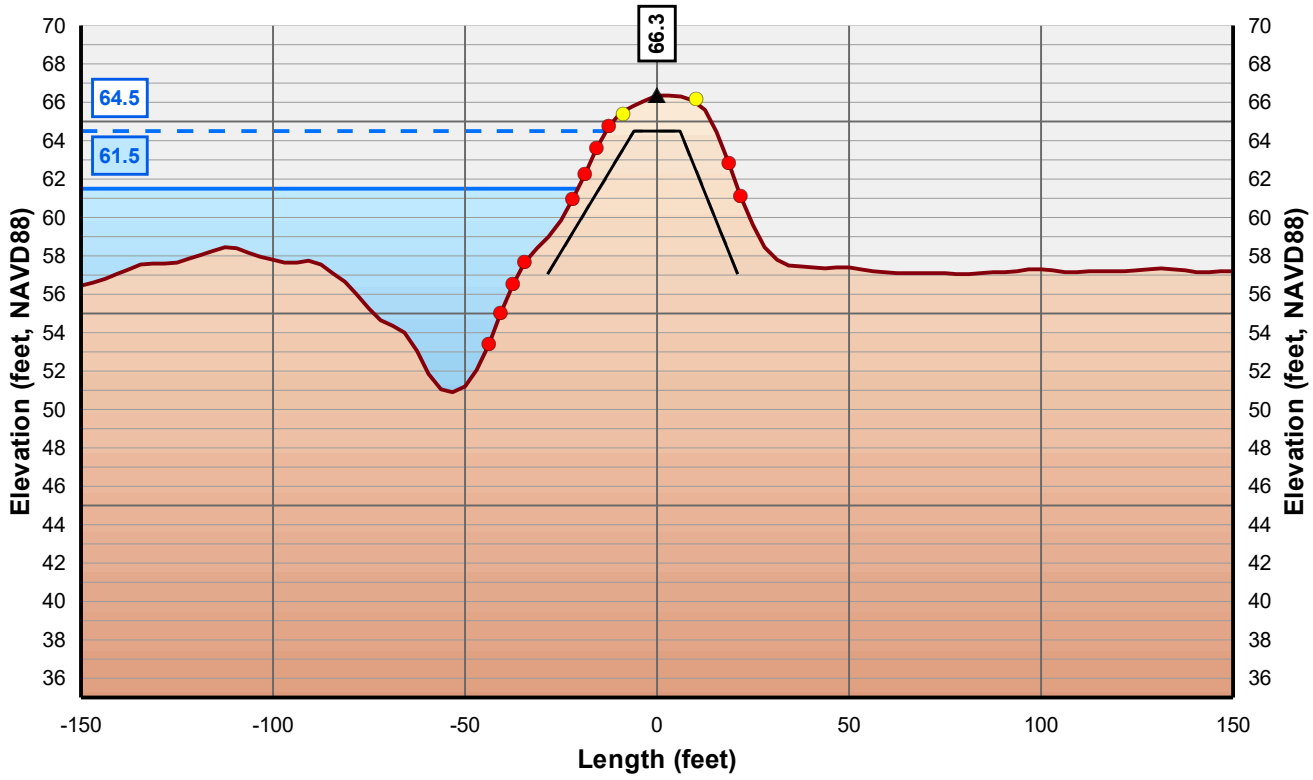
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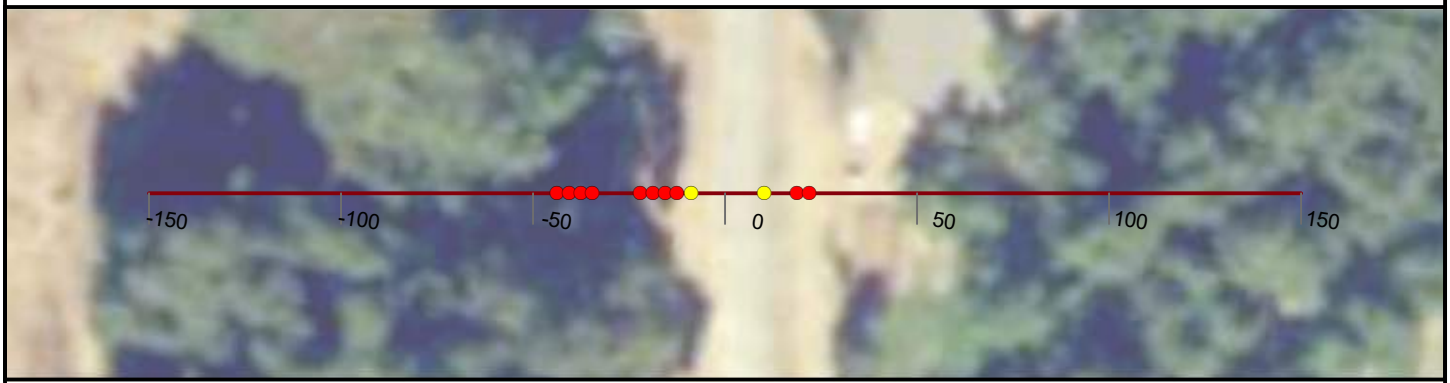
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Cross Section: Yankee Slough 137+00



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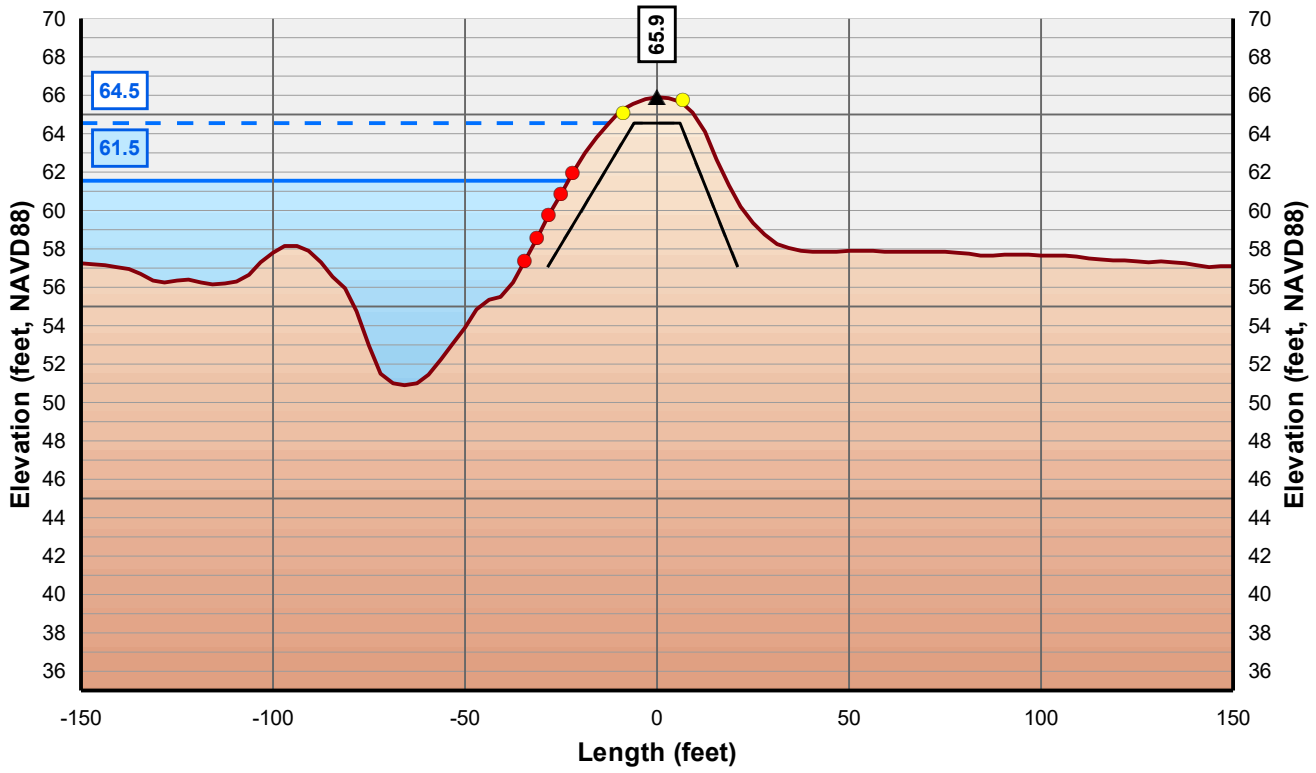
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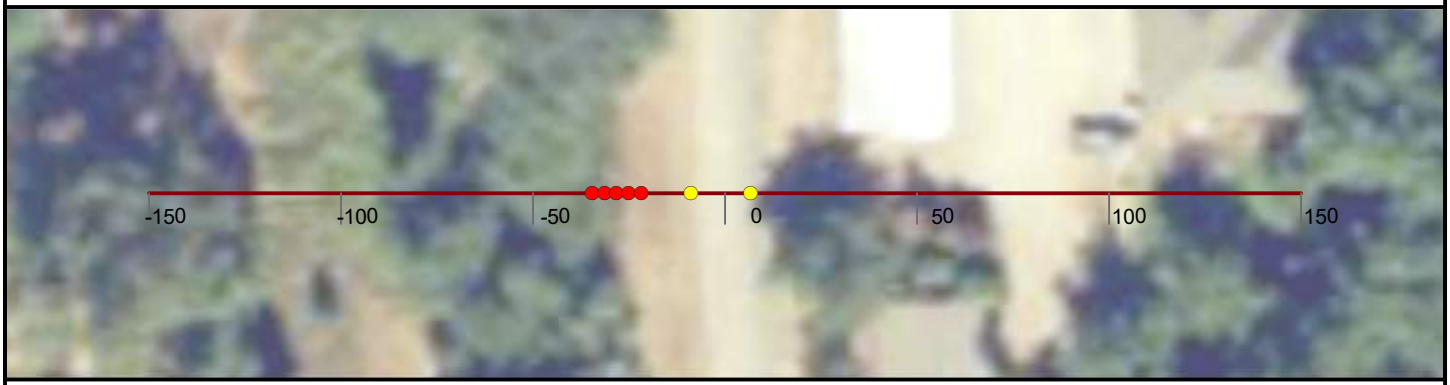
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Cross Section: Yankee Slough 138+00



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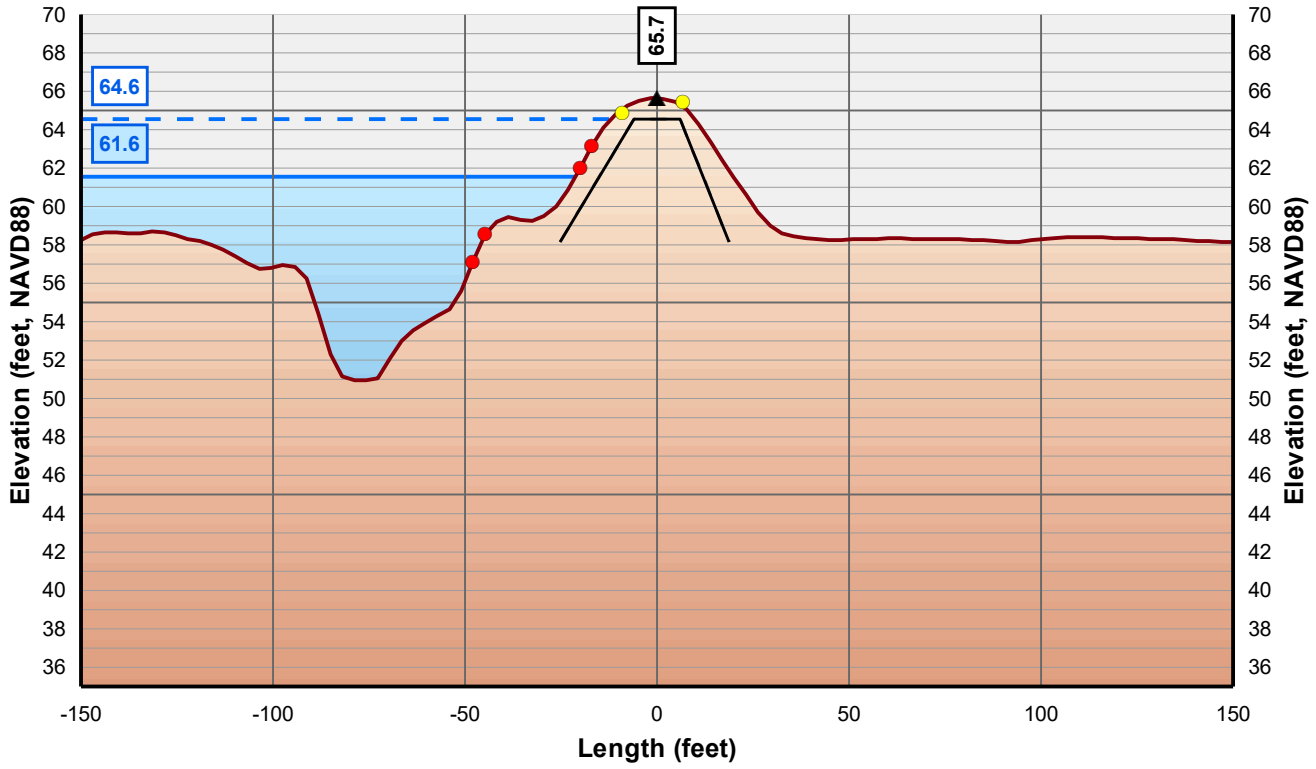
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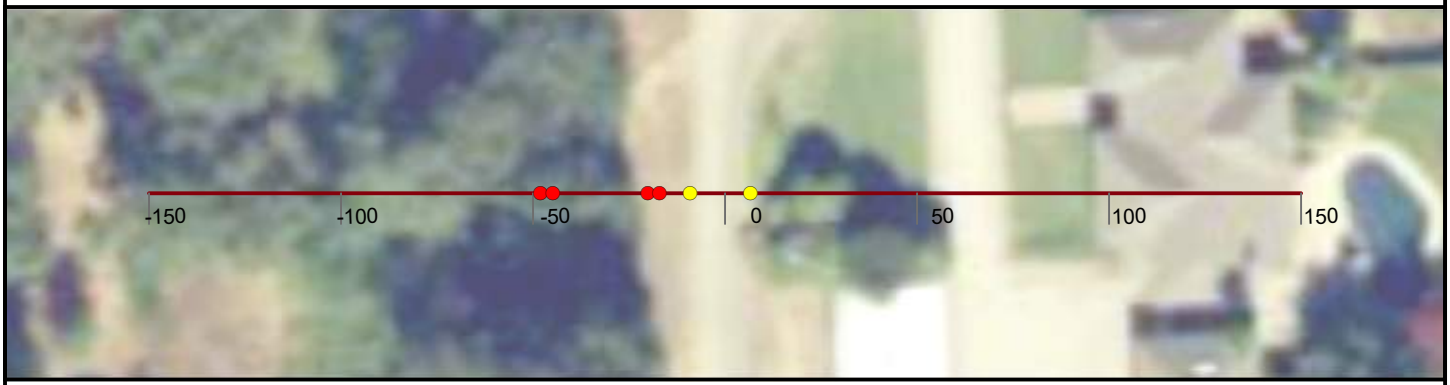
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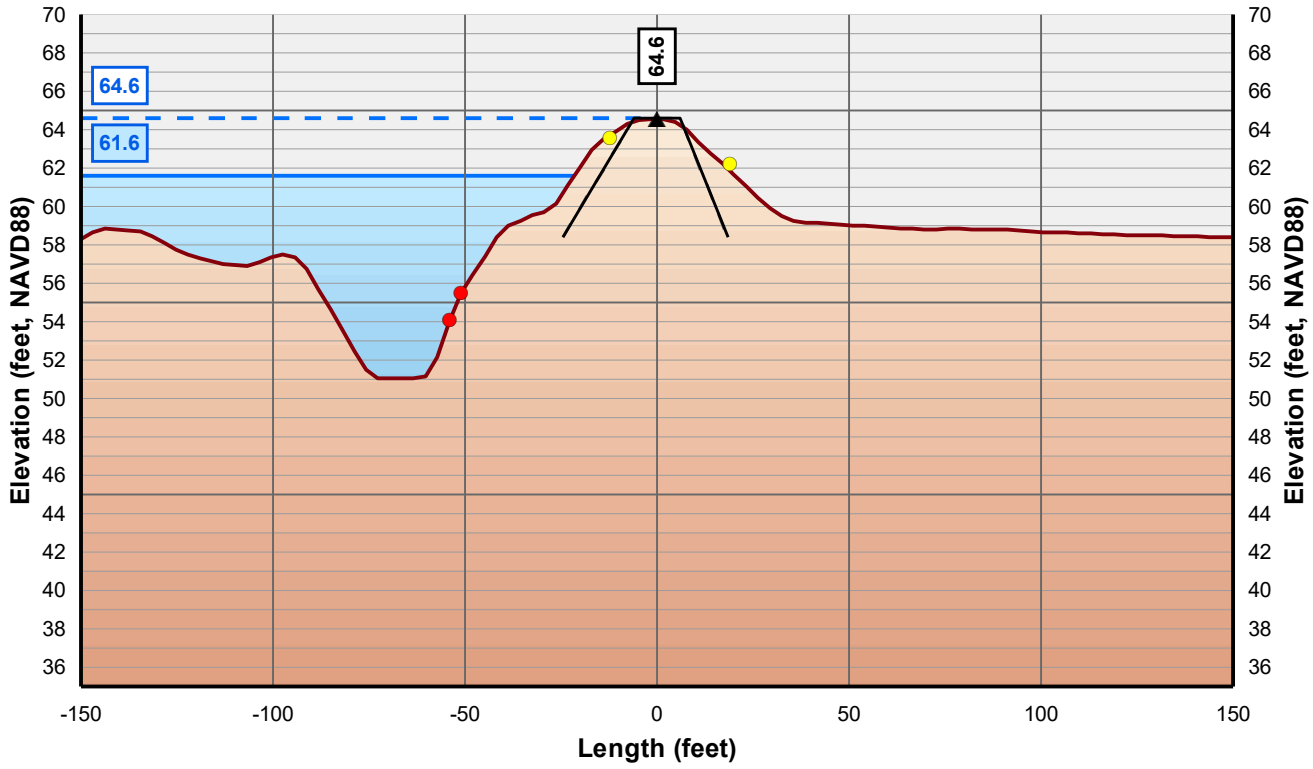
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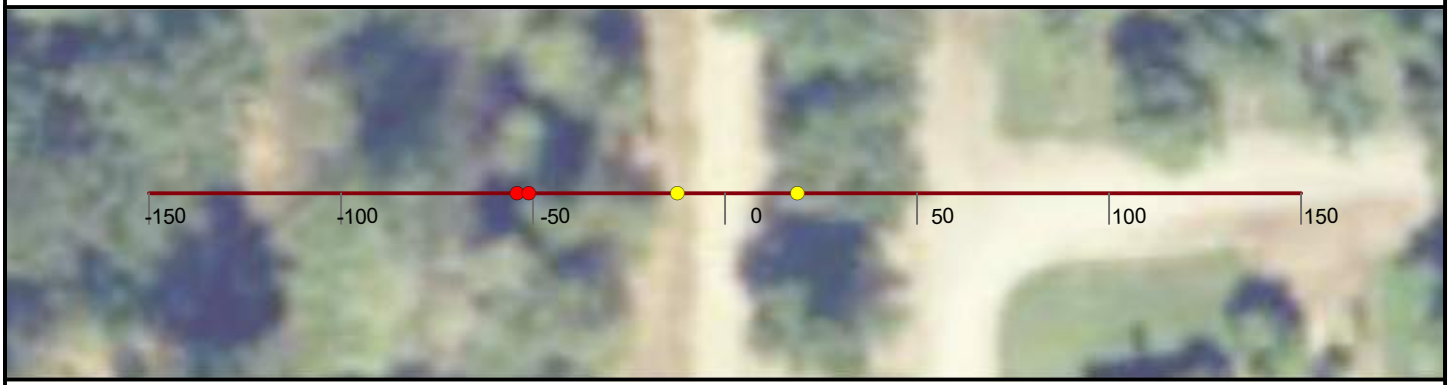
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Cross Section: Yankee Slough 140+00



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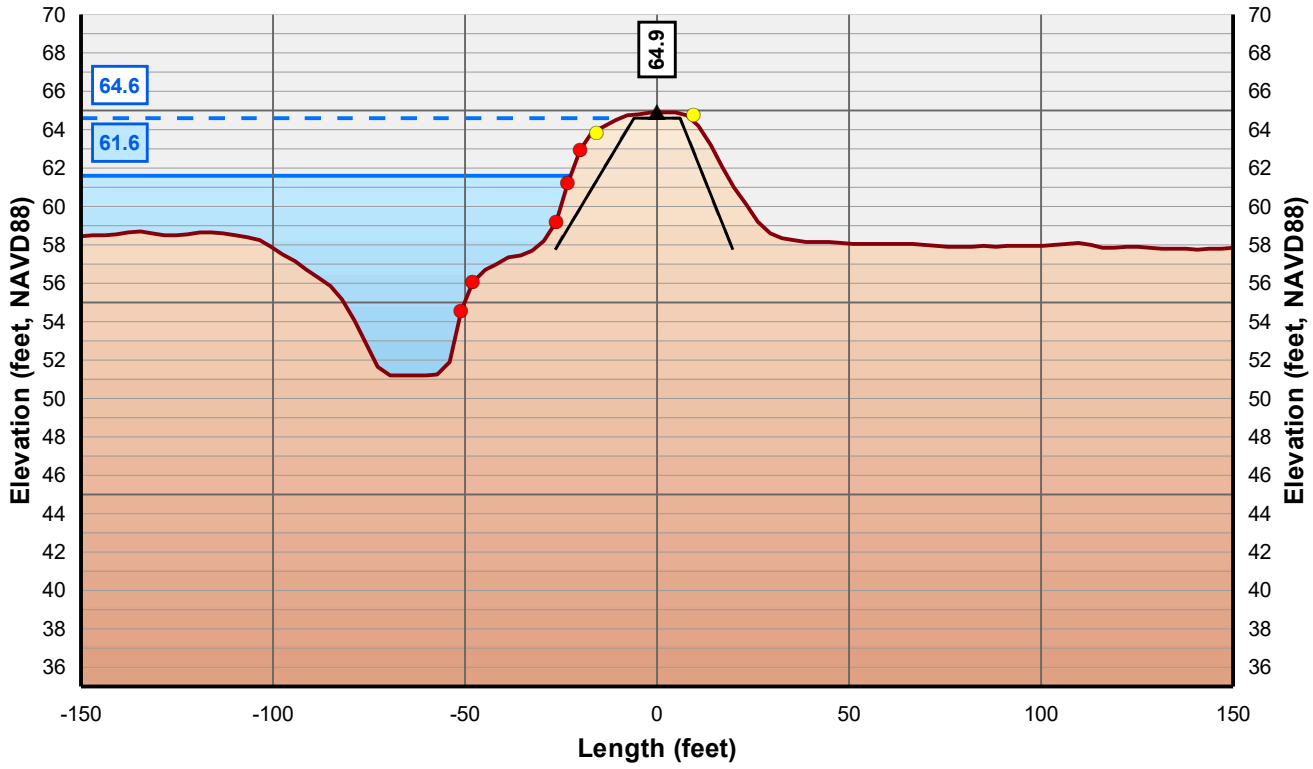
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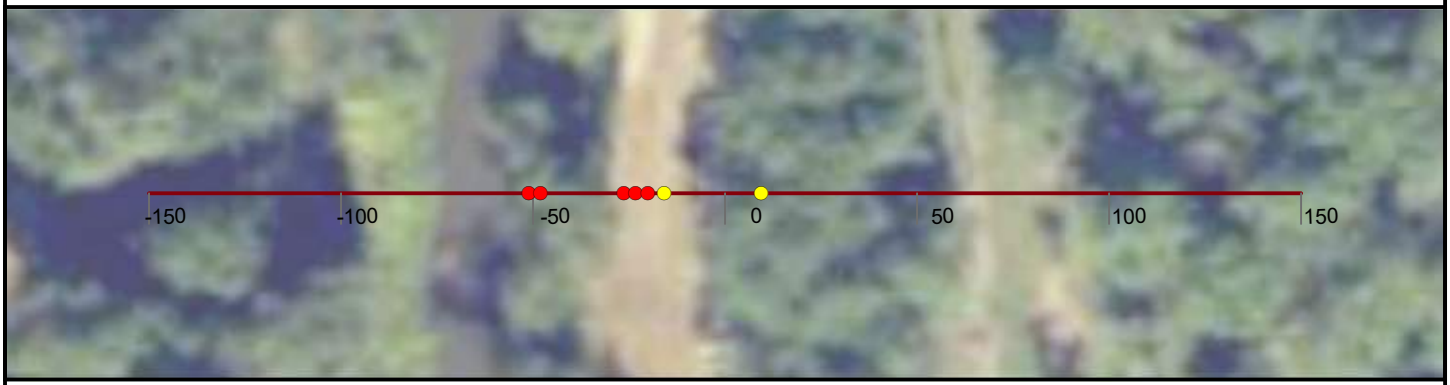
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Cross Section: Yankee Slough 141+00



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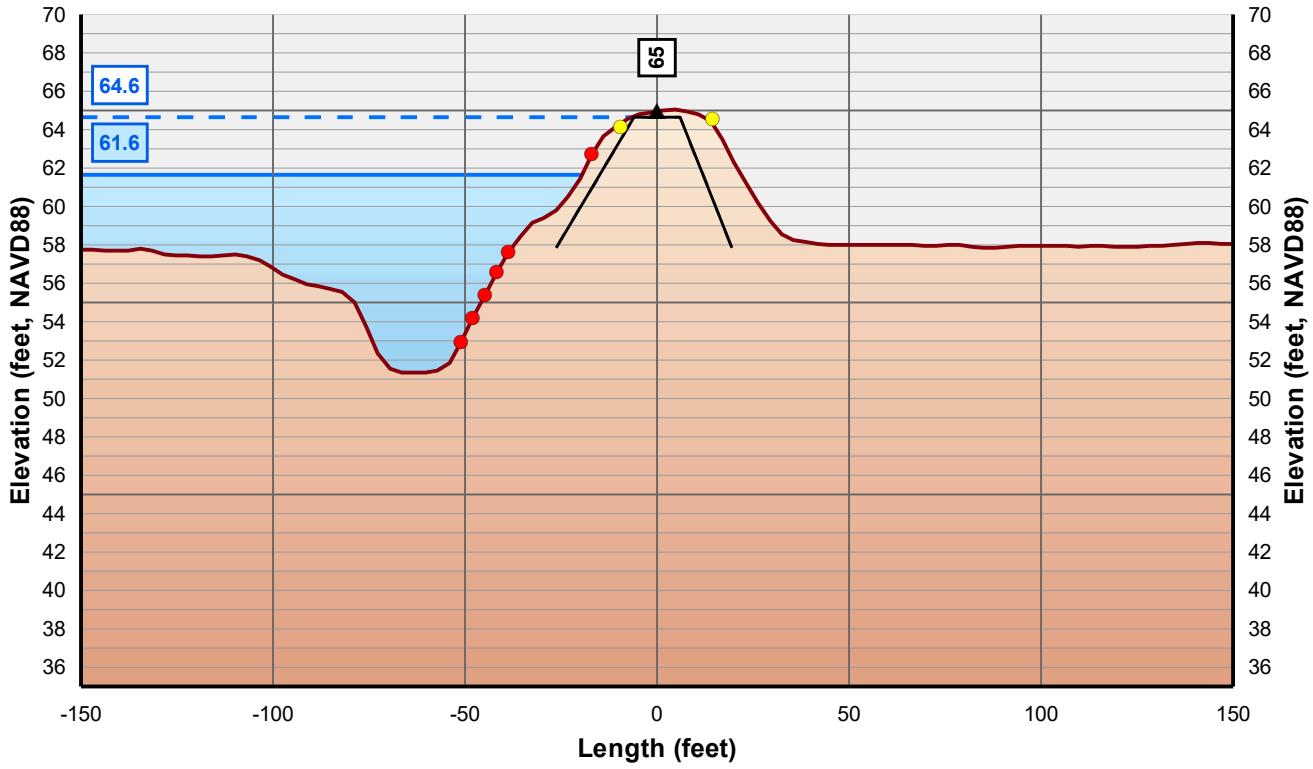
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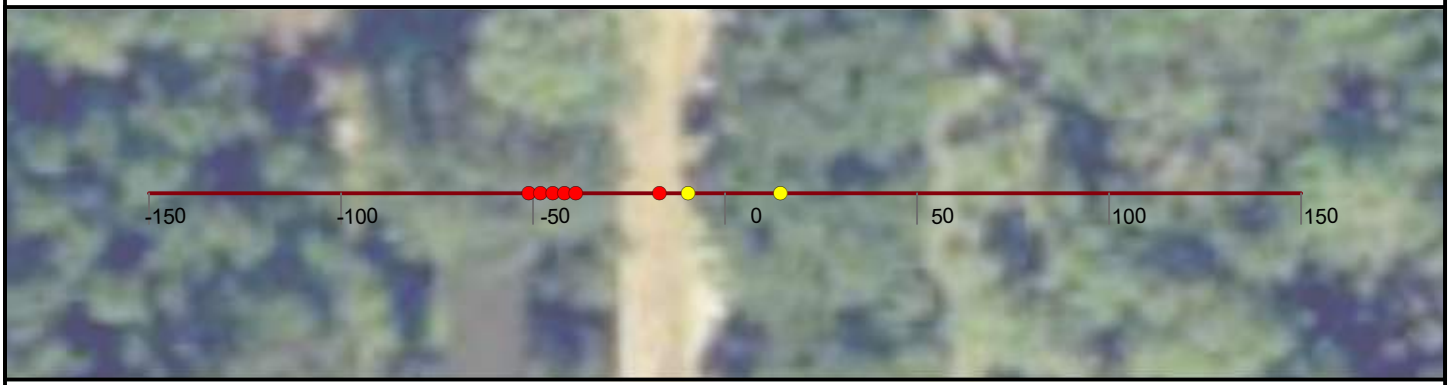
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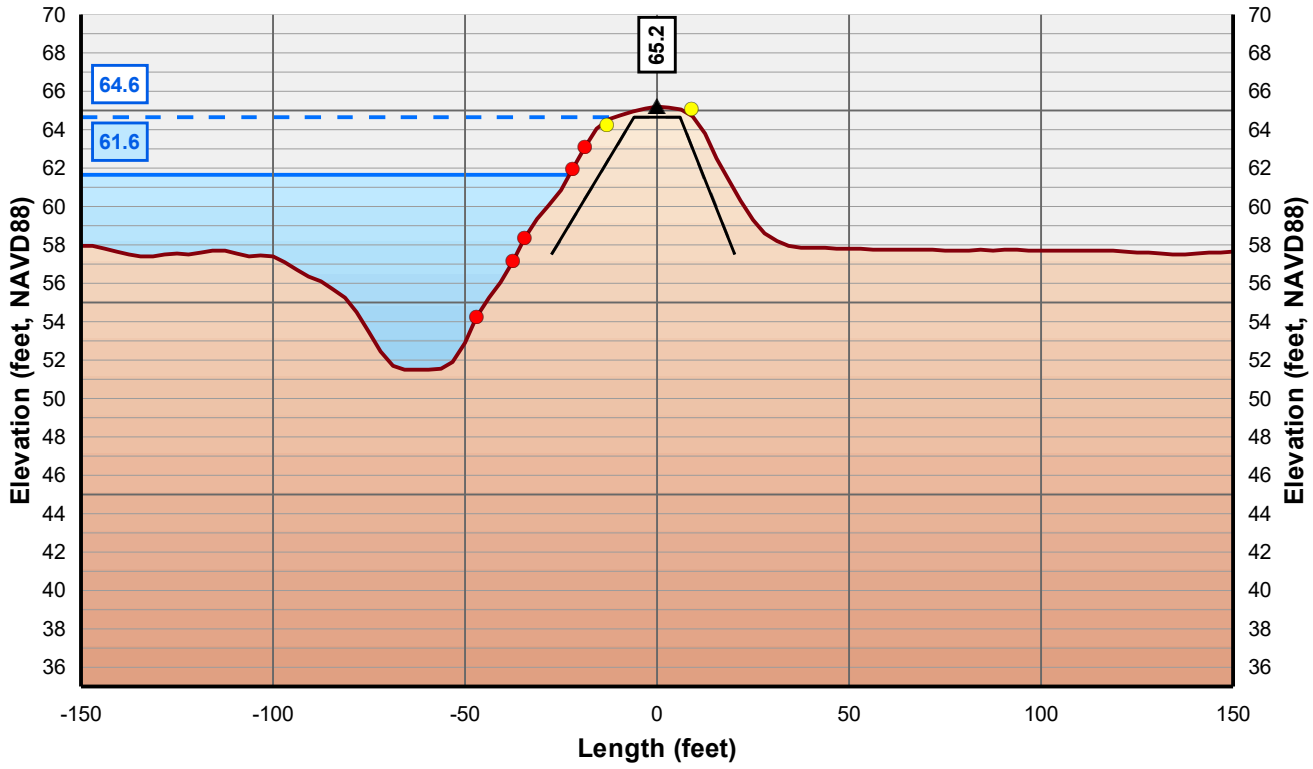
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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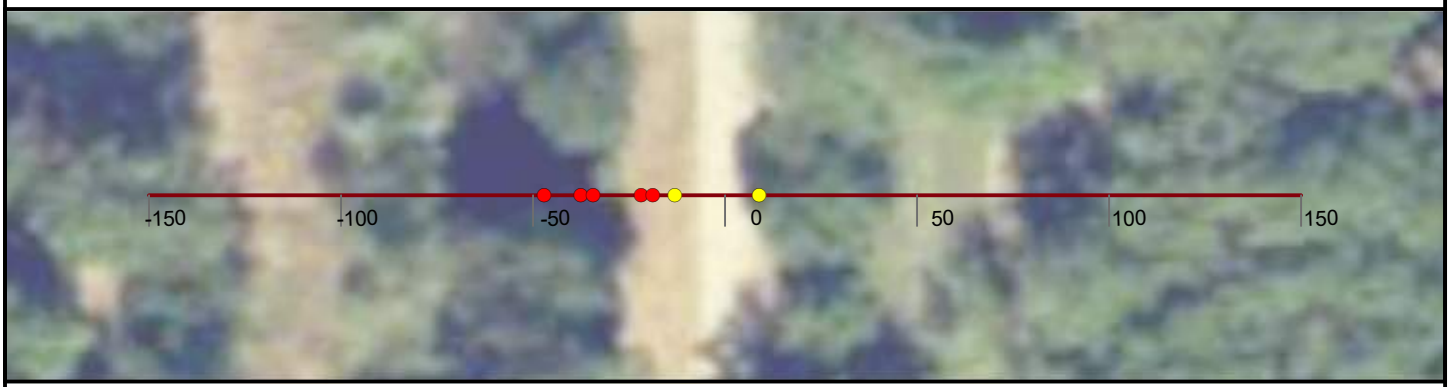
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Cross Section: Yankee Slough 143+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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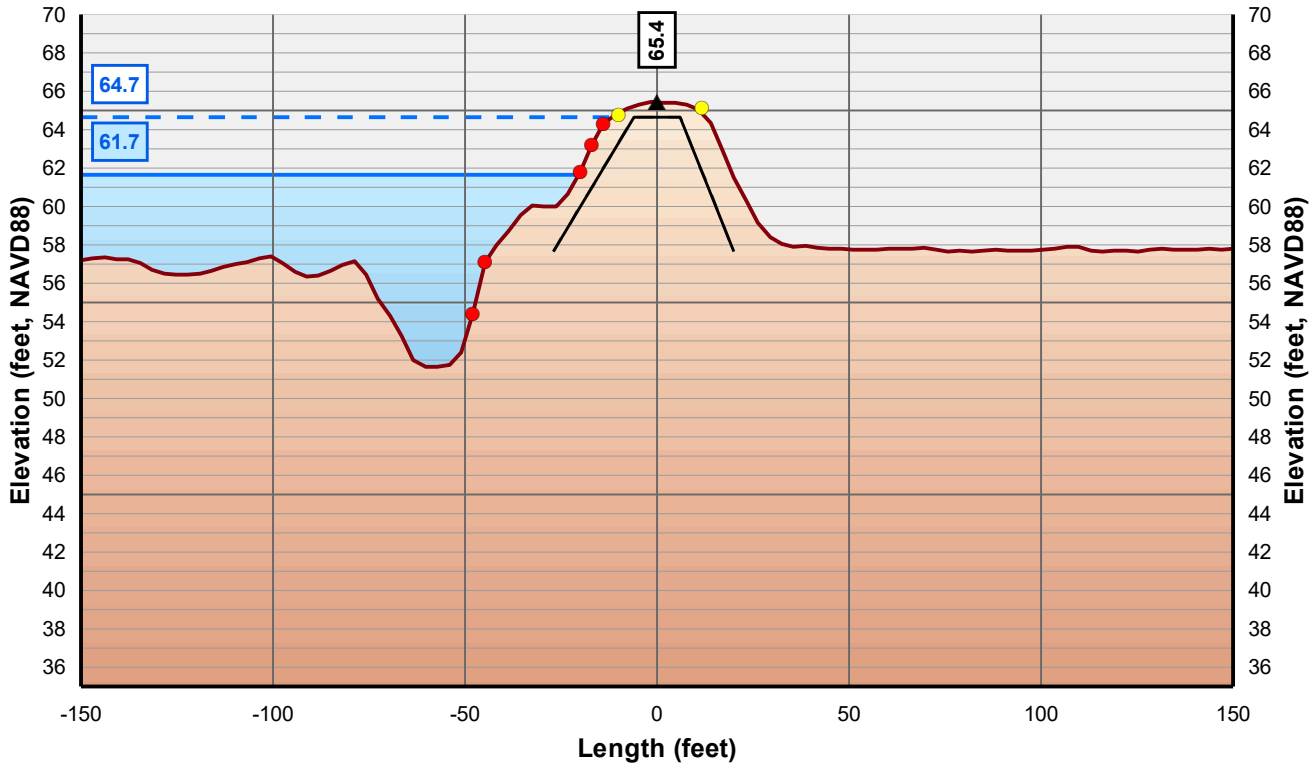
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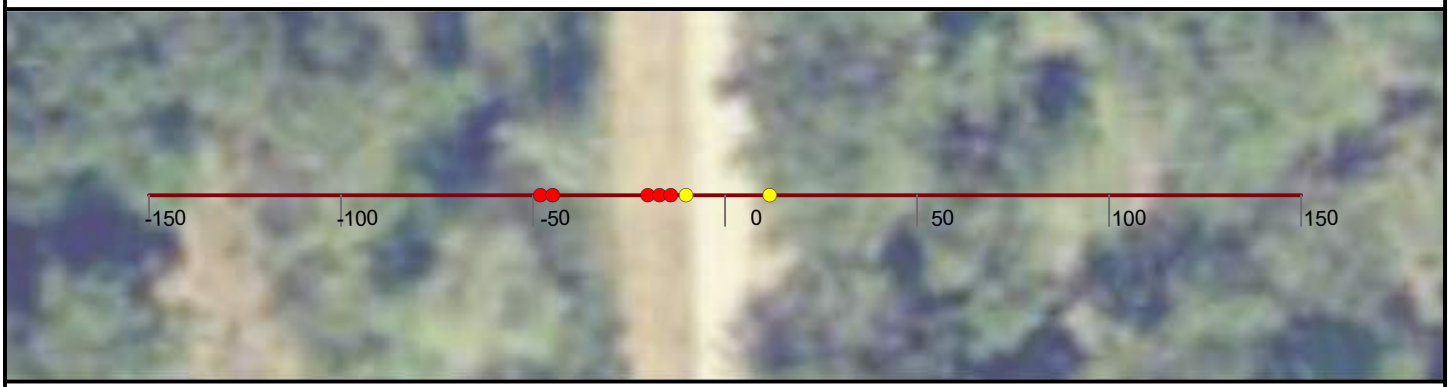
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Cross Section: Yankee Slough 144+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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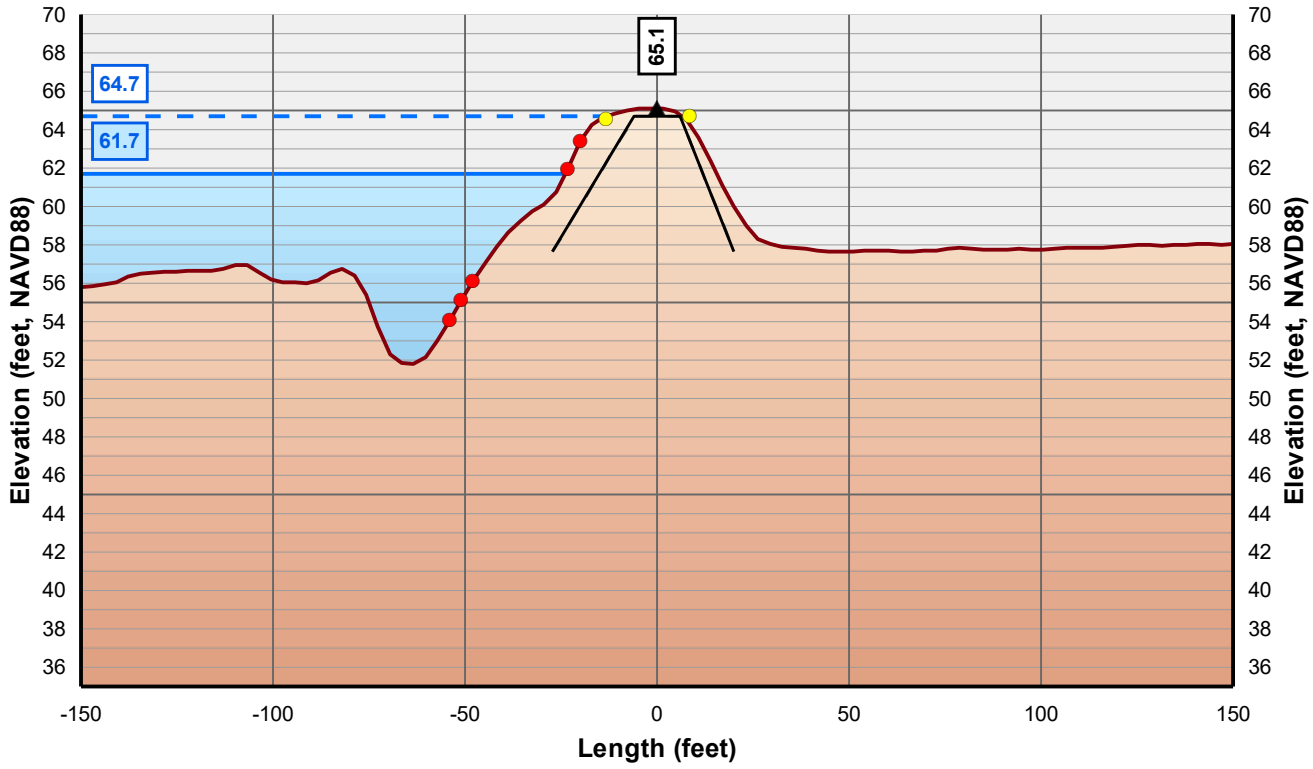
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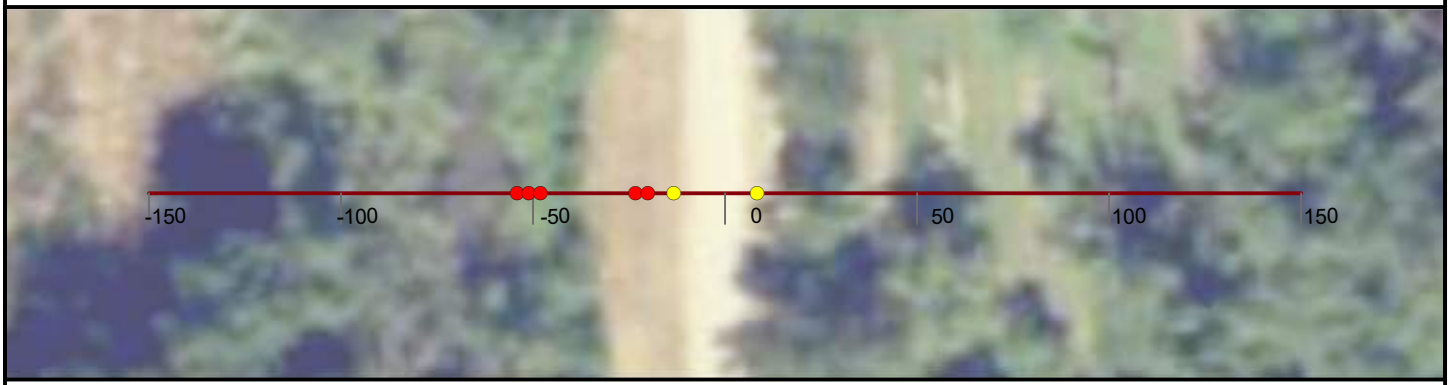
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Cross Section: Yankee Slough 145+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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NORTH

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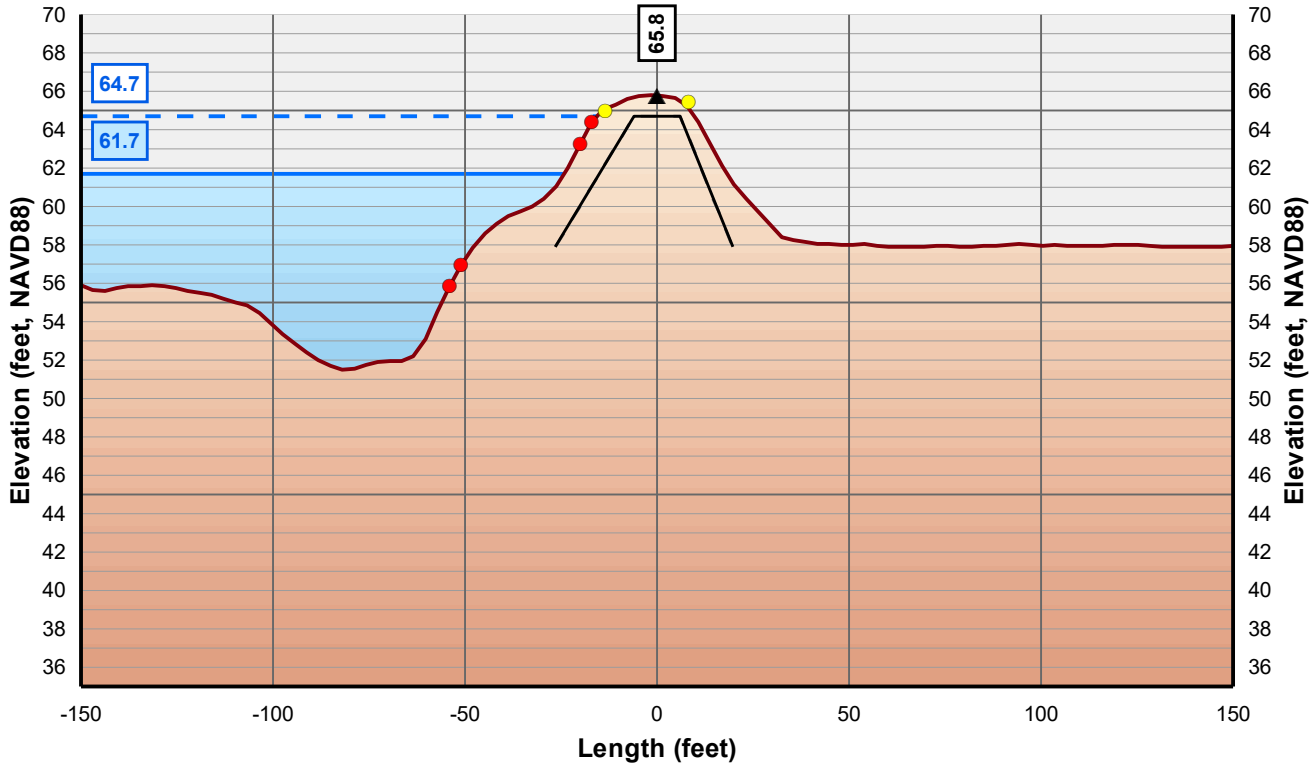
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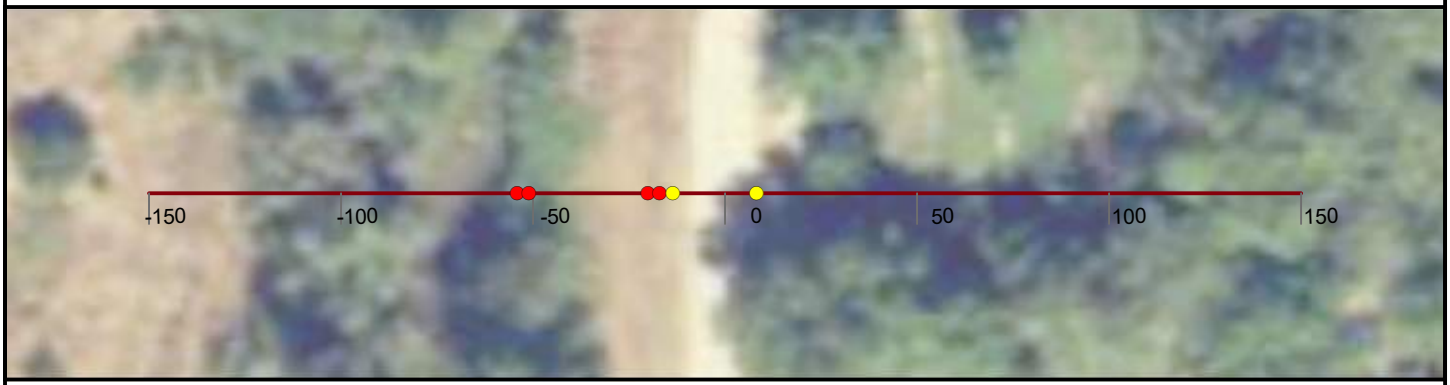
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Cross Section: Yankee Slough 146+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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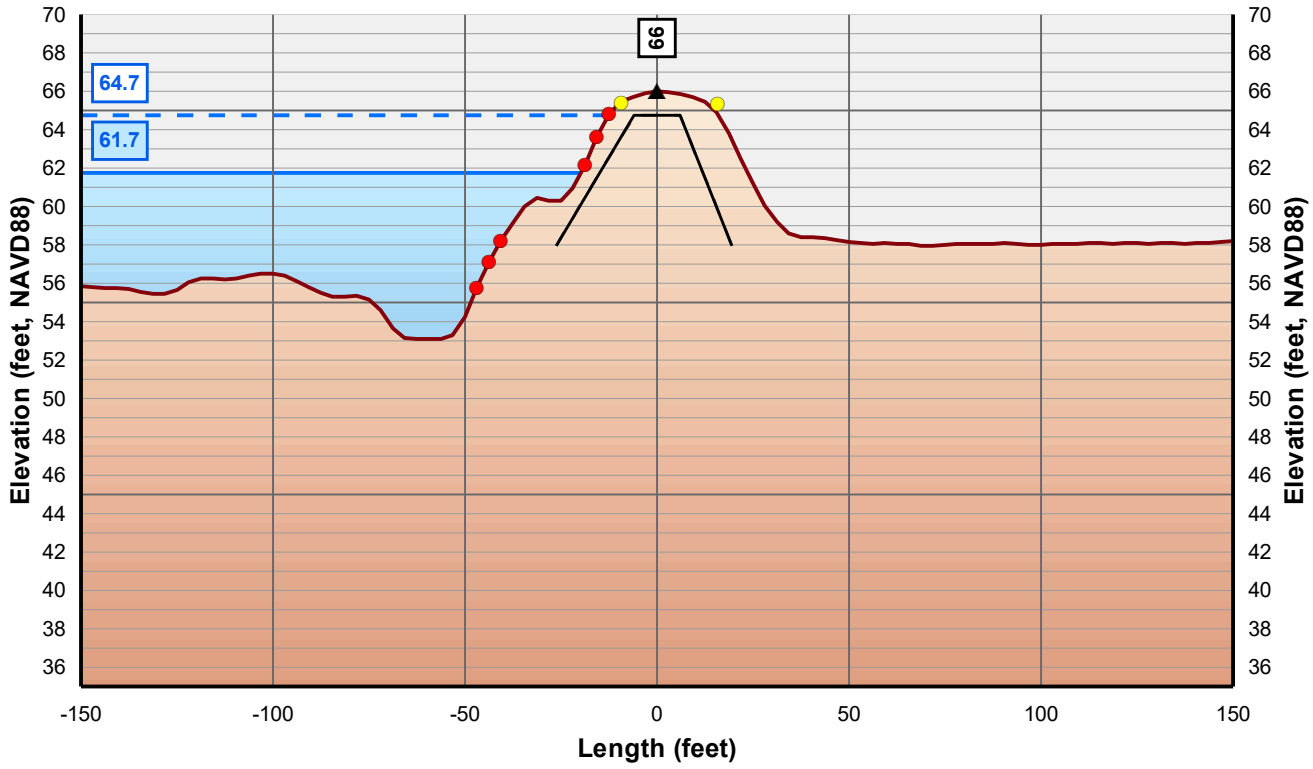
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Cross Section: Yankee Slough 147+00



Horizontal Scale: 1 inch = 50 Feet
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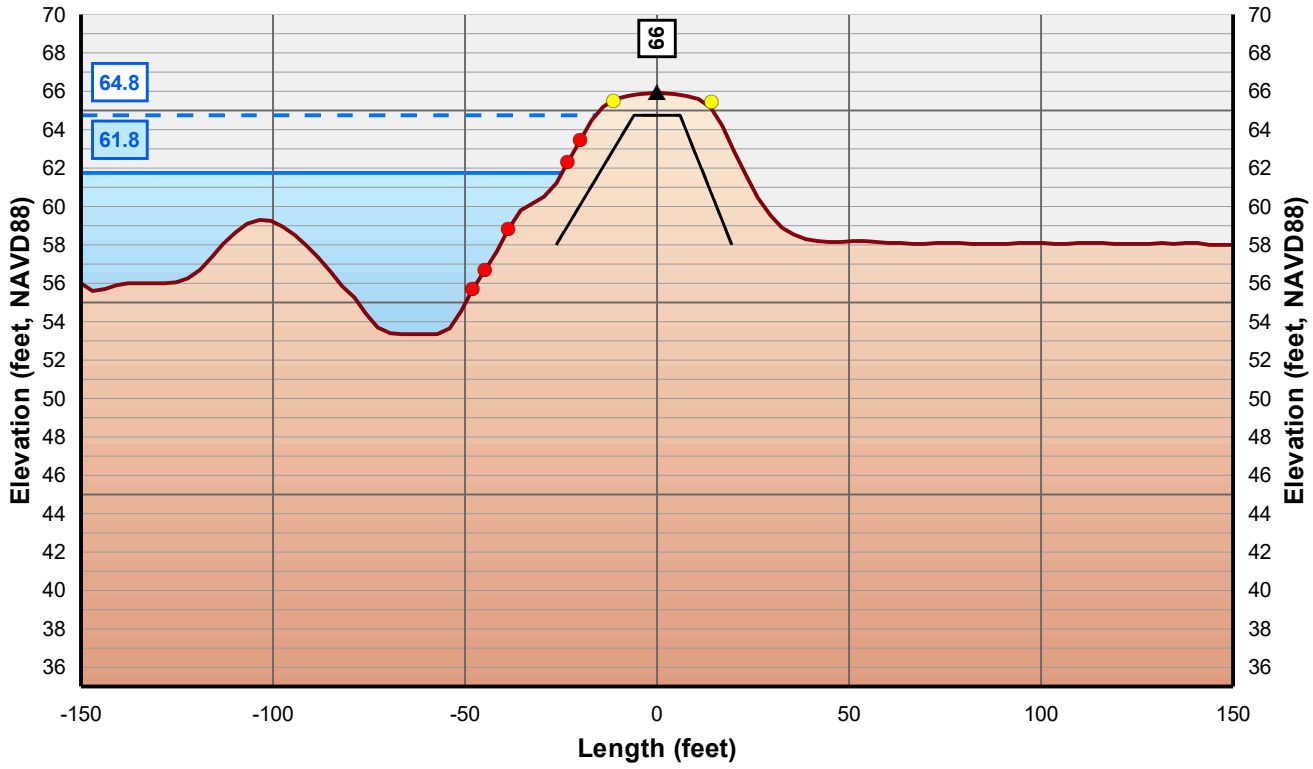
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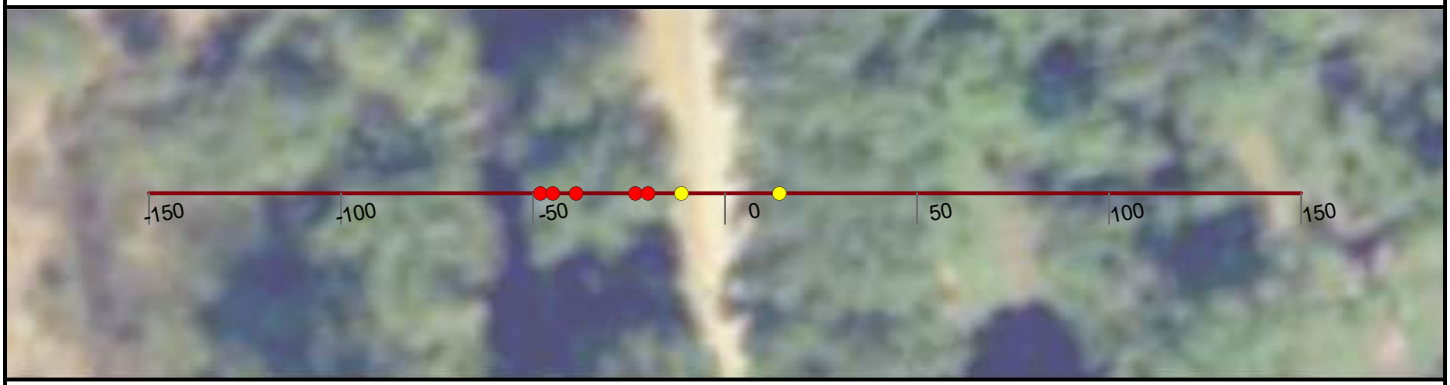
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Cross Section: Yankee Slough 148+00



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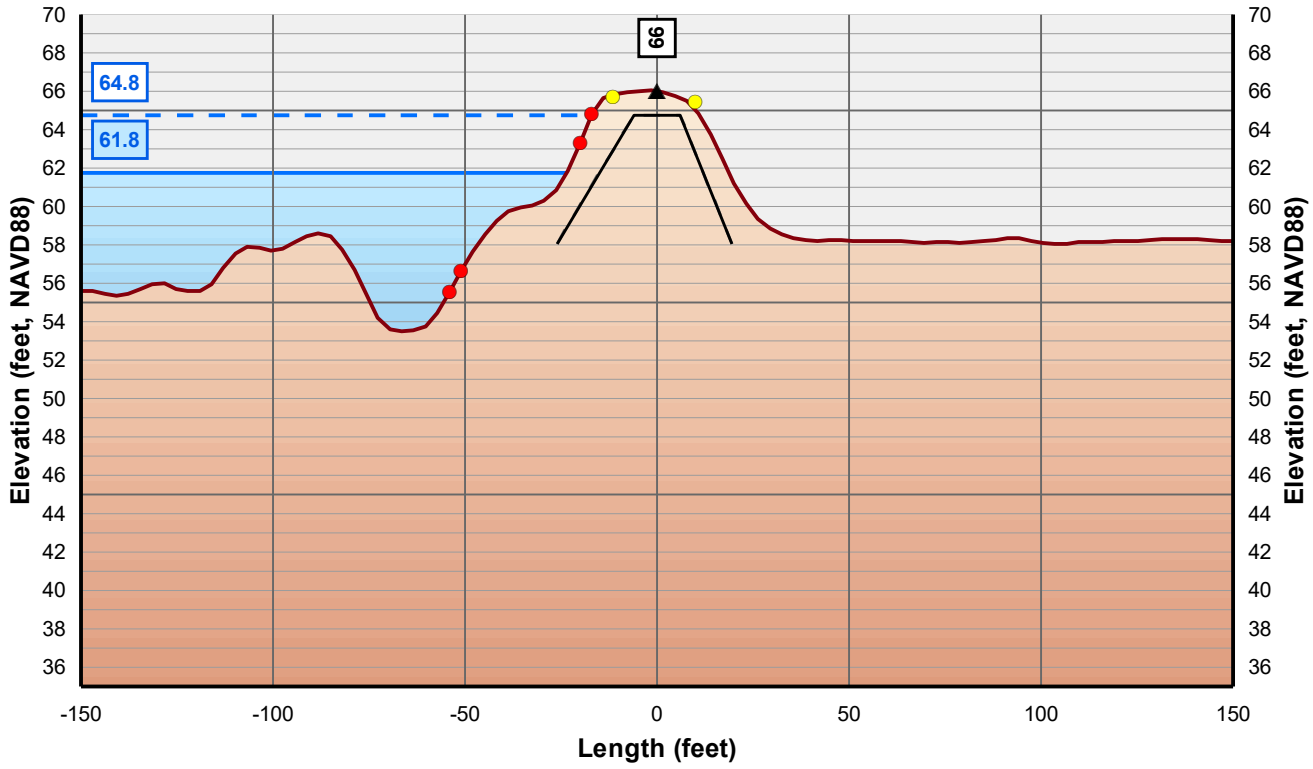
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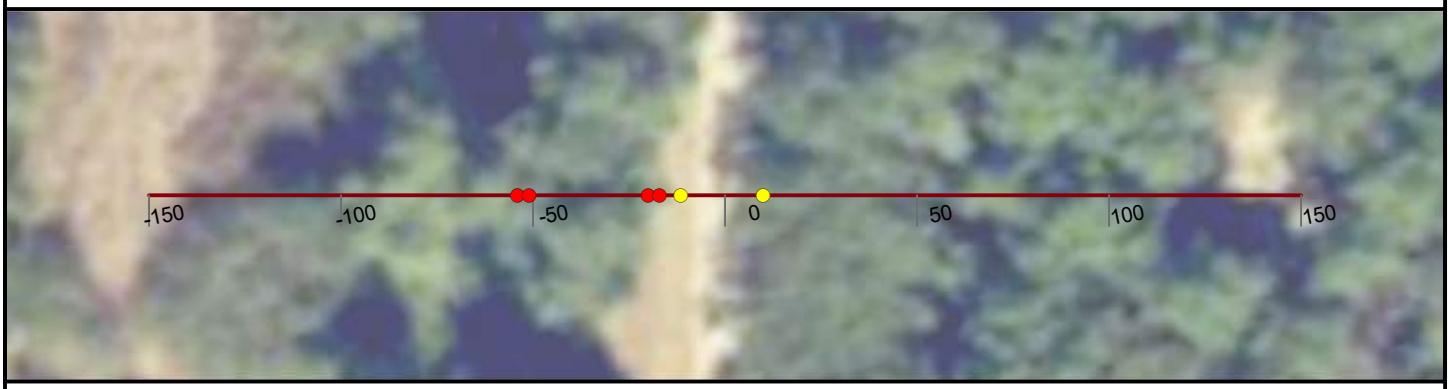
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Cross Section: Yankee Slough 149+00



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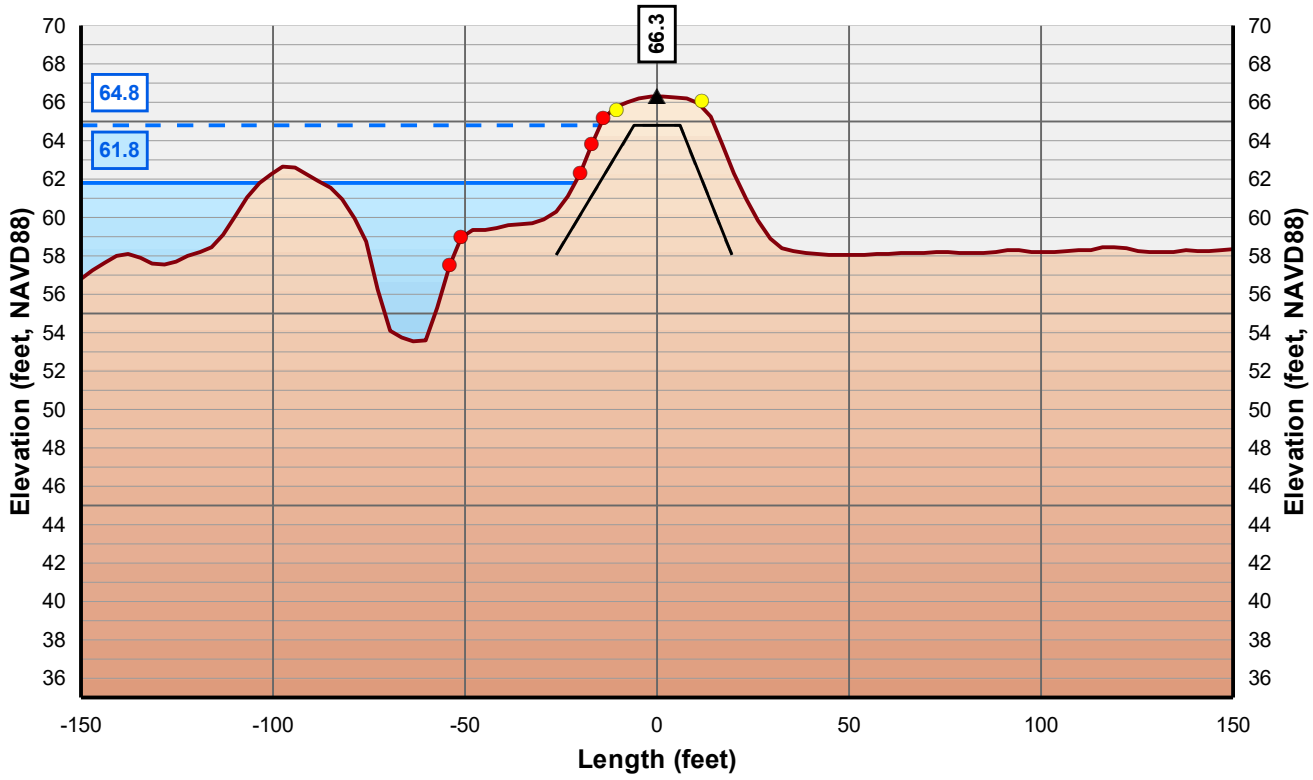
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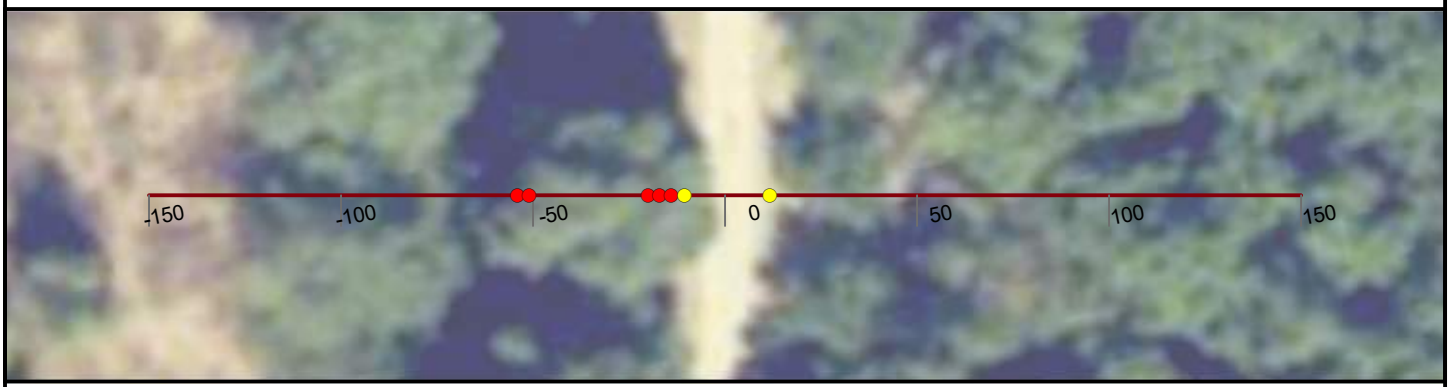
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Cross Section: Yankee Slough 150+00



Horizontal Scale: 1 inch = 50 Feet
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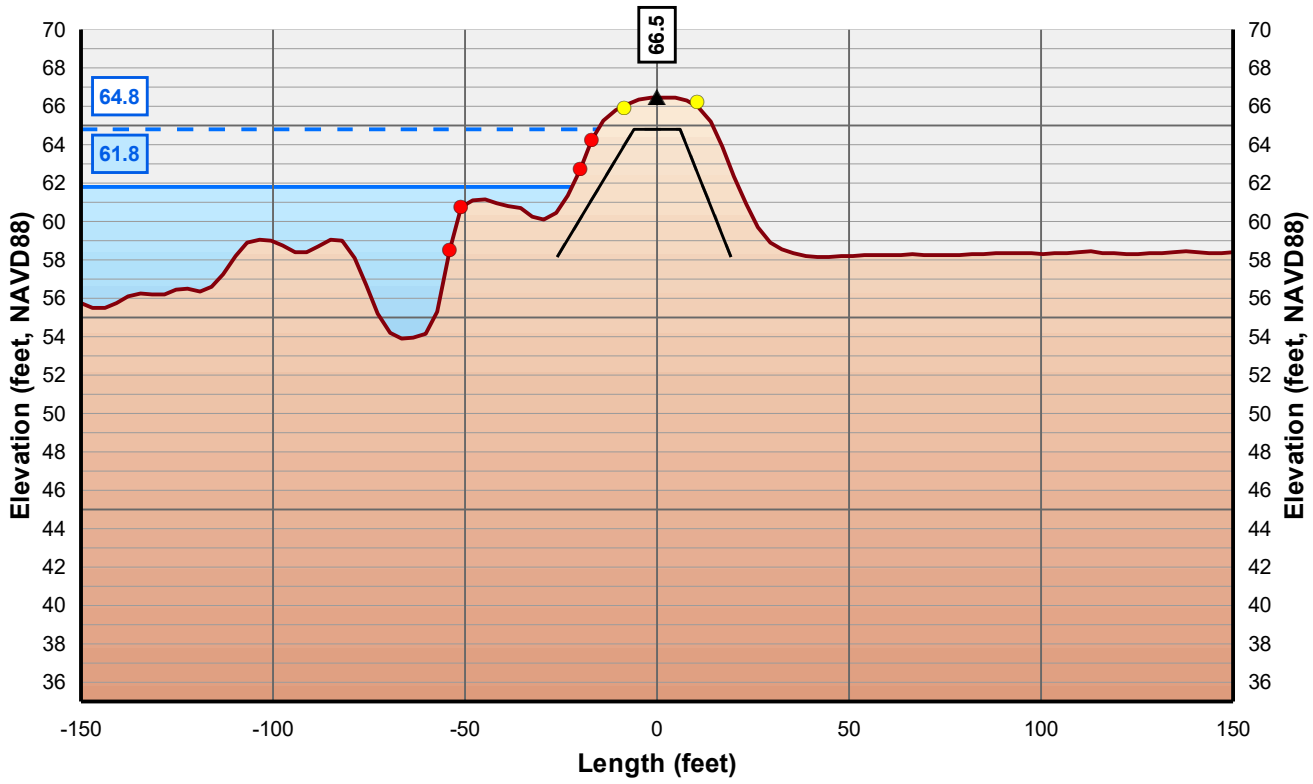
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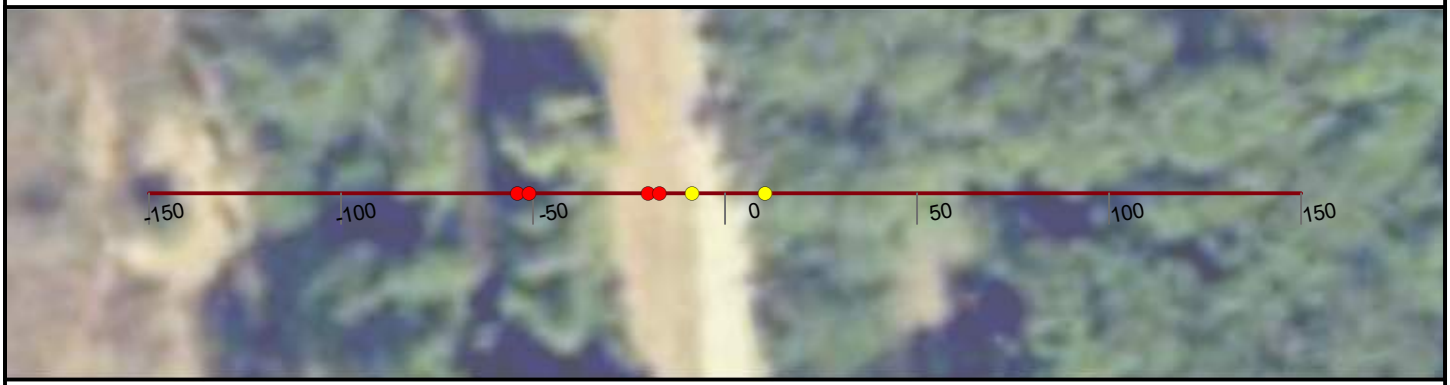
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Cross Section: Yankee Slough 151+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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CALIFORNIA

AUGUST, 2019

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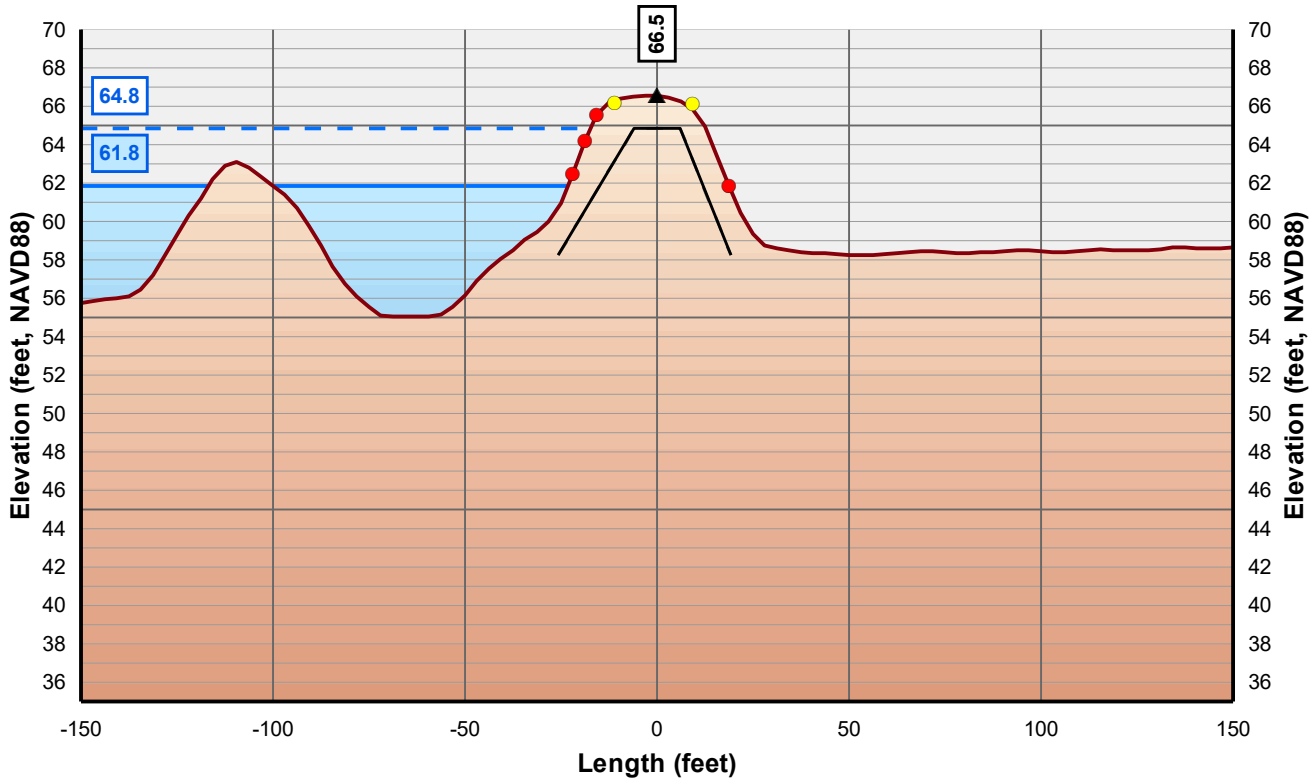
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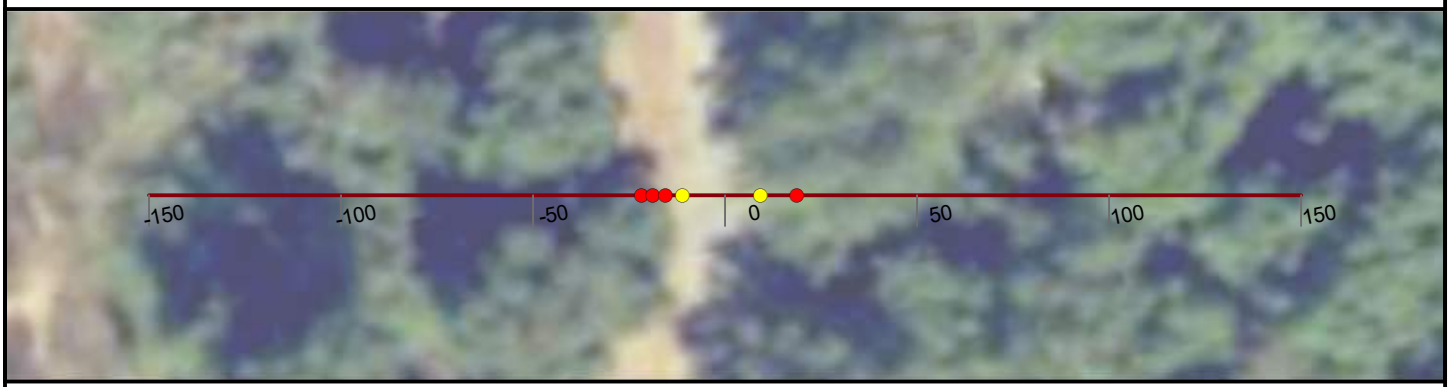
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Cross Section: Yankee Slough 152+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

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CALIFORNIA

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NORTH

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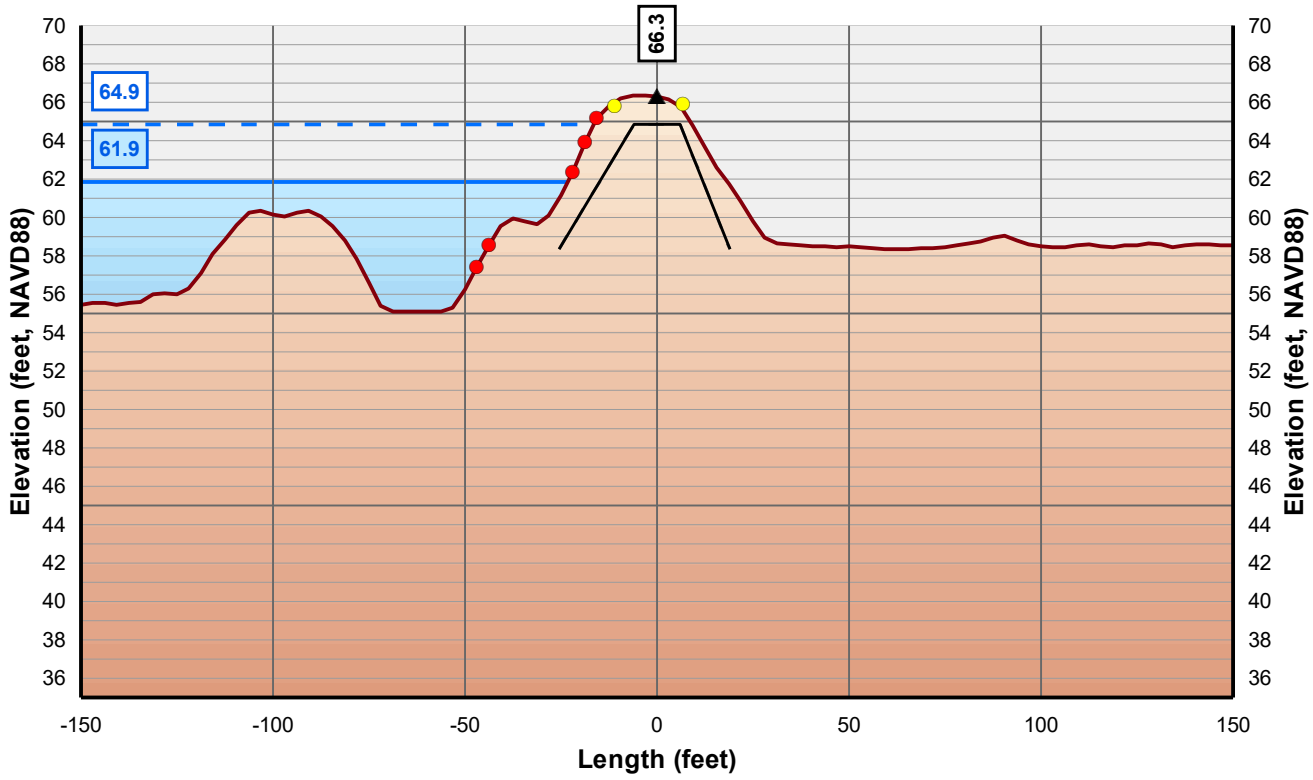
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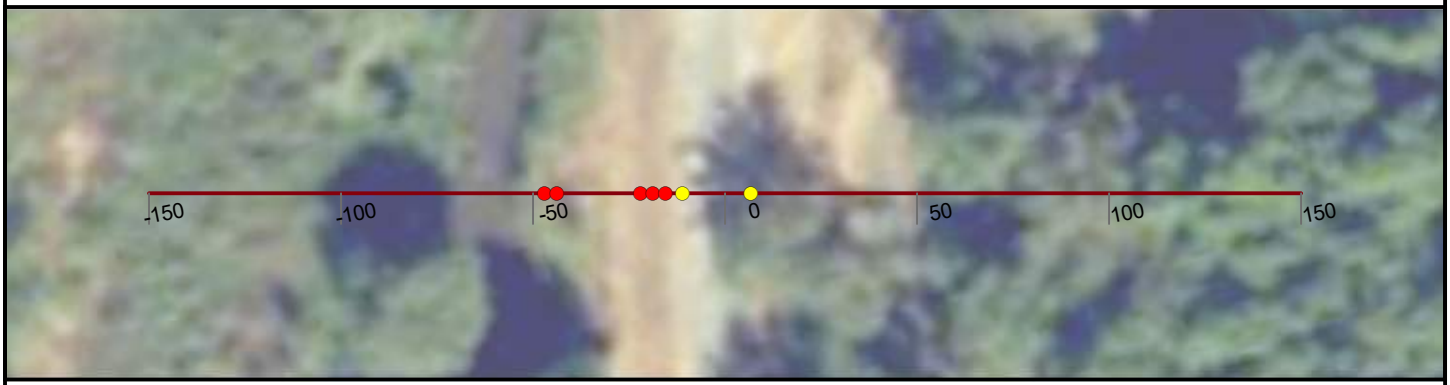
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Cross Section: Yankee Slough 153+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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CALIFORNIA

AUGUST, 2019

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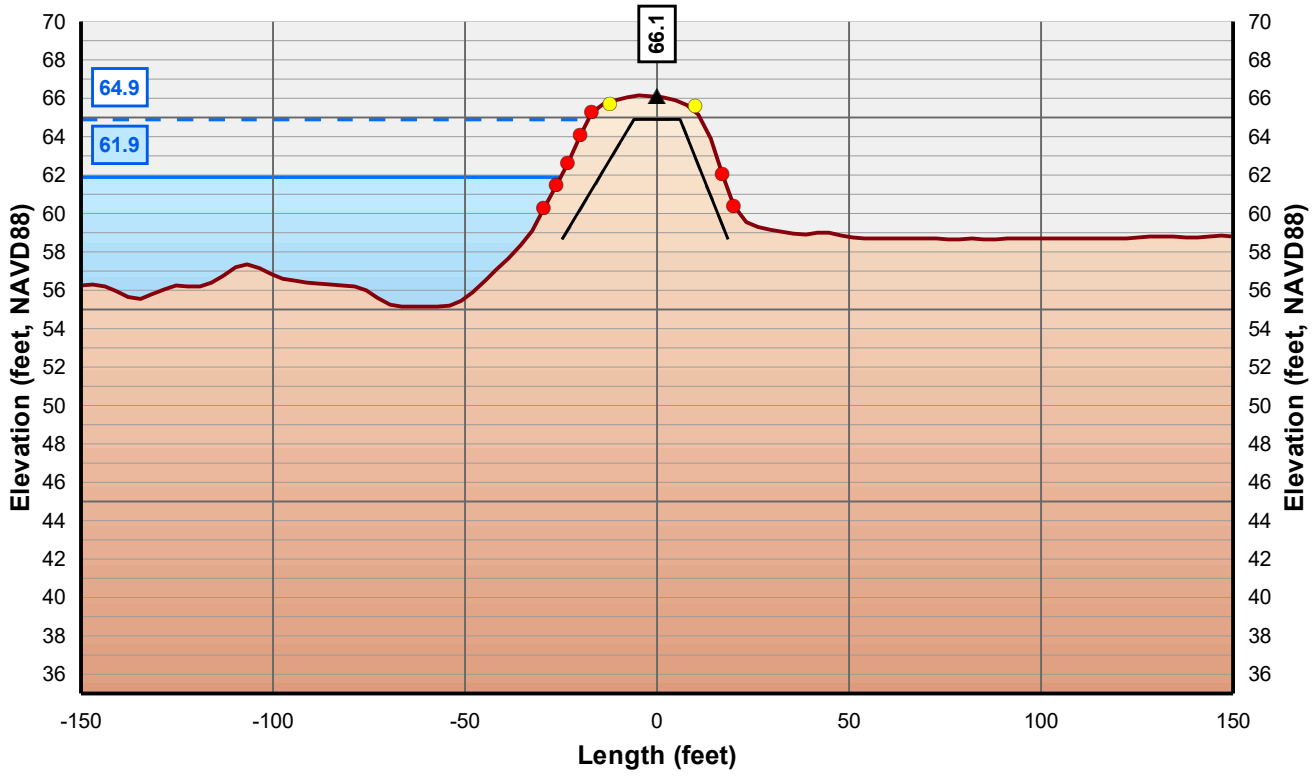
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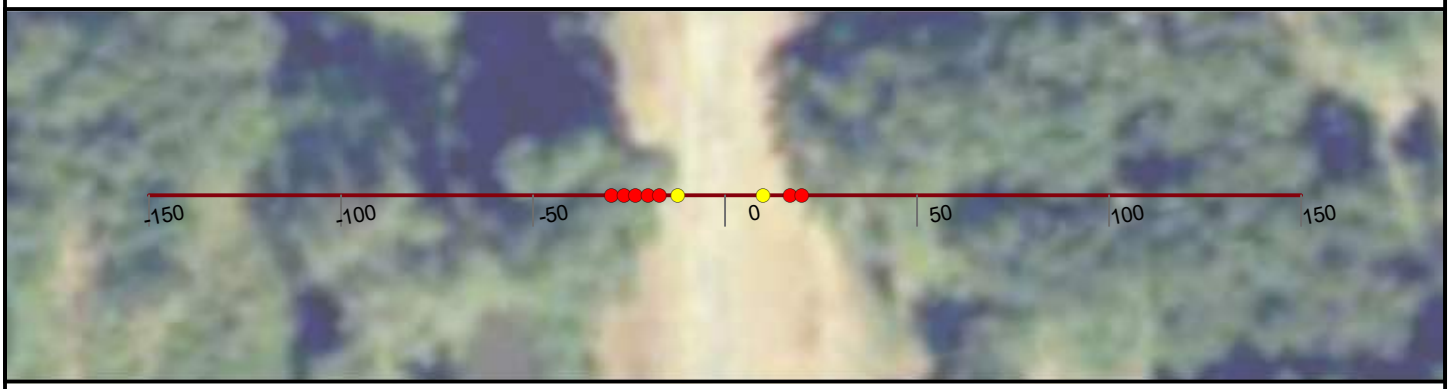
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Cross Section: Yankee Slough 154+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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- Existing Levee
- Theoretical Levee Prism Preliminary
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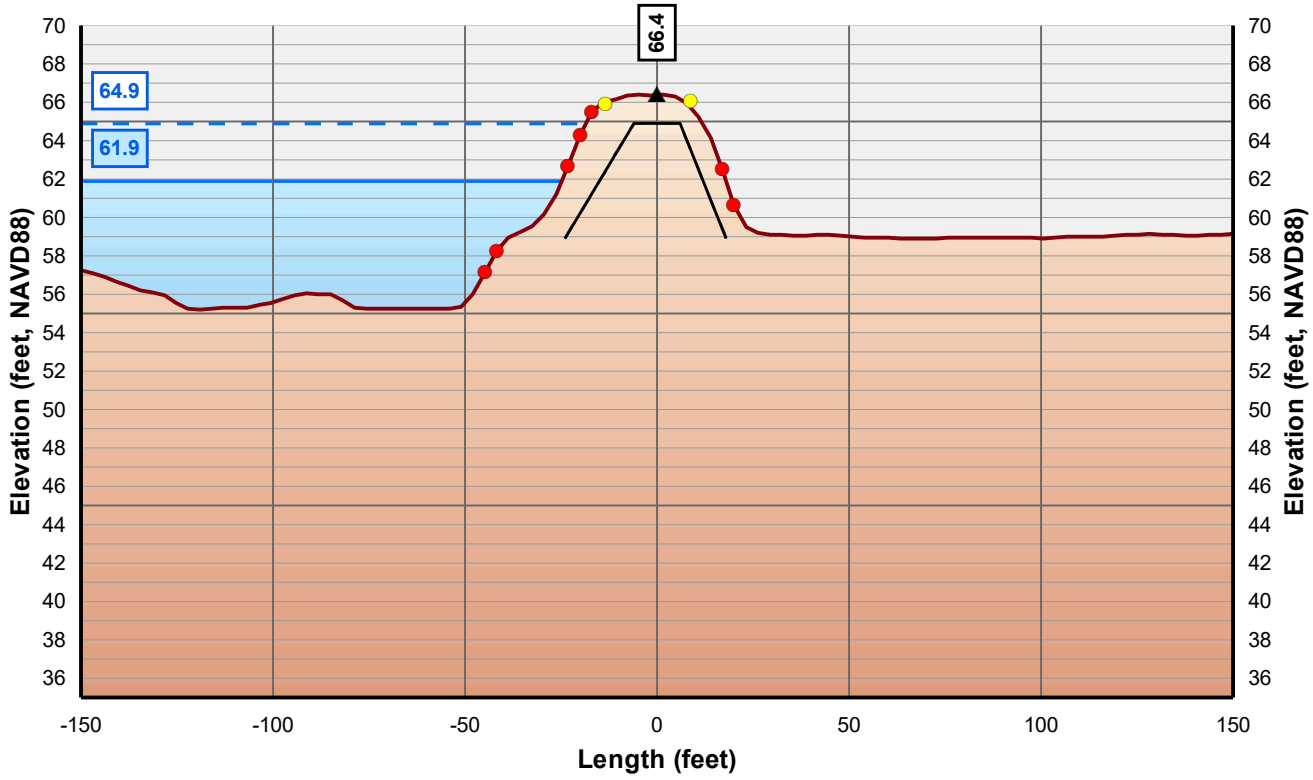
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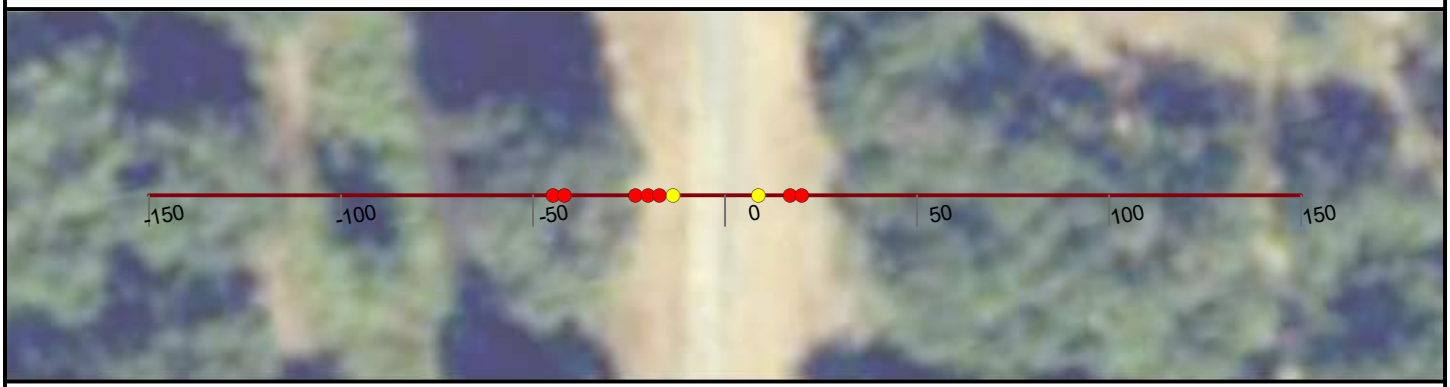
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Cross Section: Yankee Slough 155+00



Horizontal Scale: 1 inch = 50 Feet
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▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

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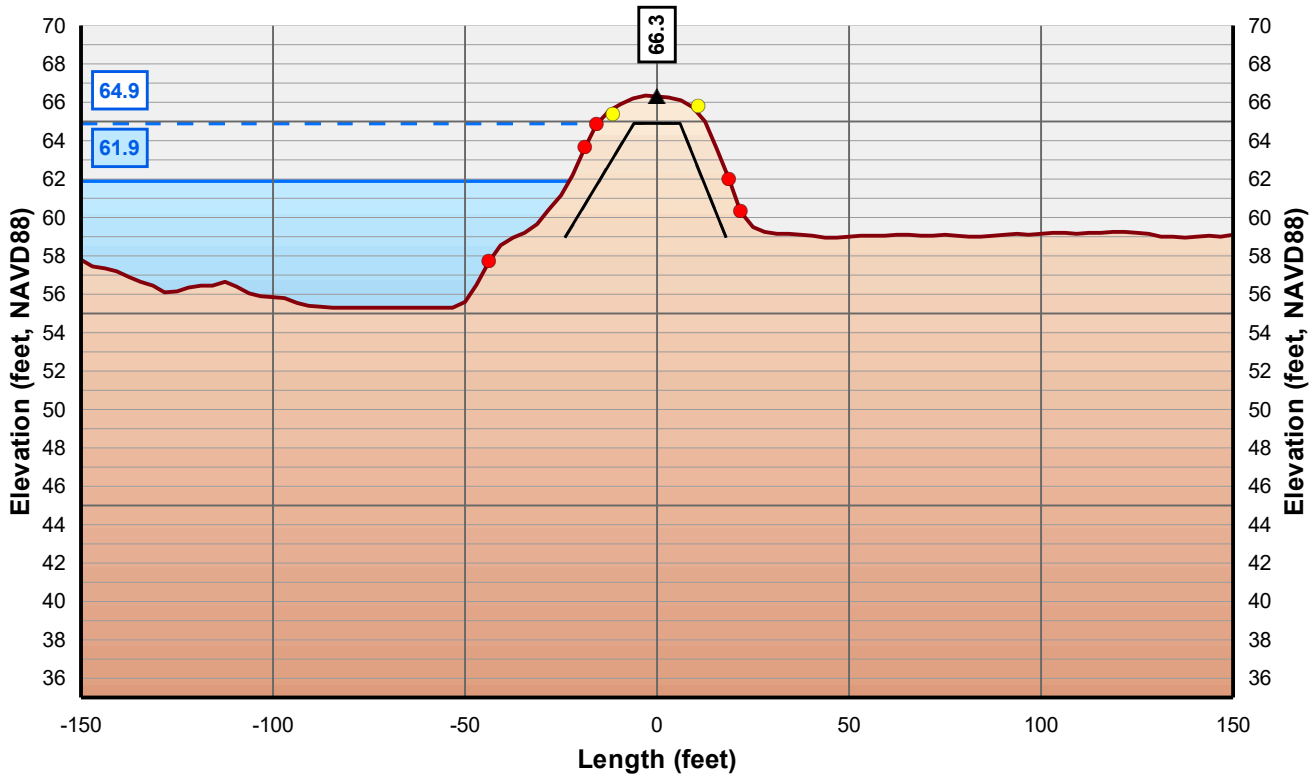
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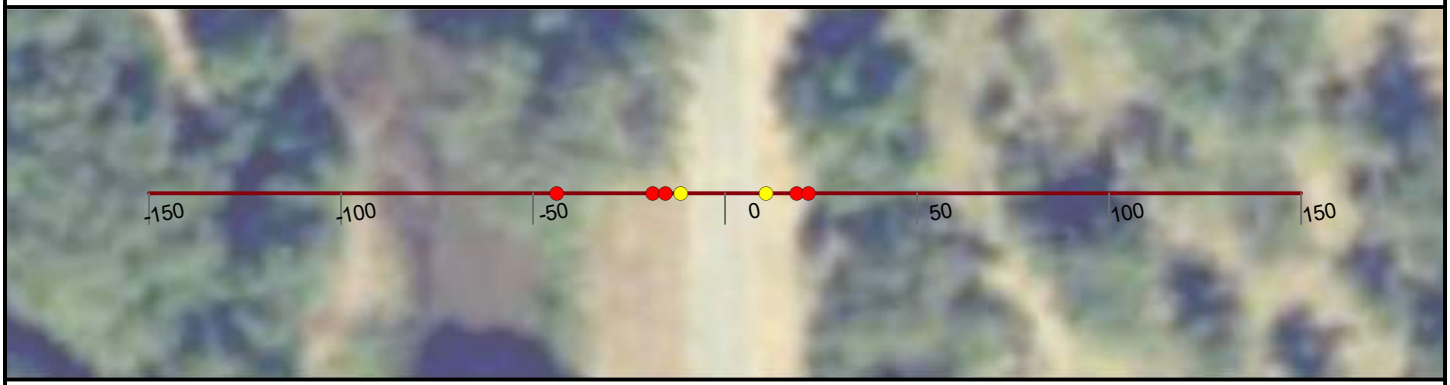
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Cross Section: Yankee Slough 156+00



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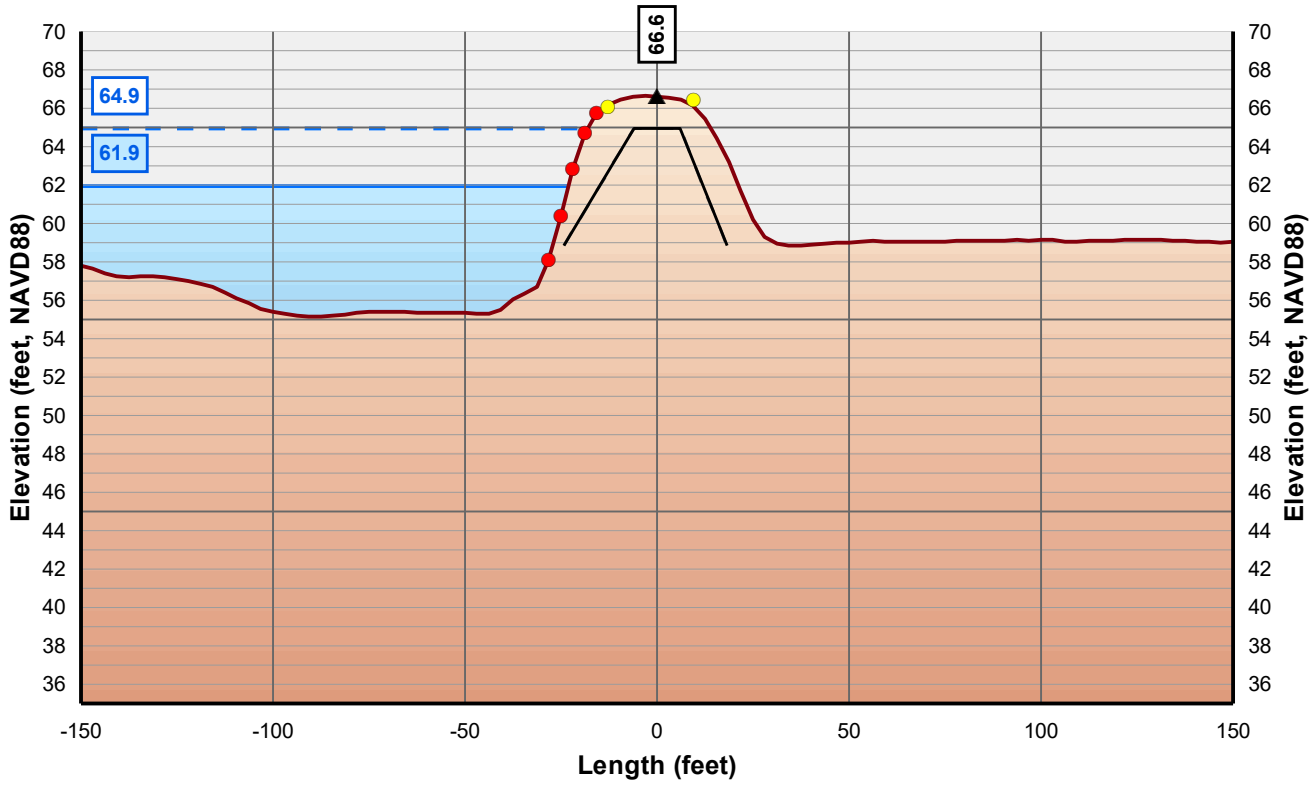
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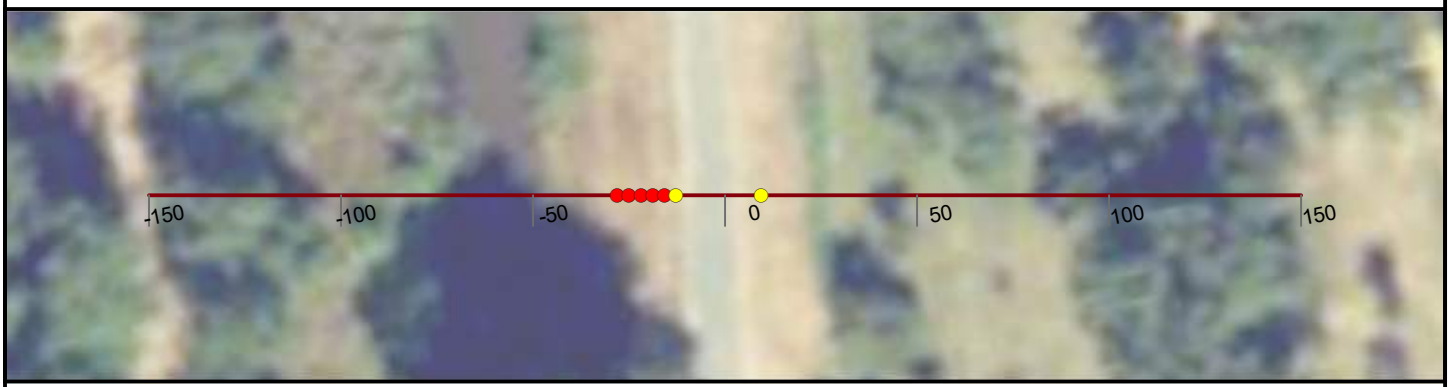
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Cross Section: Yankee Slough 157+00



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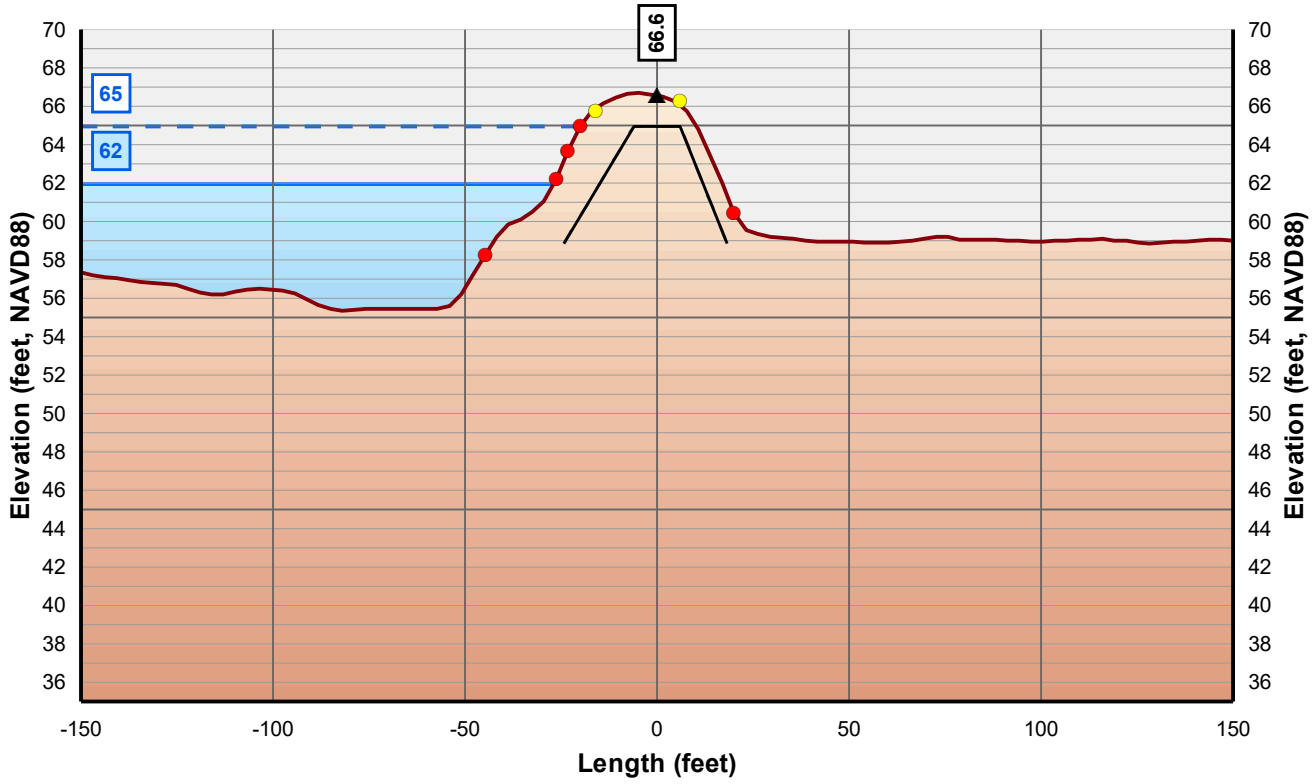
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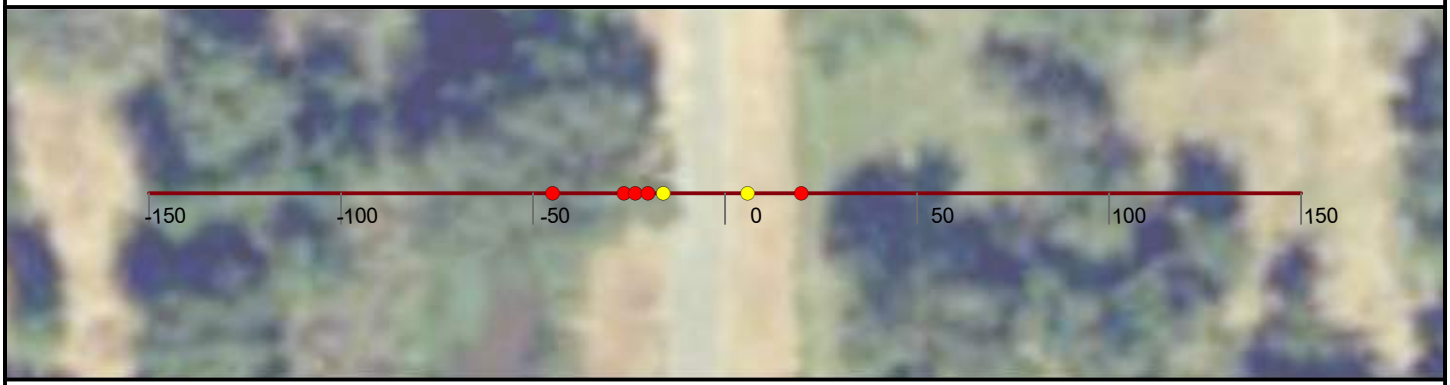
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Cross Section: Yankee Slough 158+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

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RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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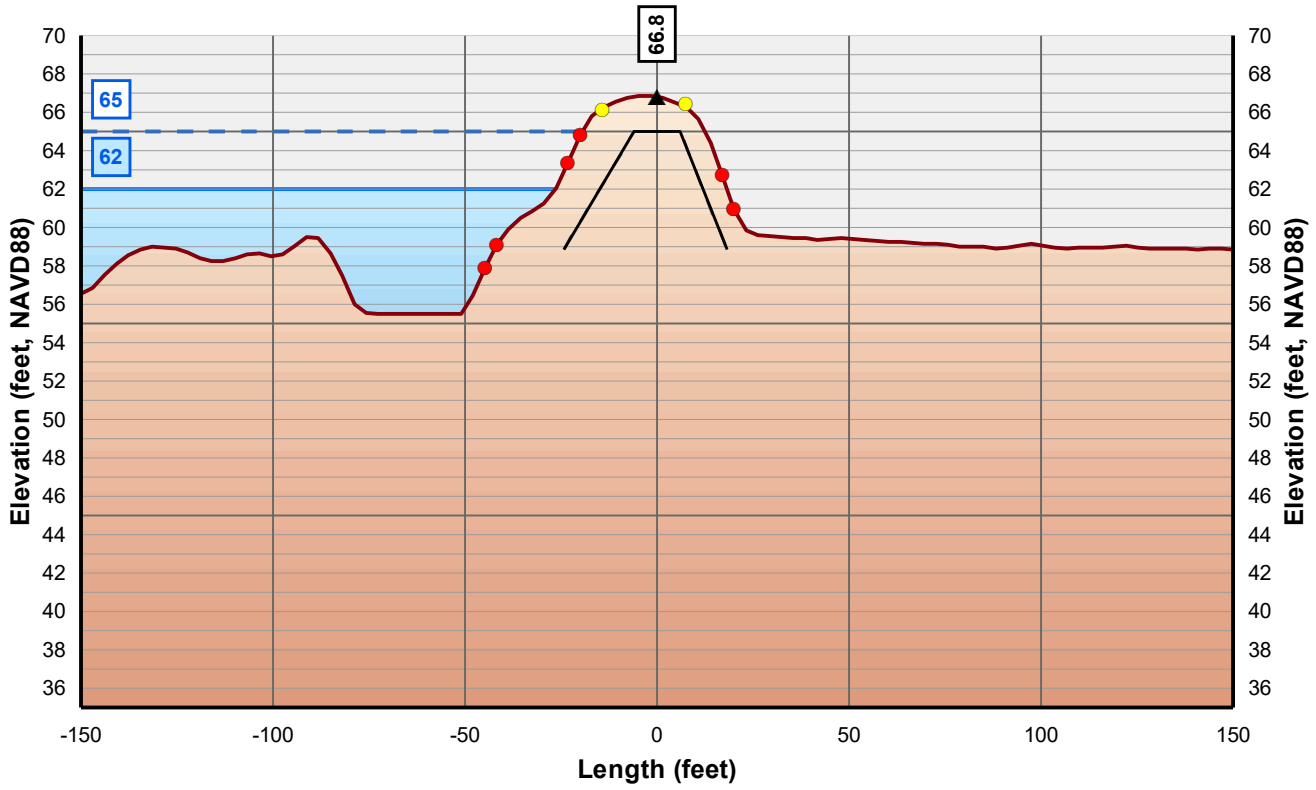
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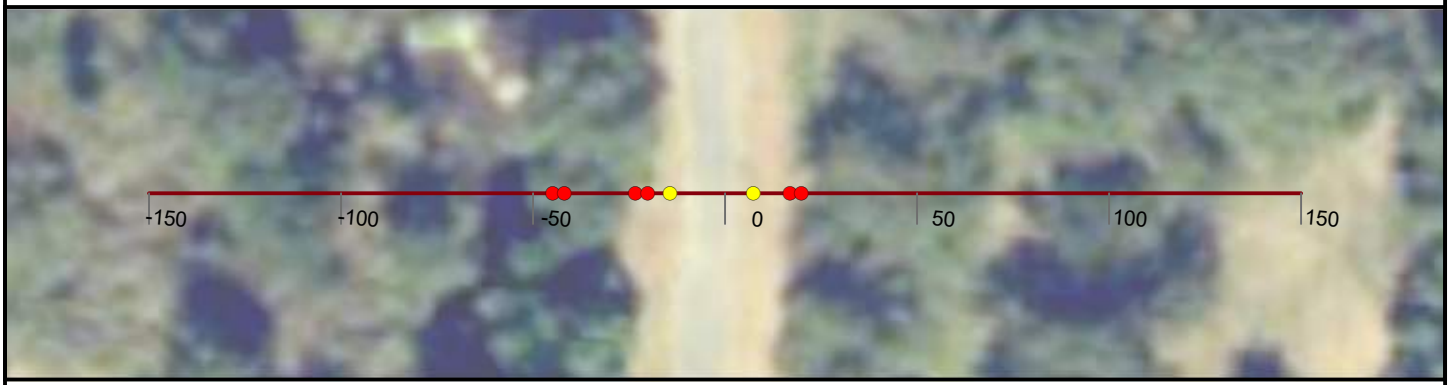
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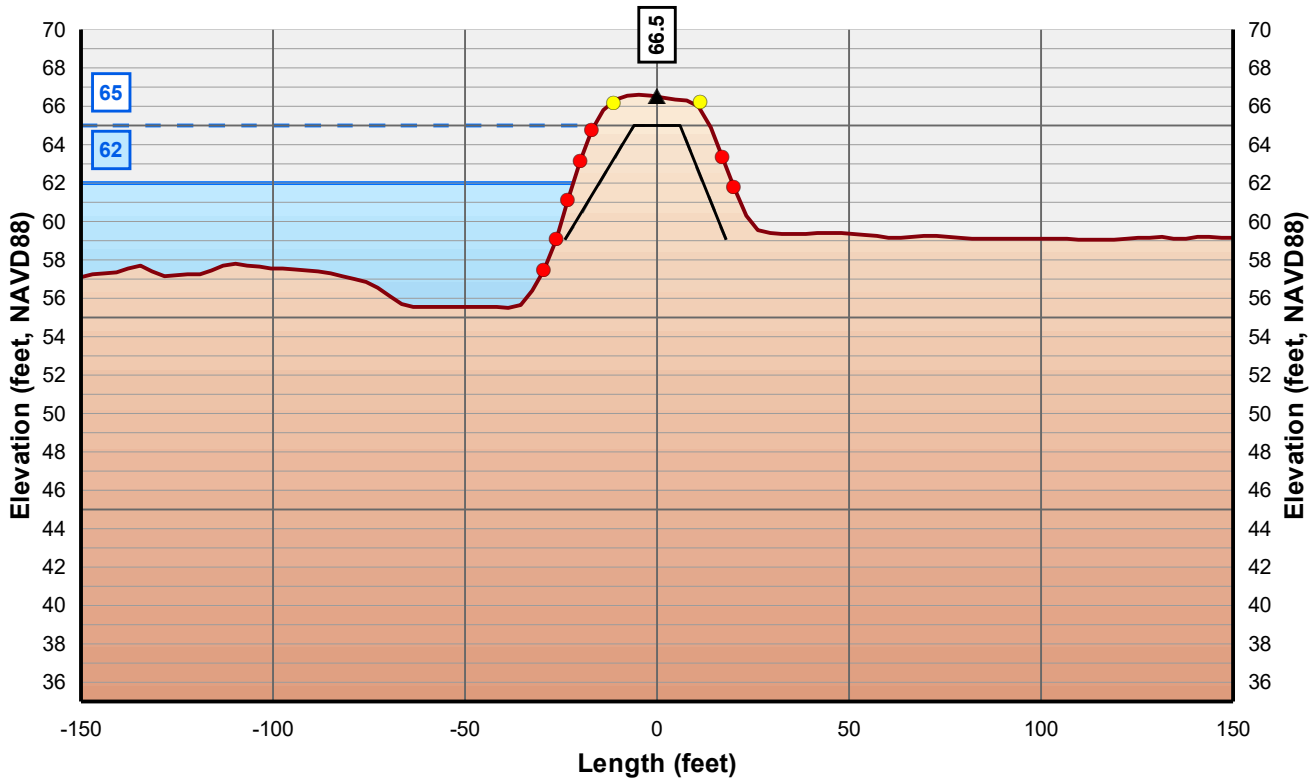
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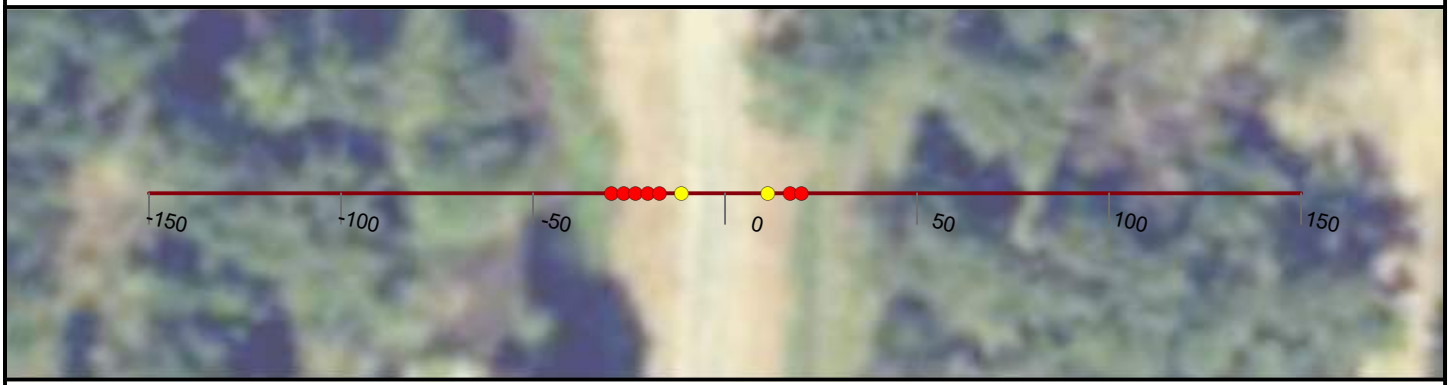
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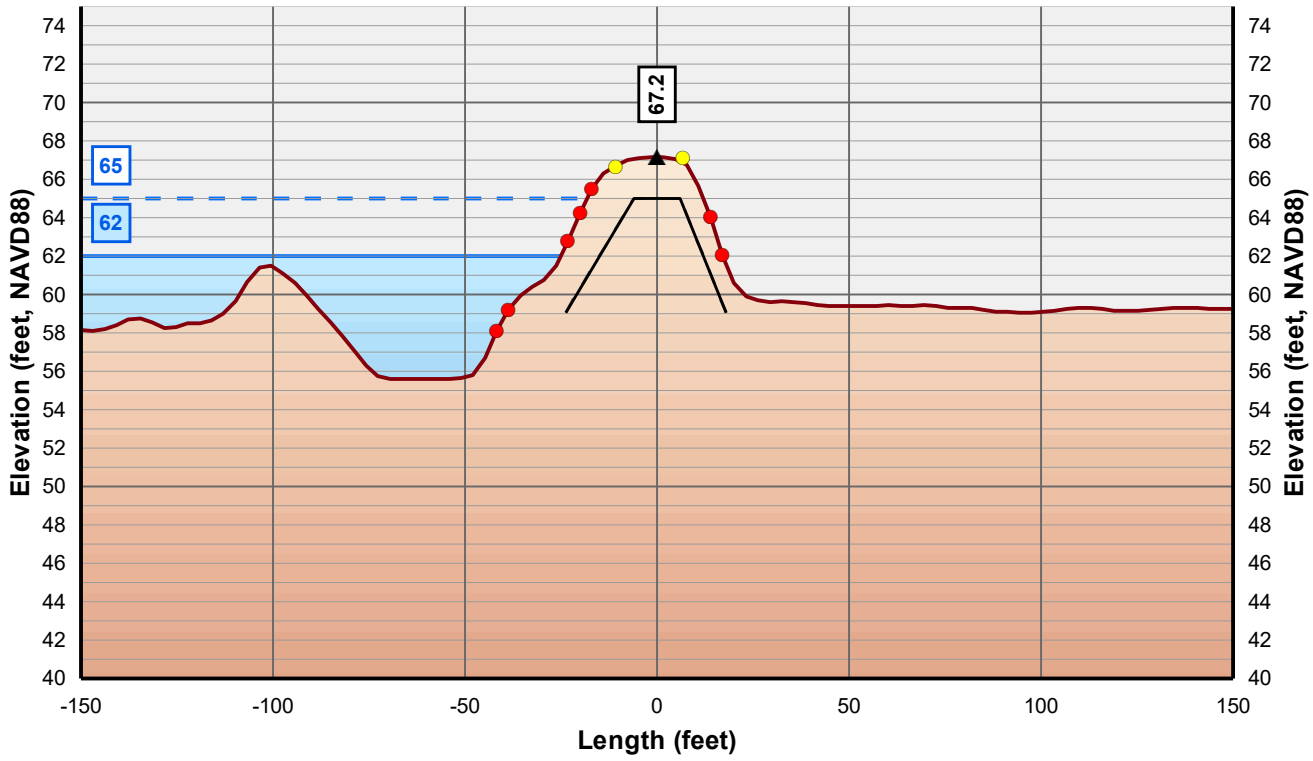
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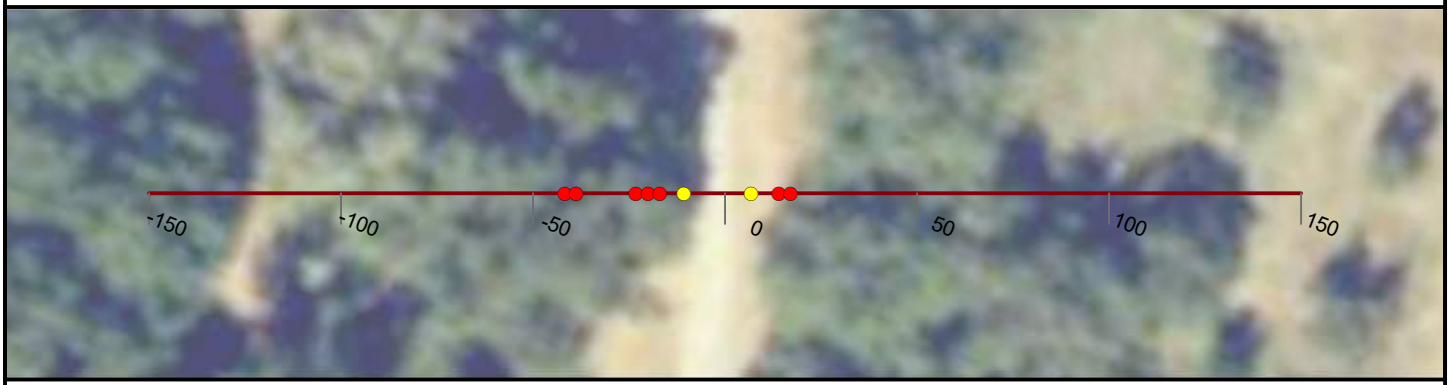
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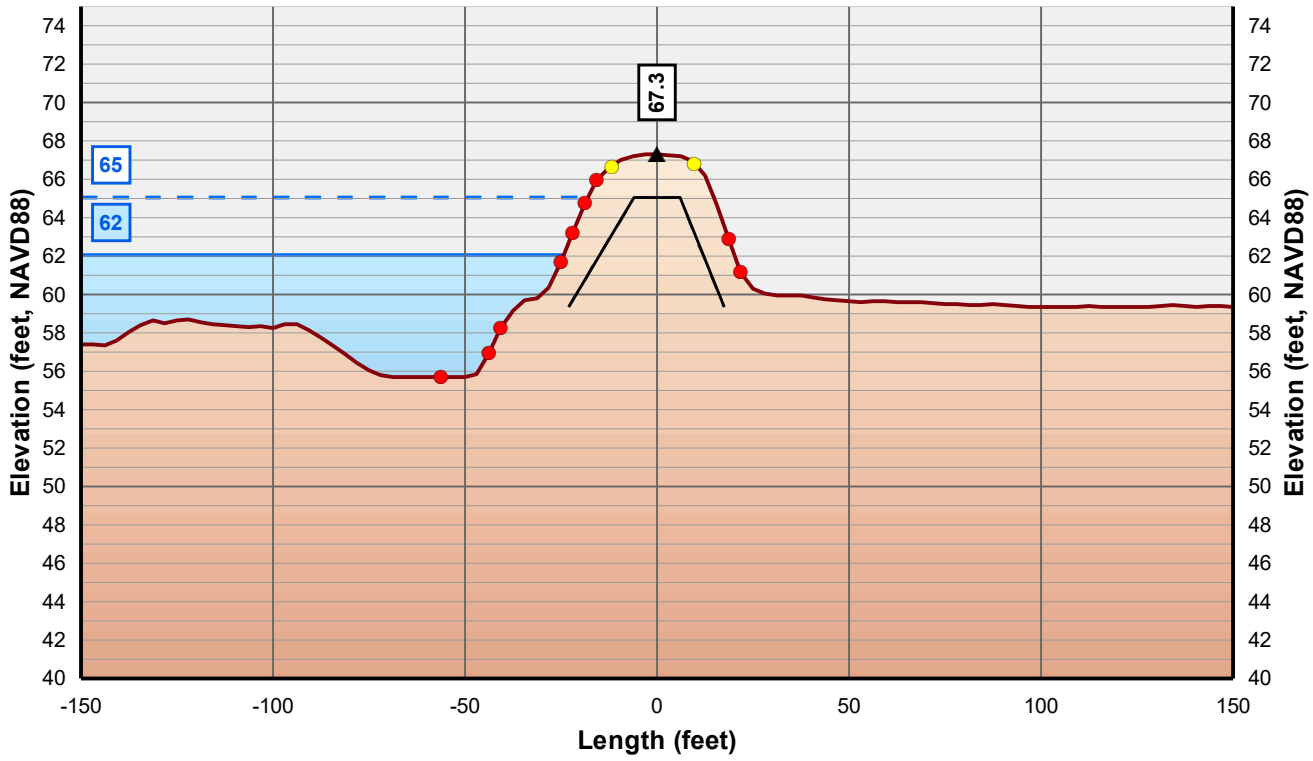
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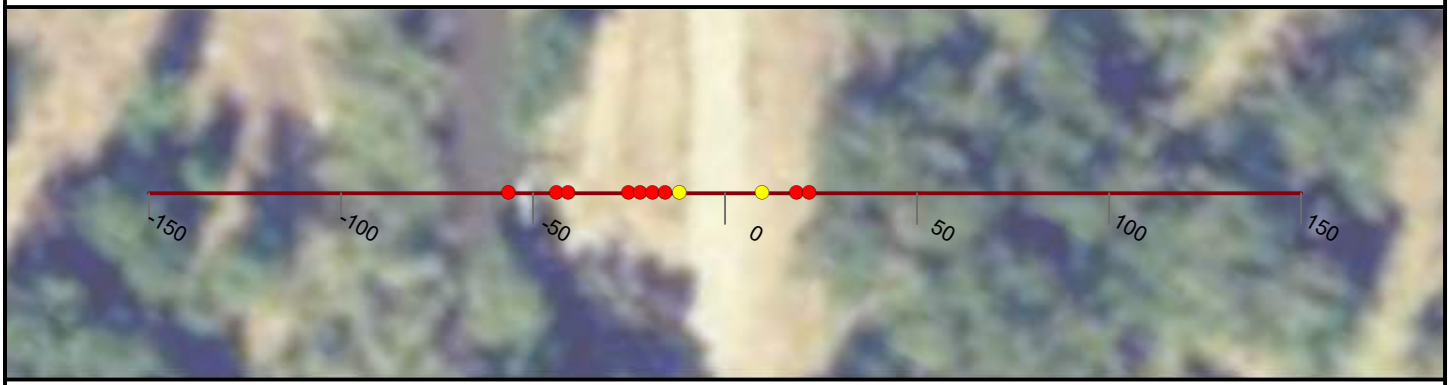
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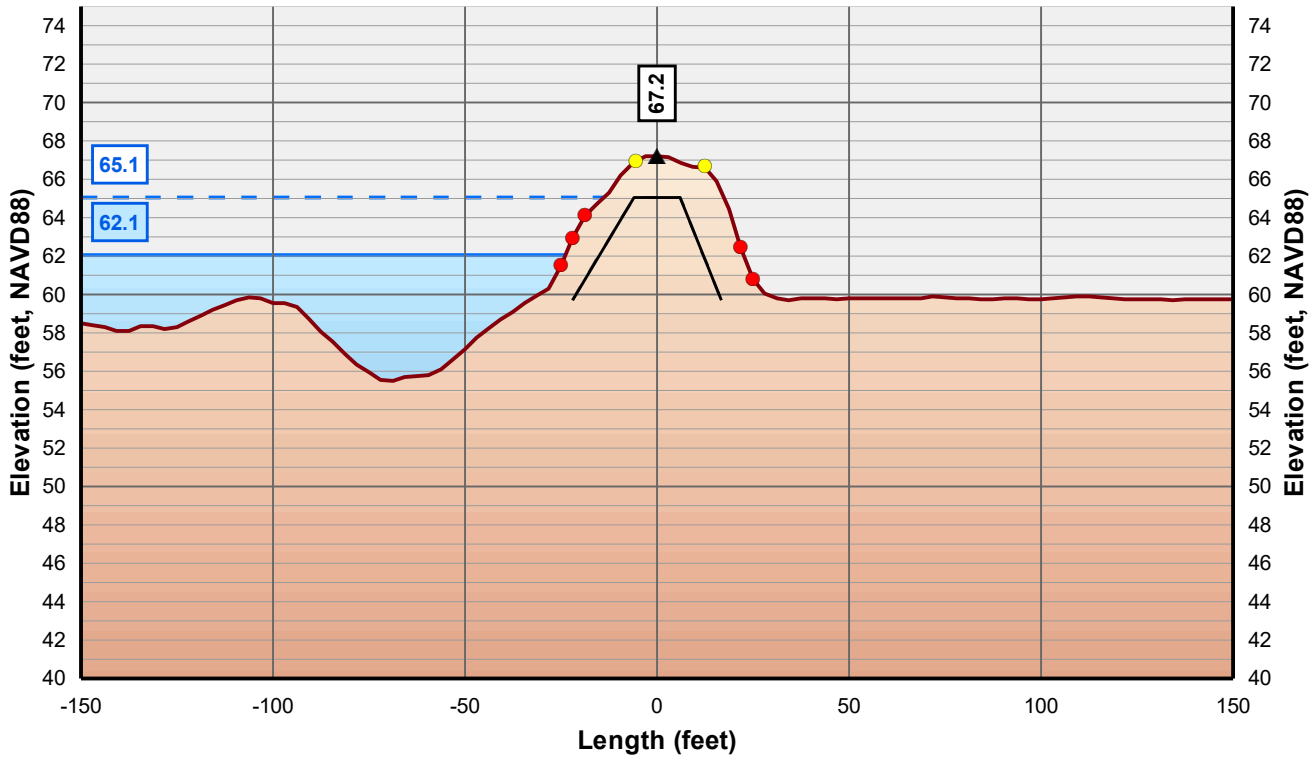
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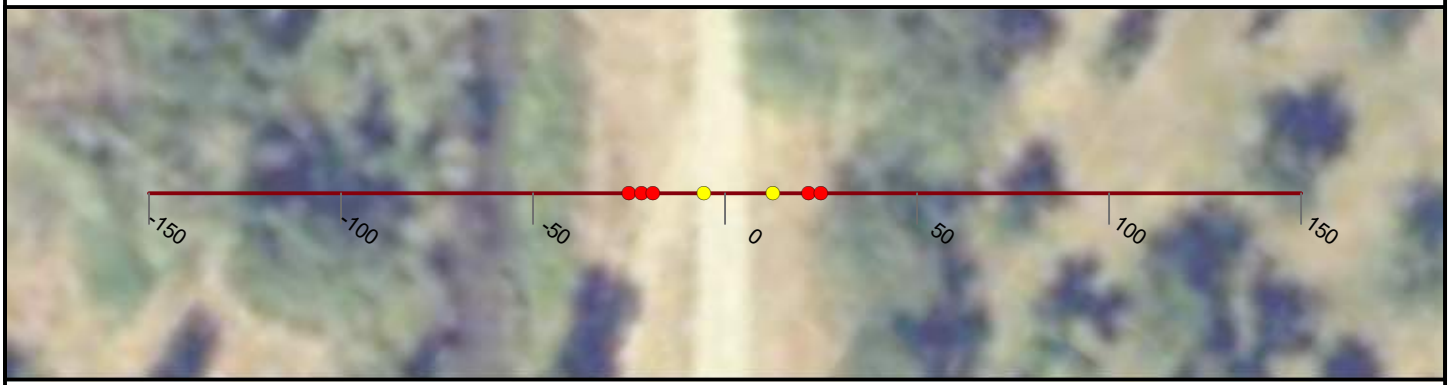
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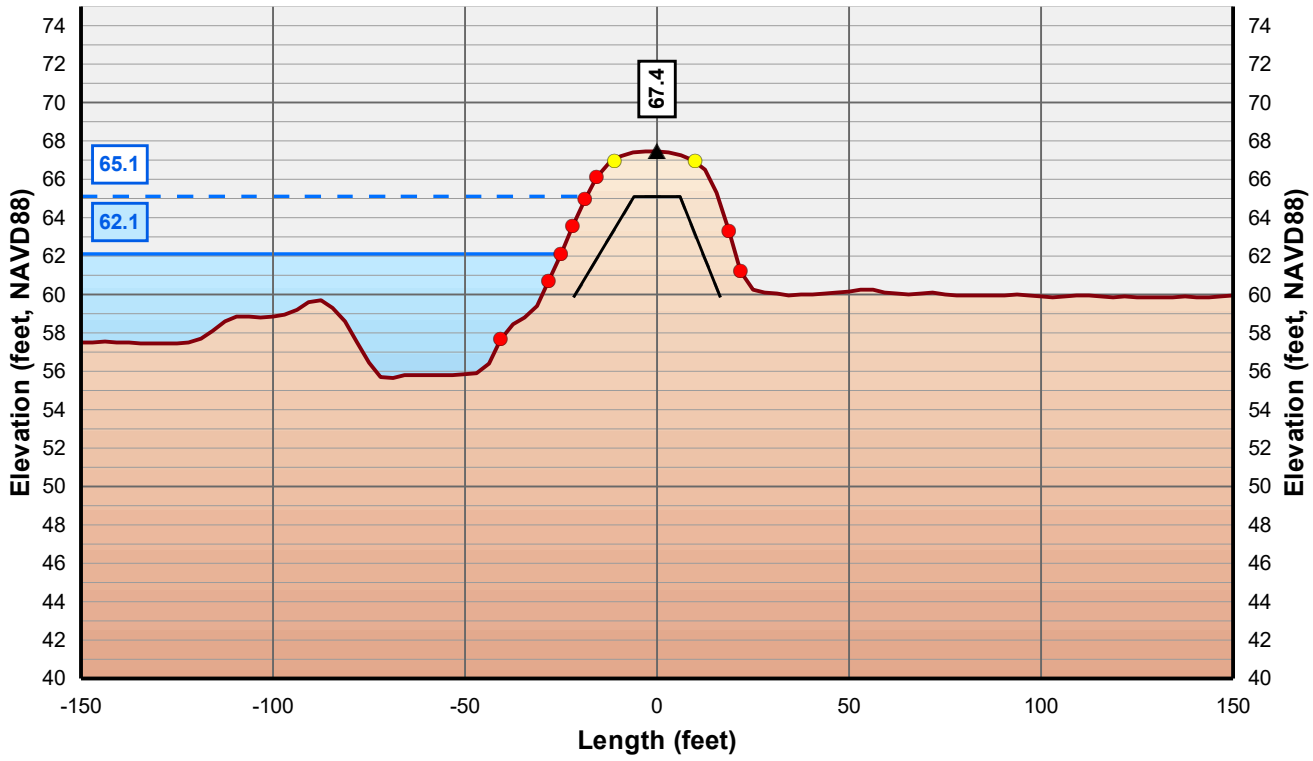
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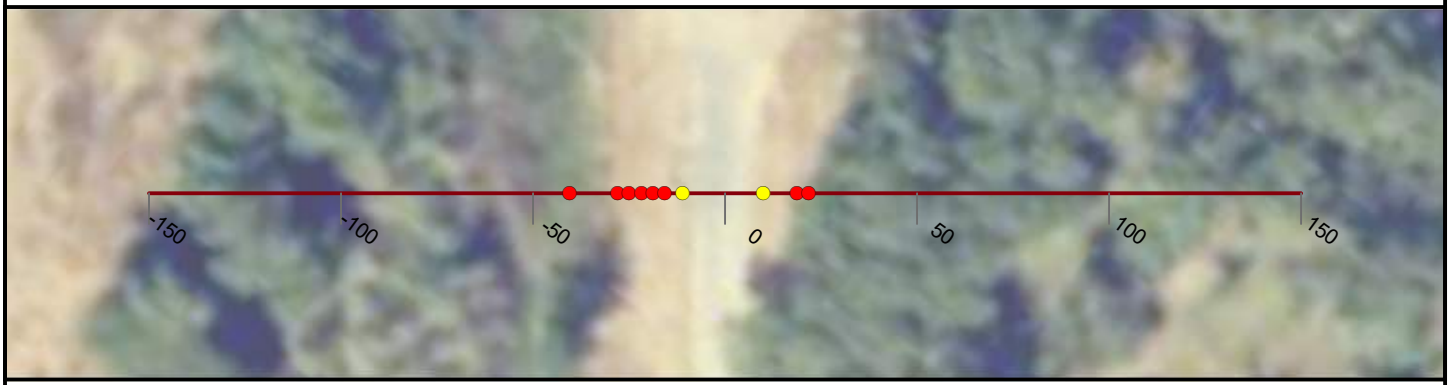
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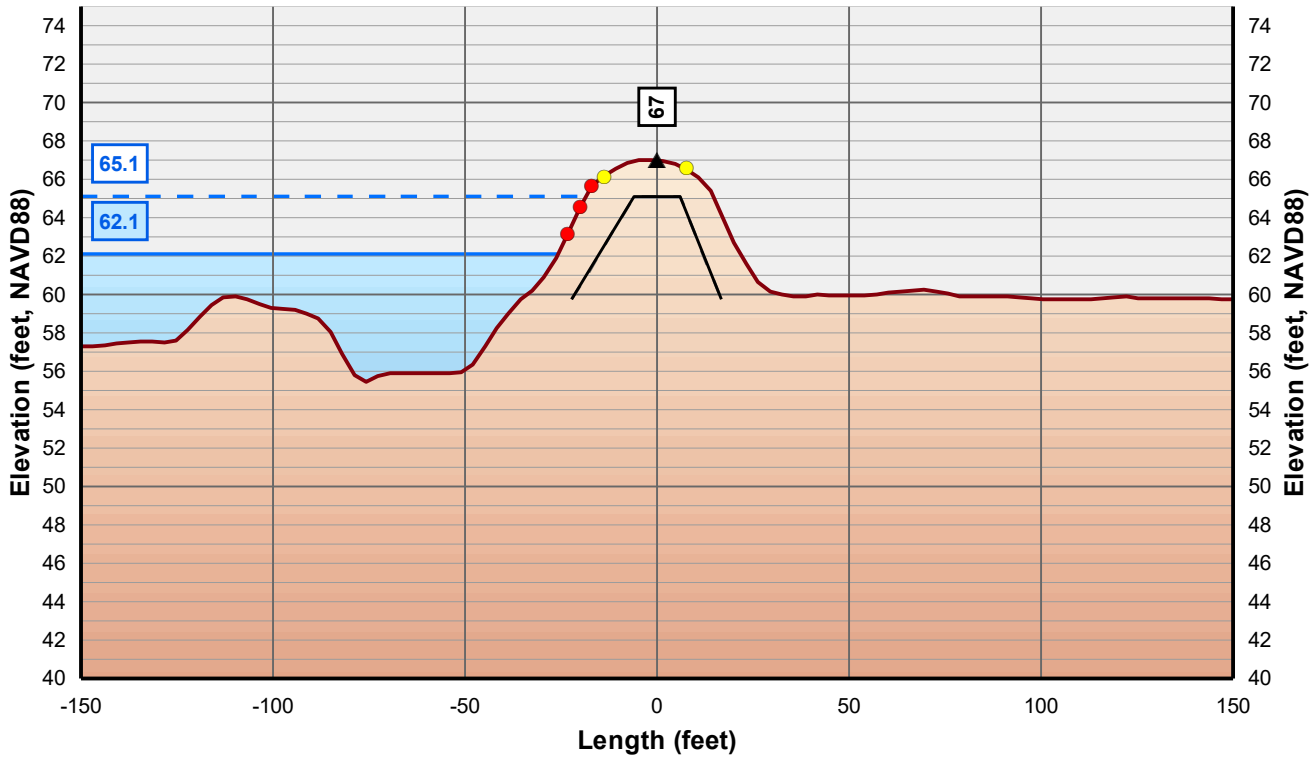
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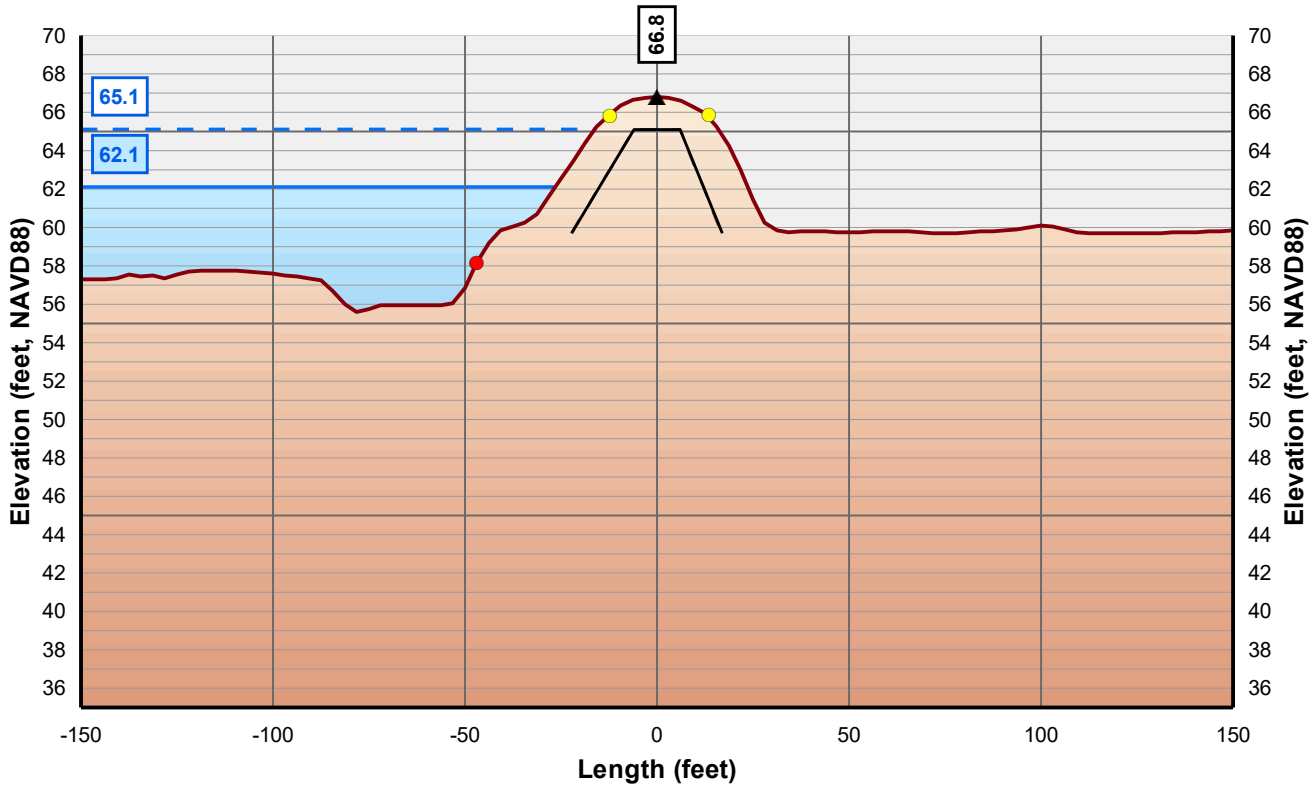
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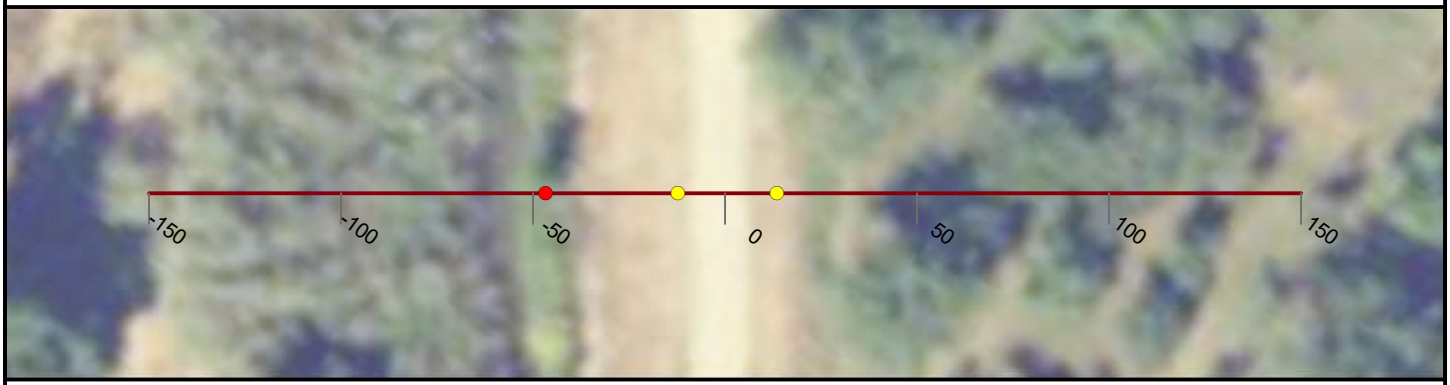
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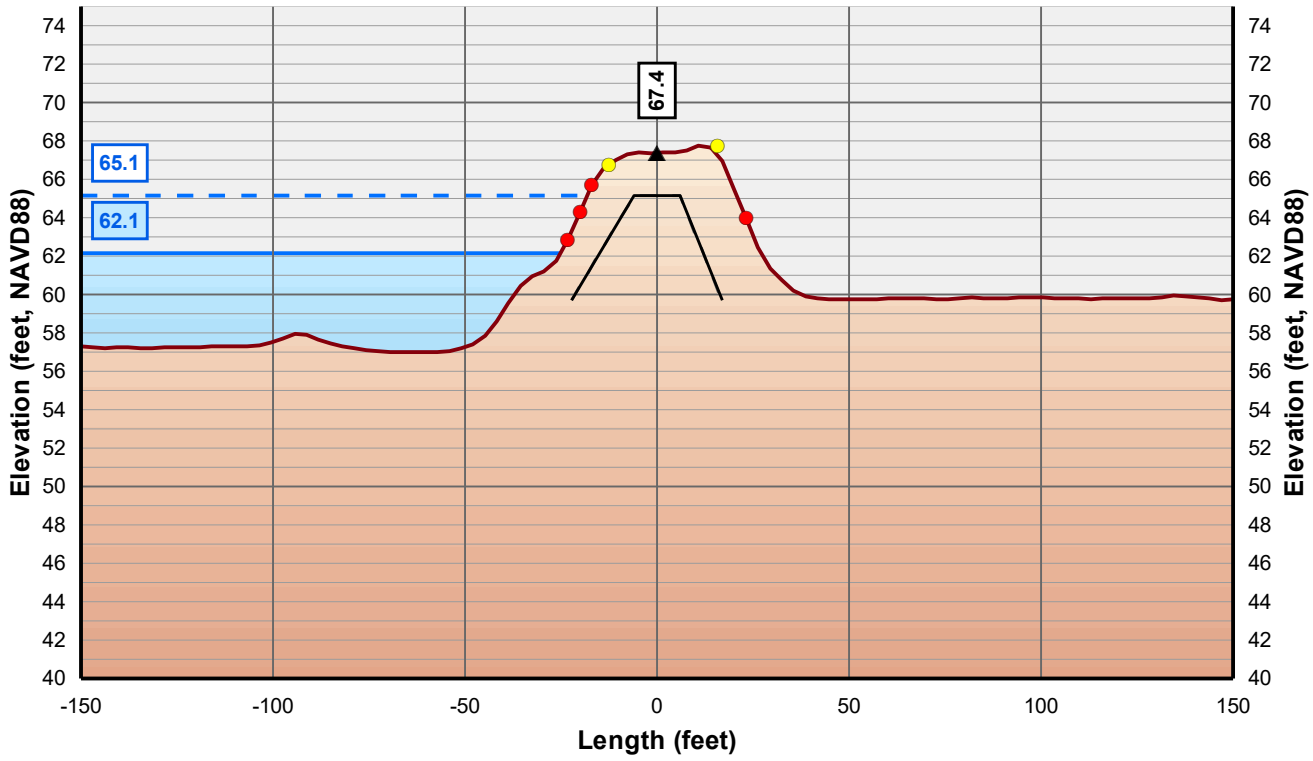
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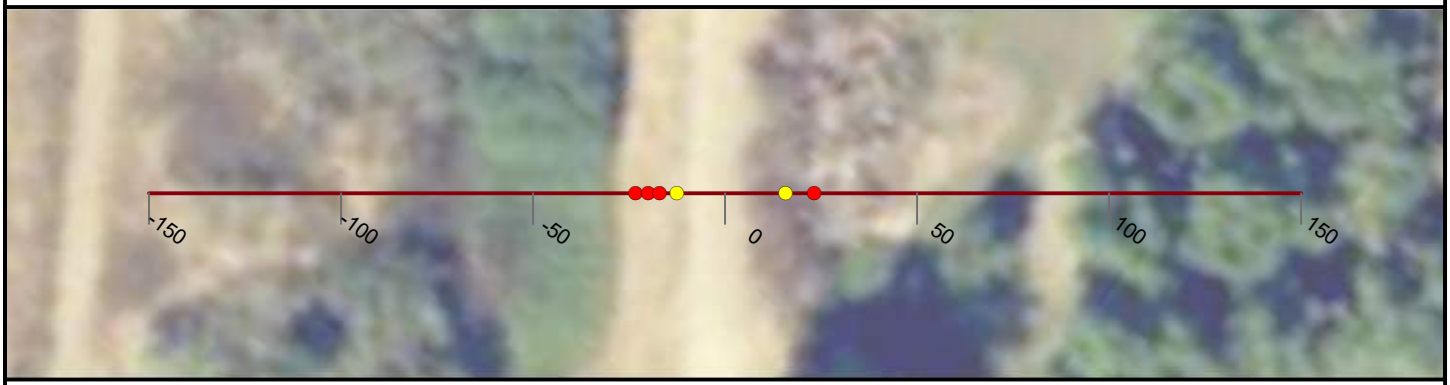
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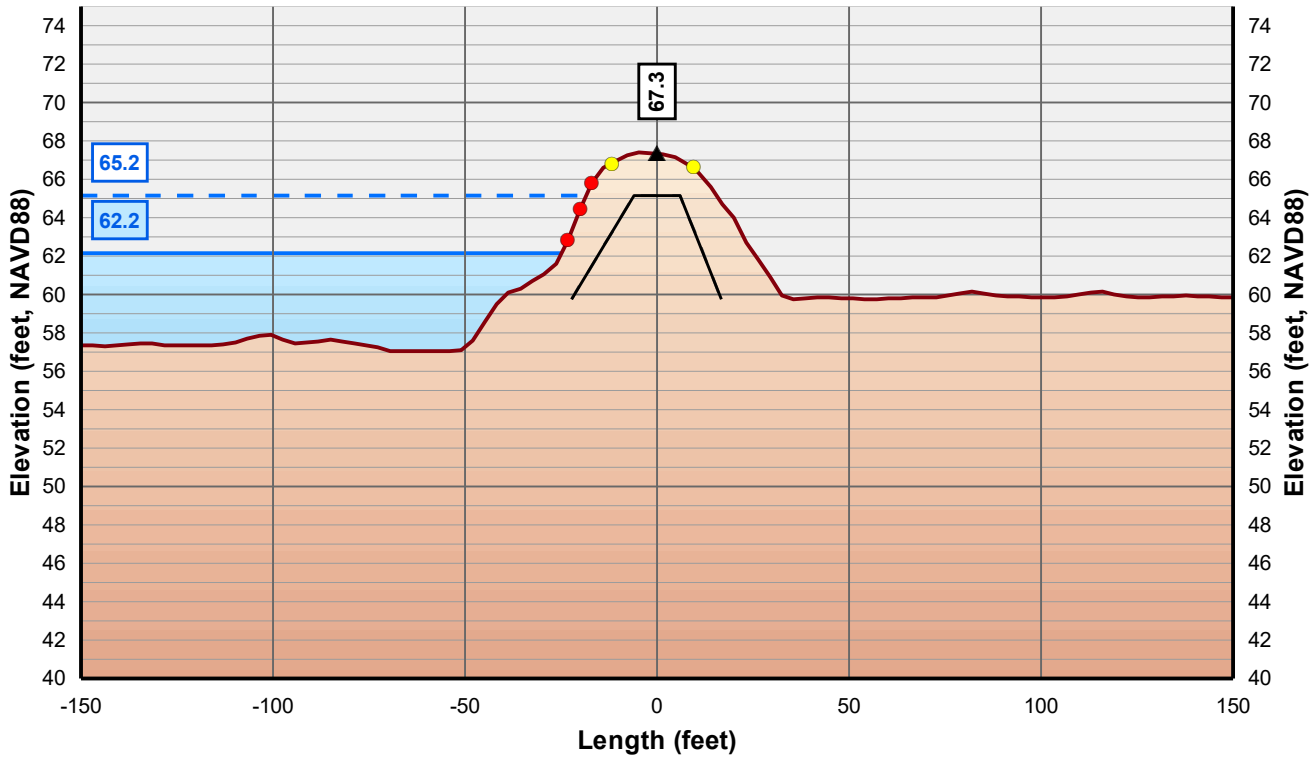
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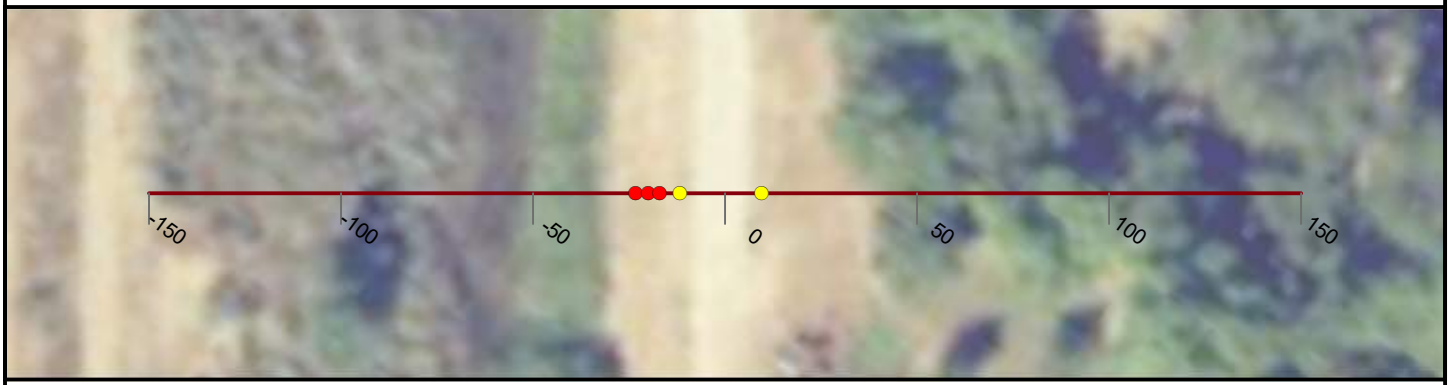
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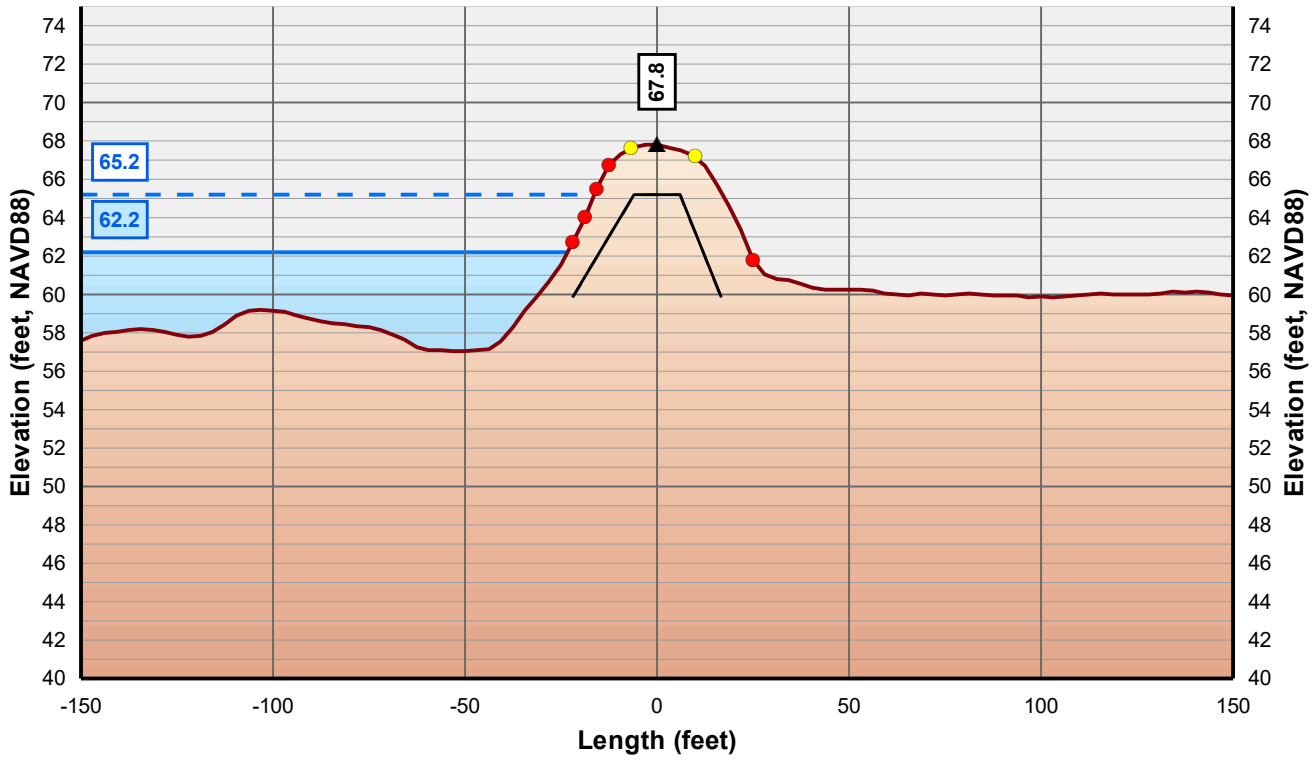
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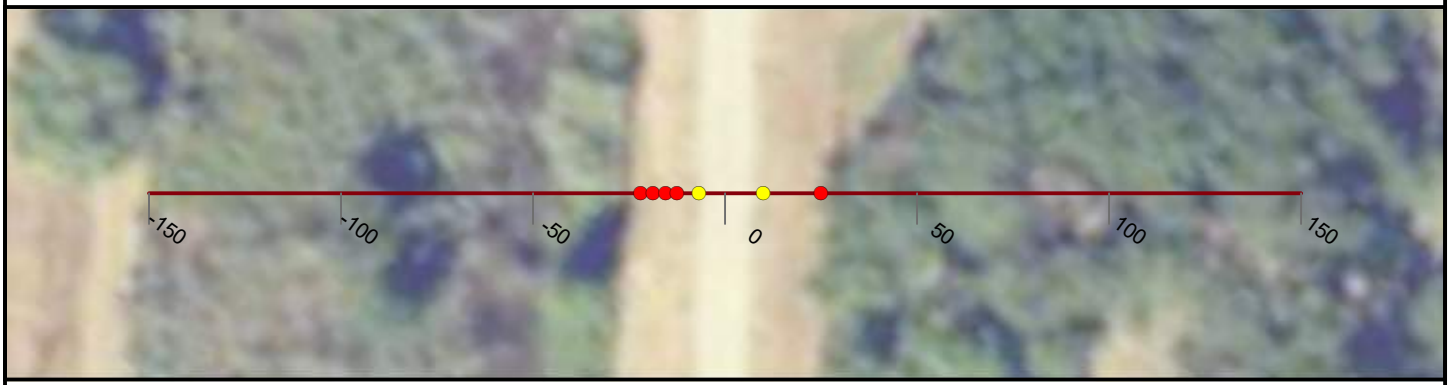
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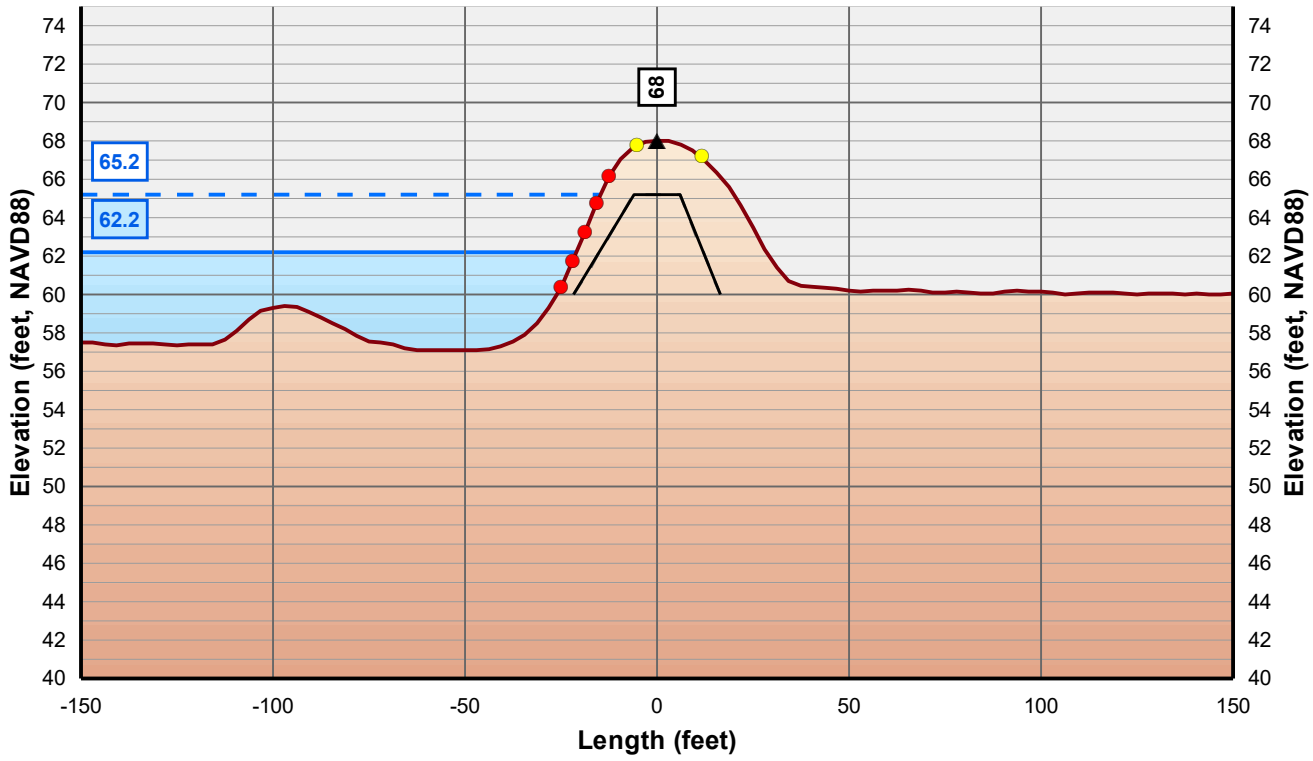
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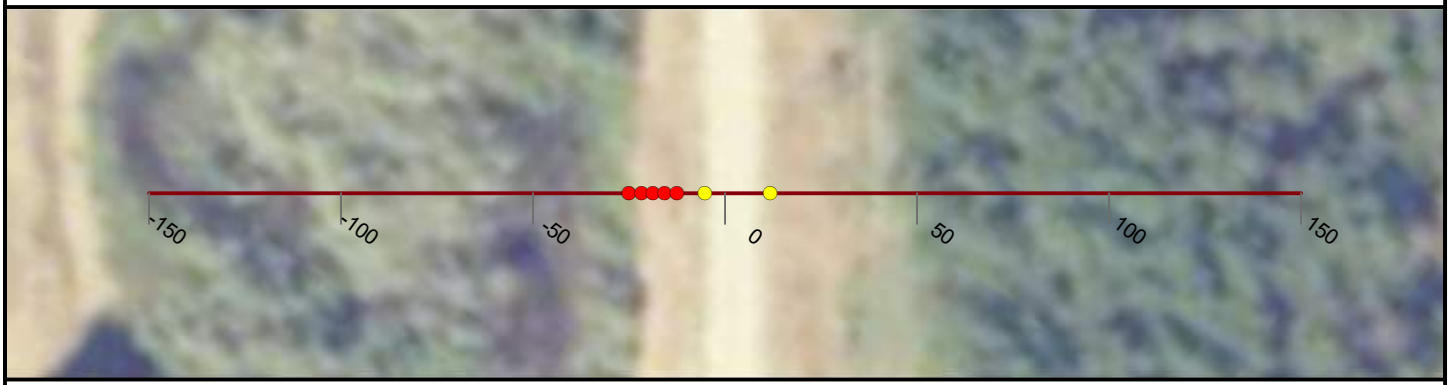
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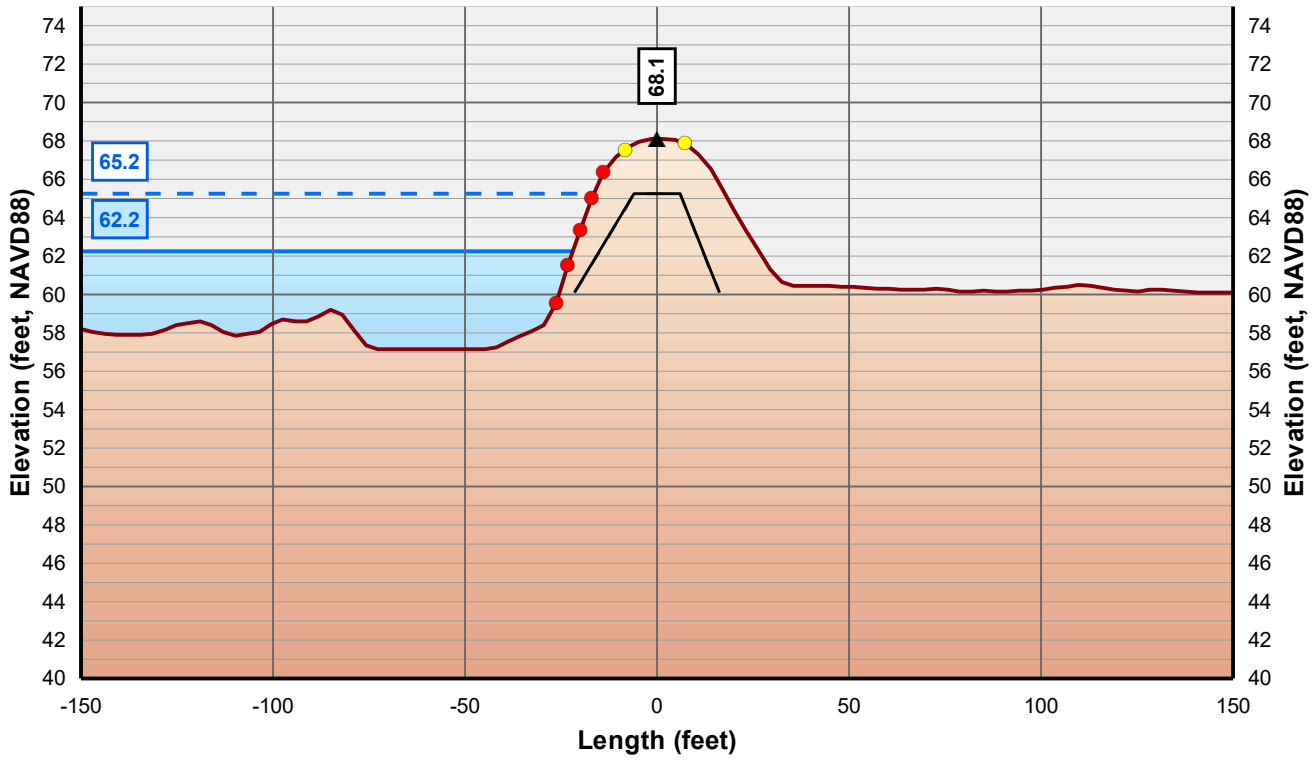
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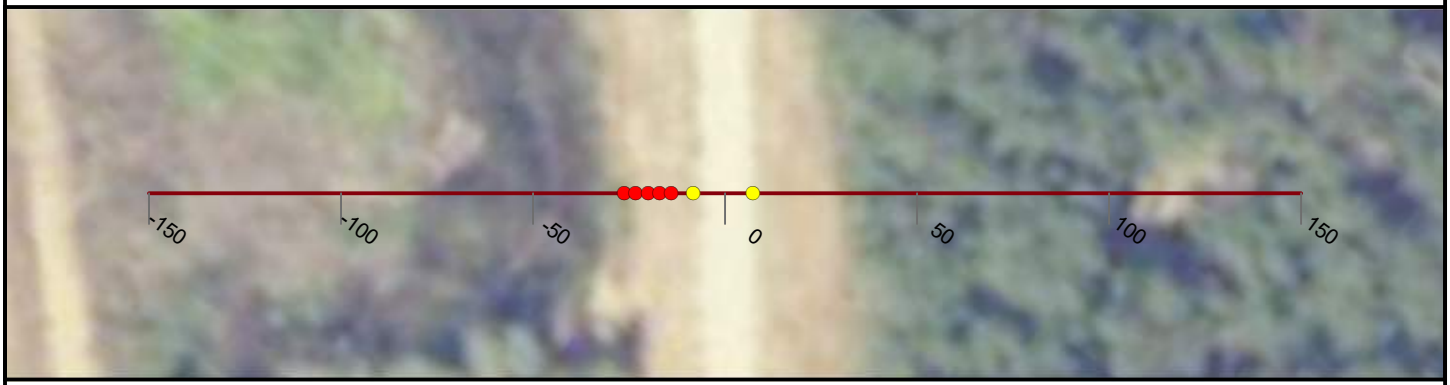
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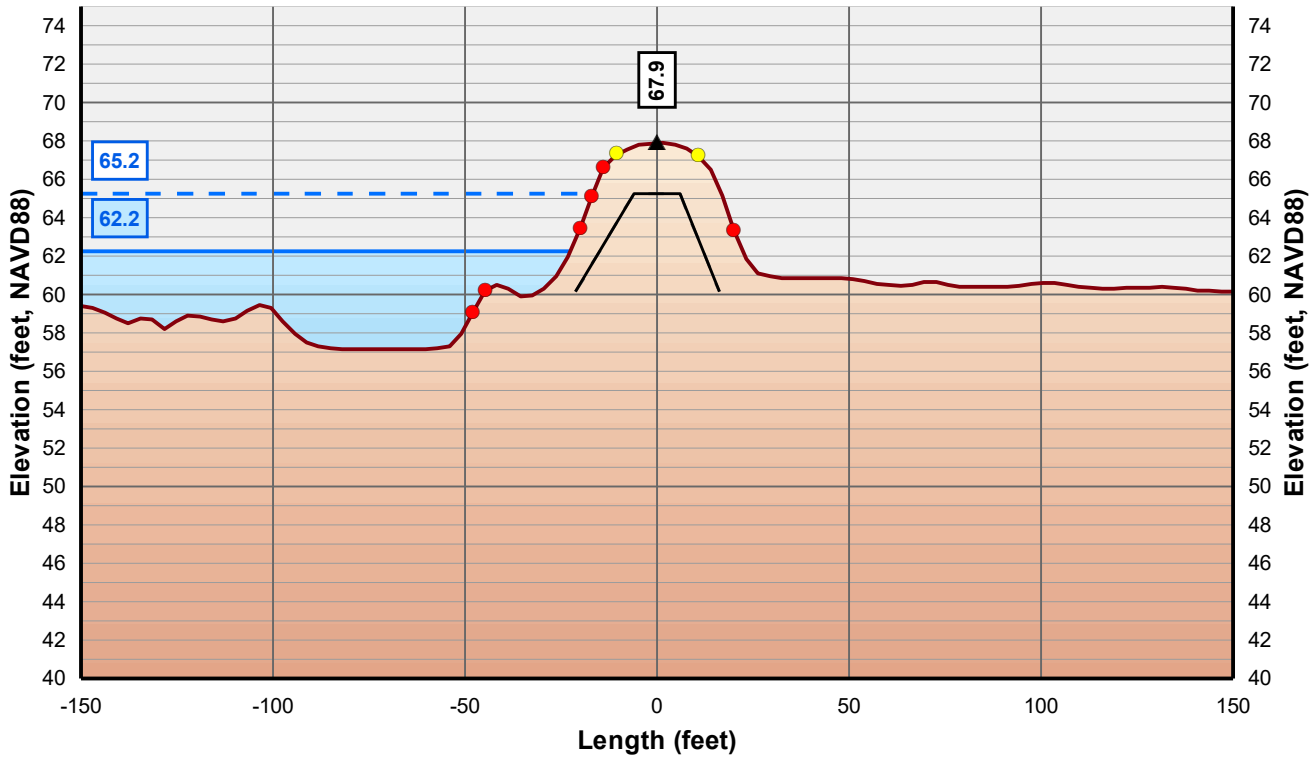
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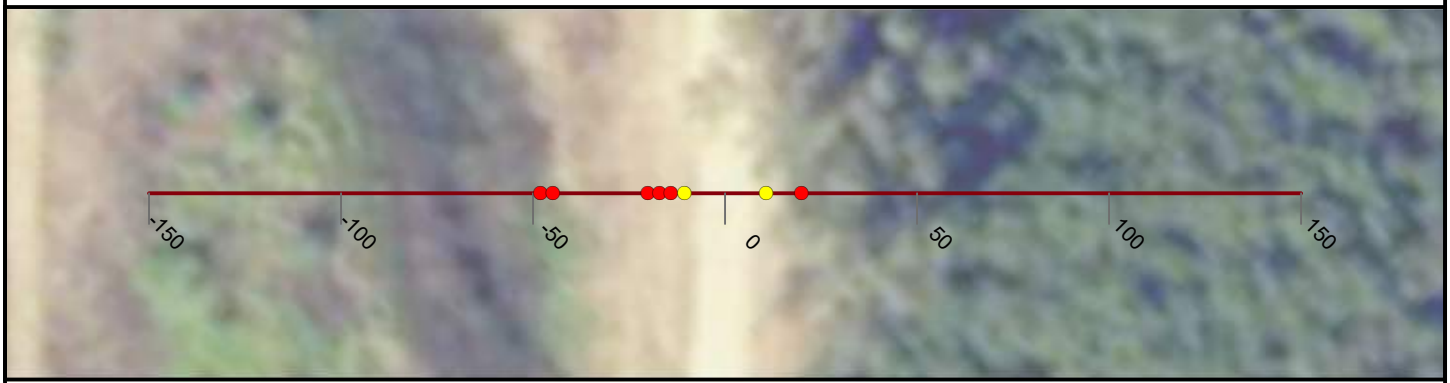
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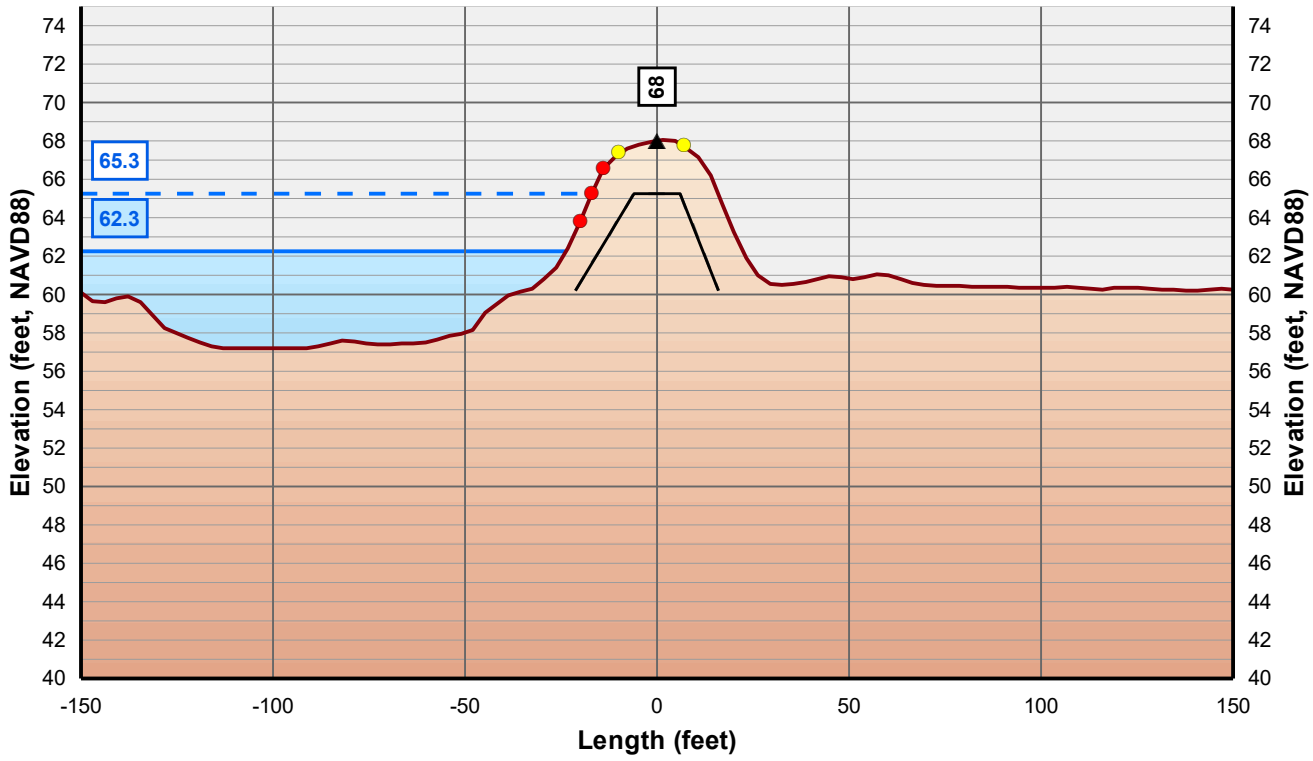
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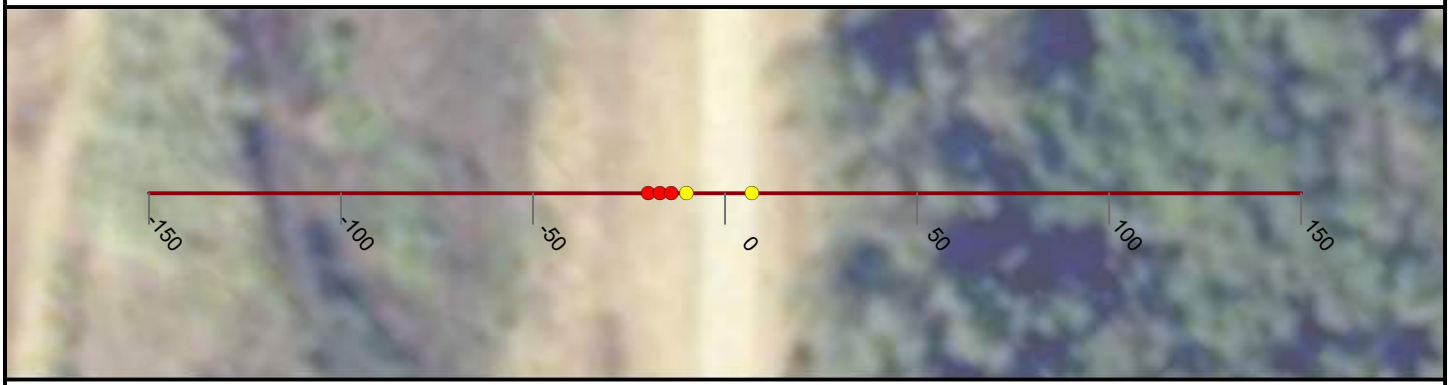
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- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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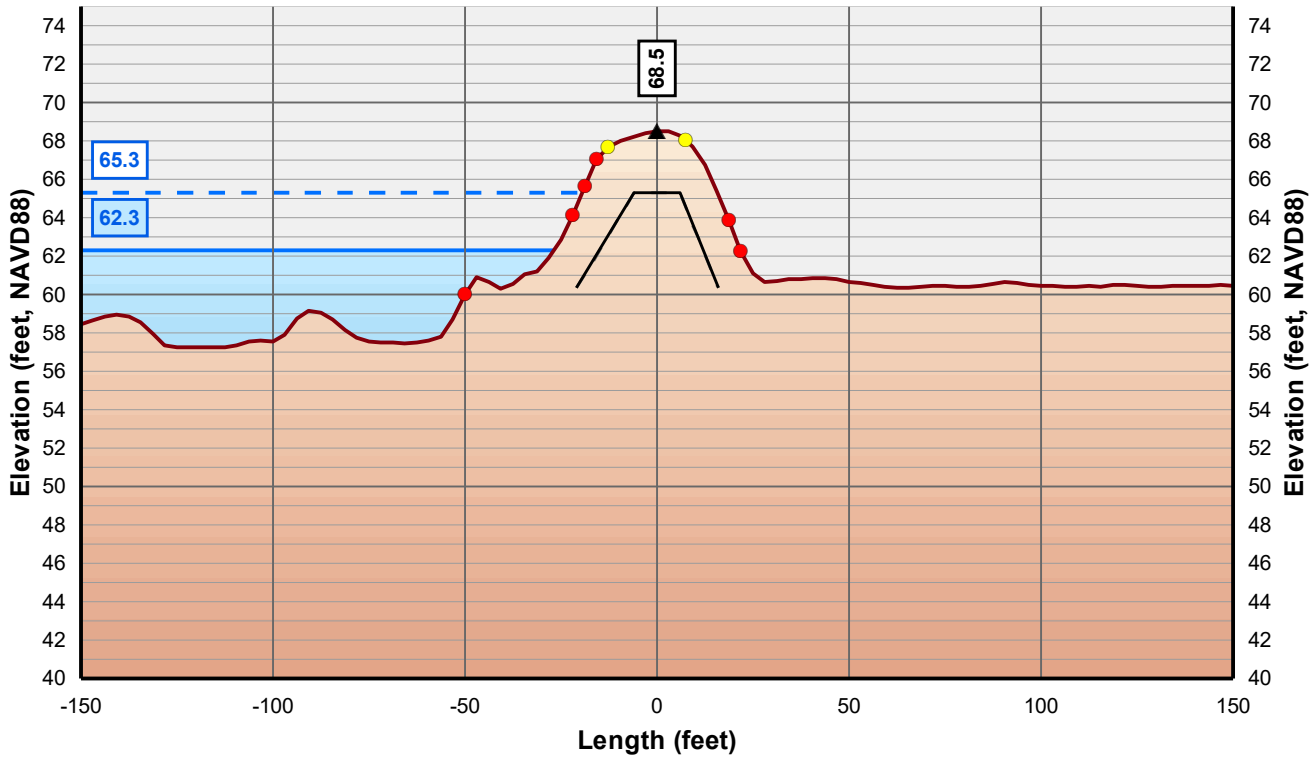
FEET

PRELIMINARY

WOOD RODGERS
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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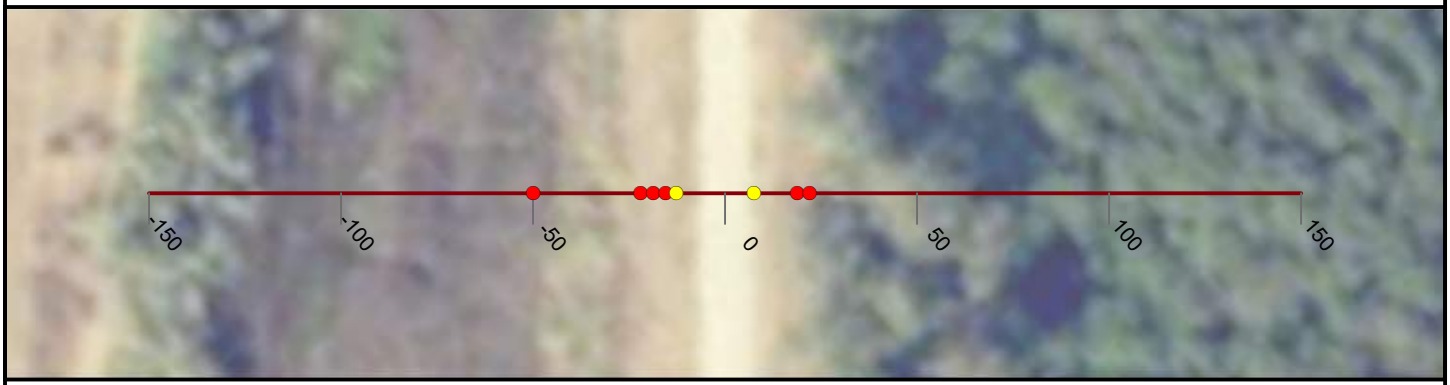
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Cross Section: Yankee Slough 174+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

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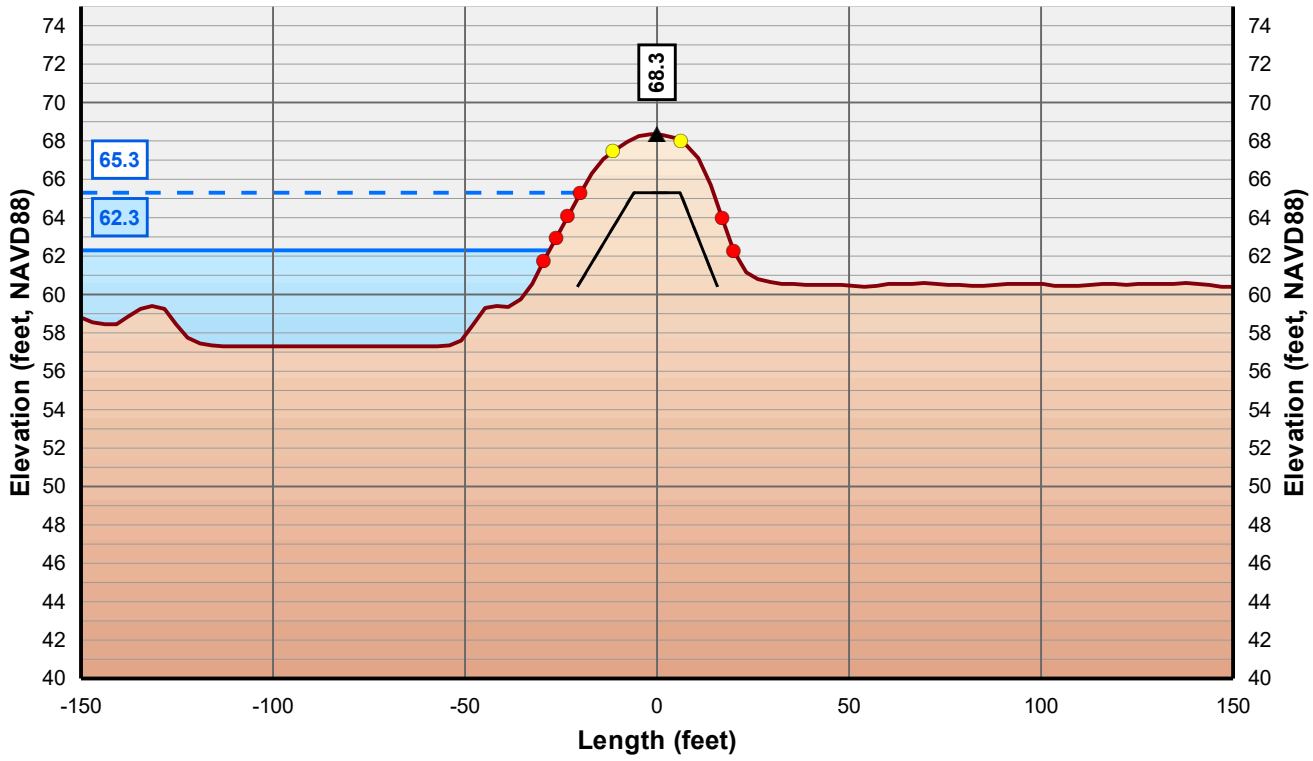
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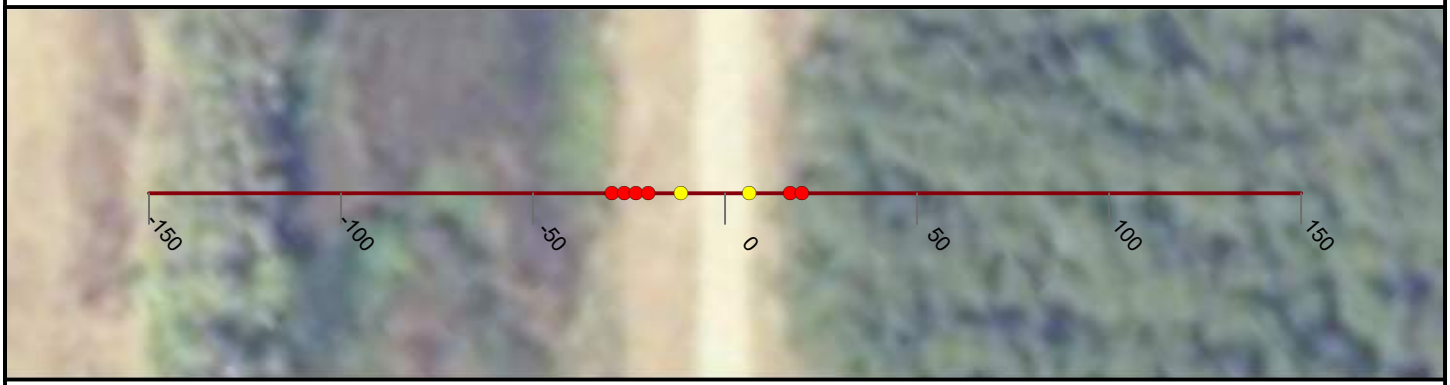
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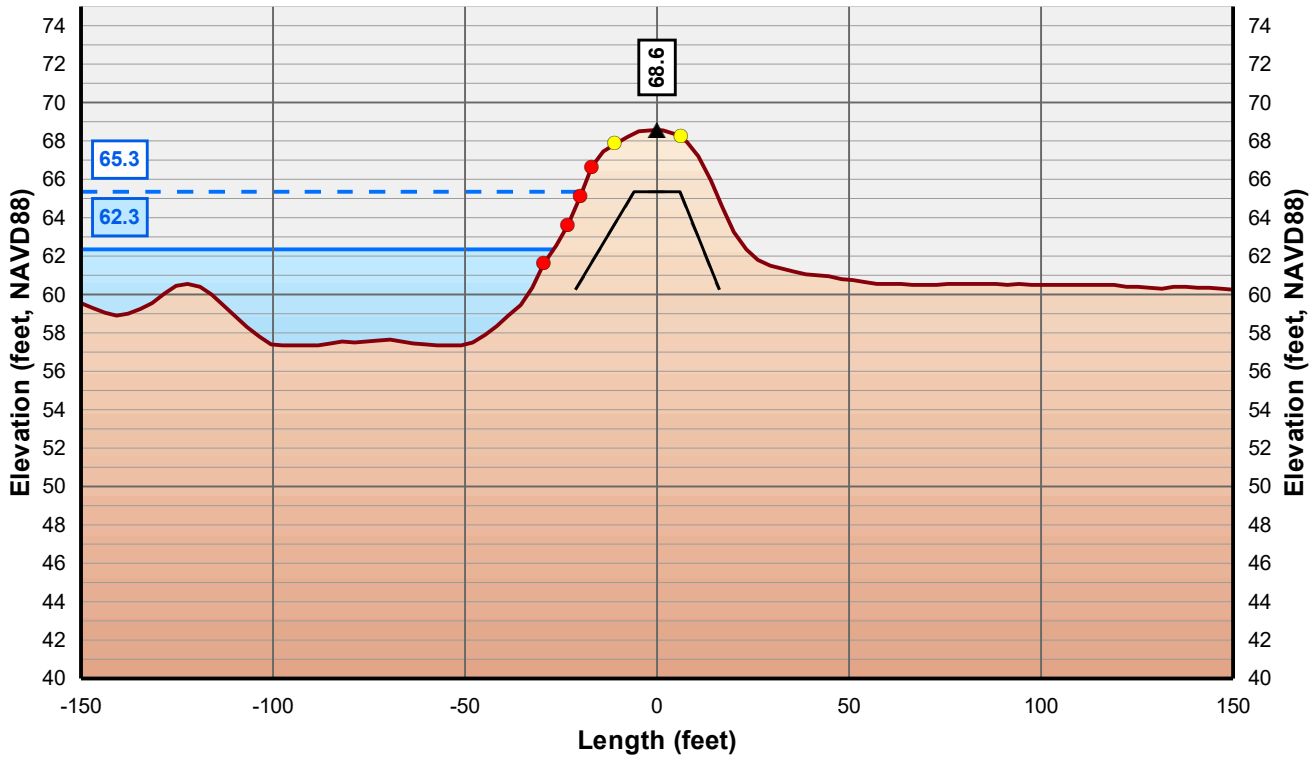
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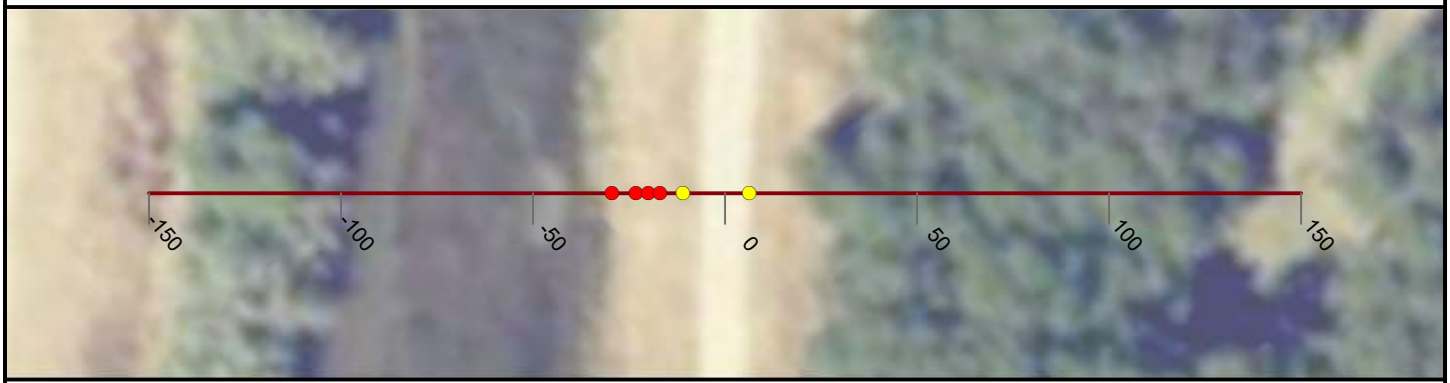
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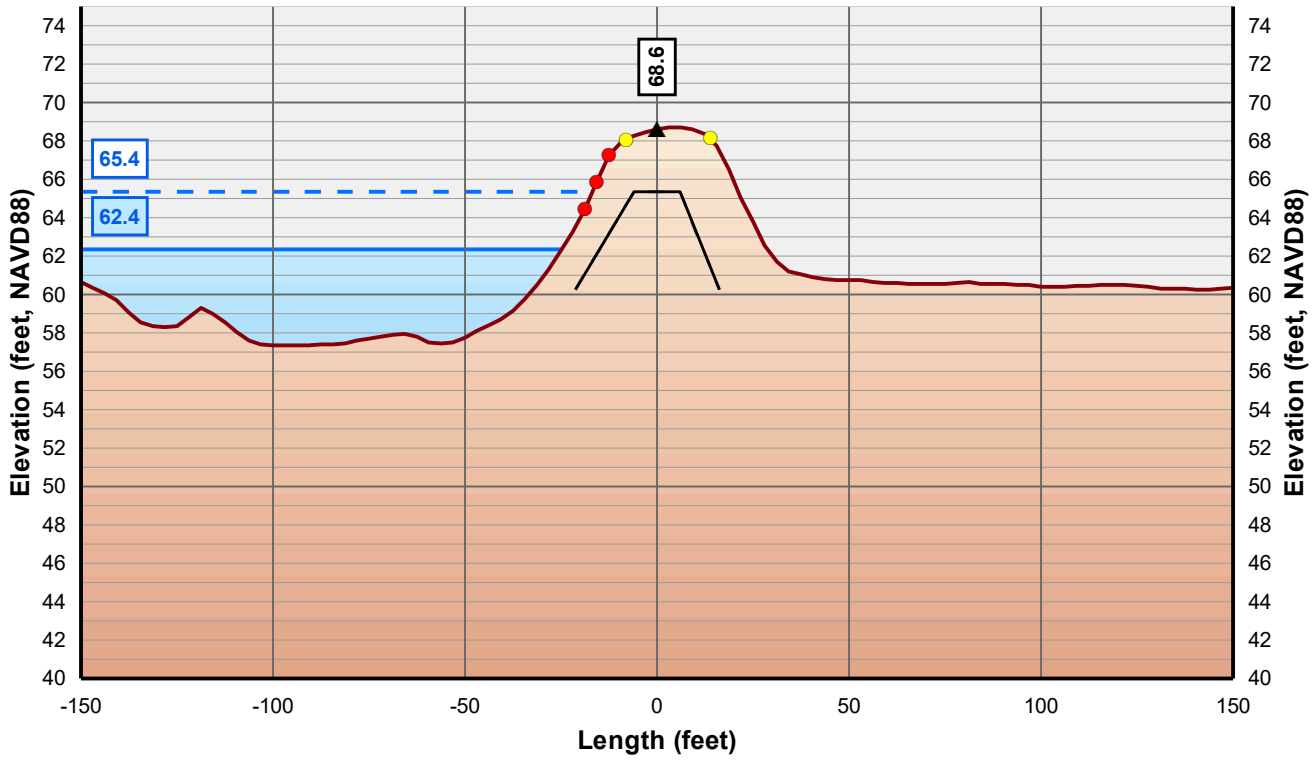
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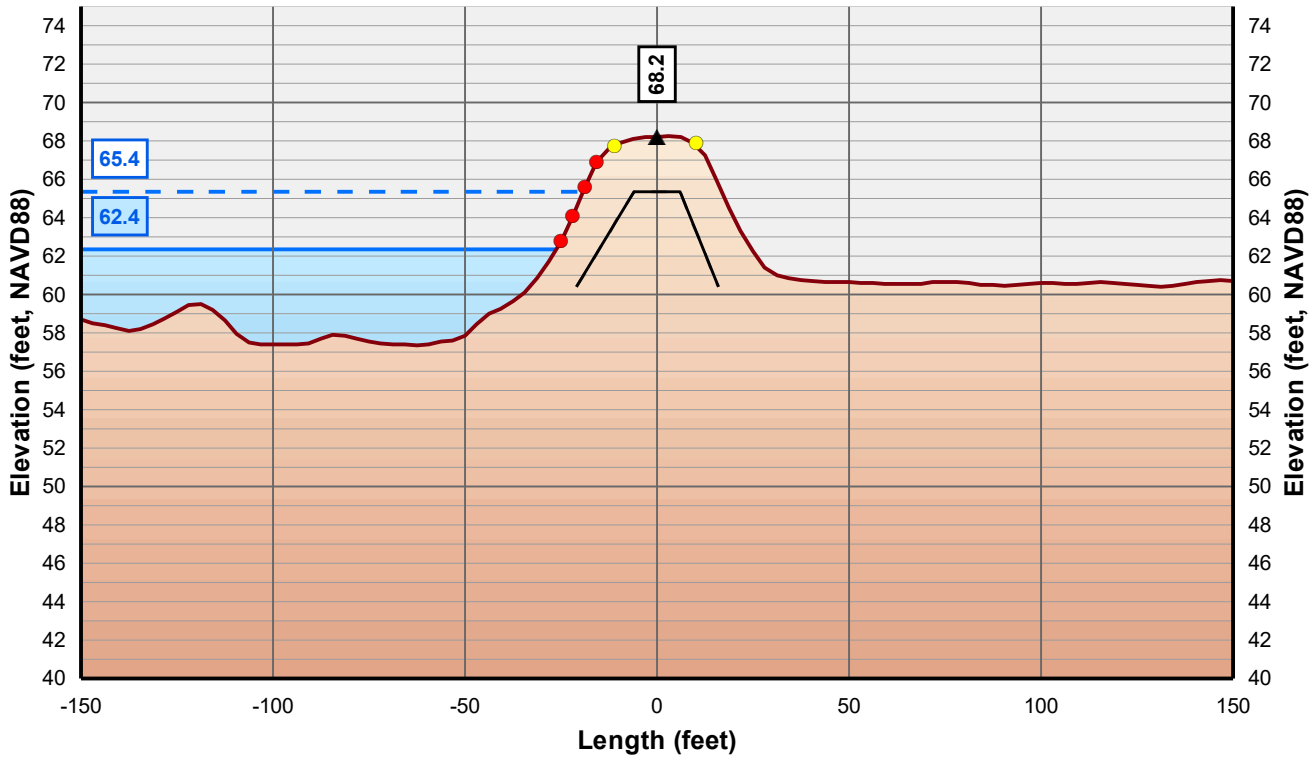
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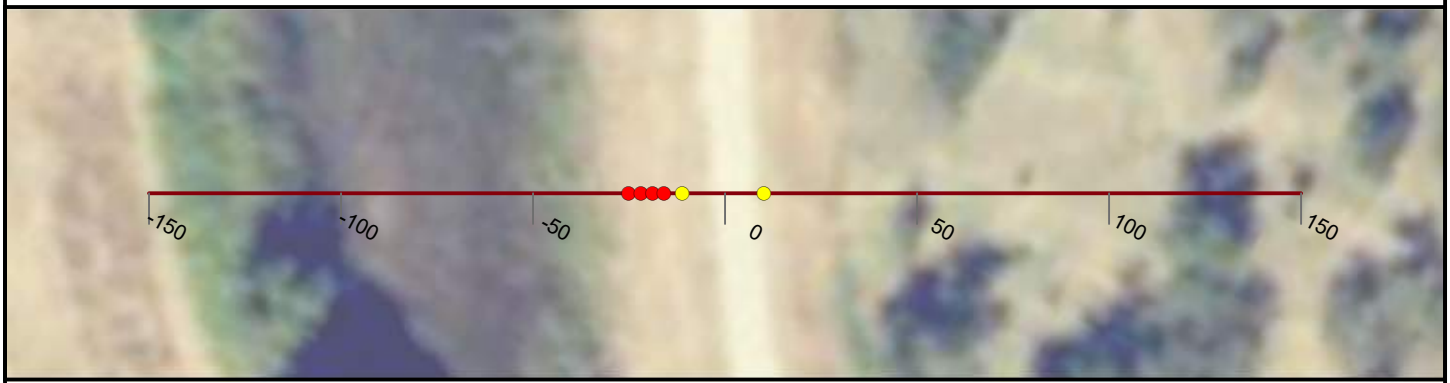
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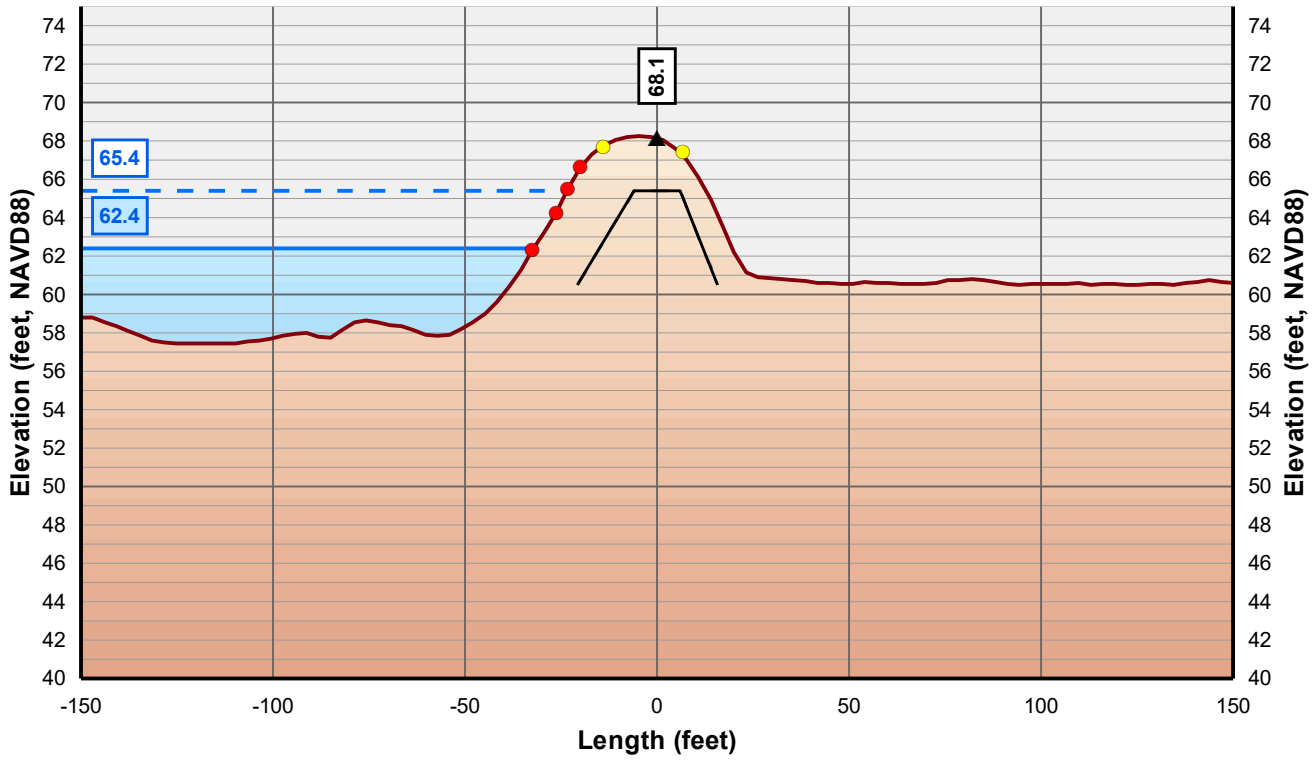
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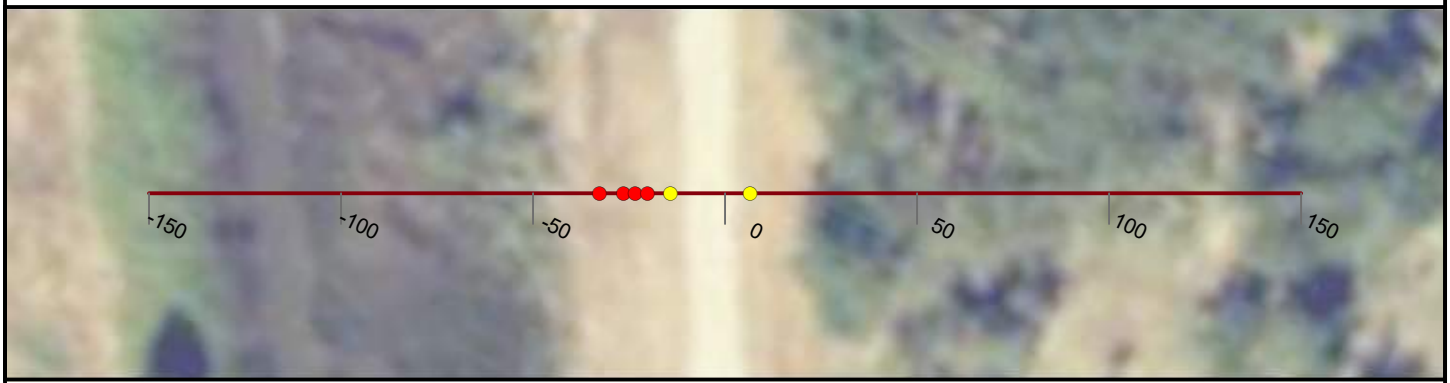
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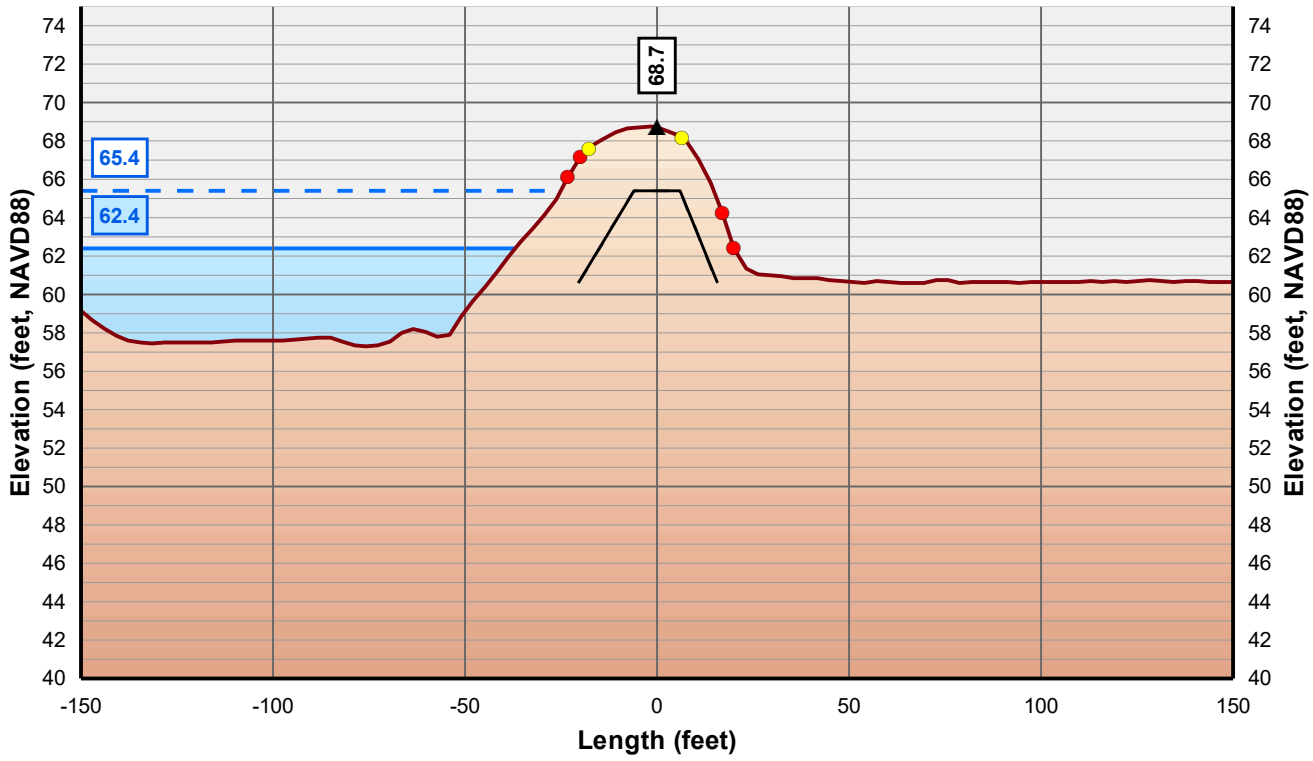
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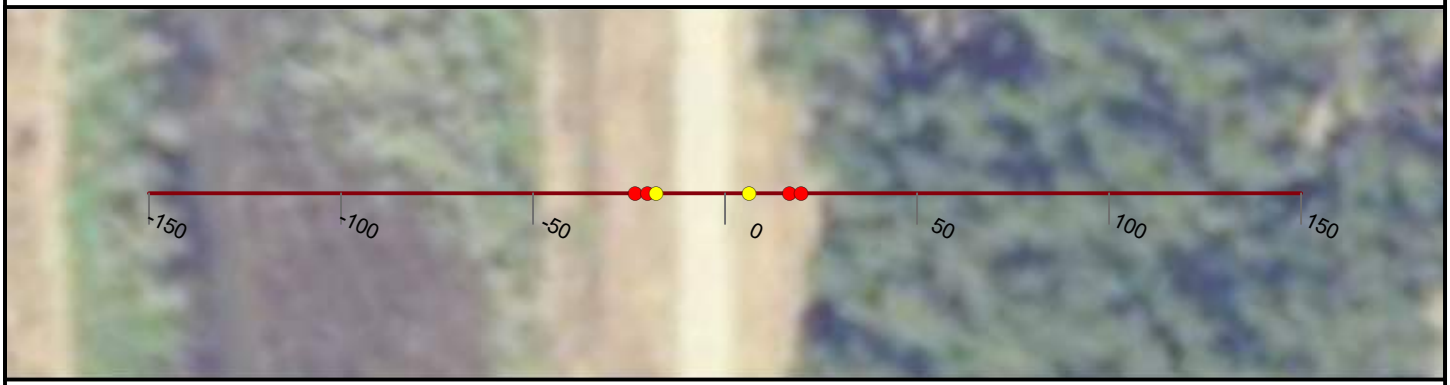
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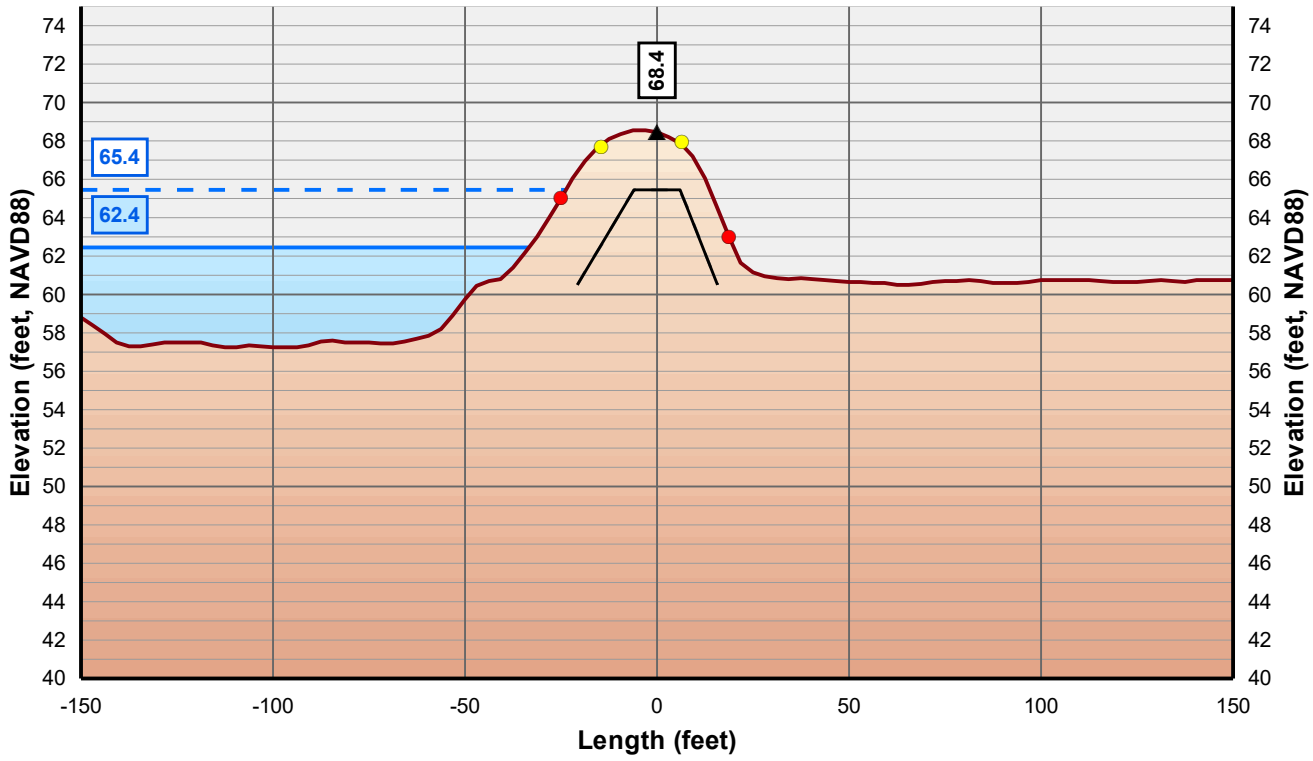
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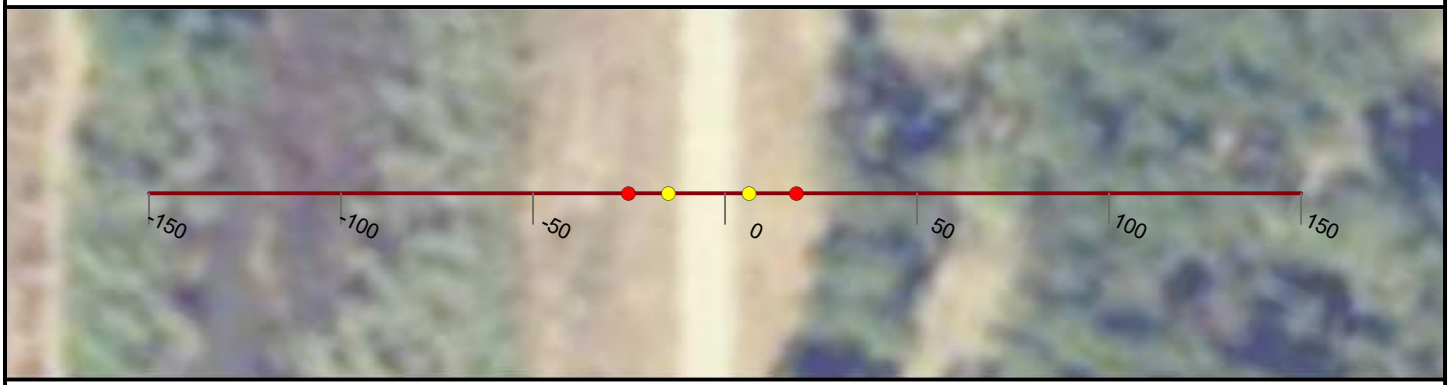
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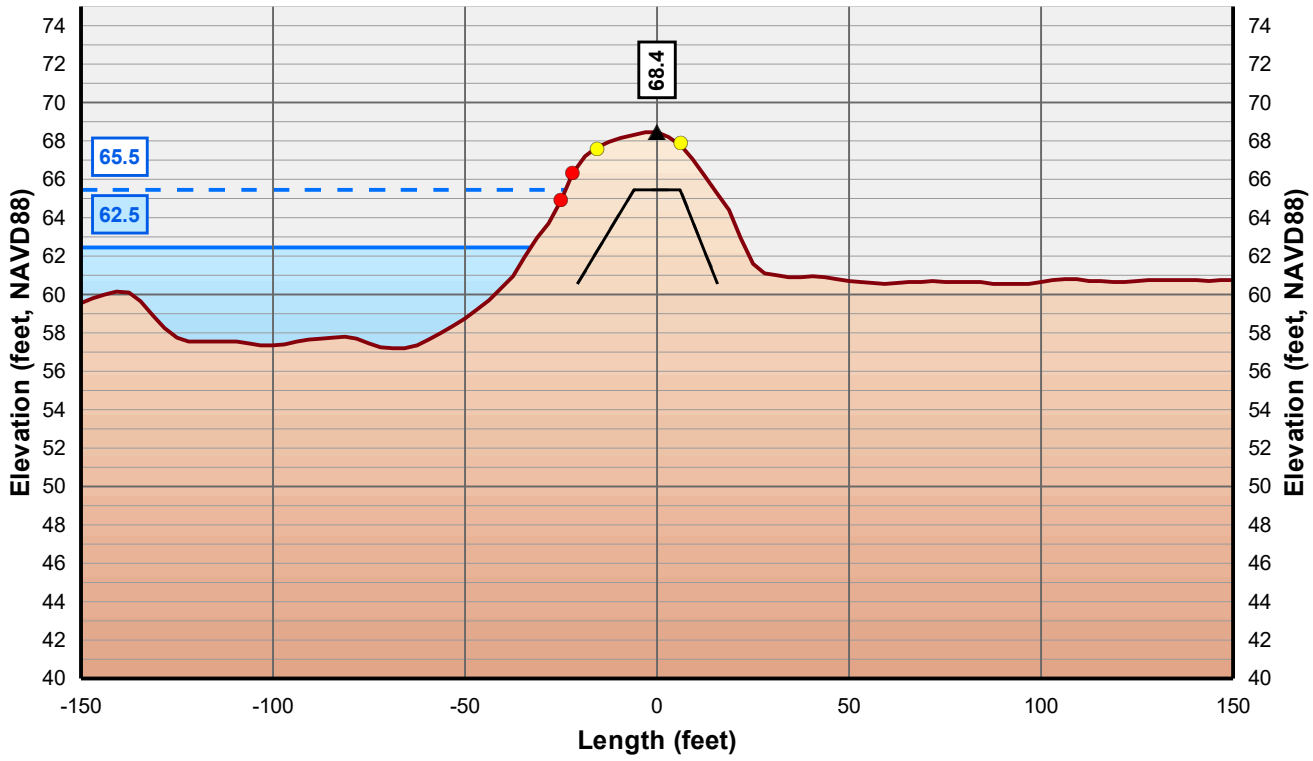
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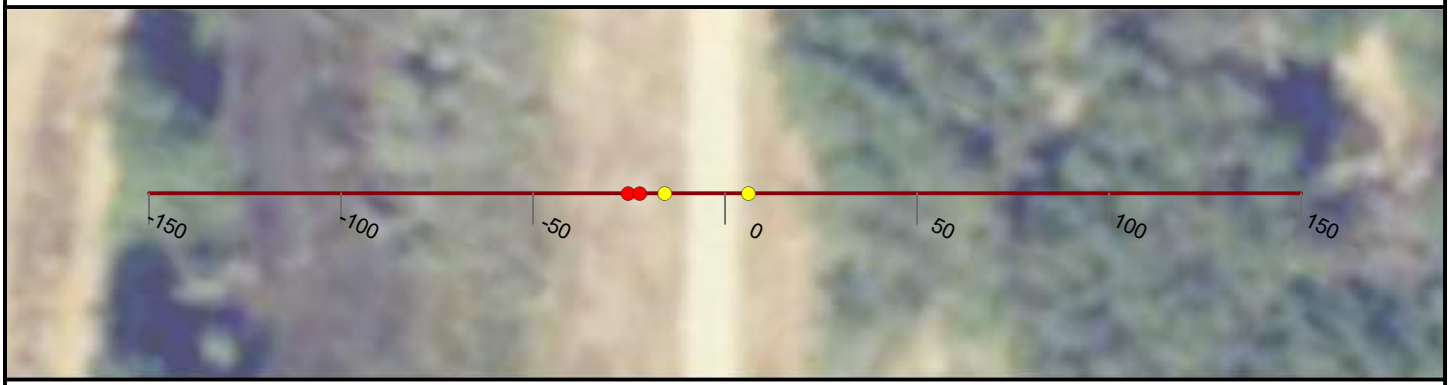
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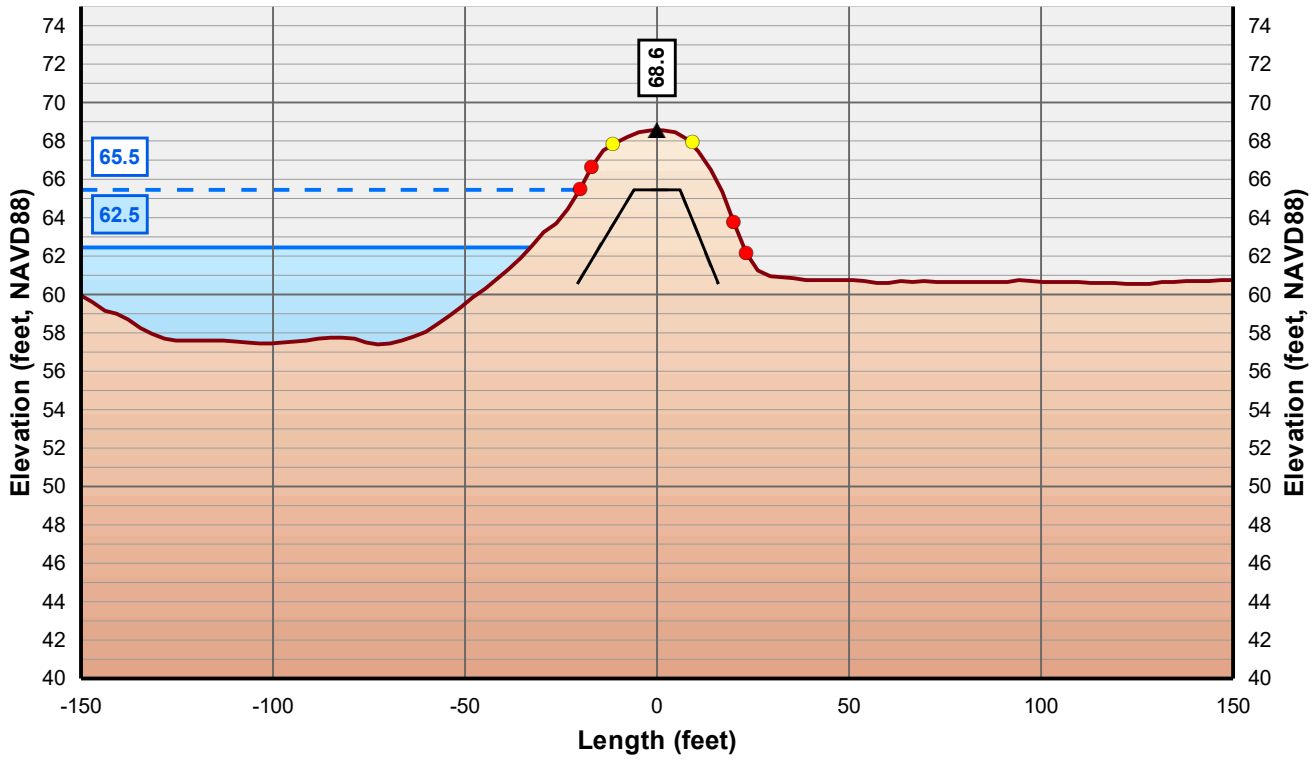
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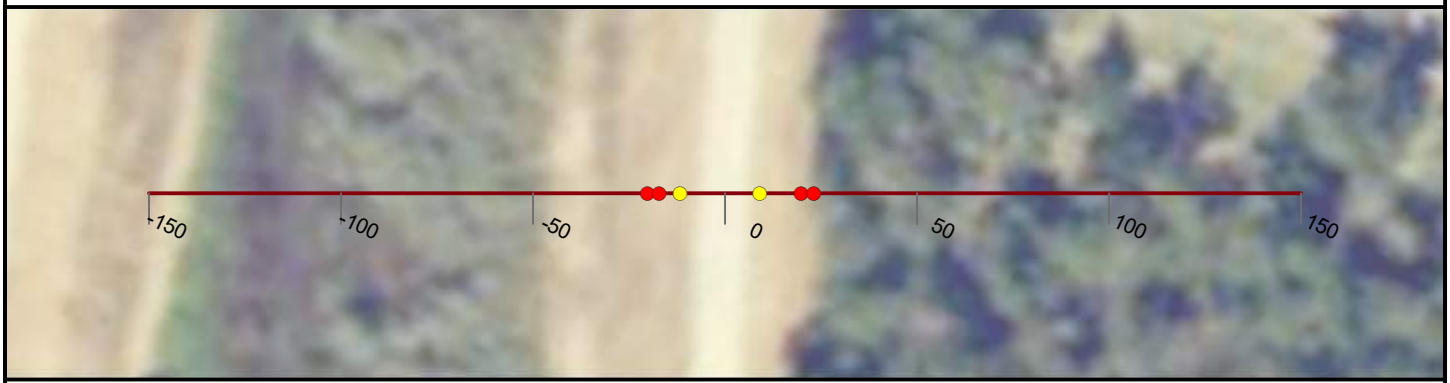
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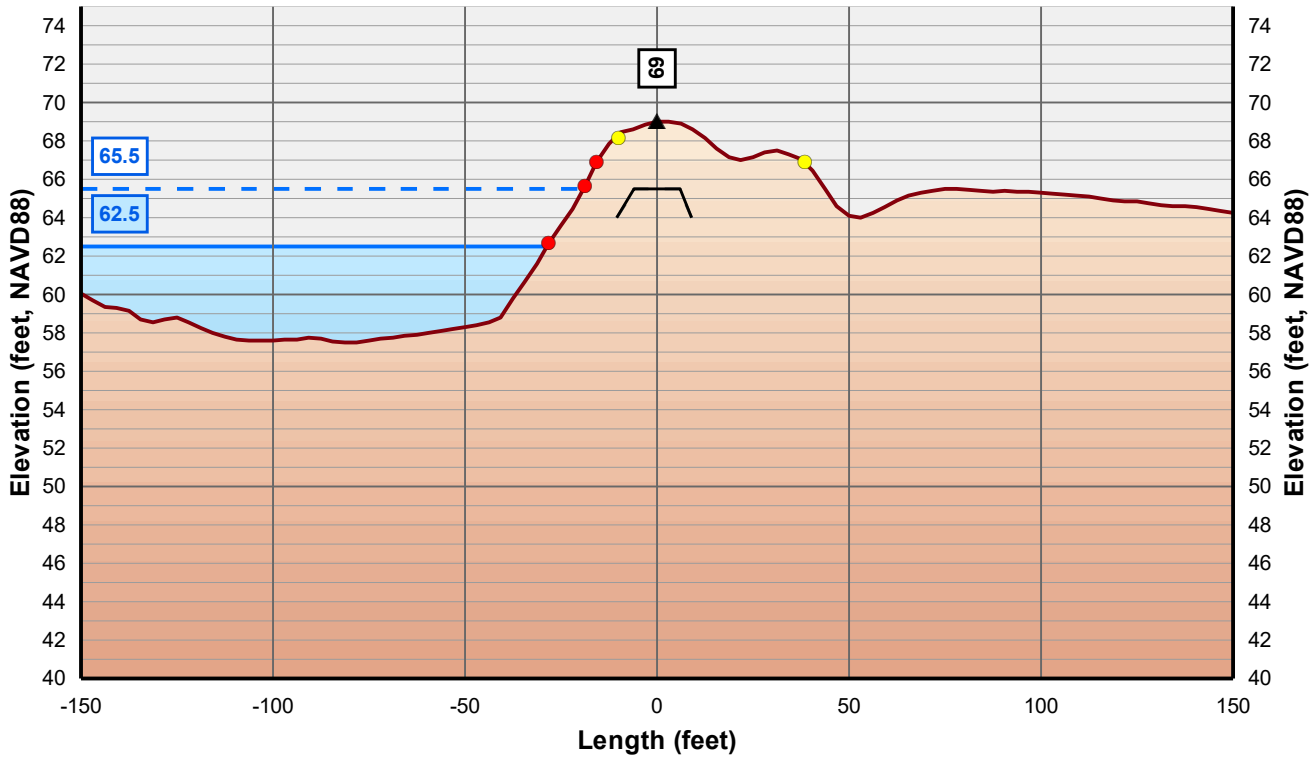
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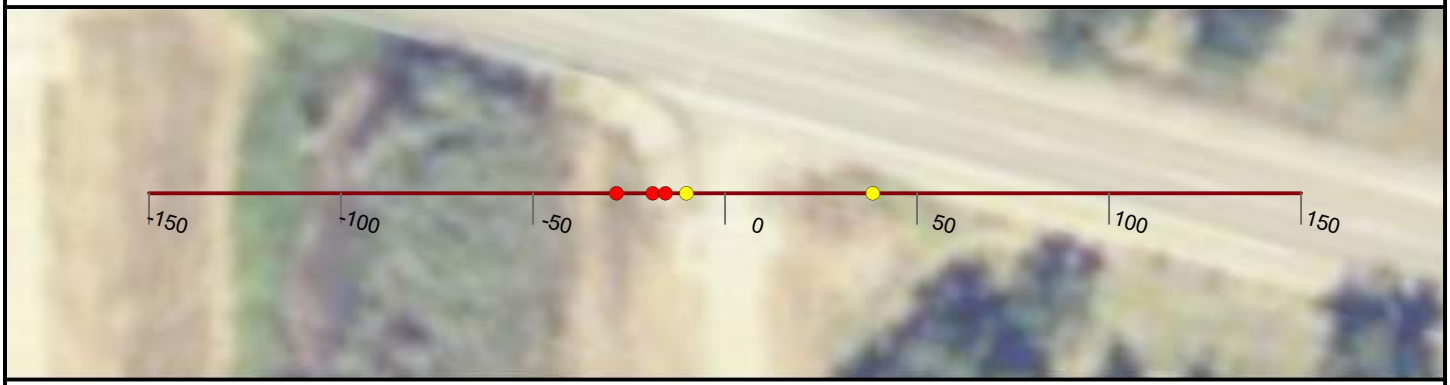
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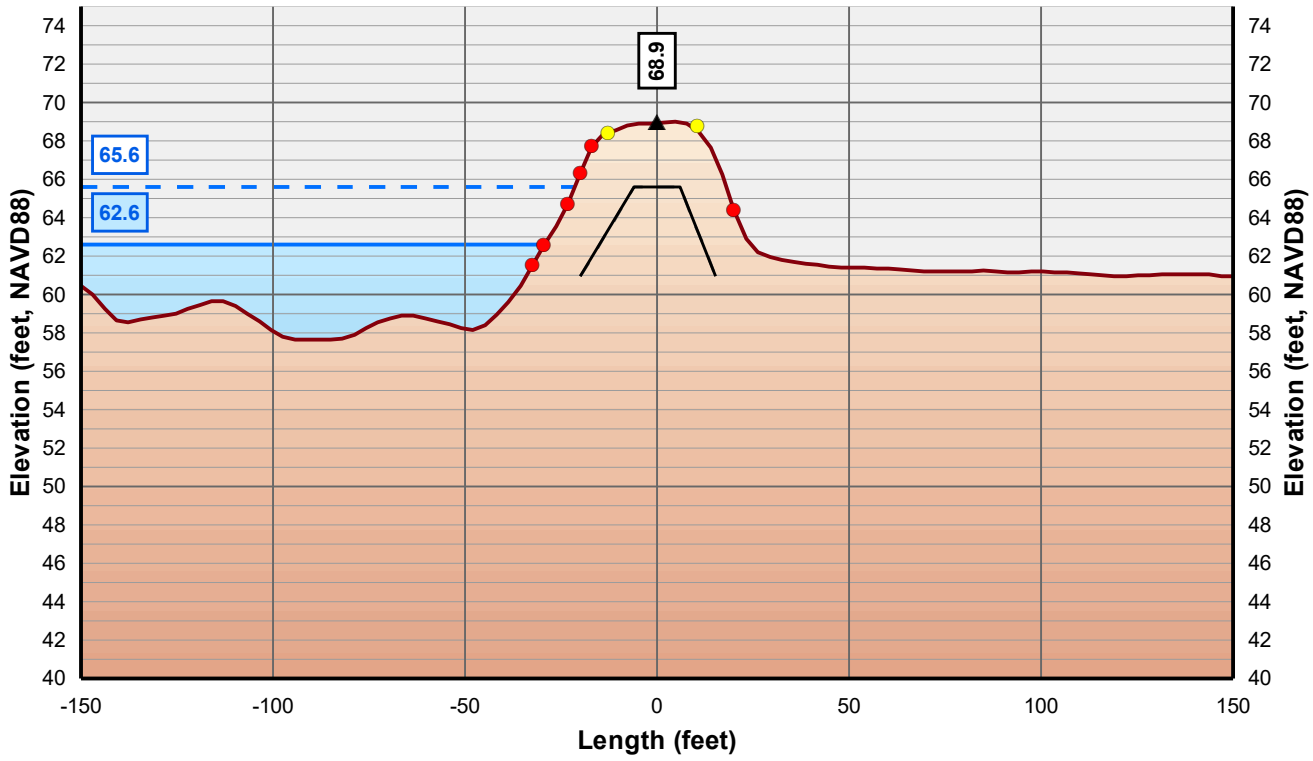
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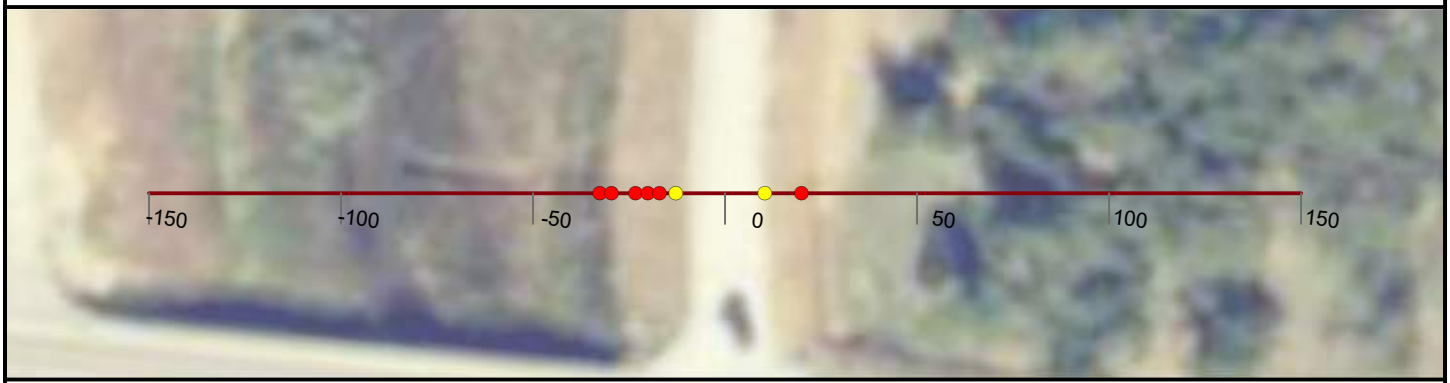
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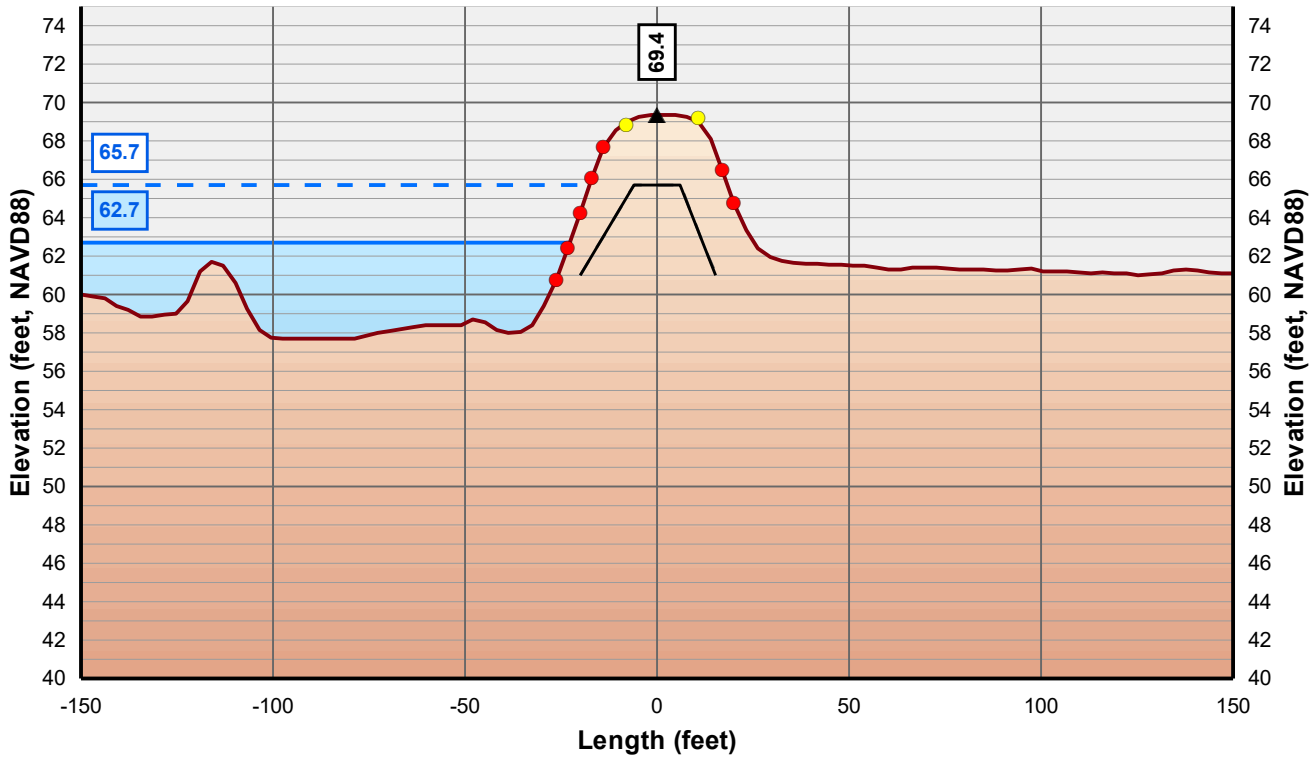
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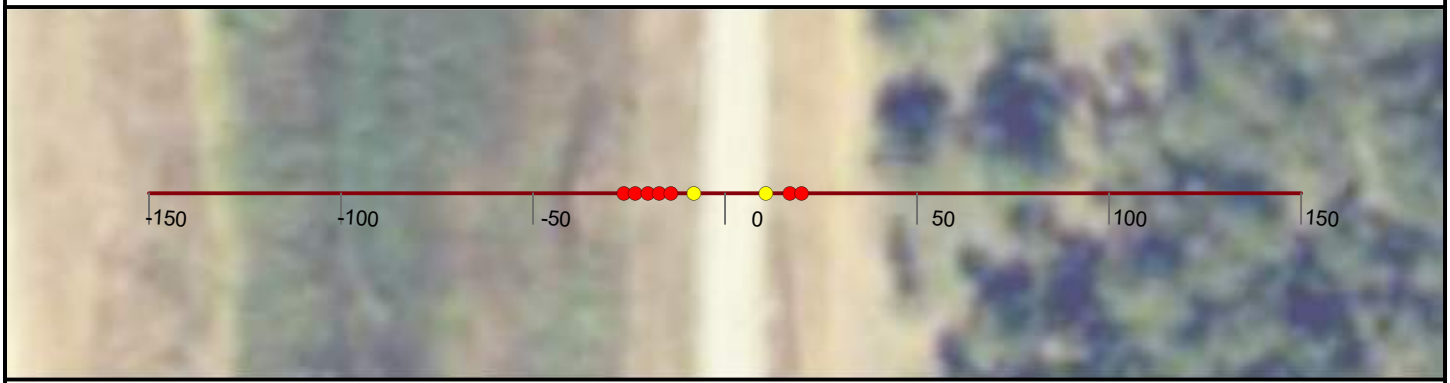
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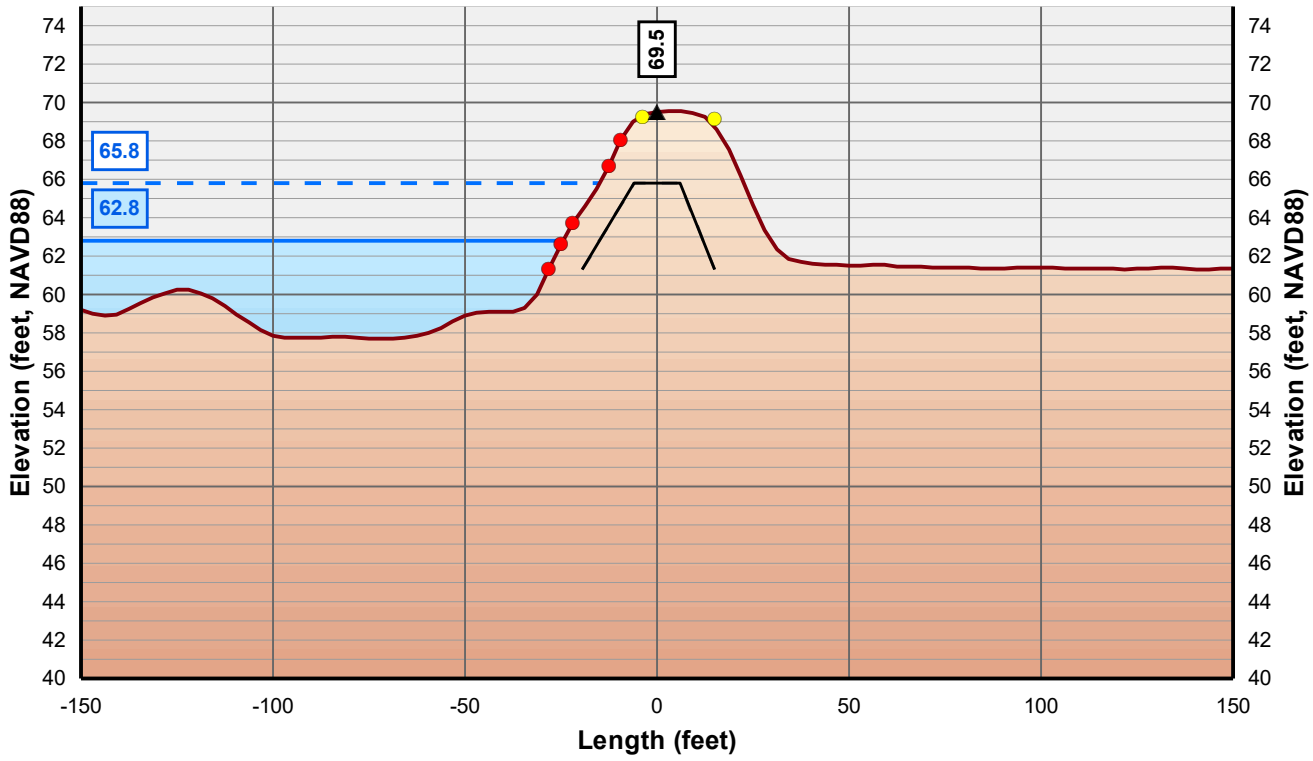
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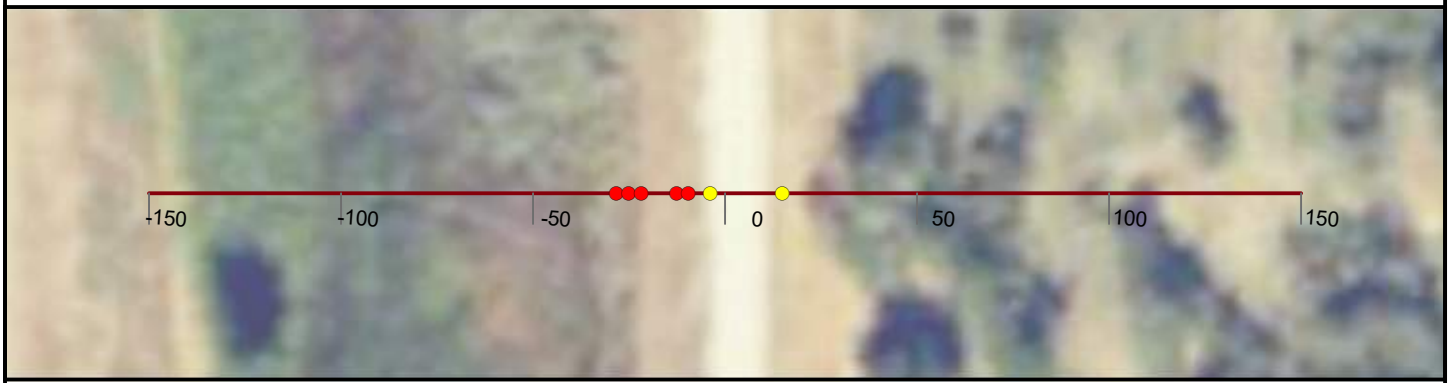
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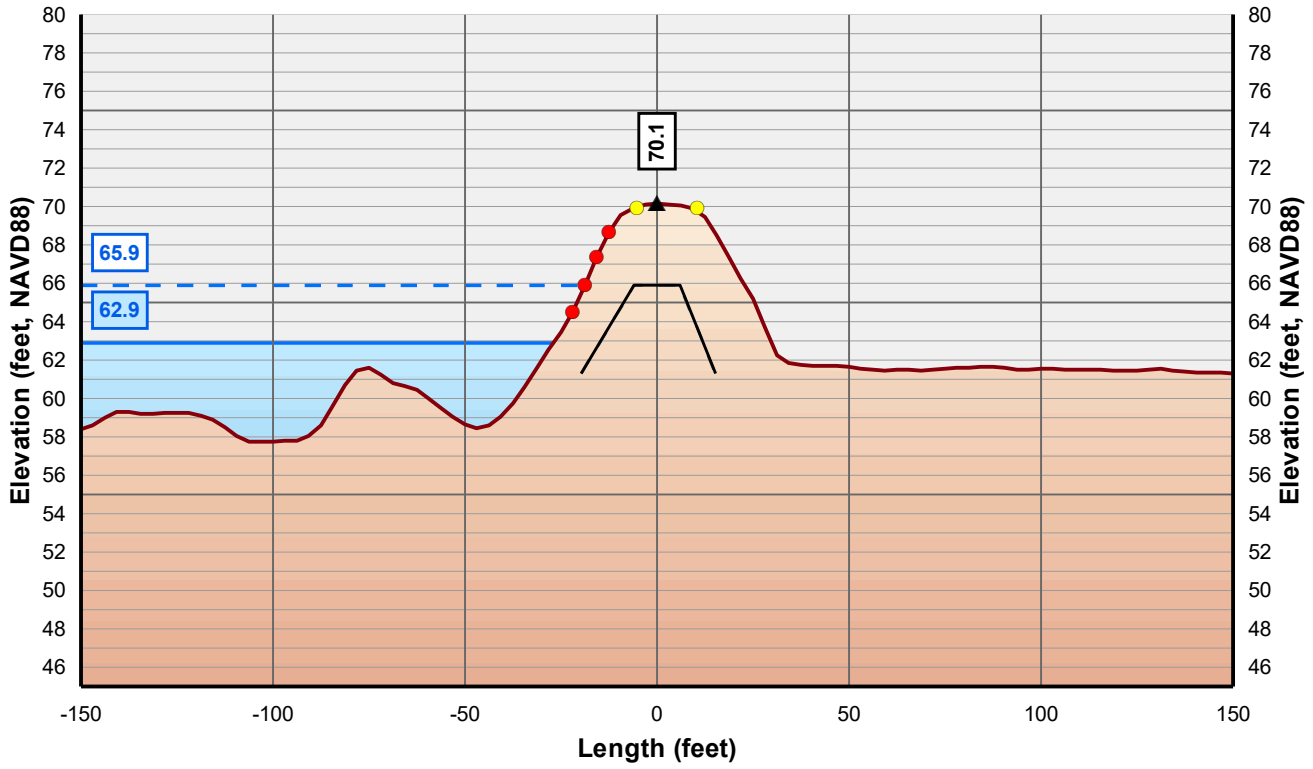
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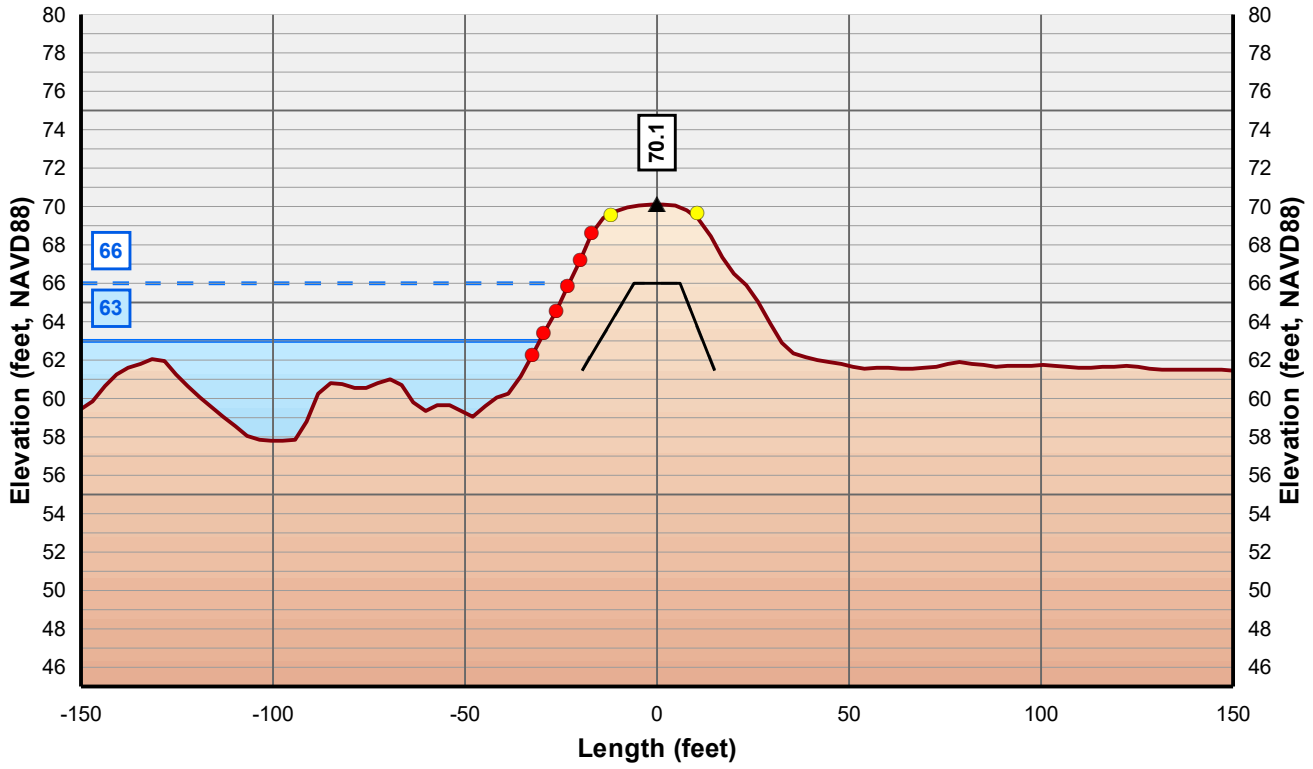
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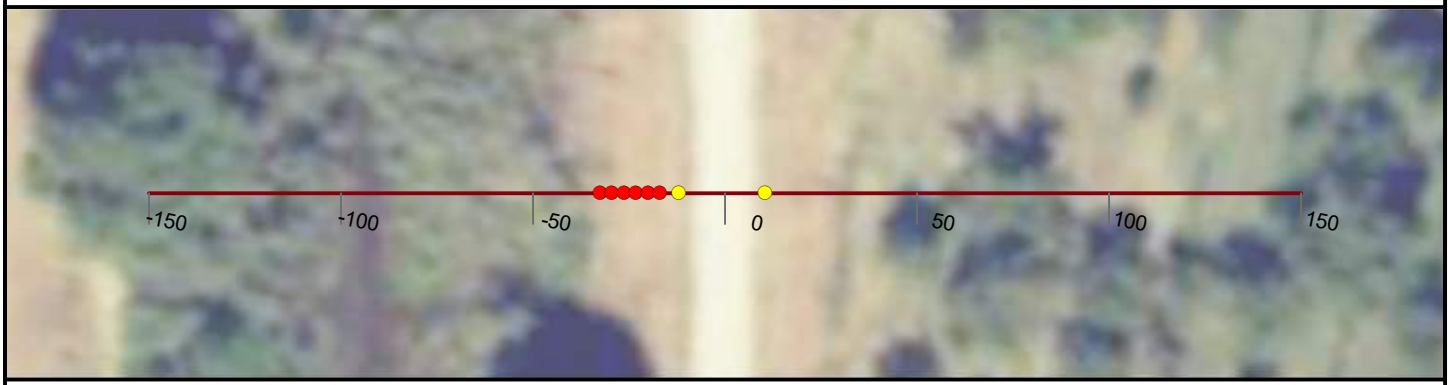
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Cross Section: Yankee Slough 189+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
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RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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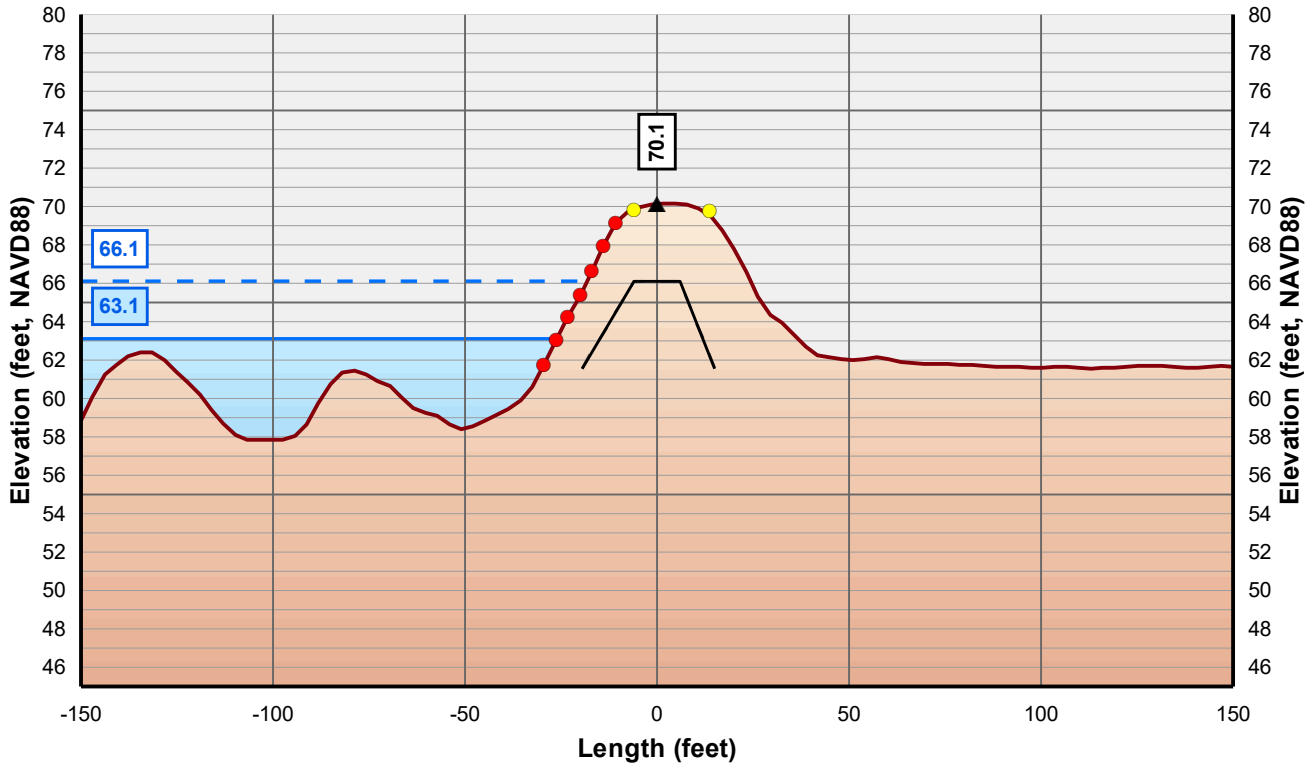
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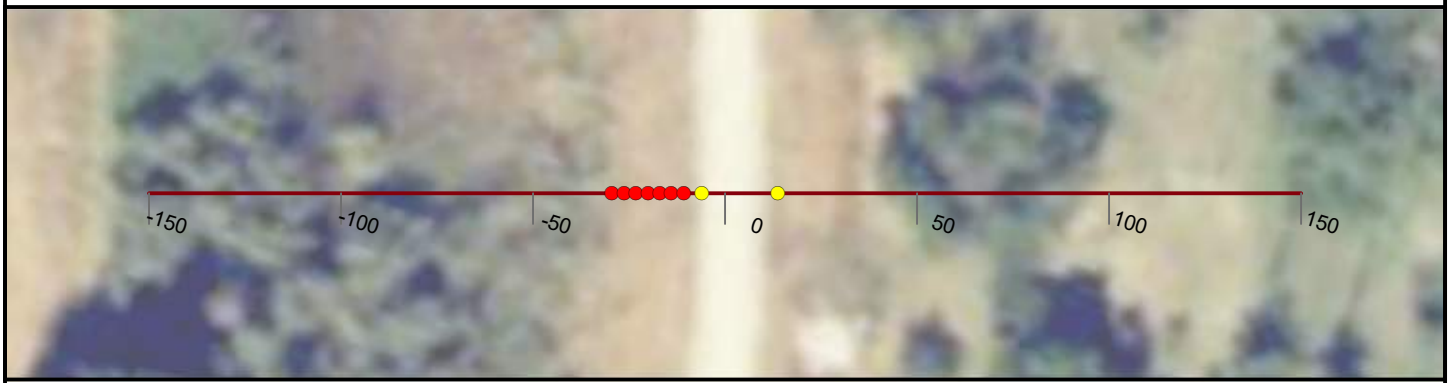
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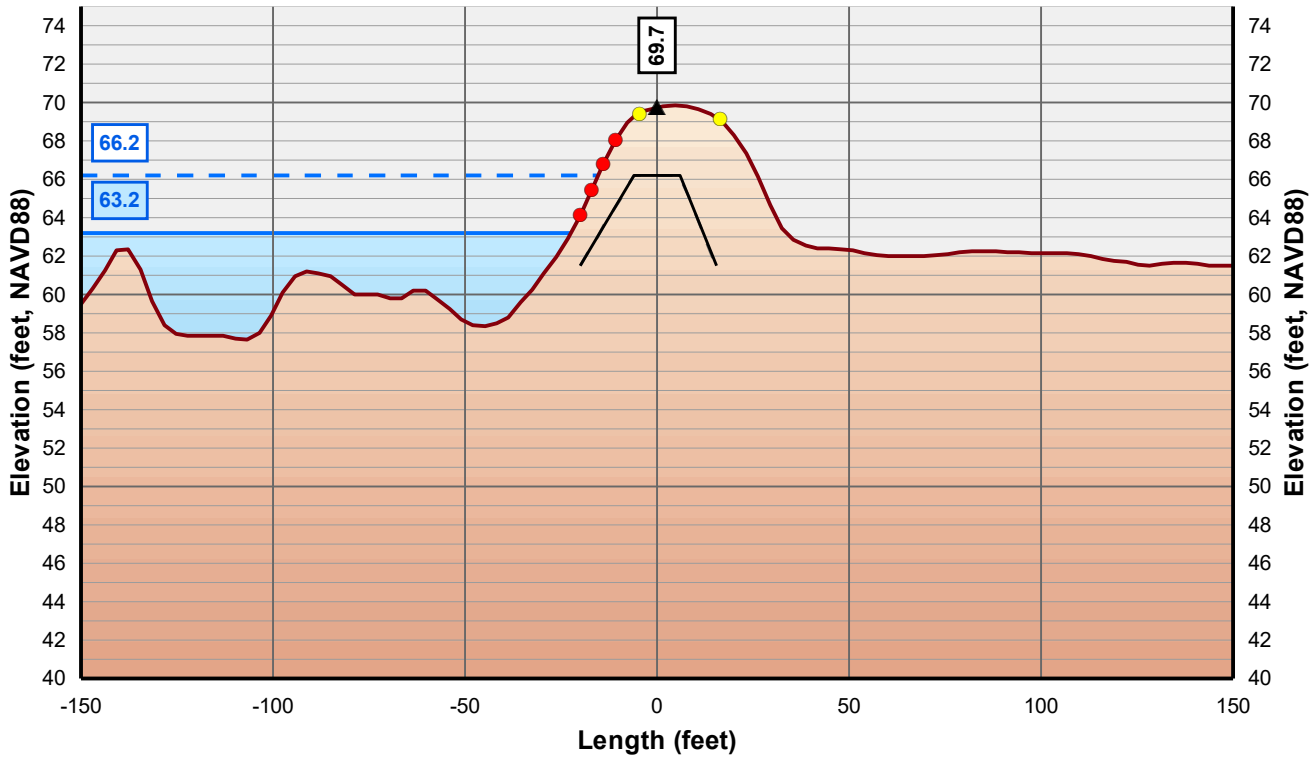
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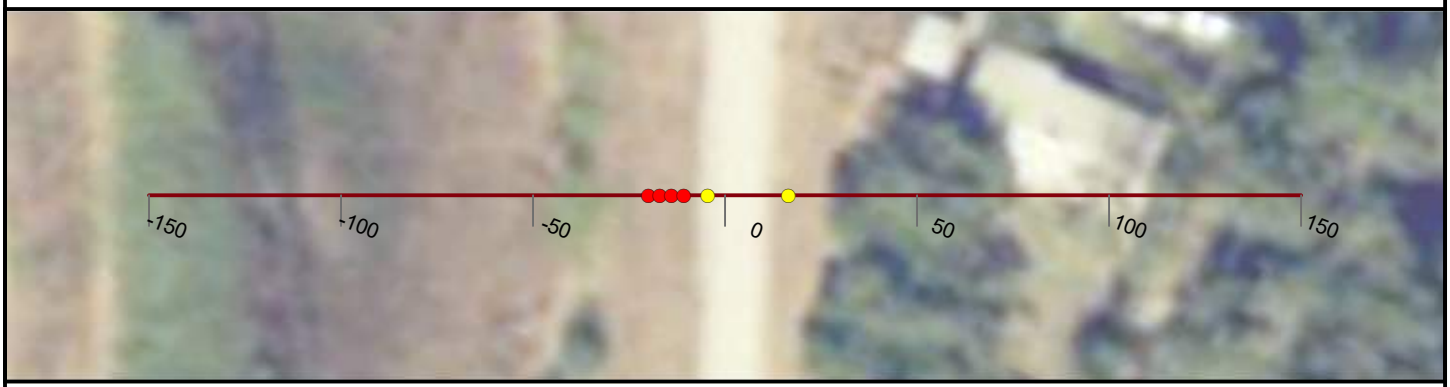
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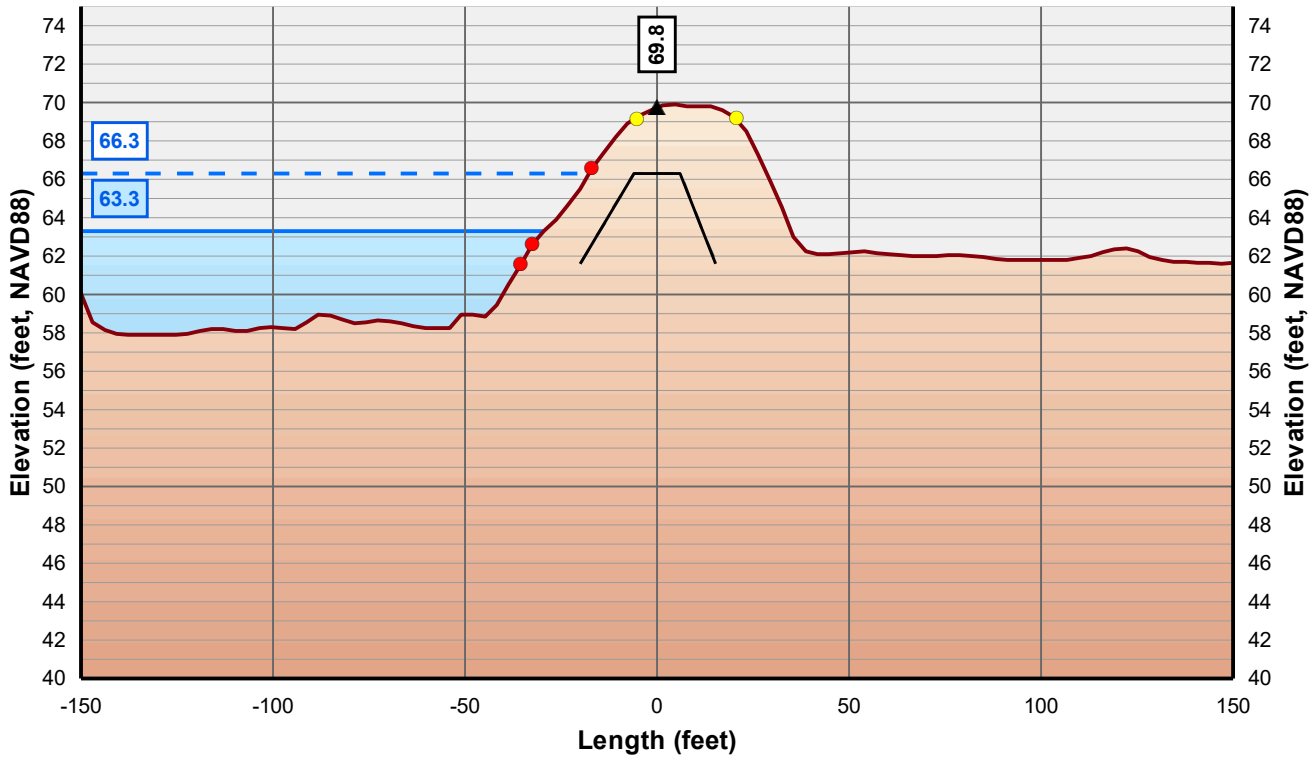
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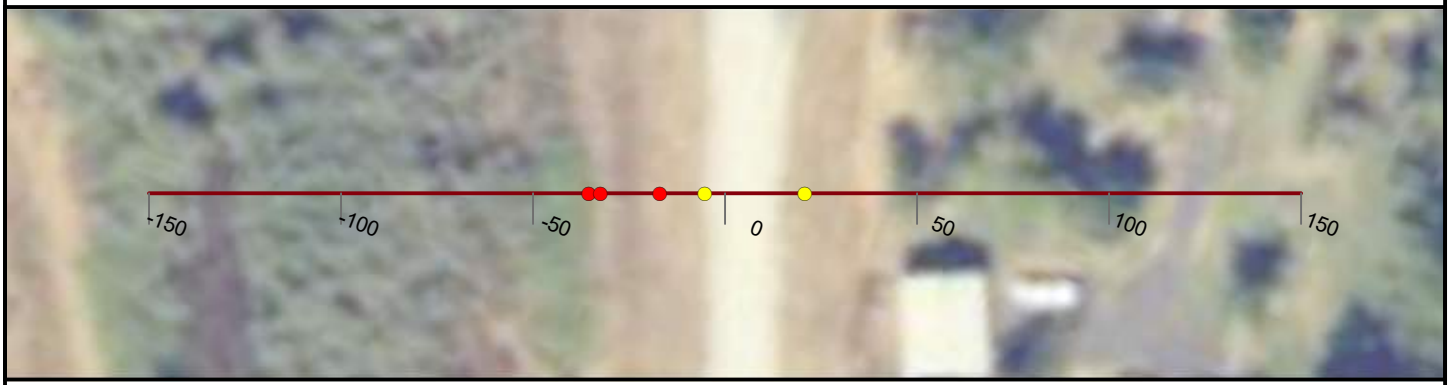
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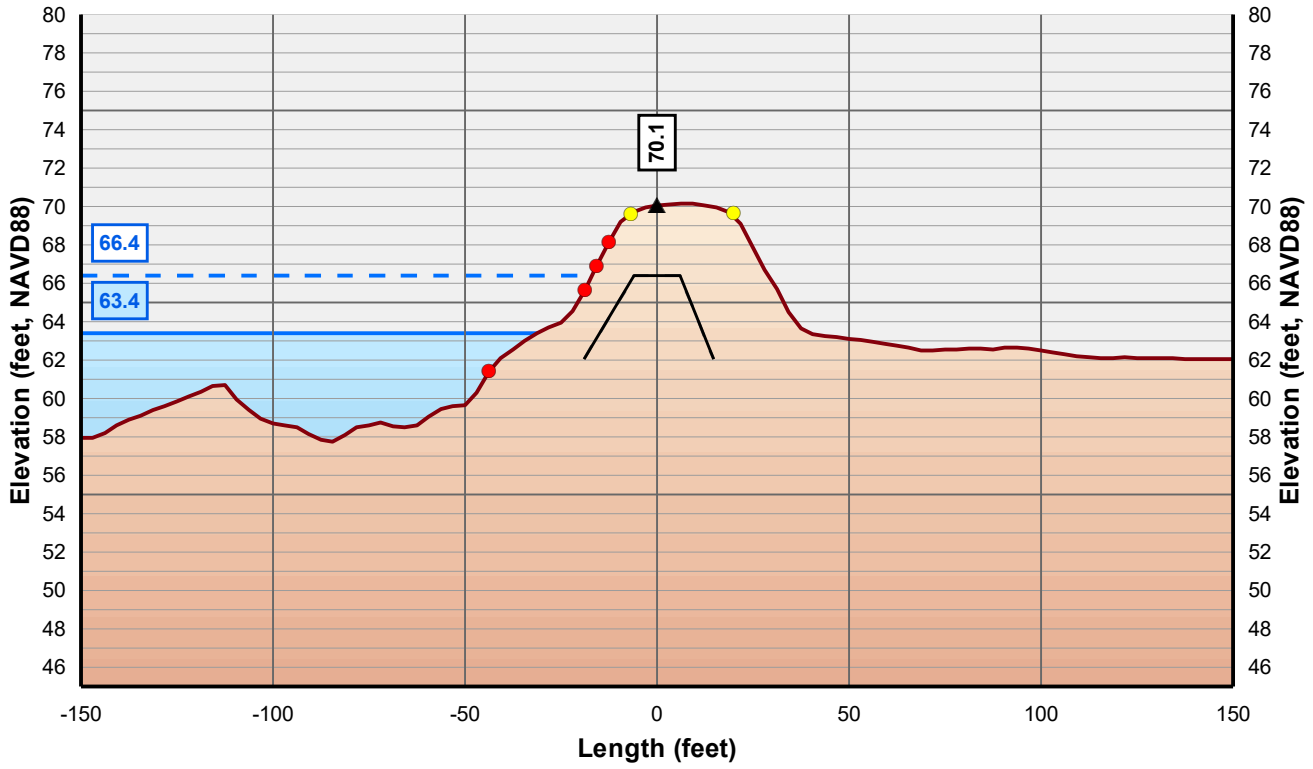
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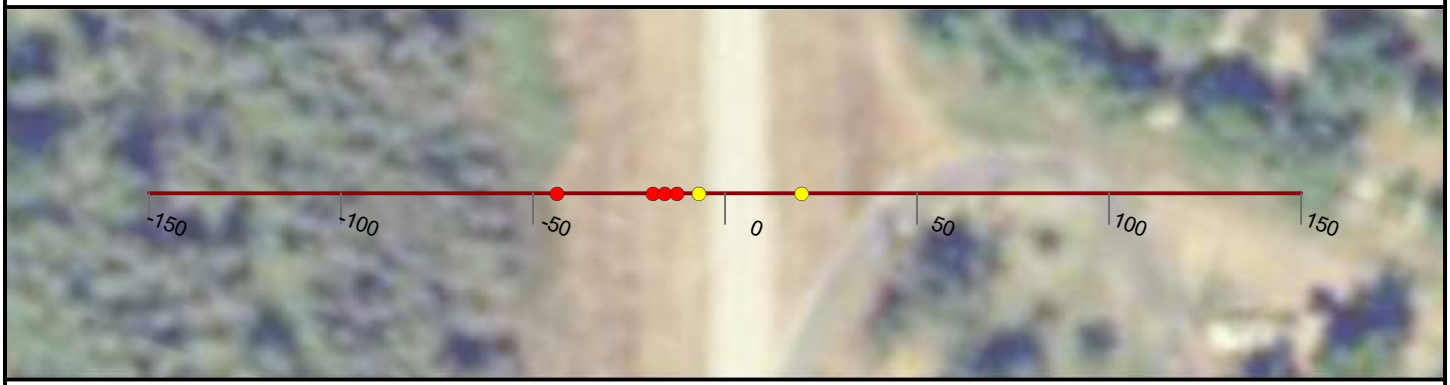
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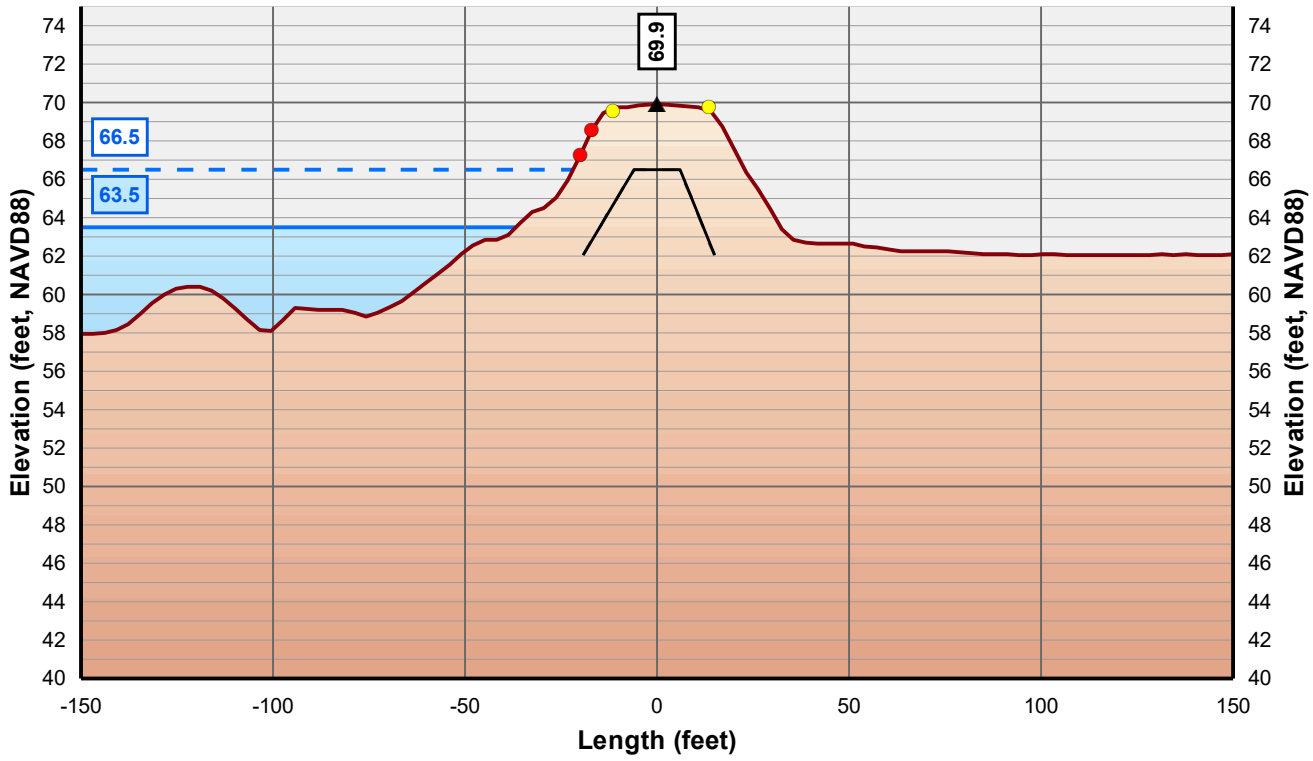
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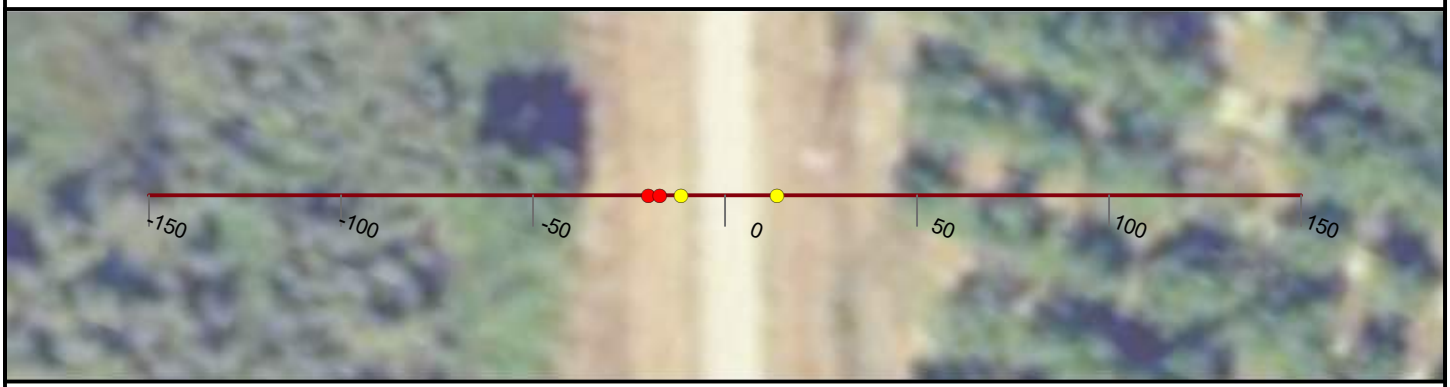
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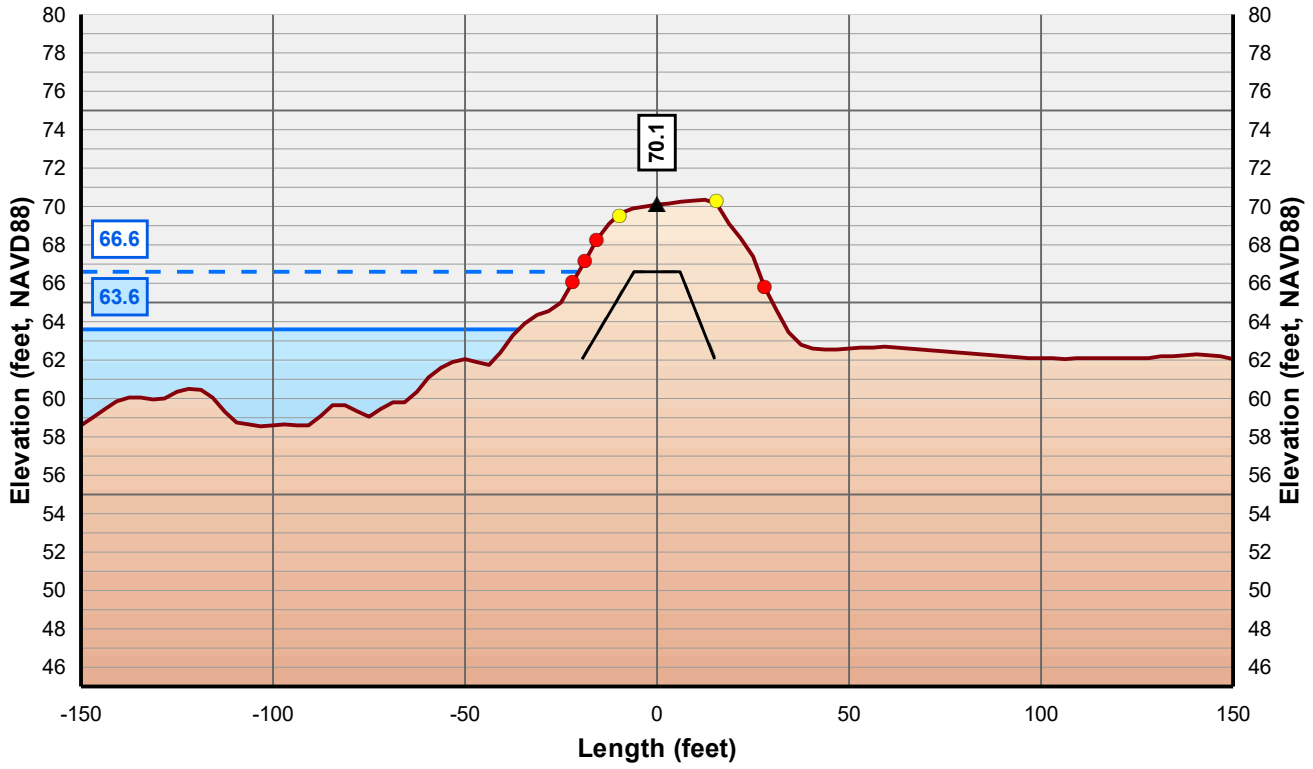
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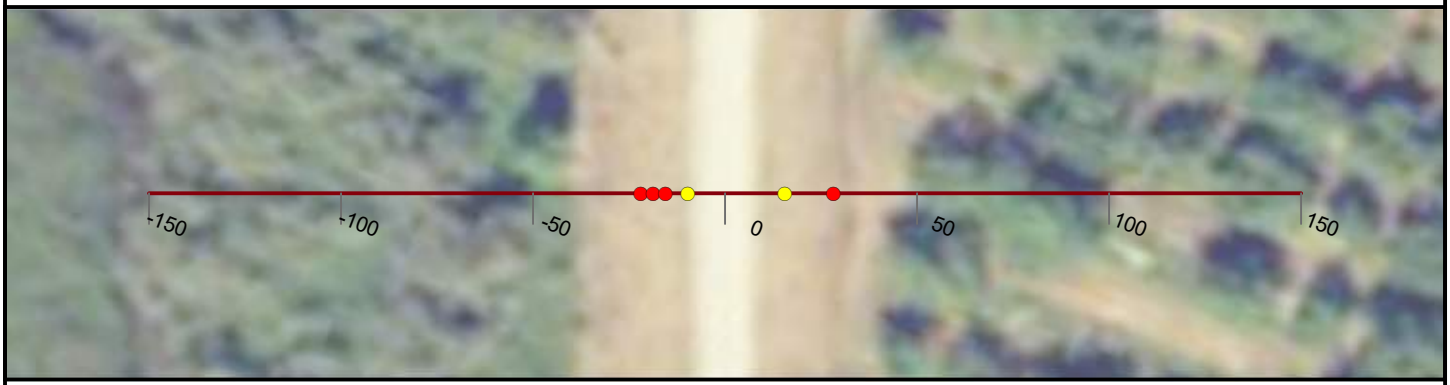
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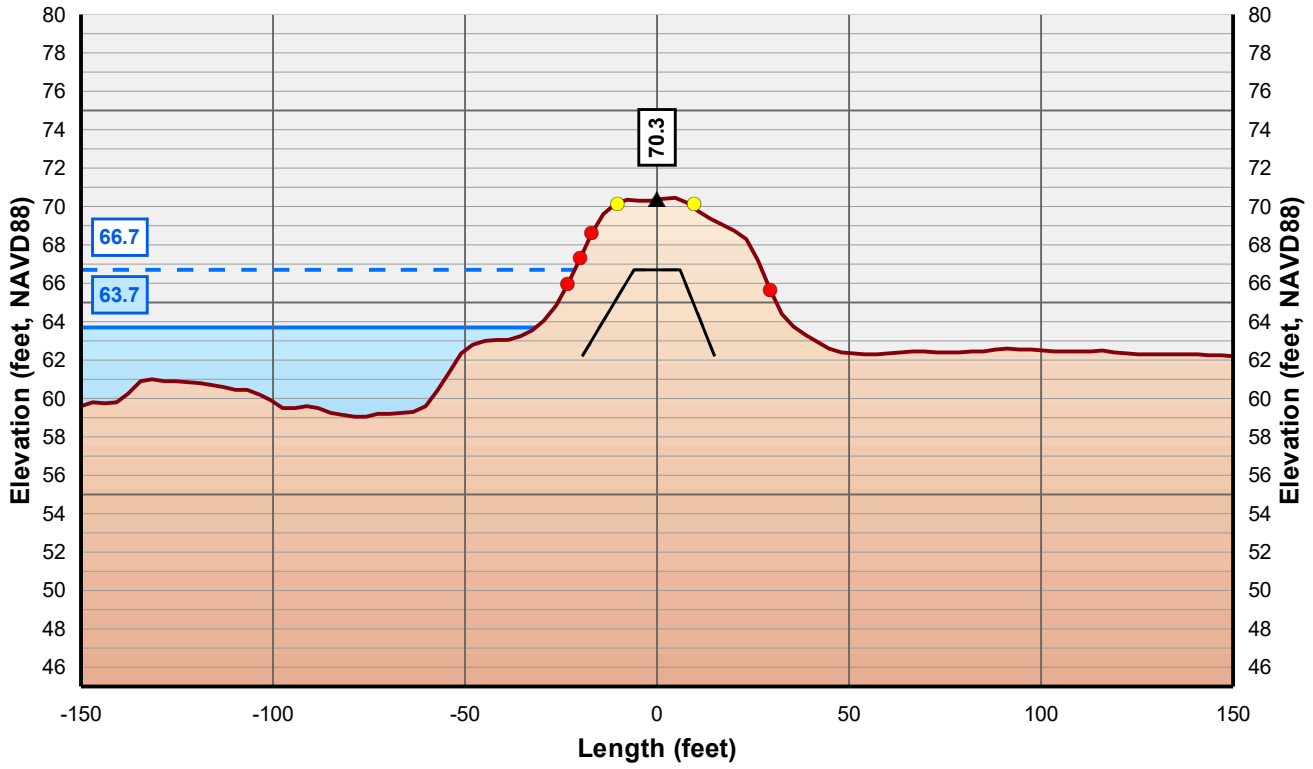
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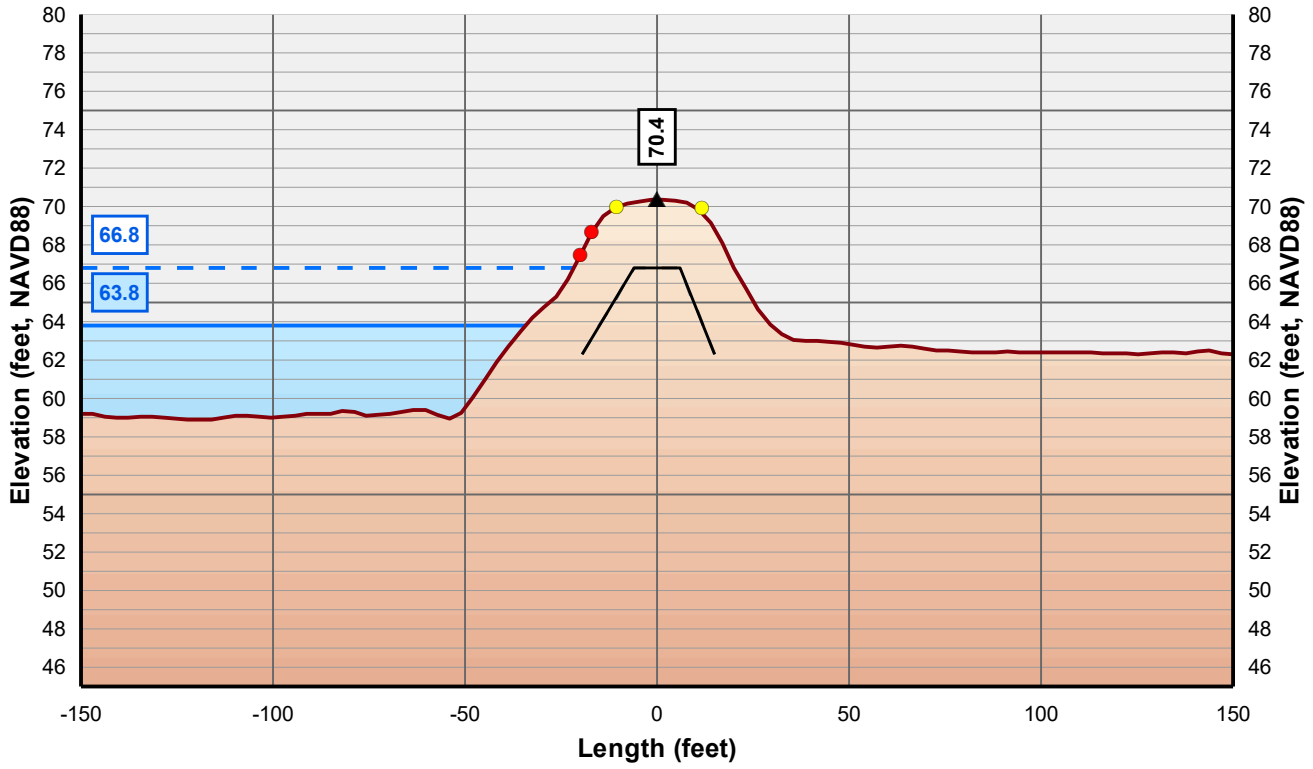
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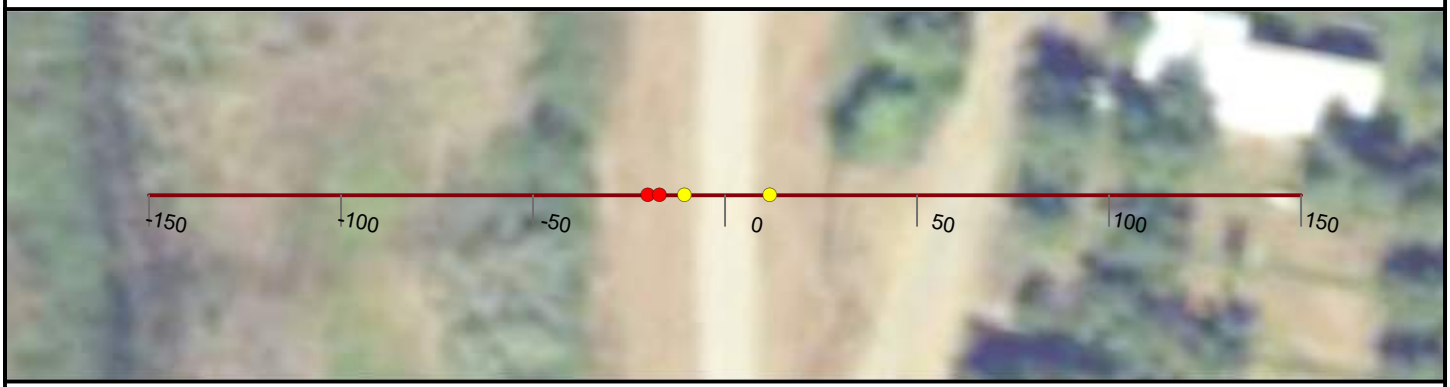
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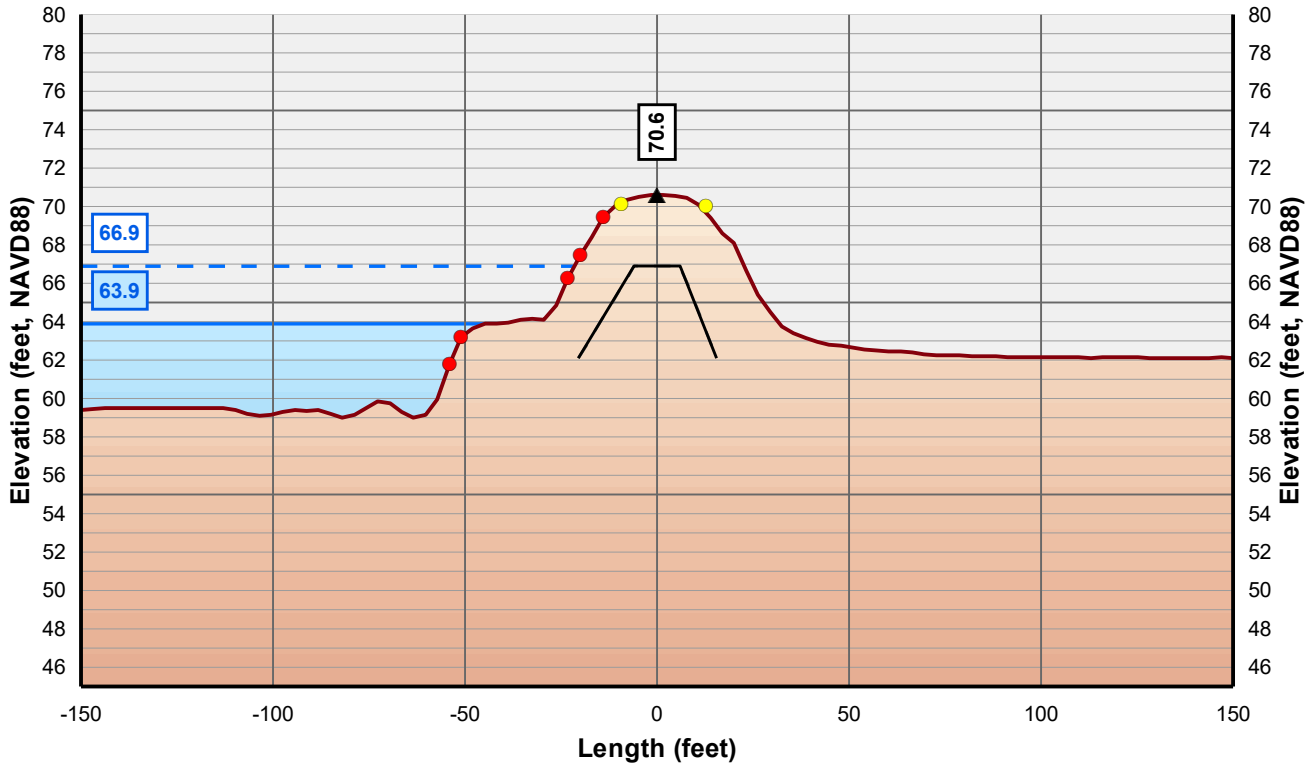
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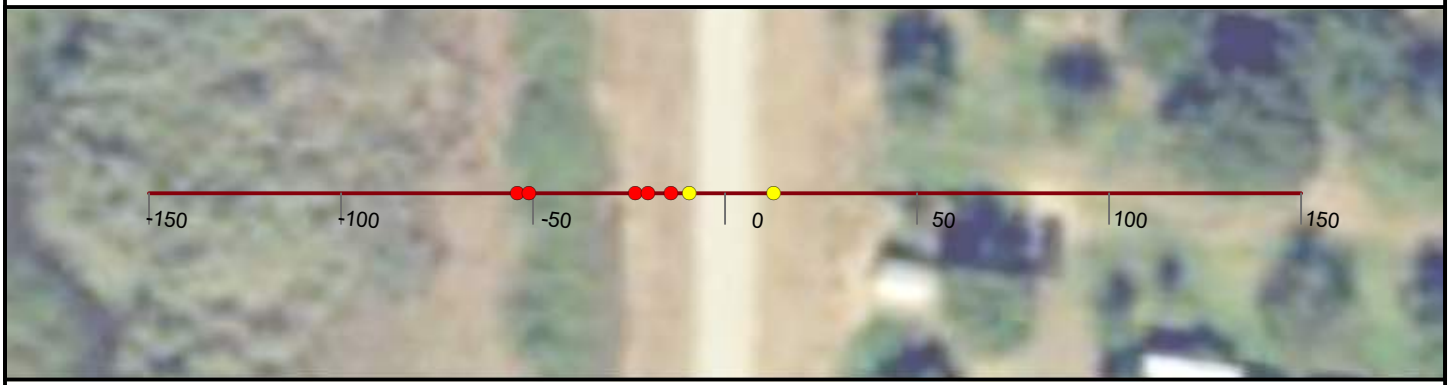
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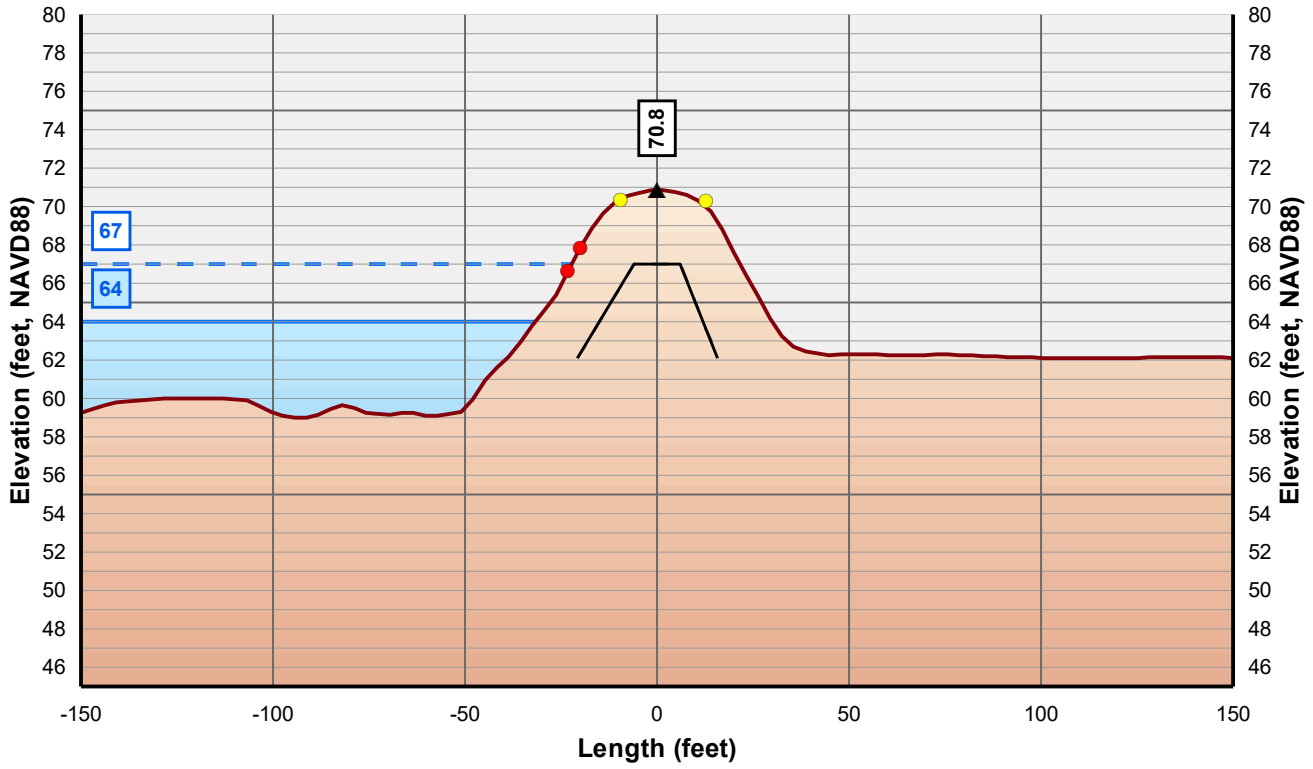
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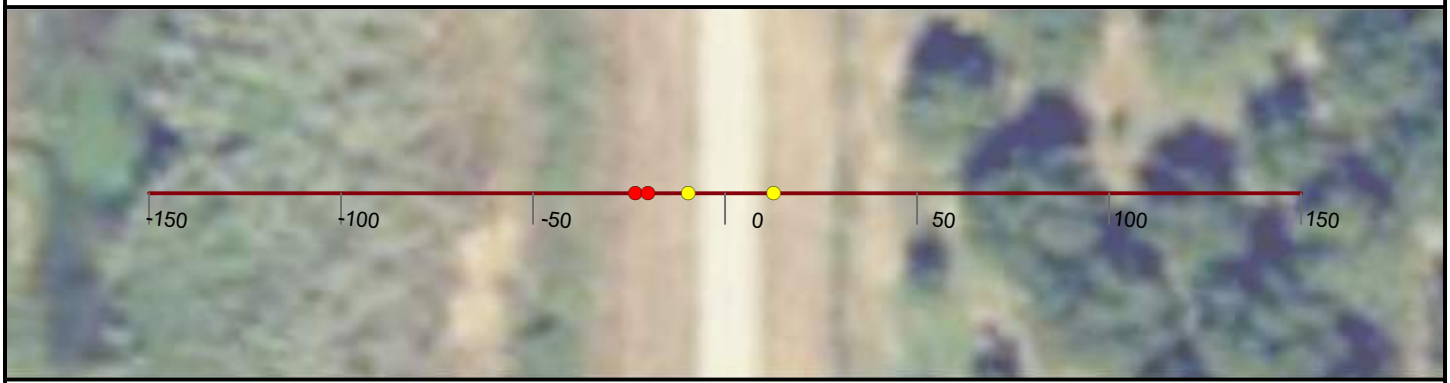
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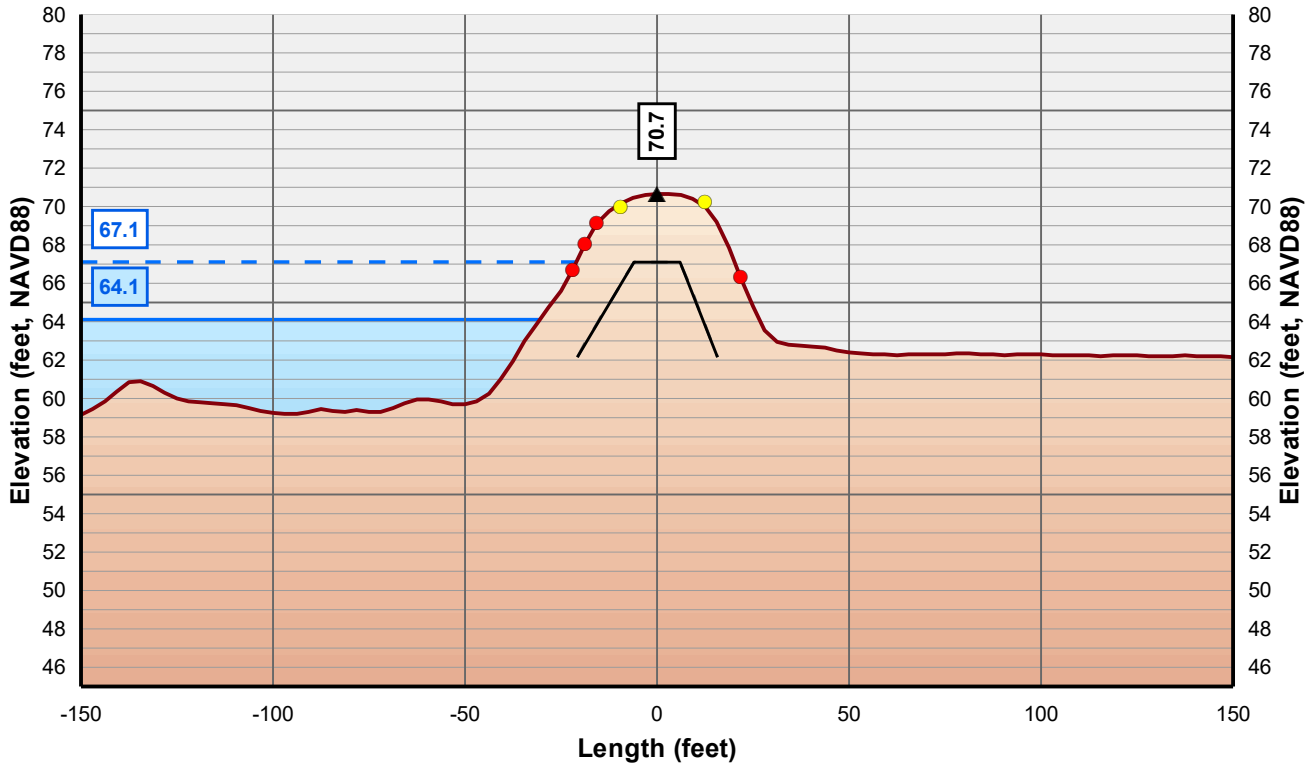
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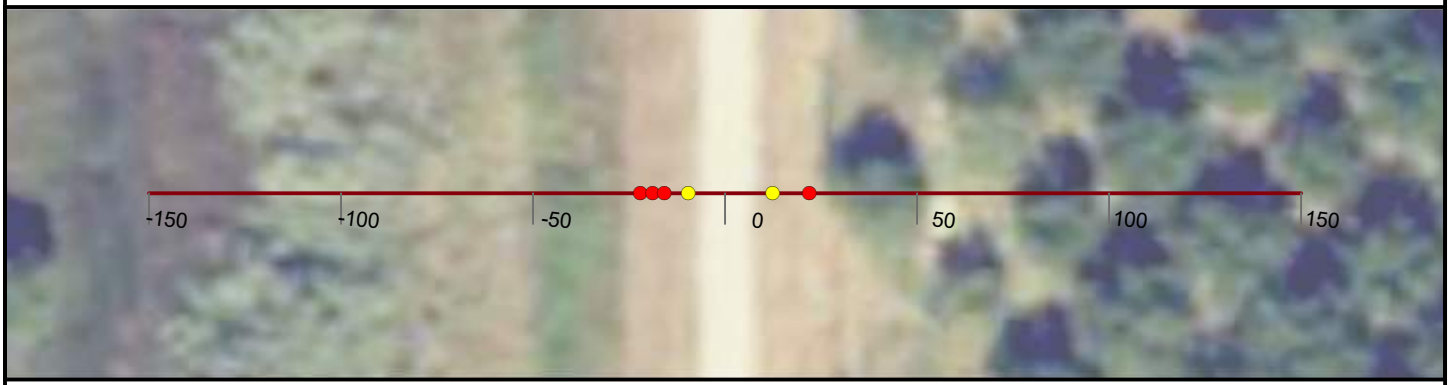
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Cross Section: Yankee Slough 200+00



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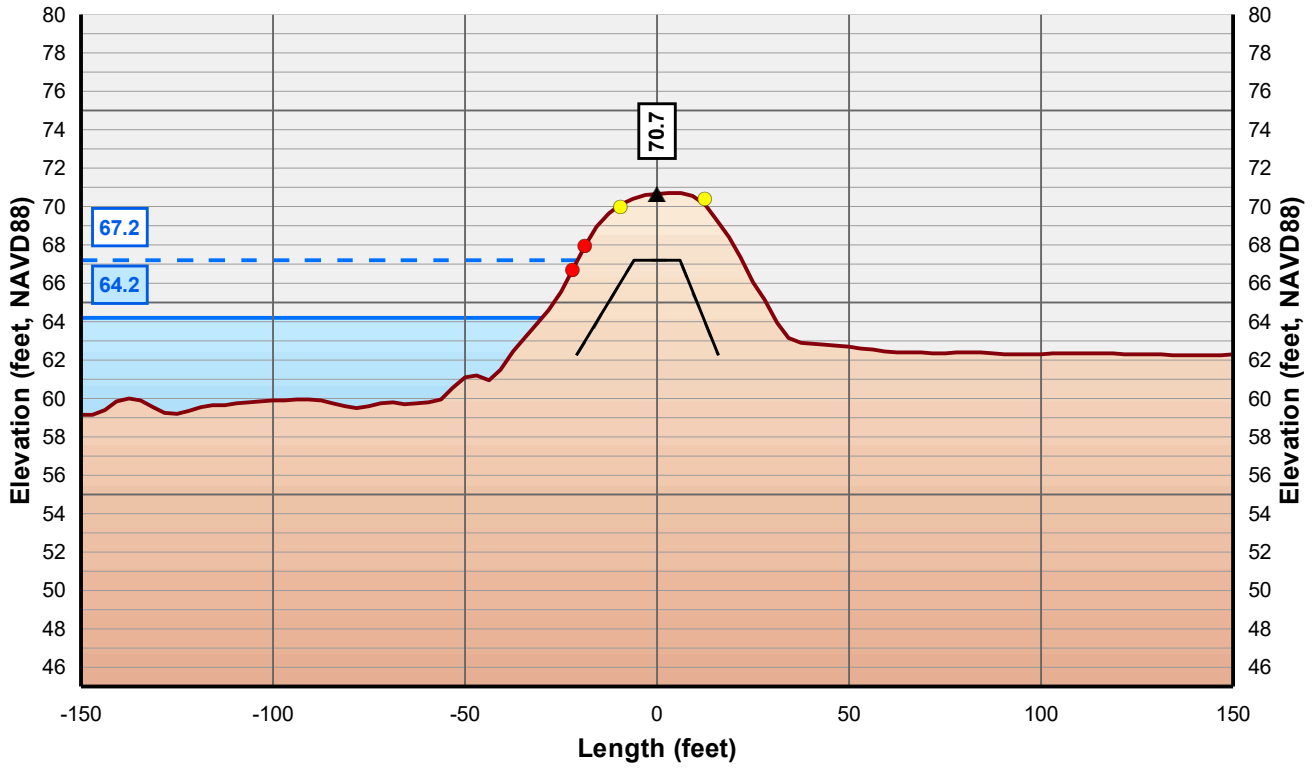
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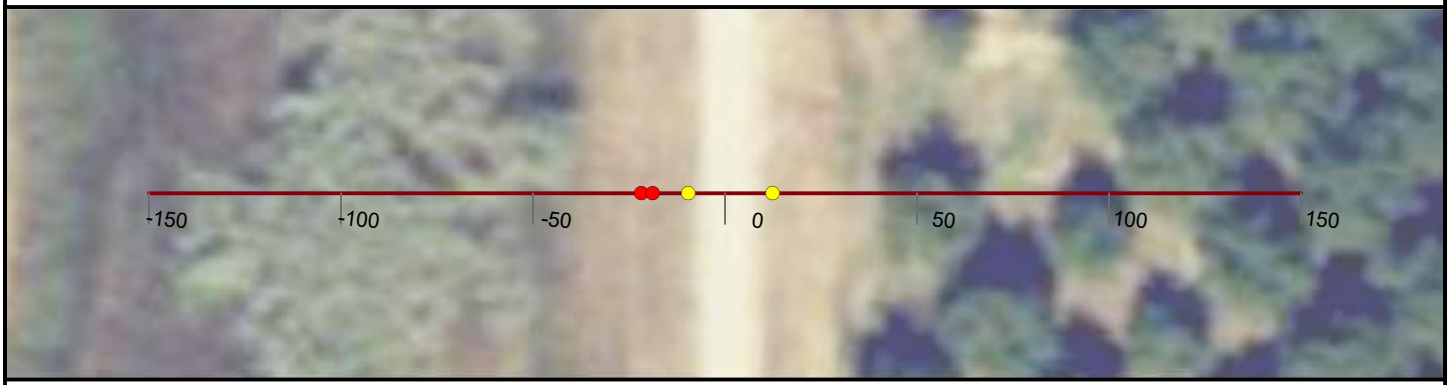
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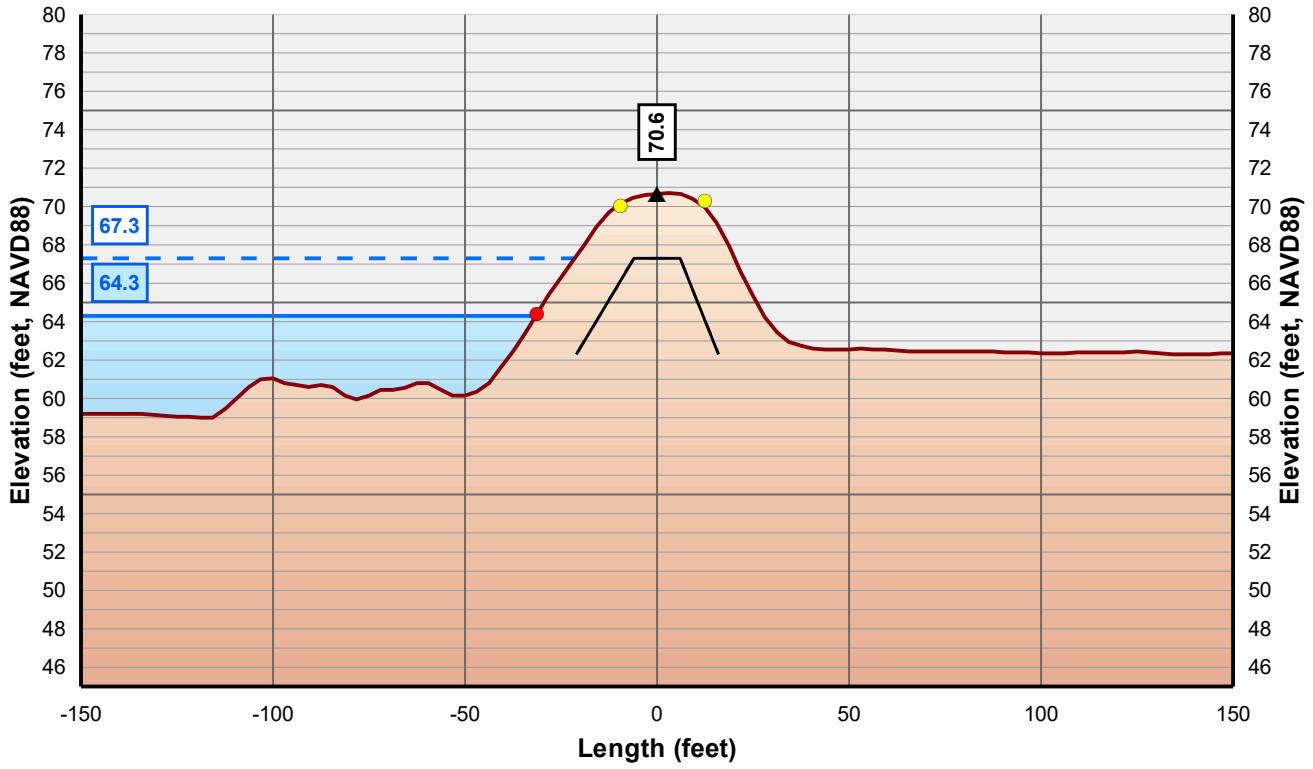
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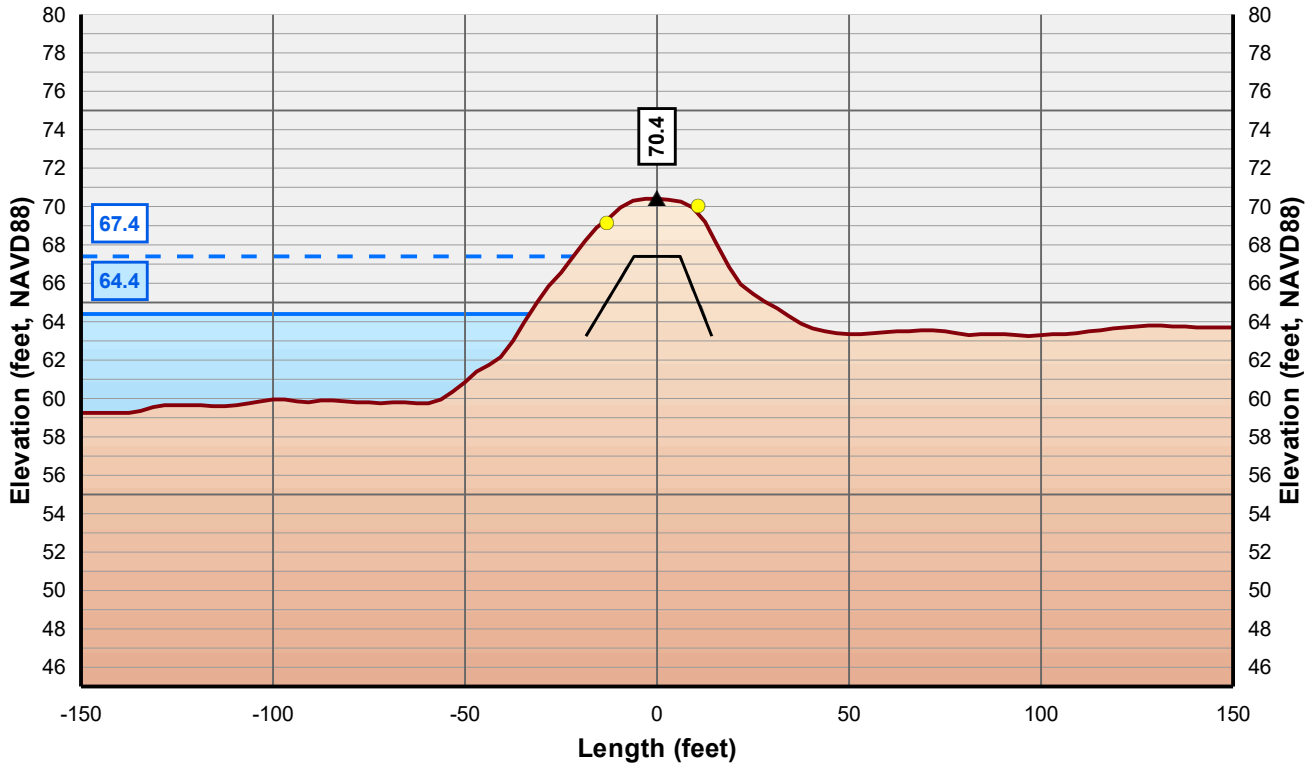
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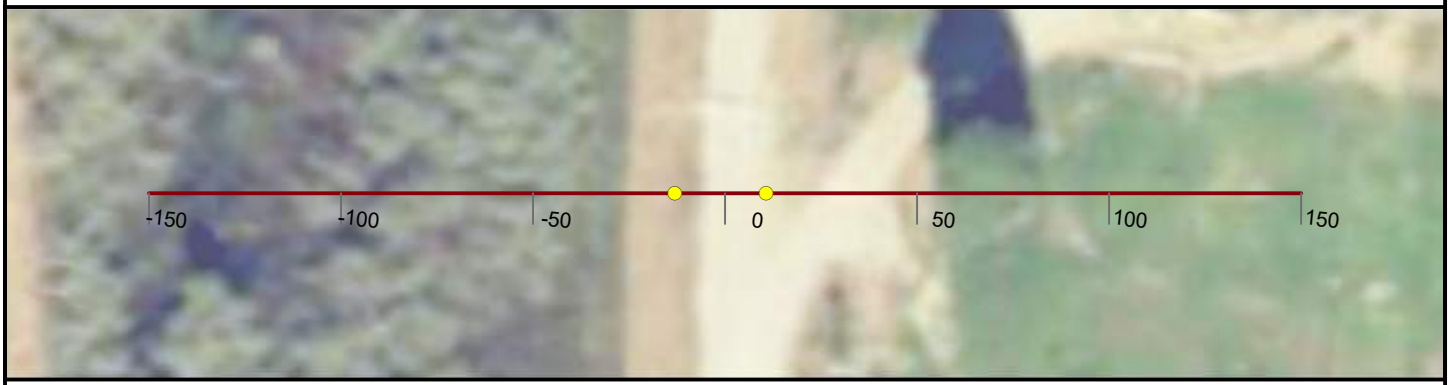
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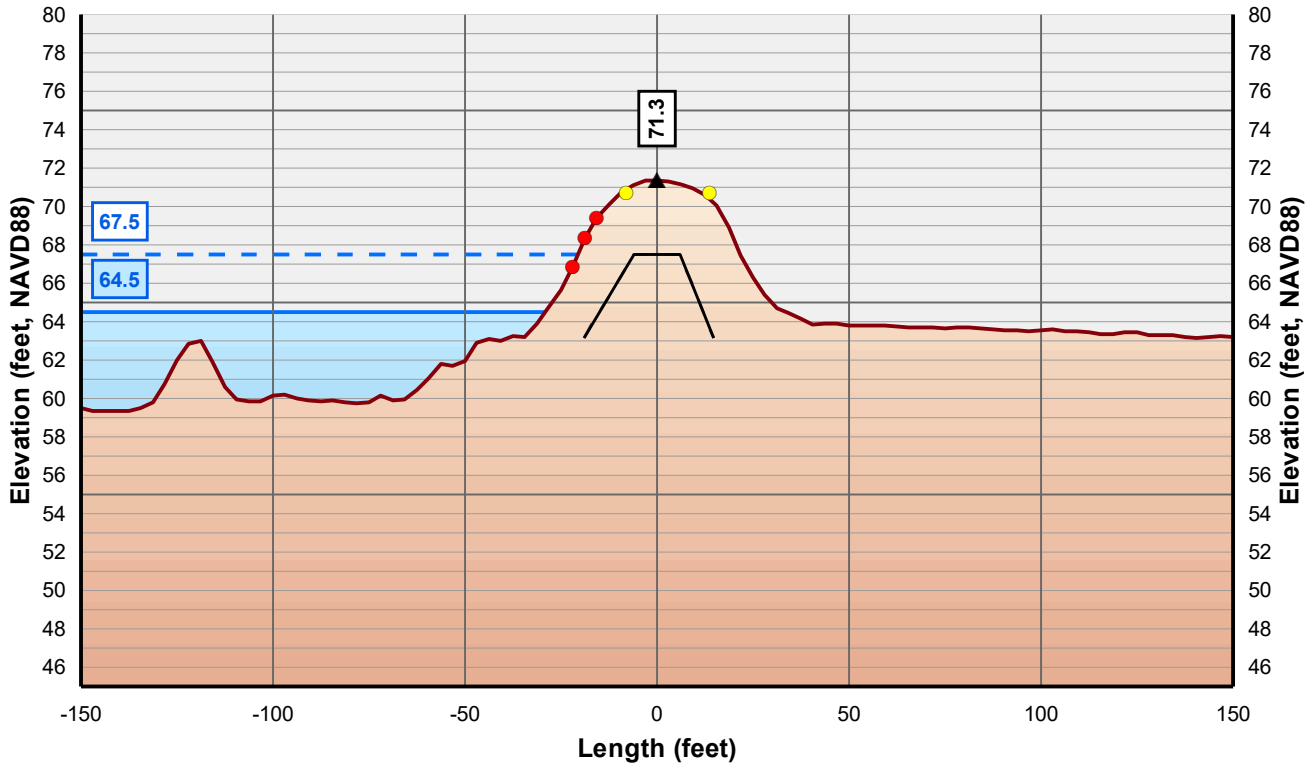
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Cross Section: Yankee Slough 204+00



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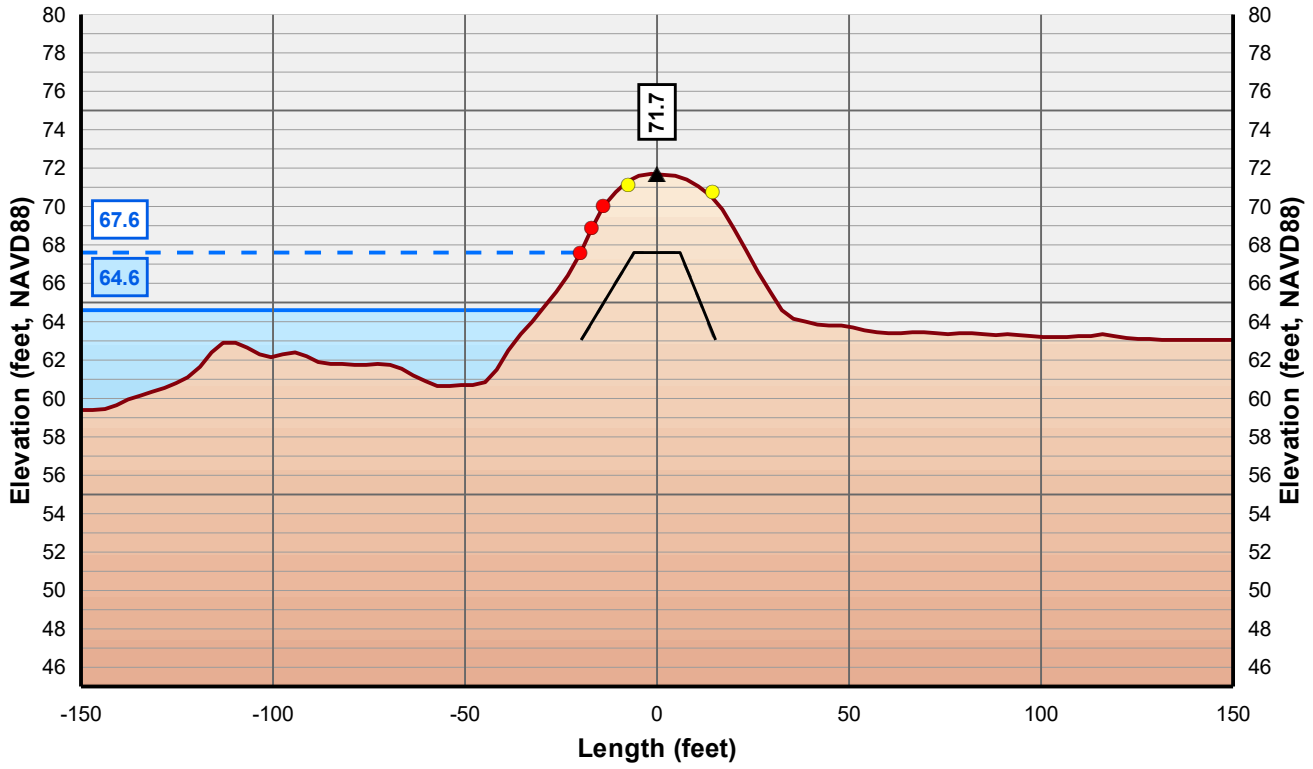
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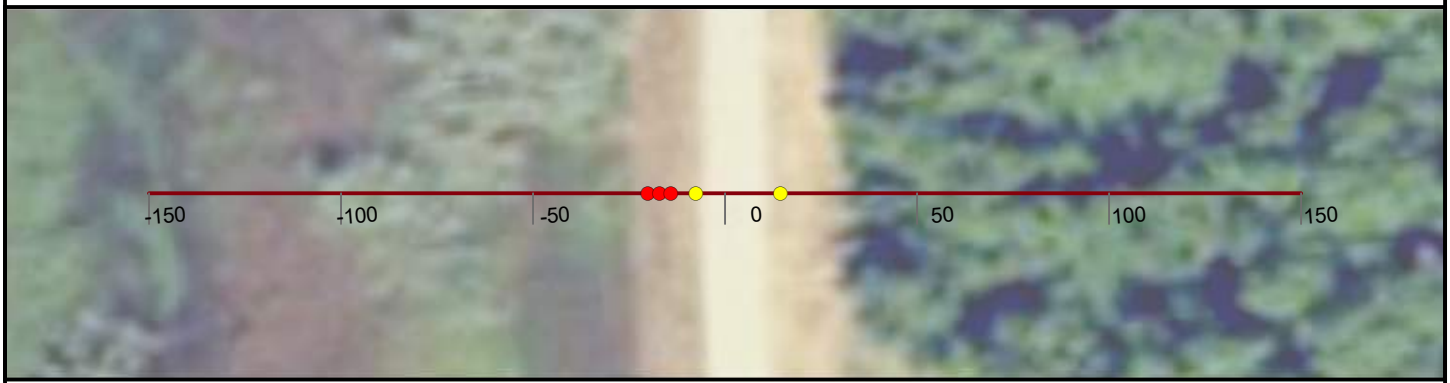
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Cross Section: Yankee Slough 205+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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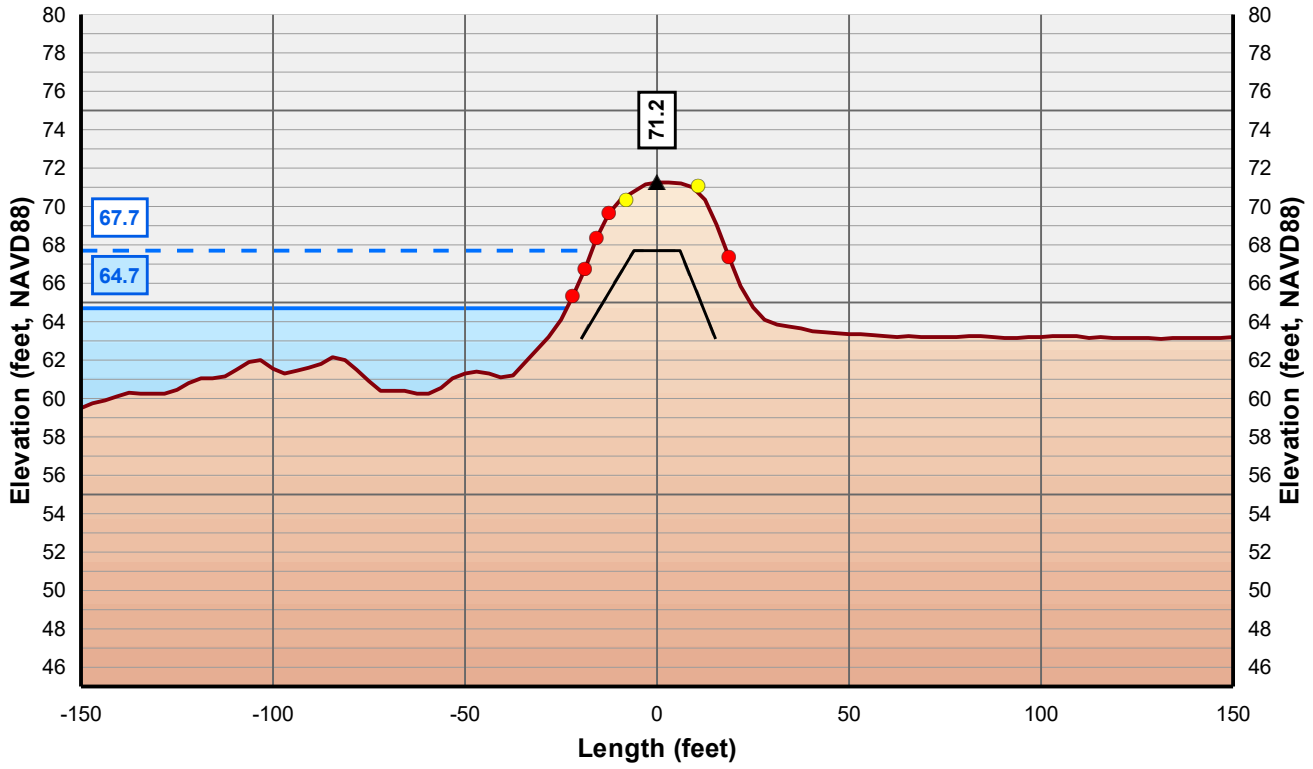
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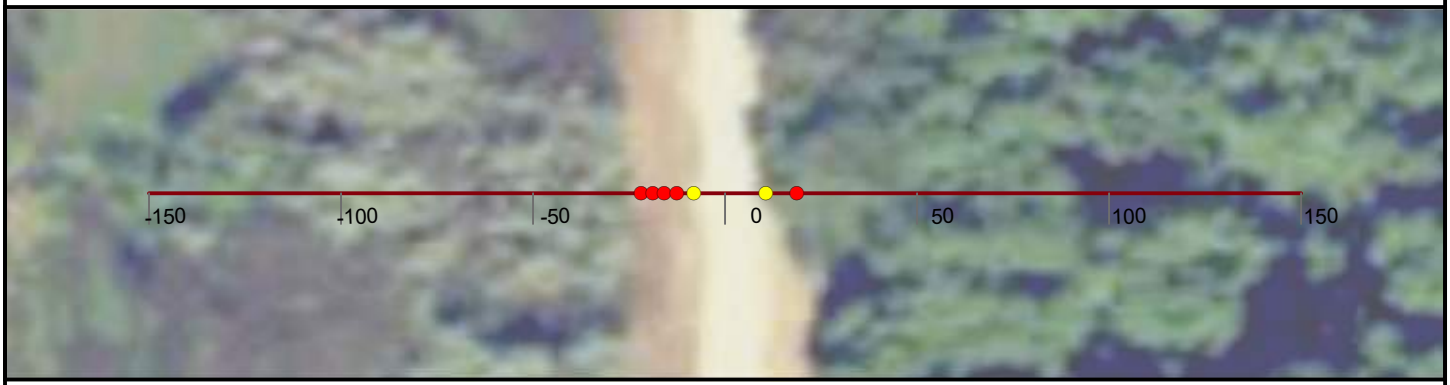
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Cross Section: Yankee Slough 206+00



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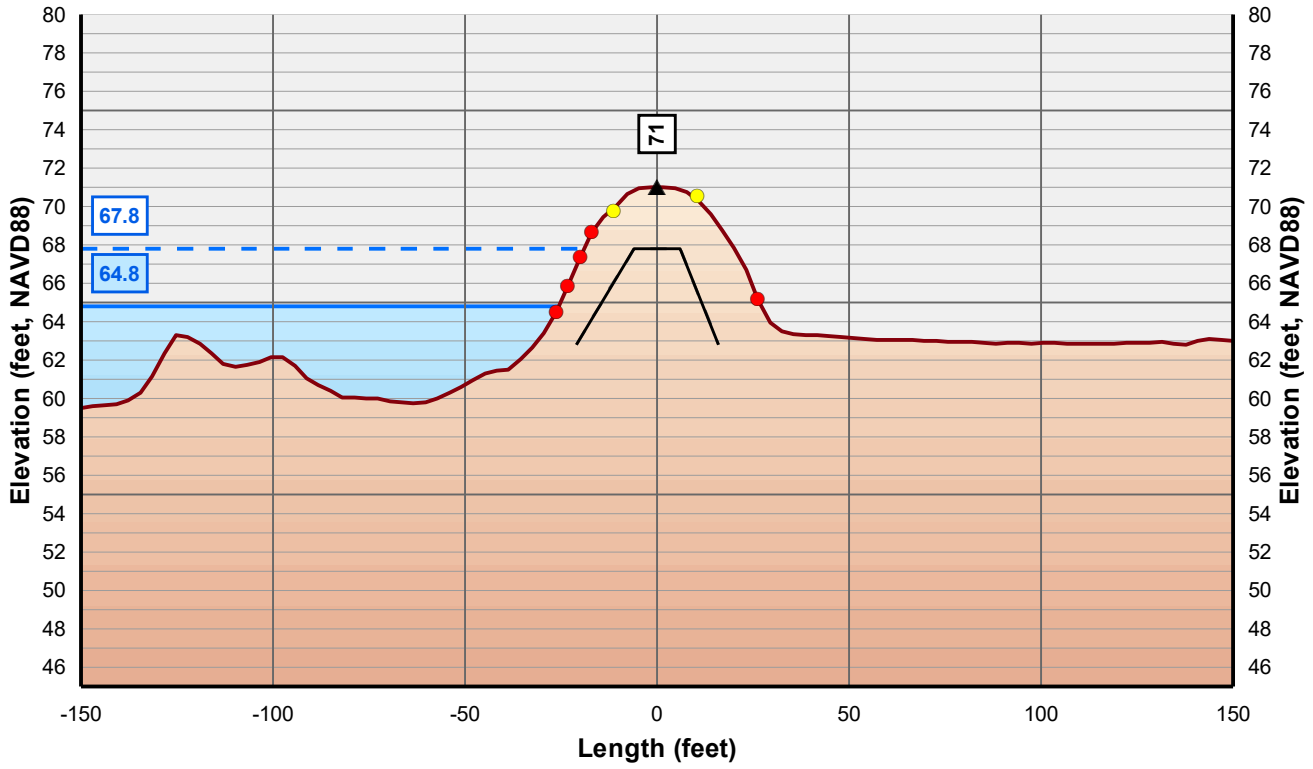
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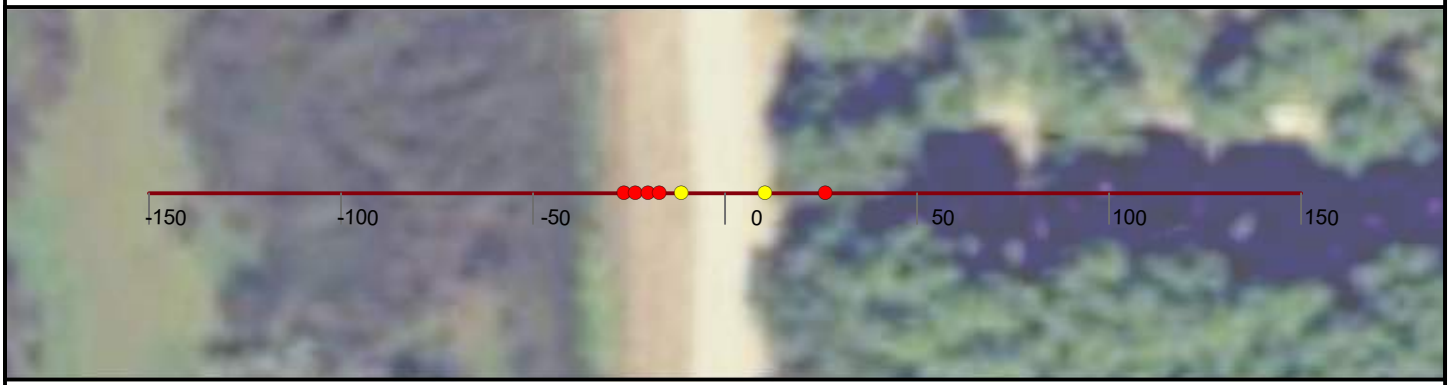
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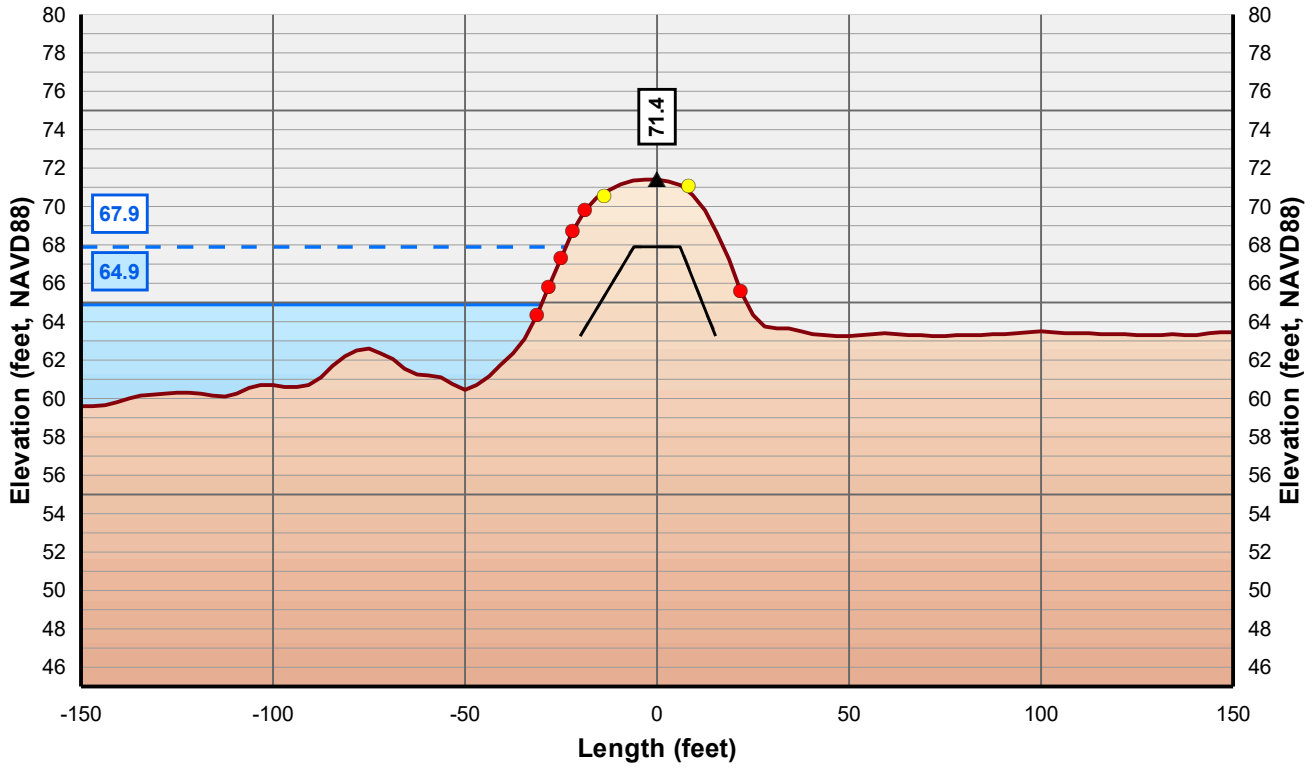
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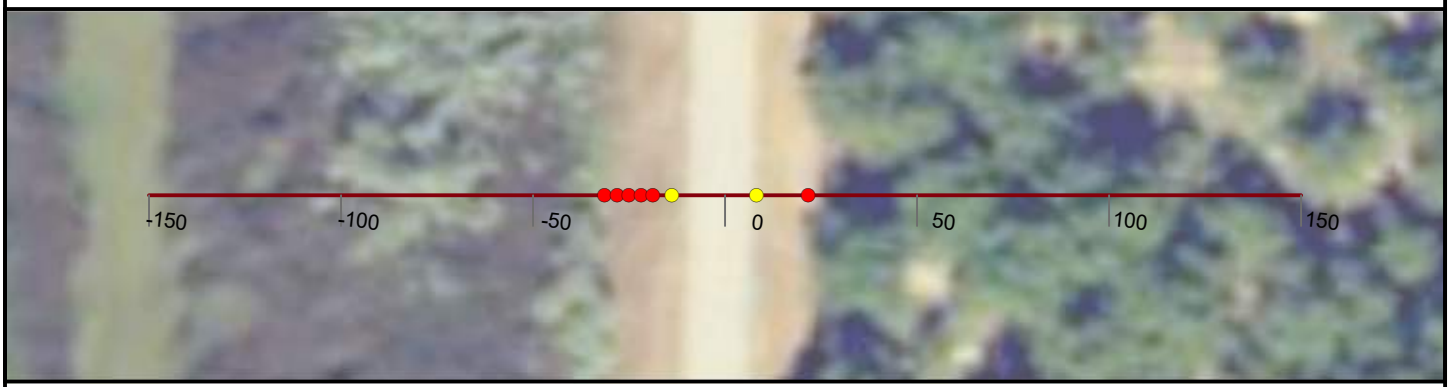
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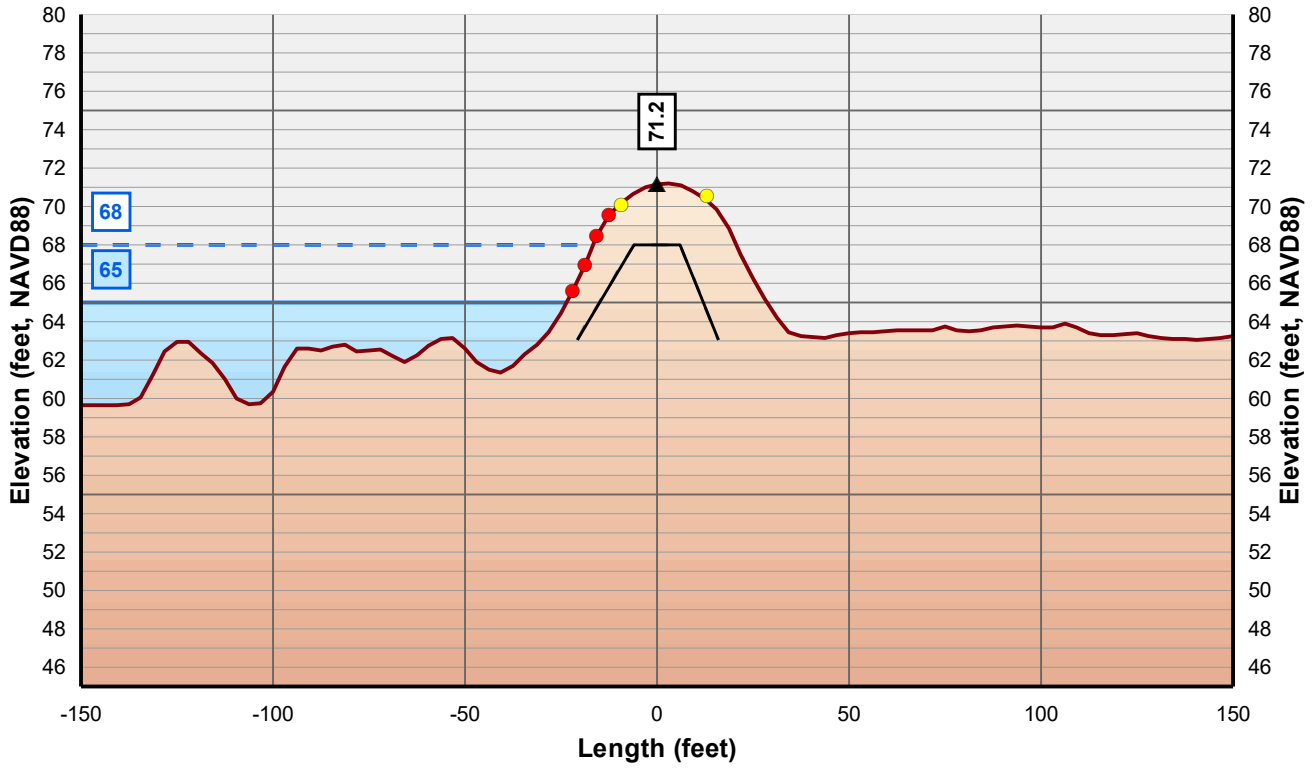
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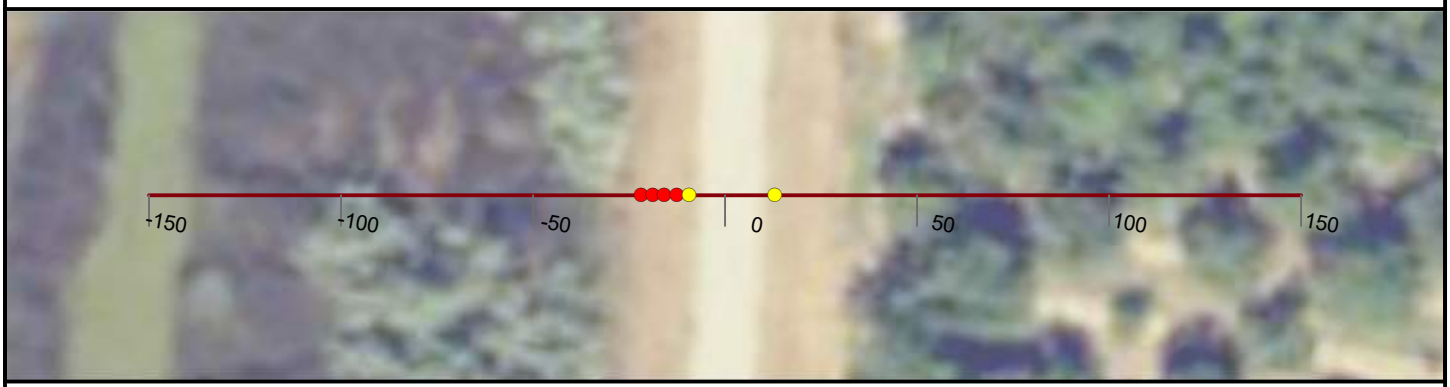
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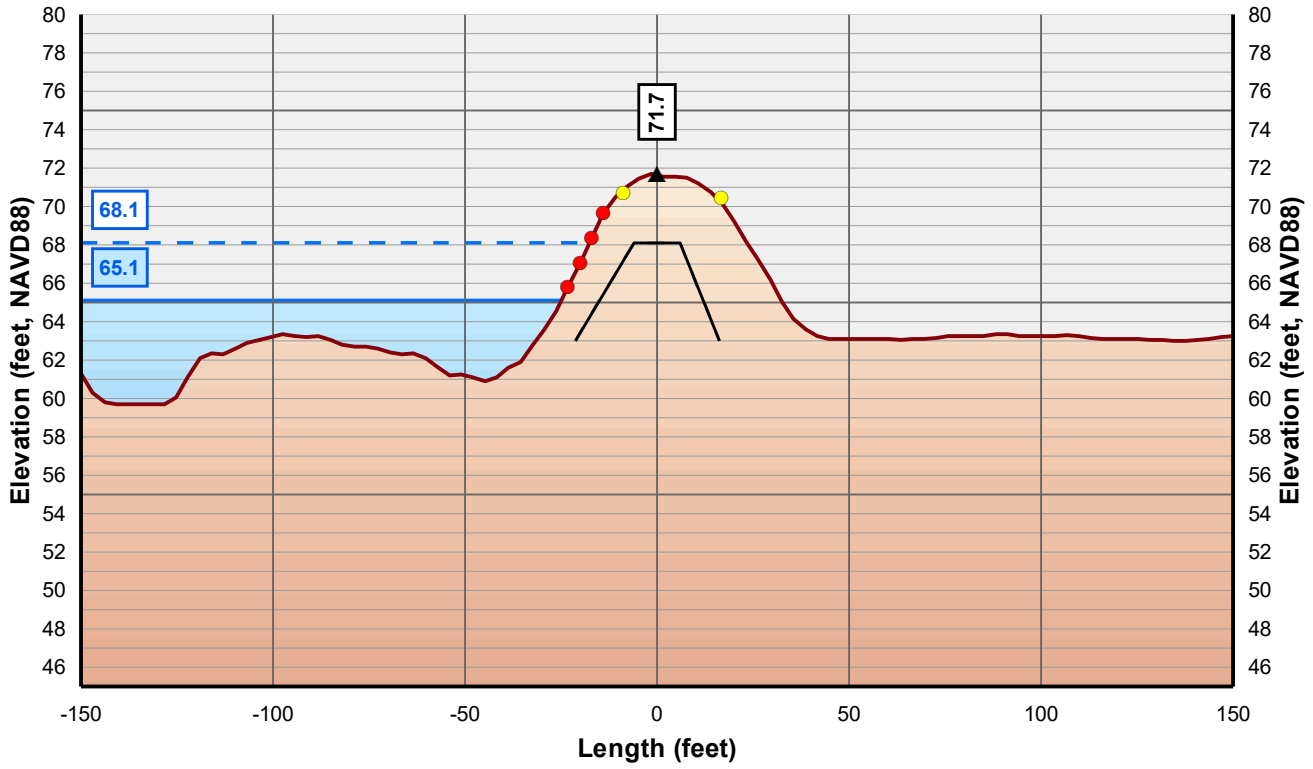
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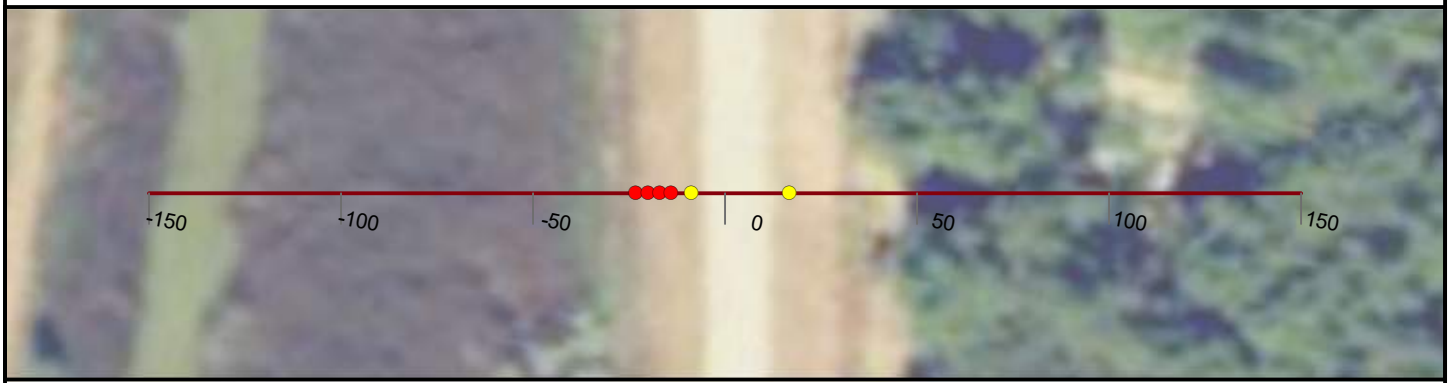
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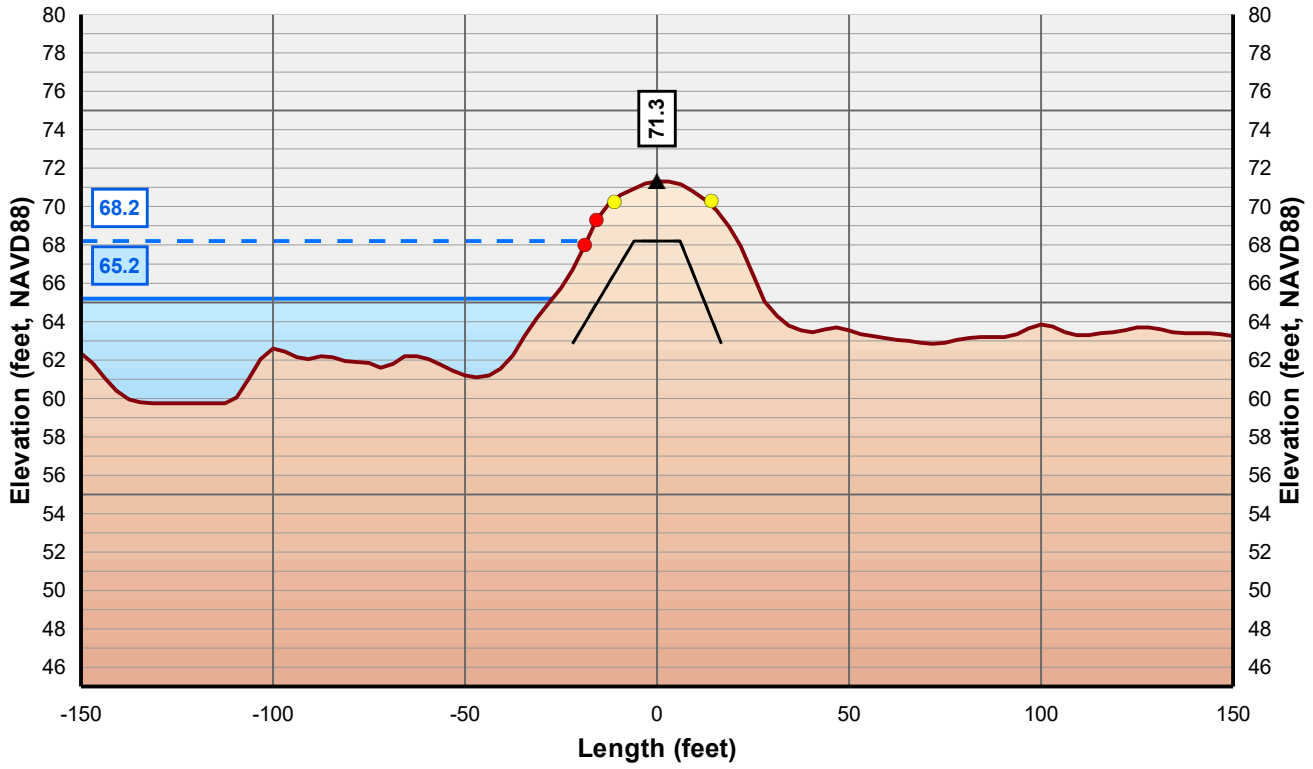
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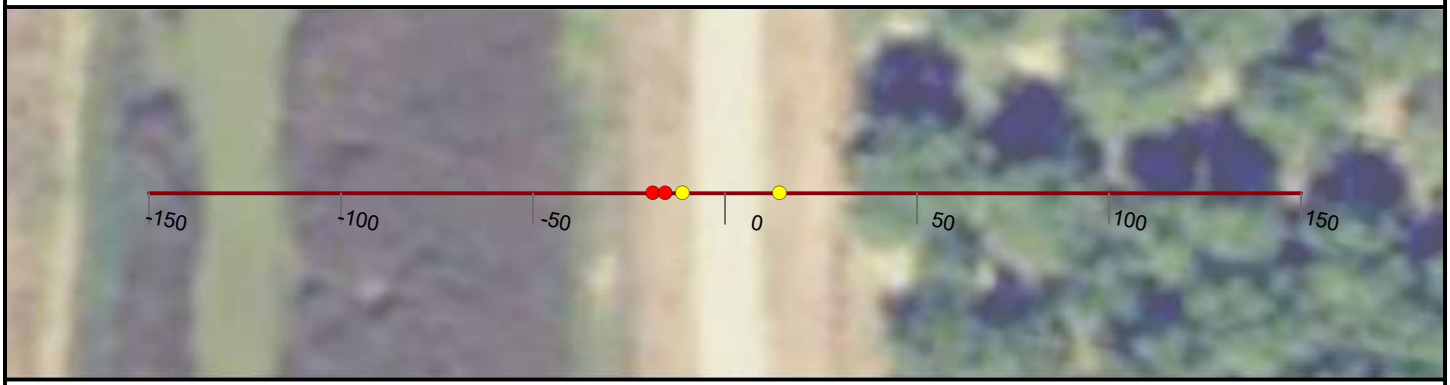
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Cross Section: Yankee Slough 211+00



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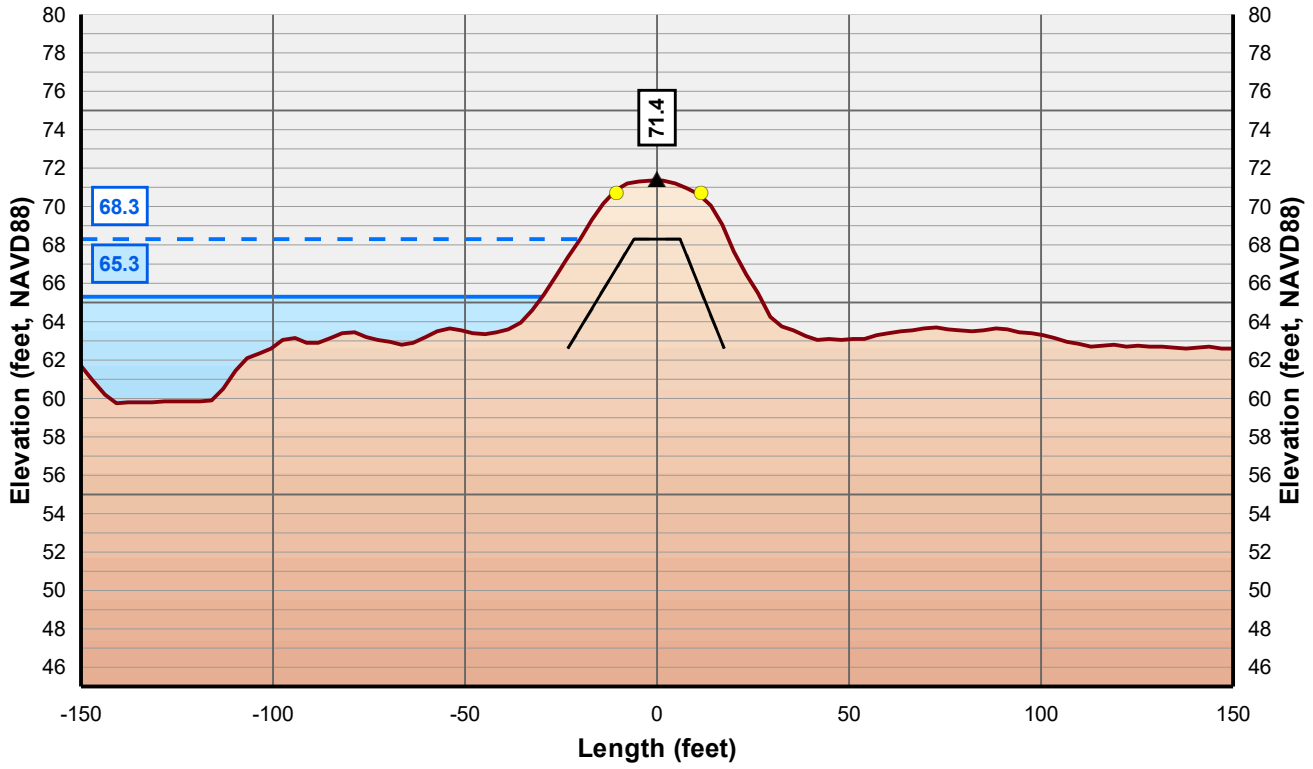
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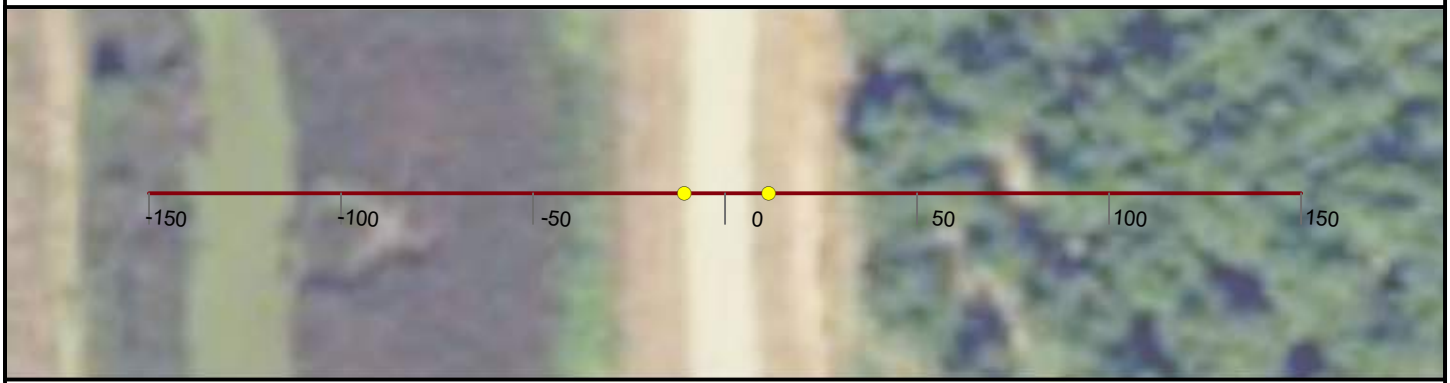
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Cross Section: Yankee Slough 212+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
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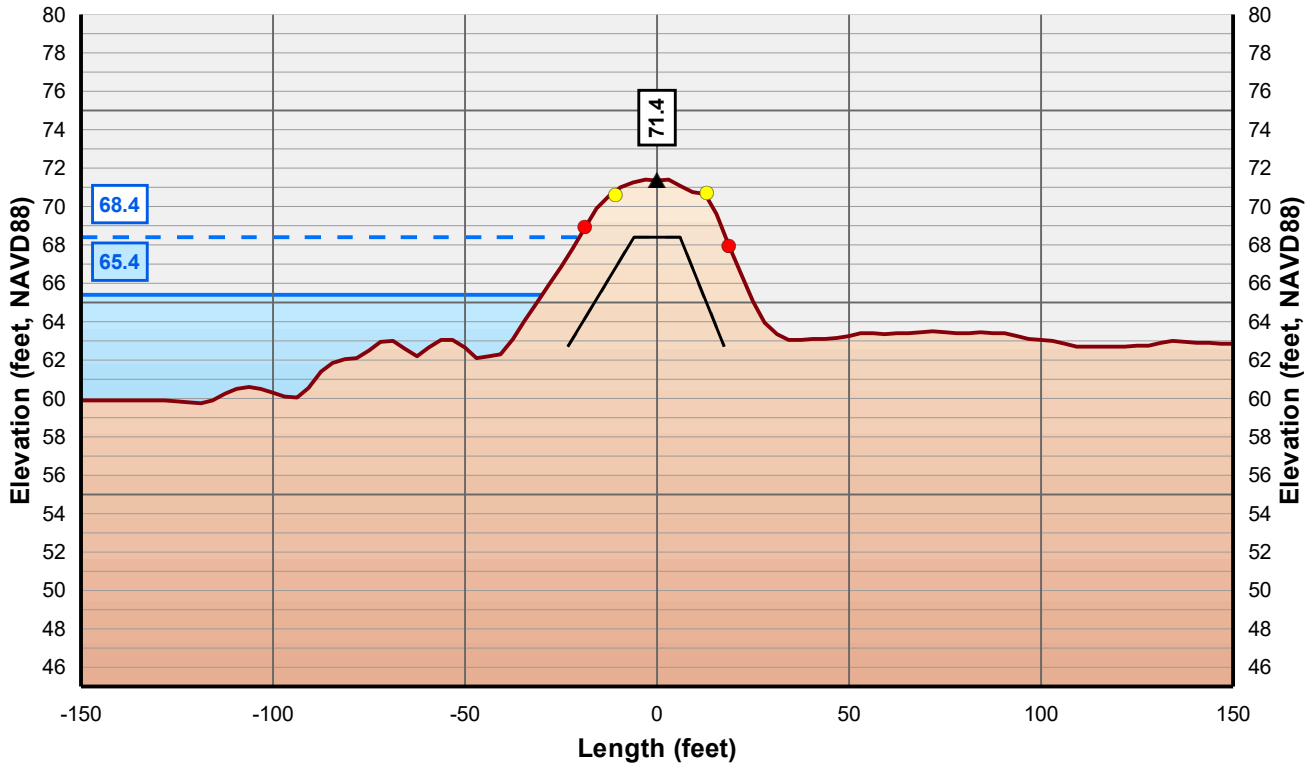
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Cross Section: Yankee Slough 213+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
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- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

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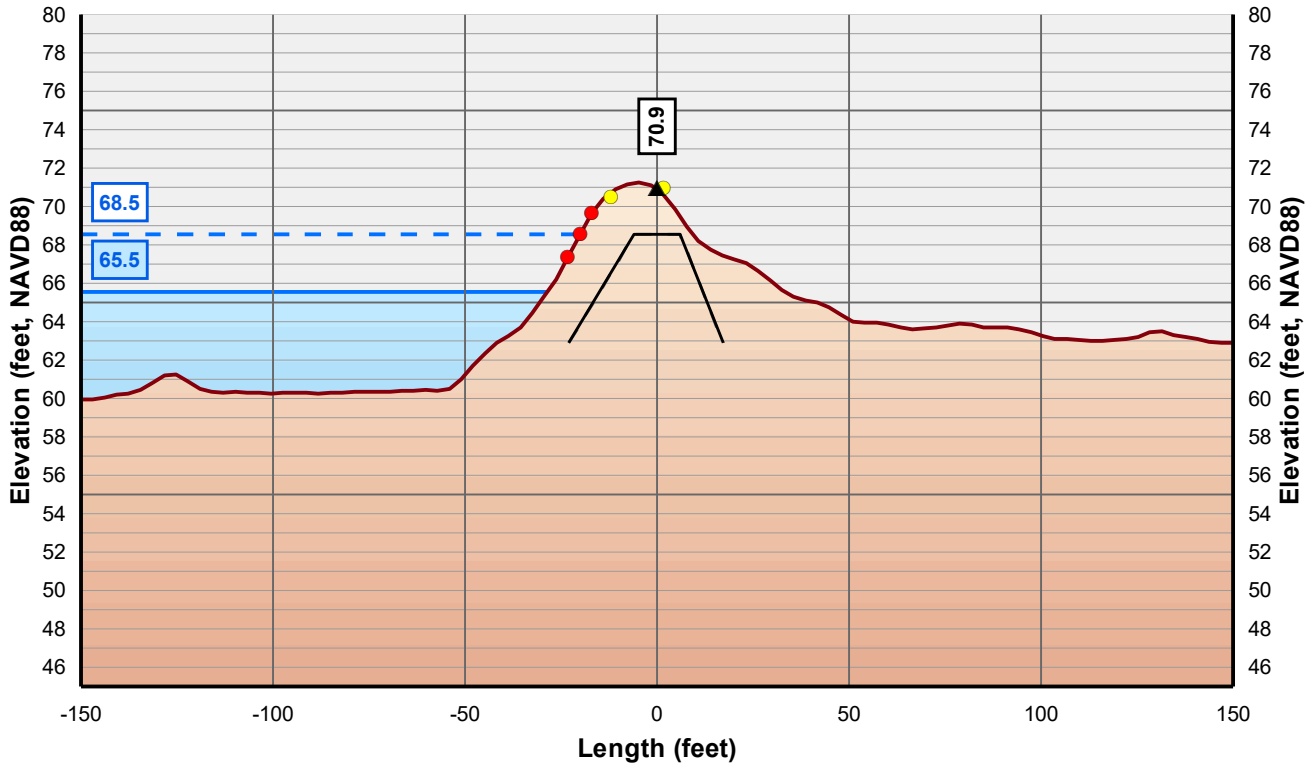
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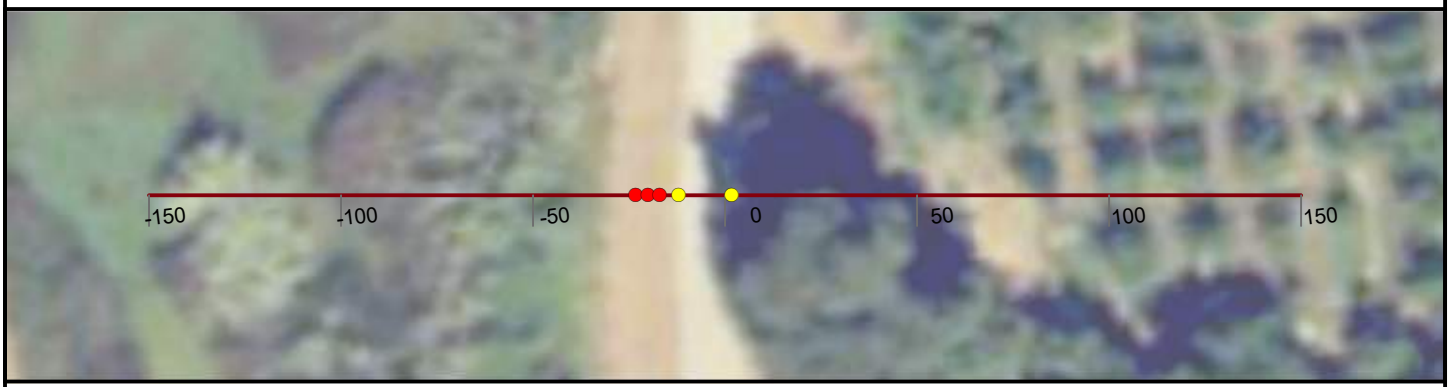
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Cross Section: Yankee Slough 214+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY
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AUGUST, 2019

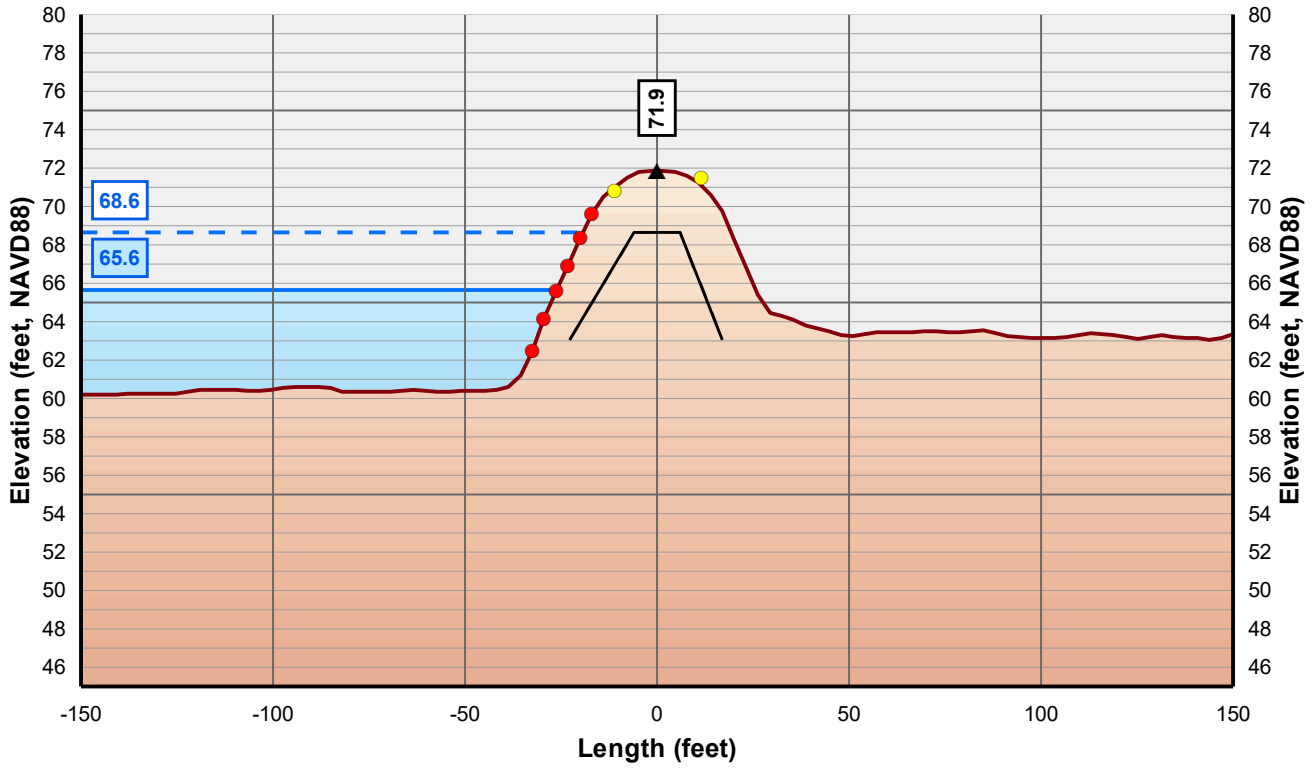
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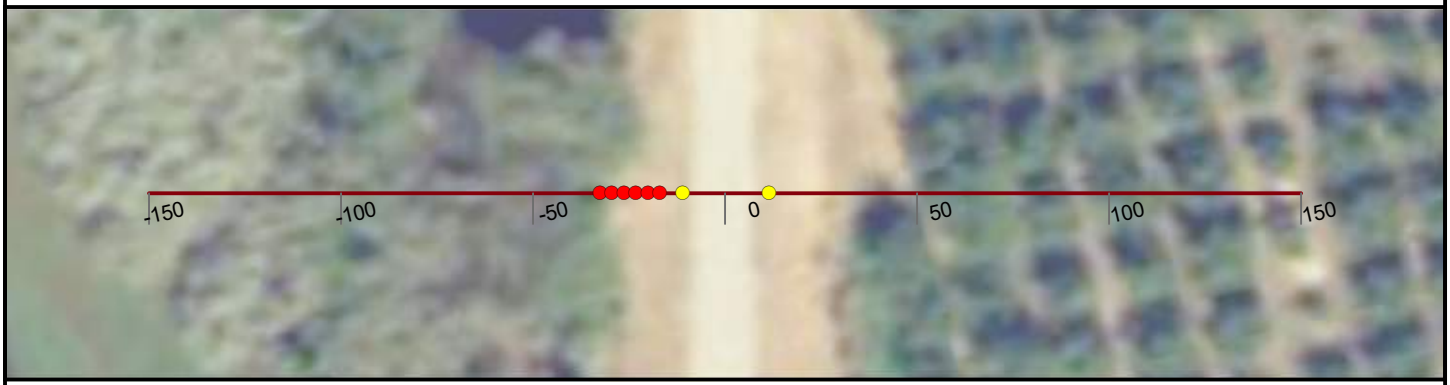
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Cross Section: Yankee Slough 215+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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- Theoretical Levee Prism Preliminary
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FEASIBILITY STUDY

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AUGUST, 2019

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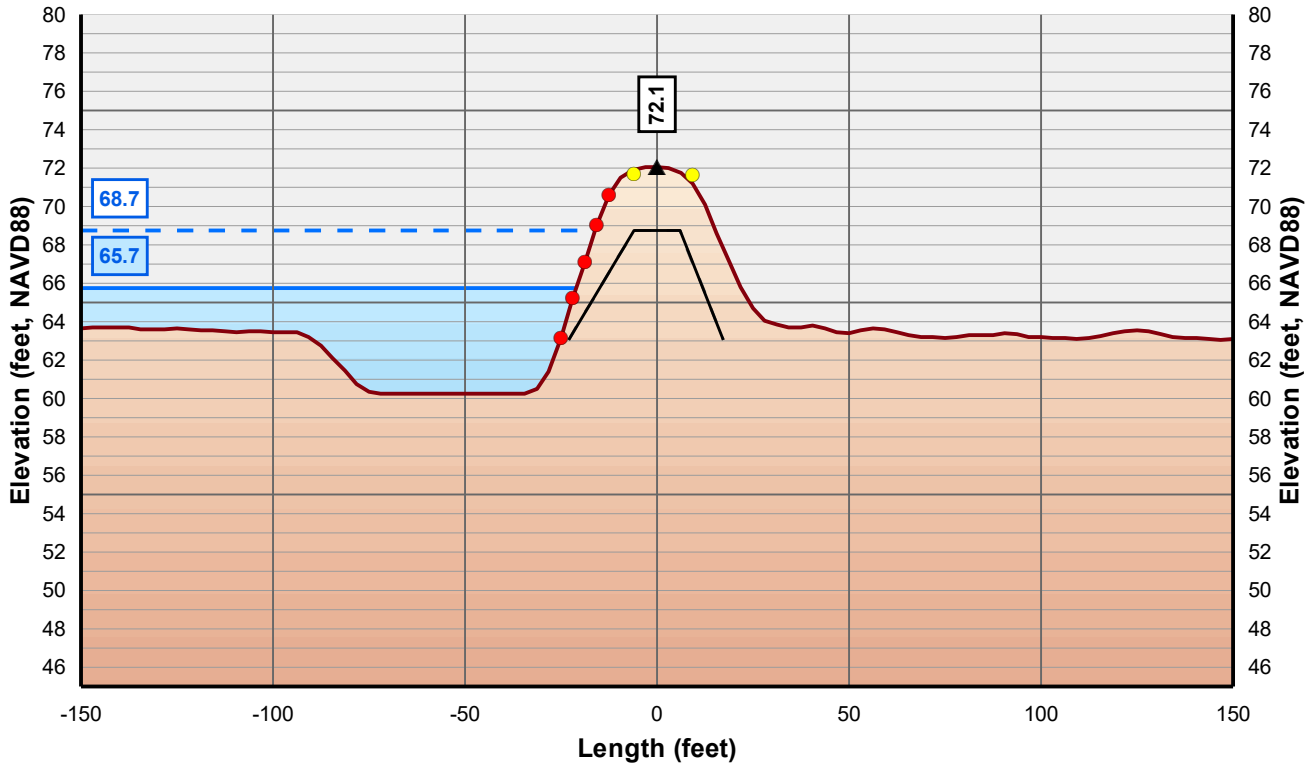
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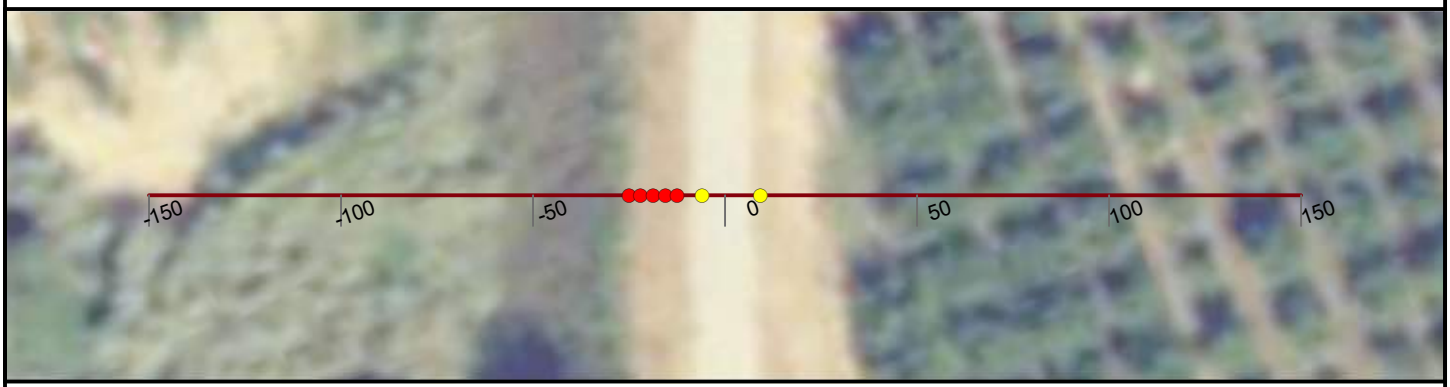
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Cross Section: Yankee Slough 216+00



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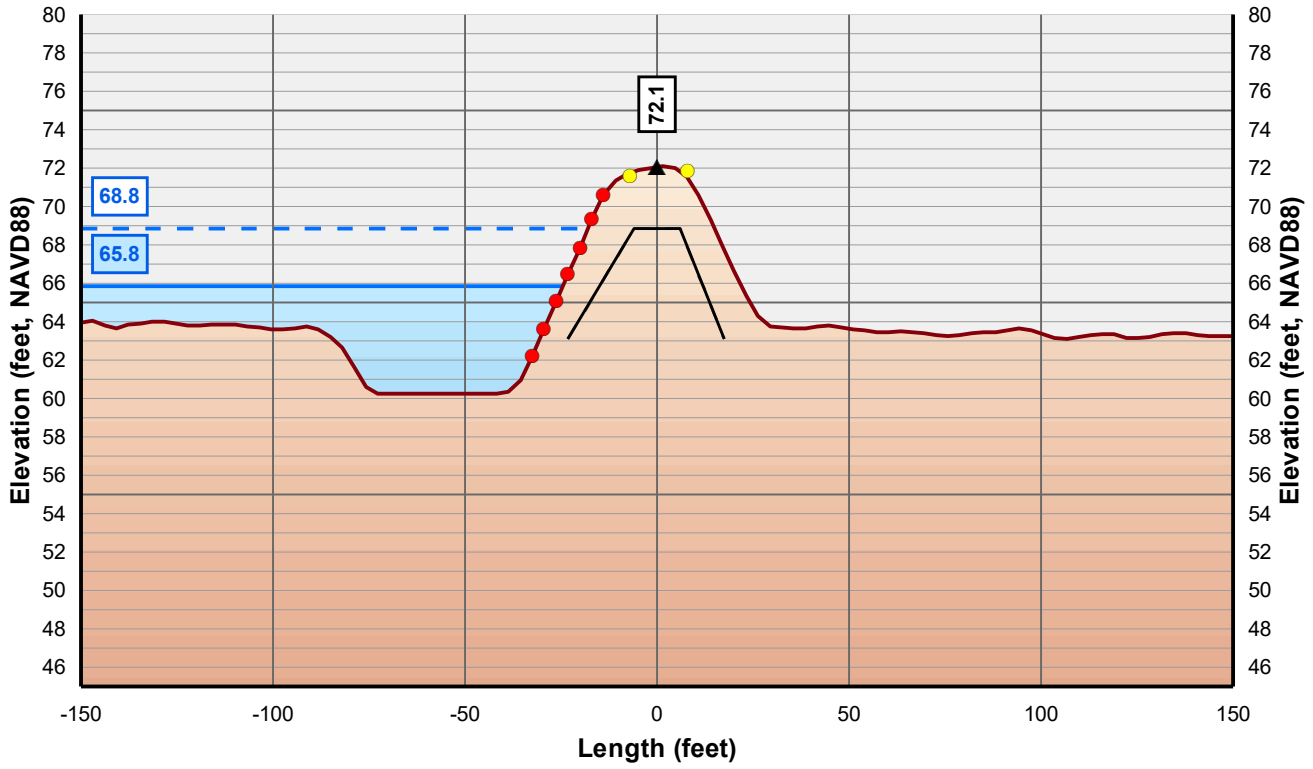
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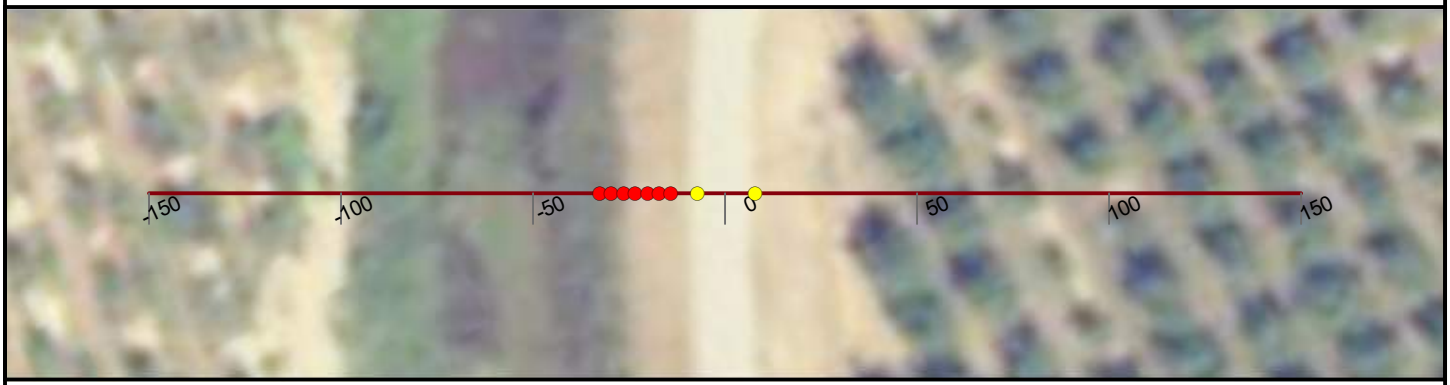
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Cross Section: Yankee Slough 217+00



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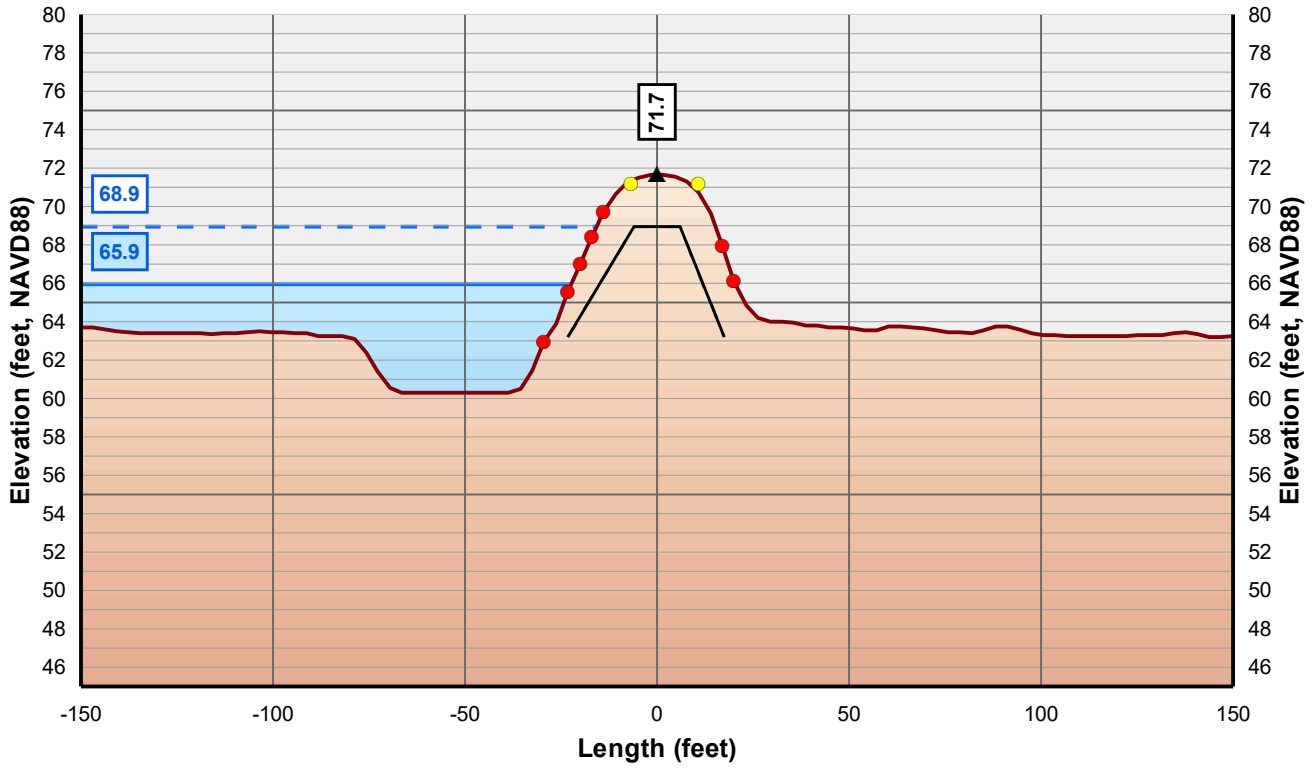
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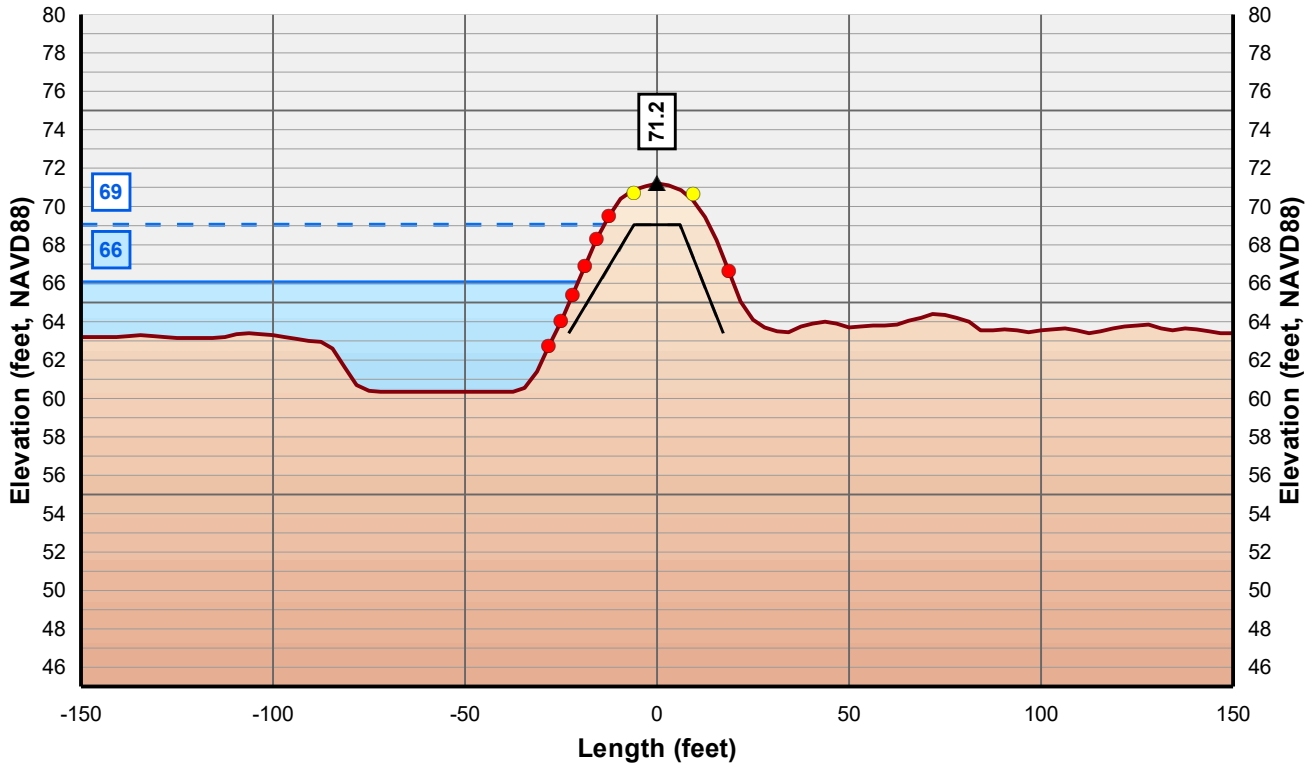
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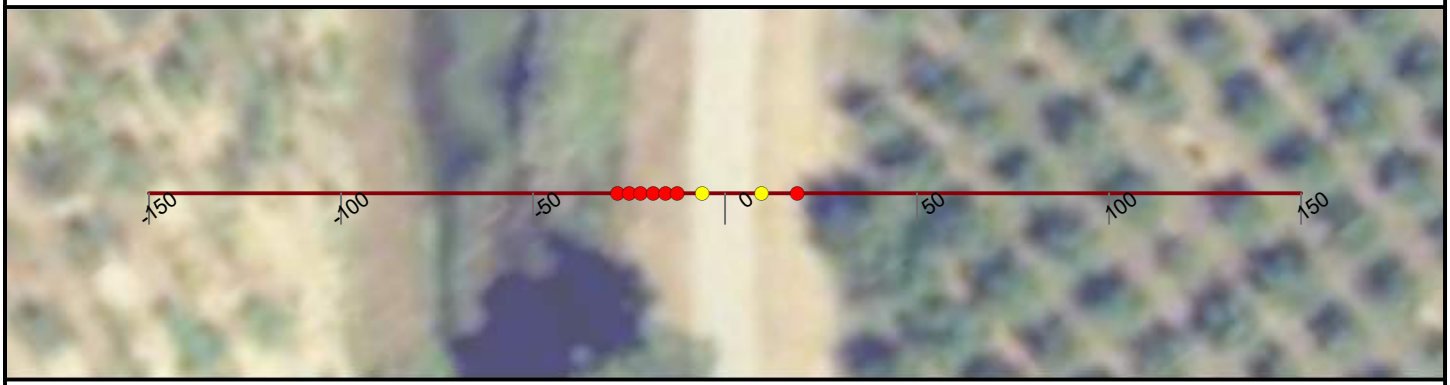
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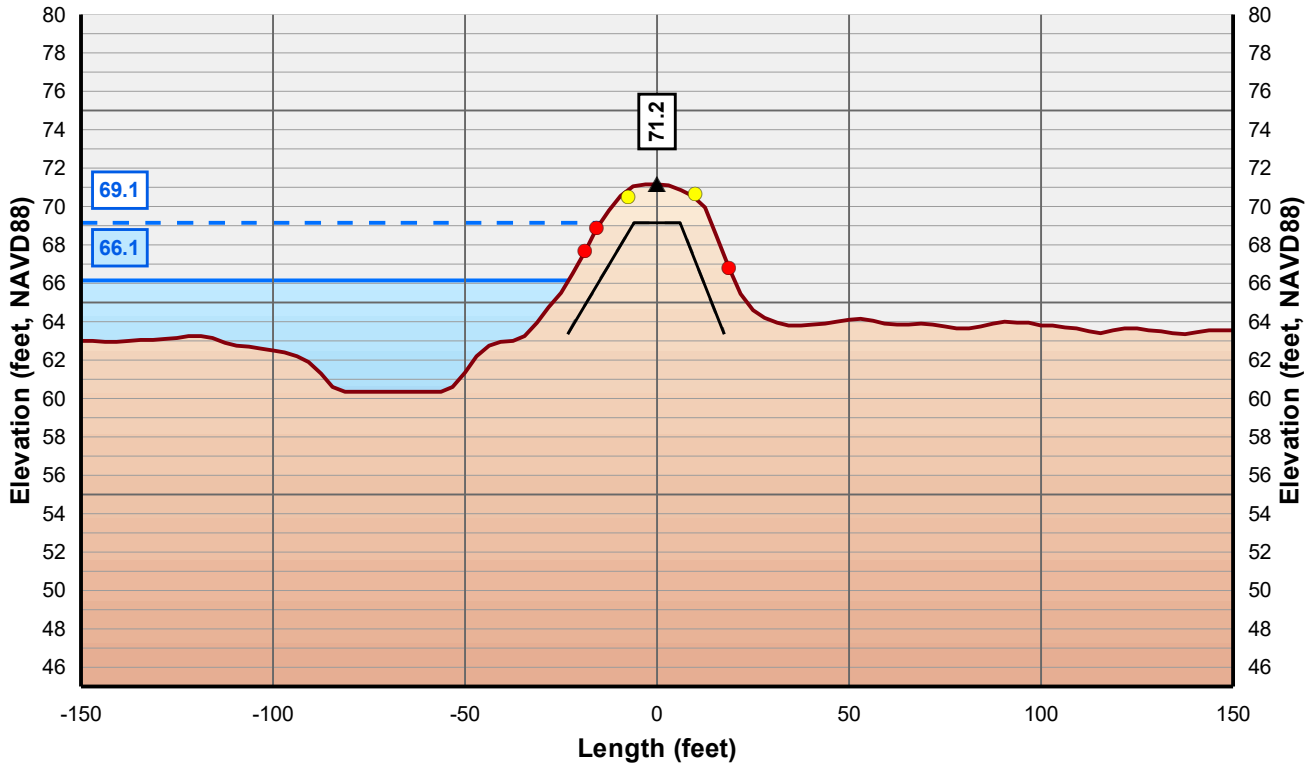
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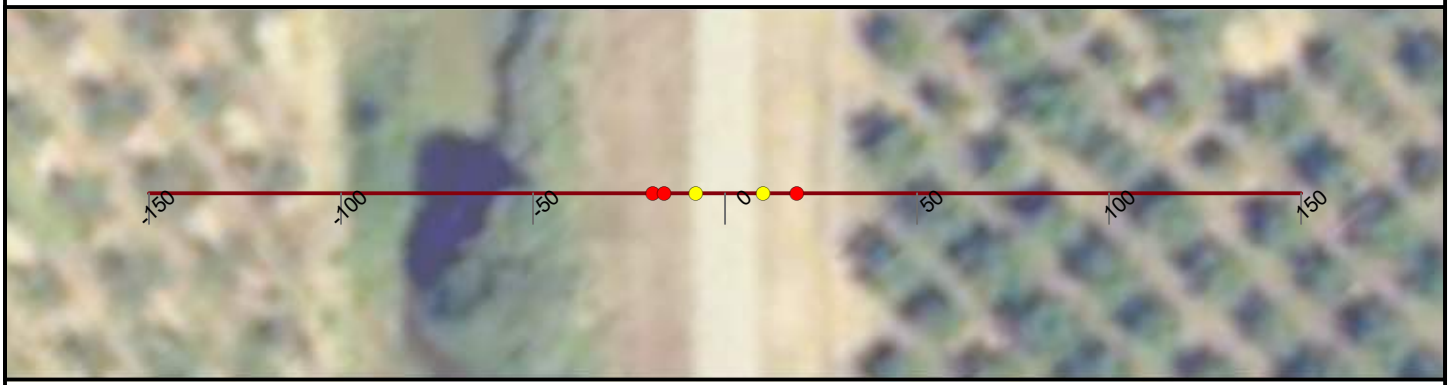
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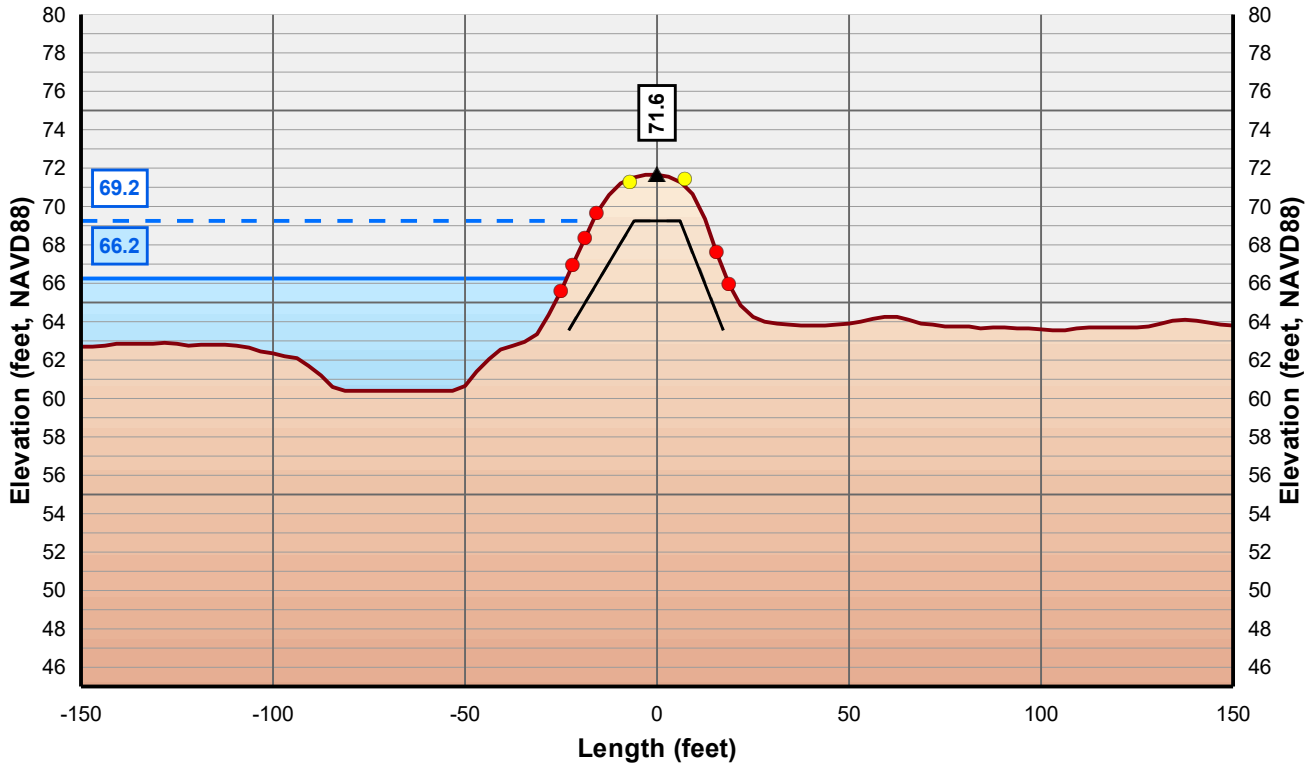
FEET

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WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

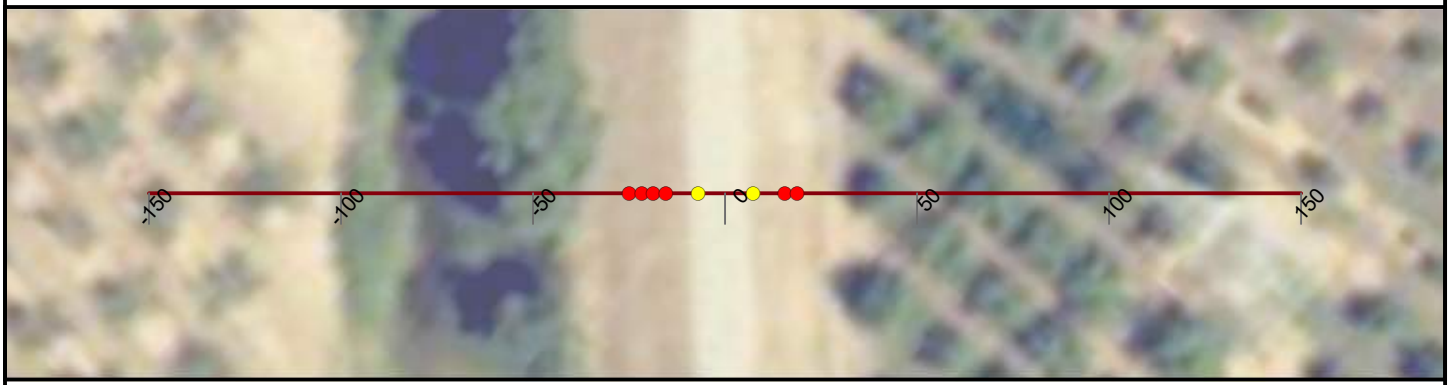
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Cross Section: Yankee Slough 221+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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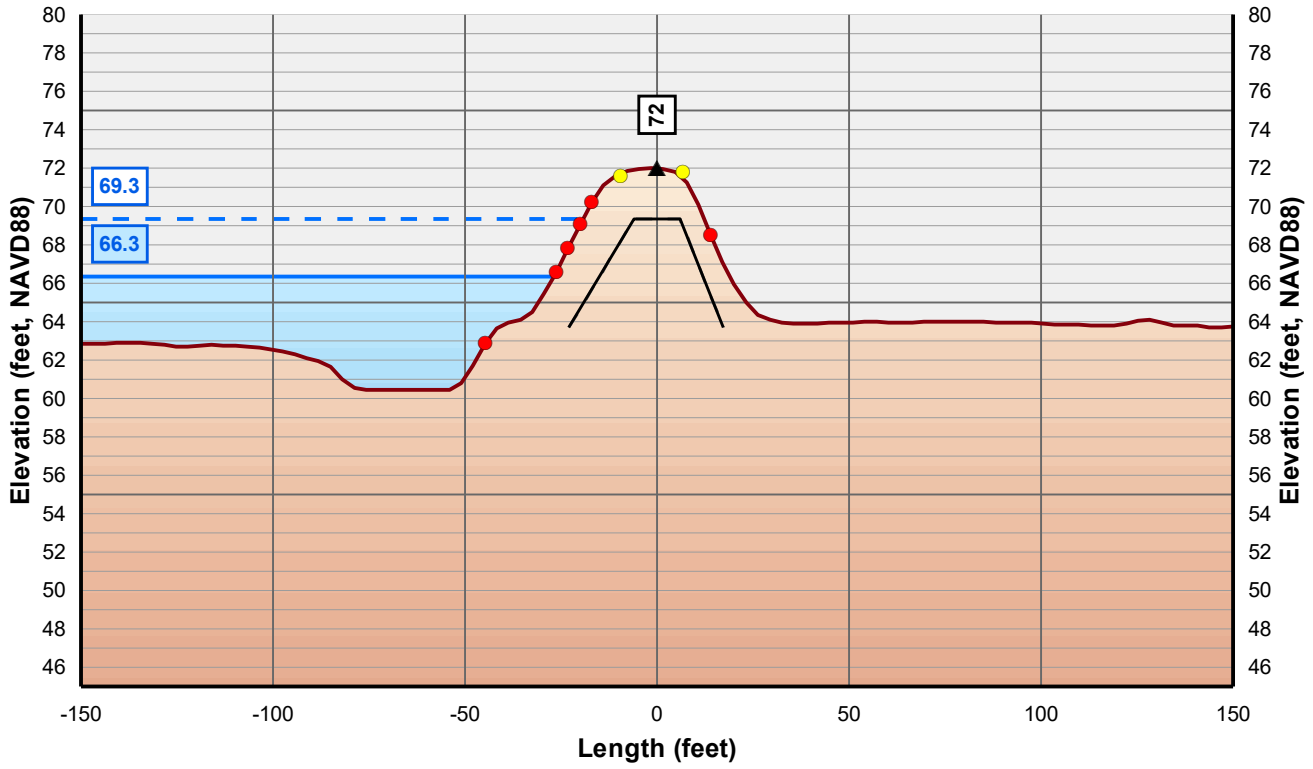
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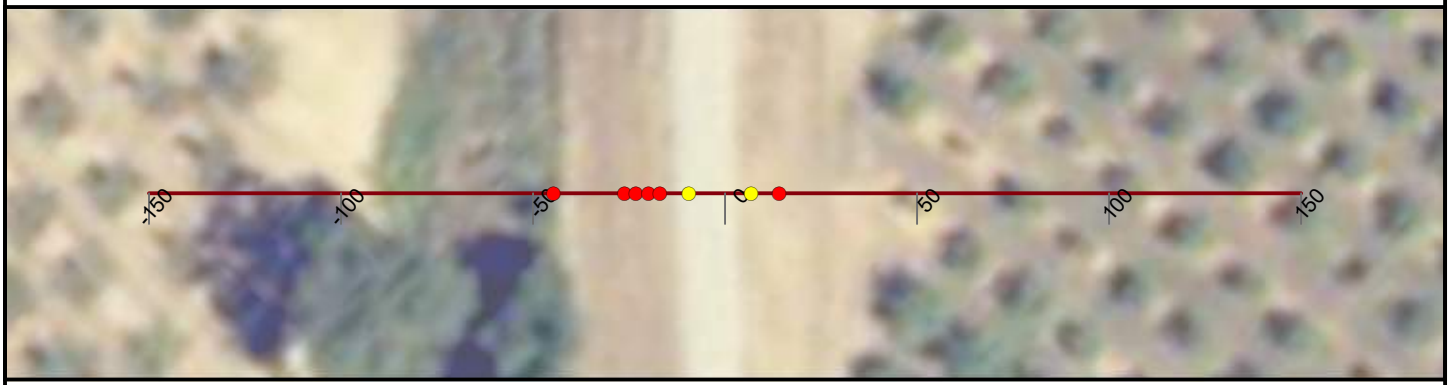
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Cross Section: Yankee Slough 222+00



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AUGUST, 2019

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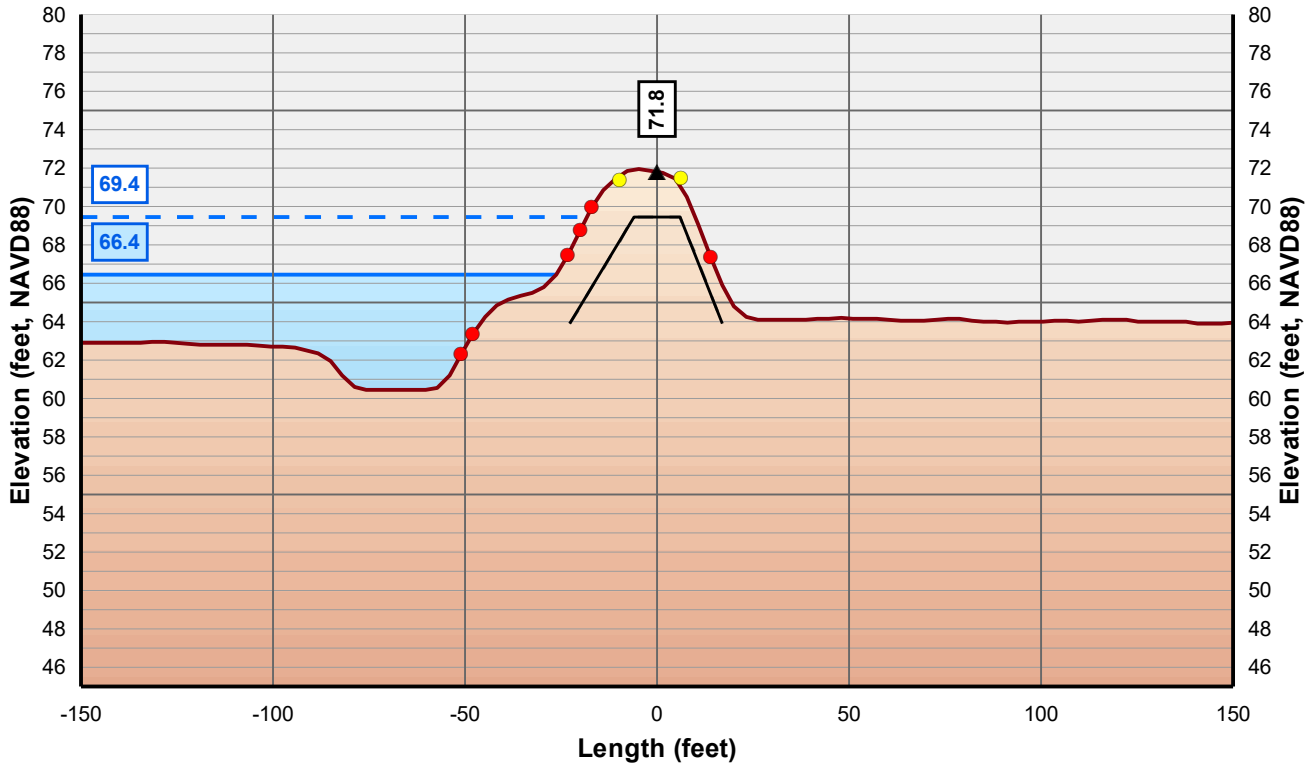
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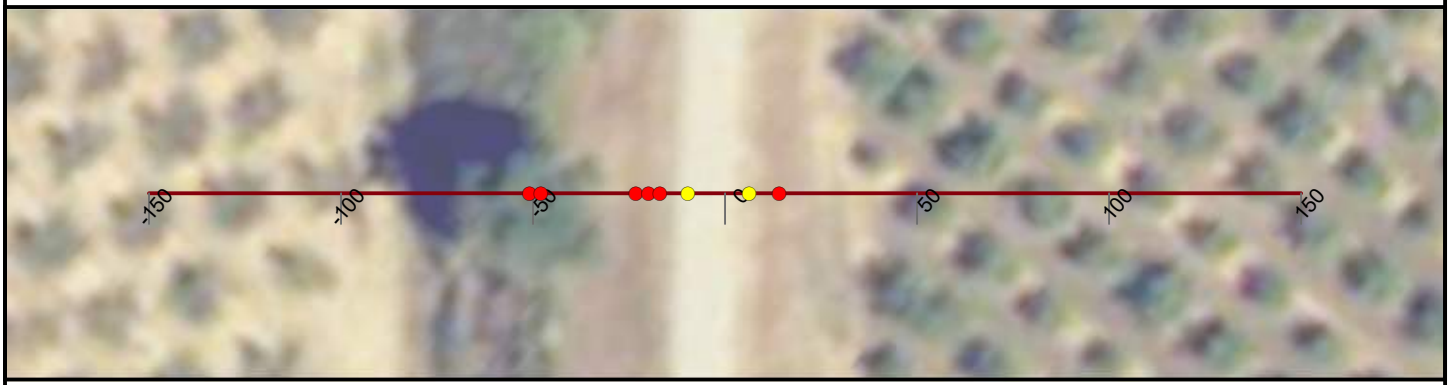
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Cross Section: Yankee Slough 223+00



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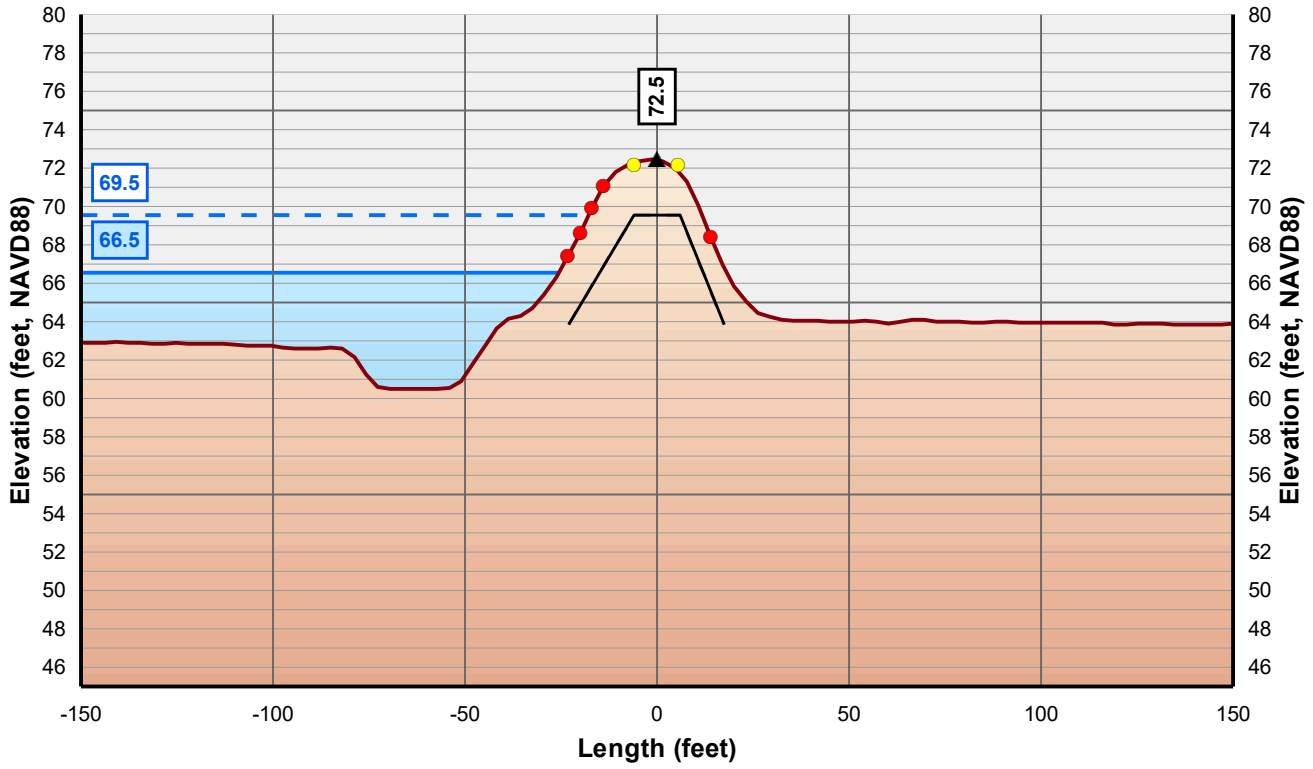
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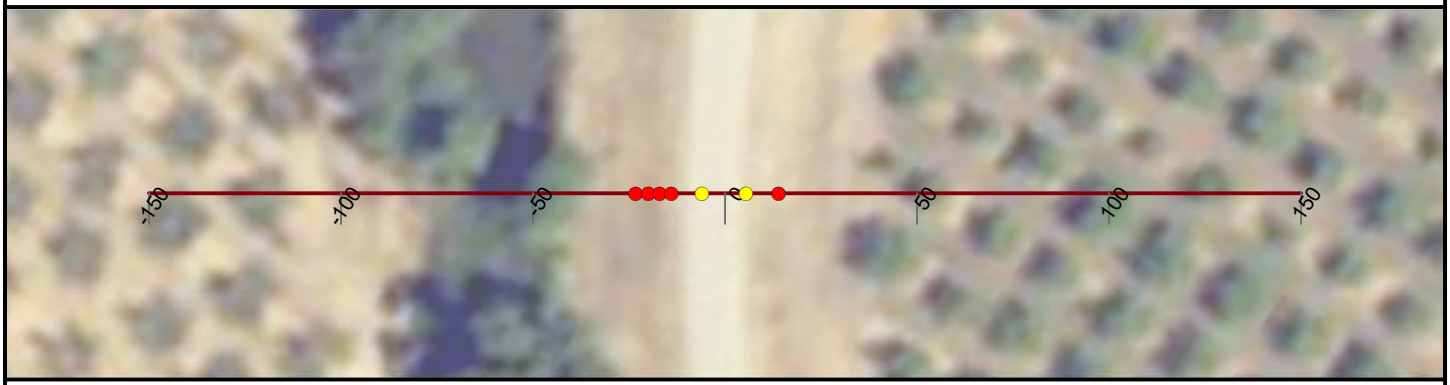
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Cross Section: Yankee Slough 224+00



Horizontal Scale: 1 inch = 50 Feet
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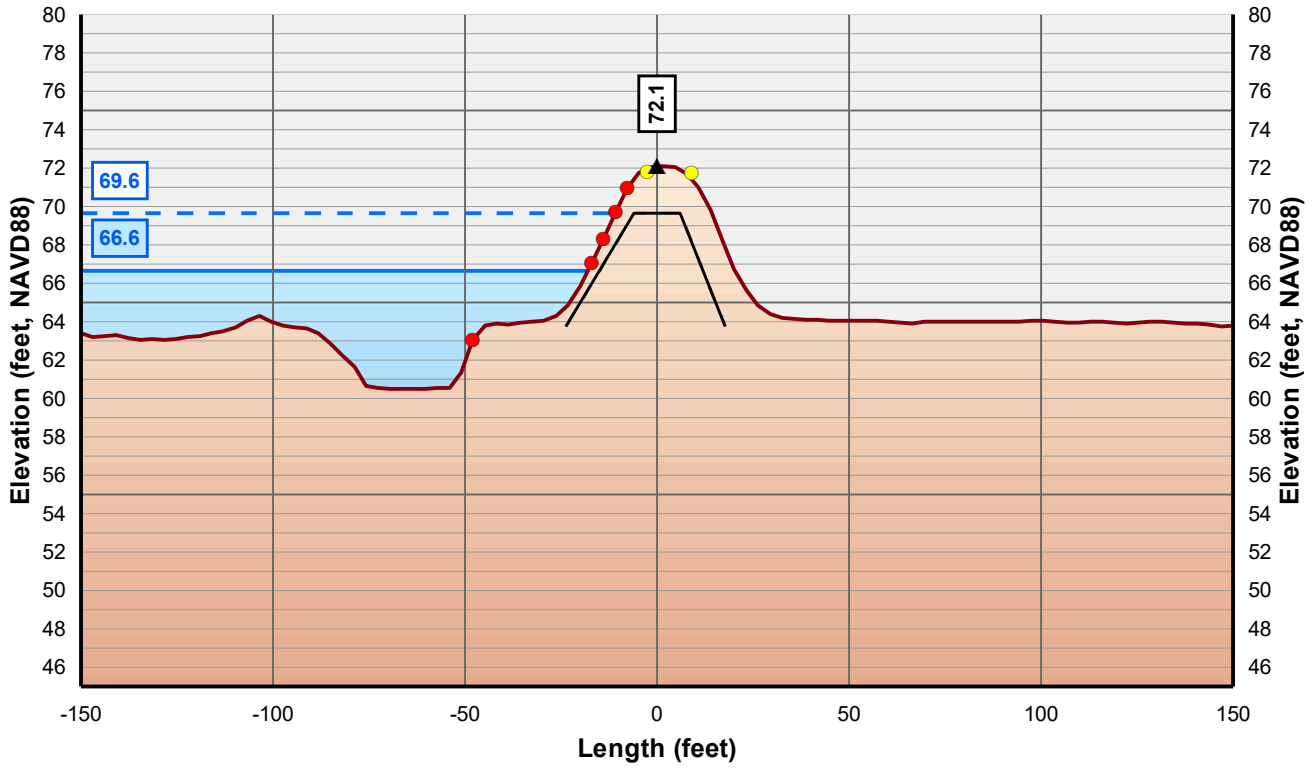
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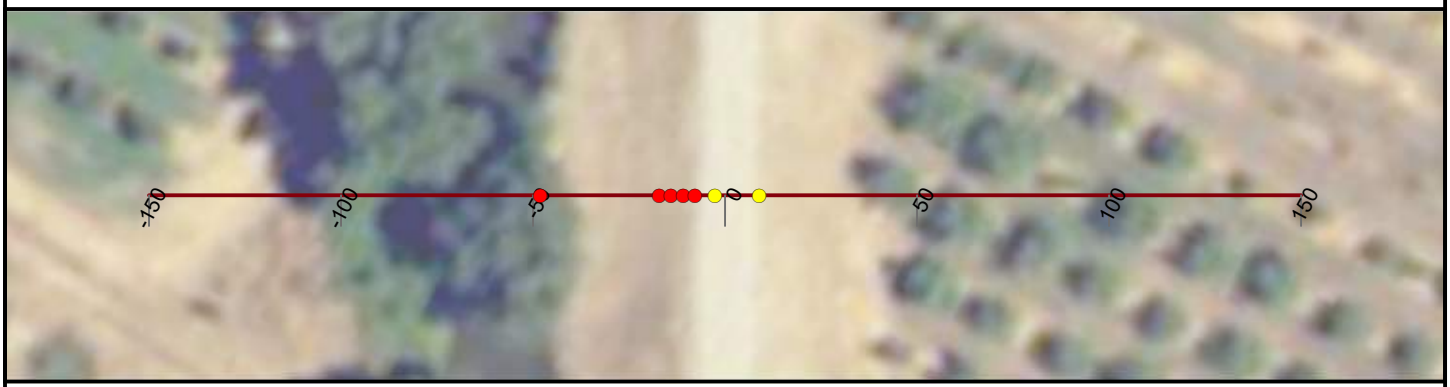
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Cross Section: Yankee Slough 225+00



Horizontal Scale: 1 inch = 50 Feet
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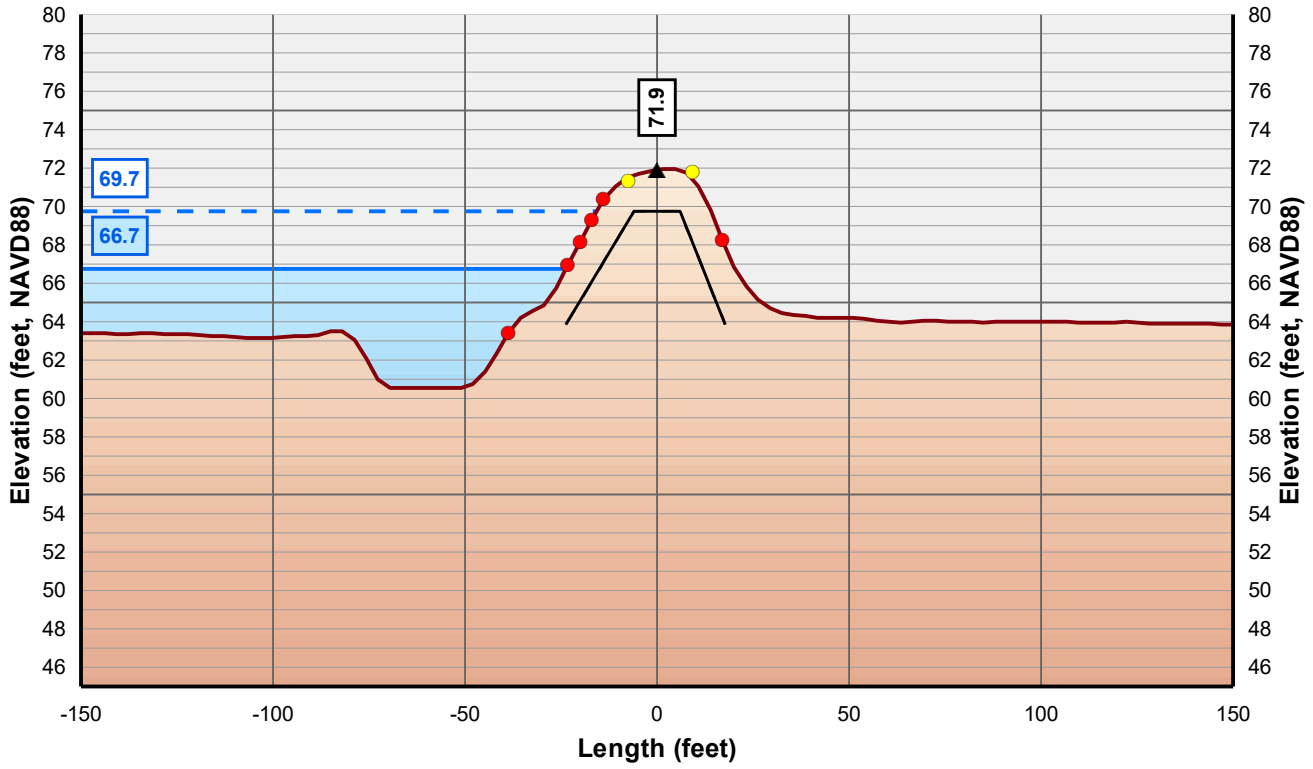
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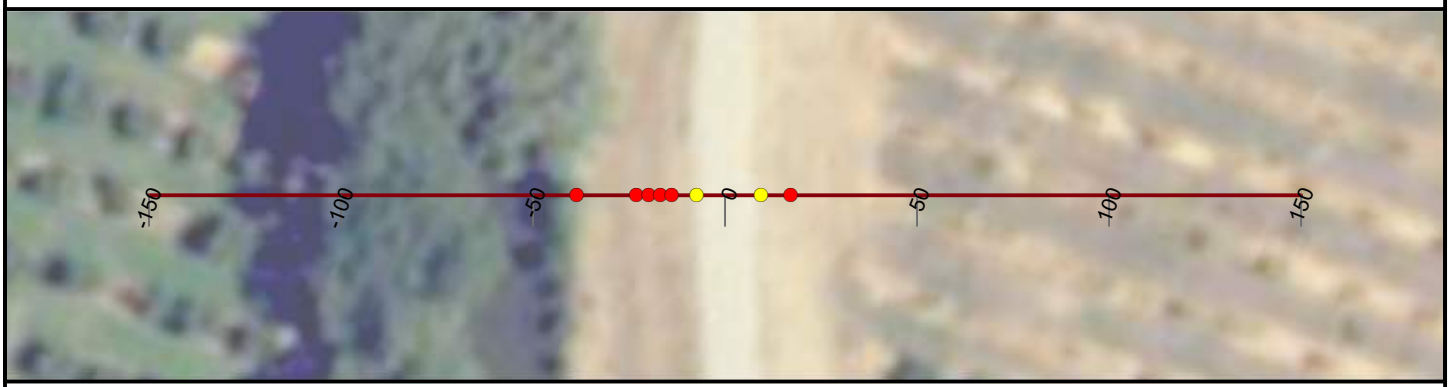
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Cross Section: Yankee Slough 226+00



Horizontal Scale: 1 inch = 50 Feet
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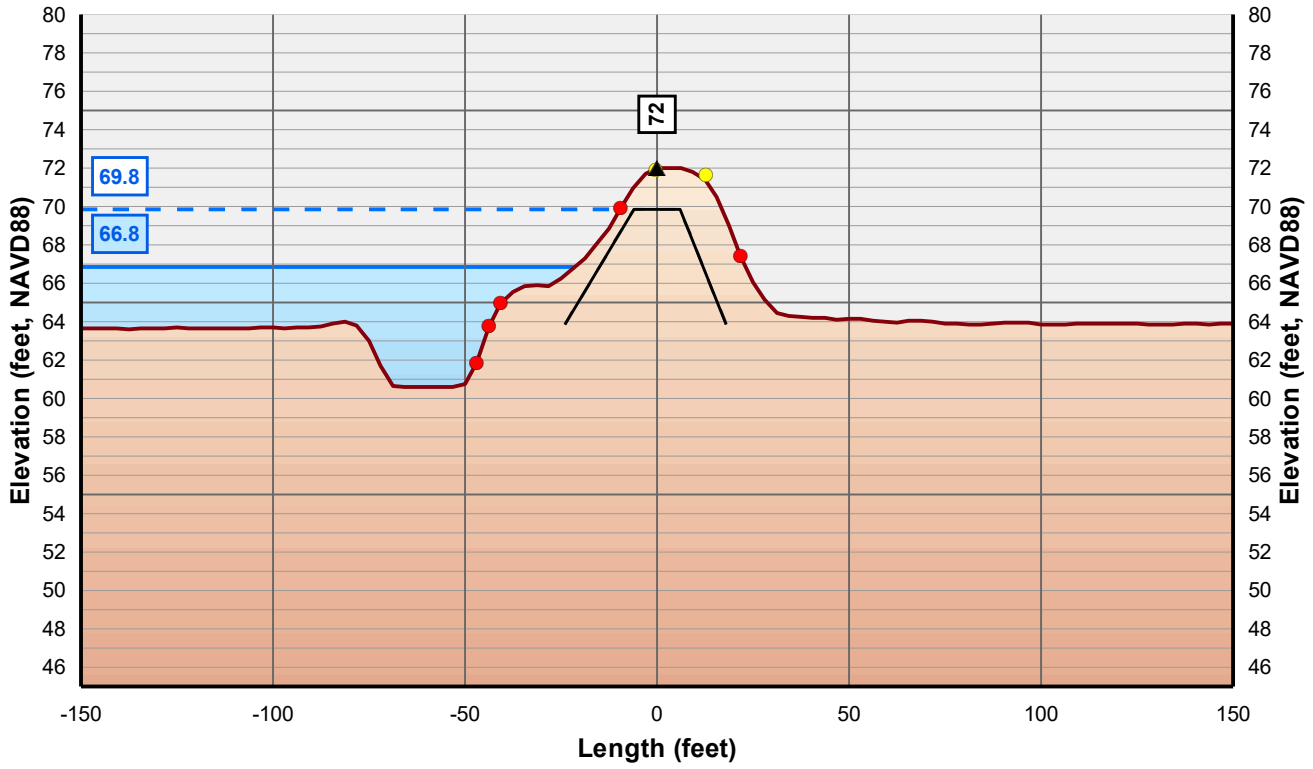
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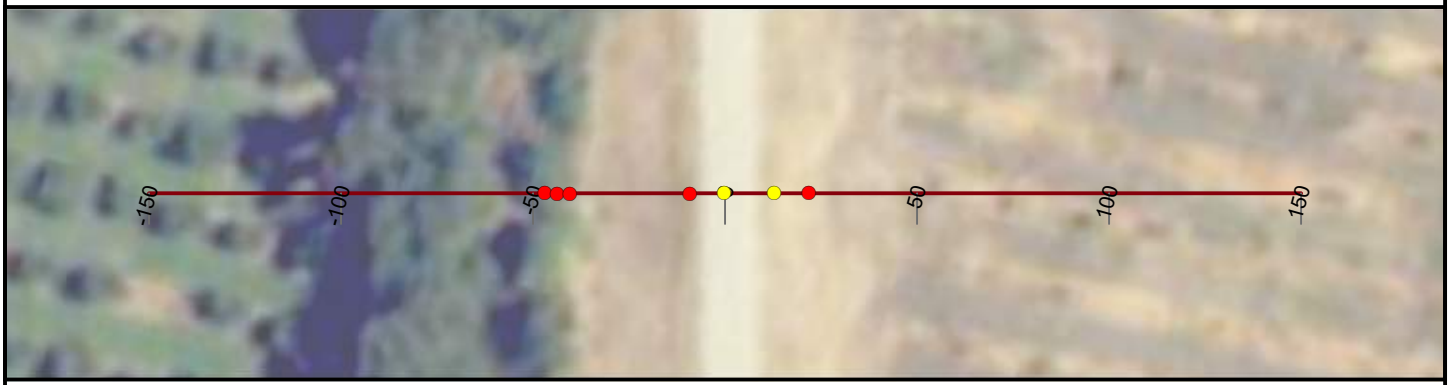
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Cross Section: Yankee Slough 227+00



Horizontal Scale: 1 inch = 50 Feet
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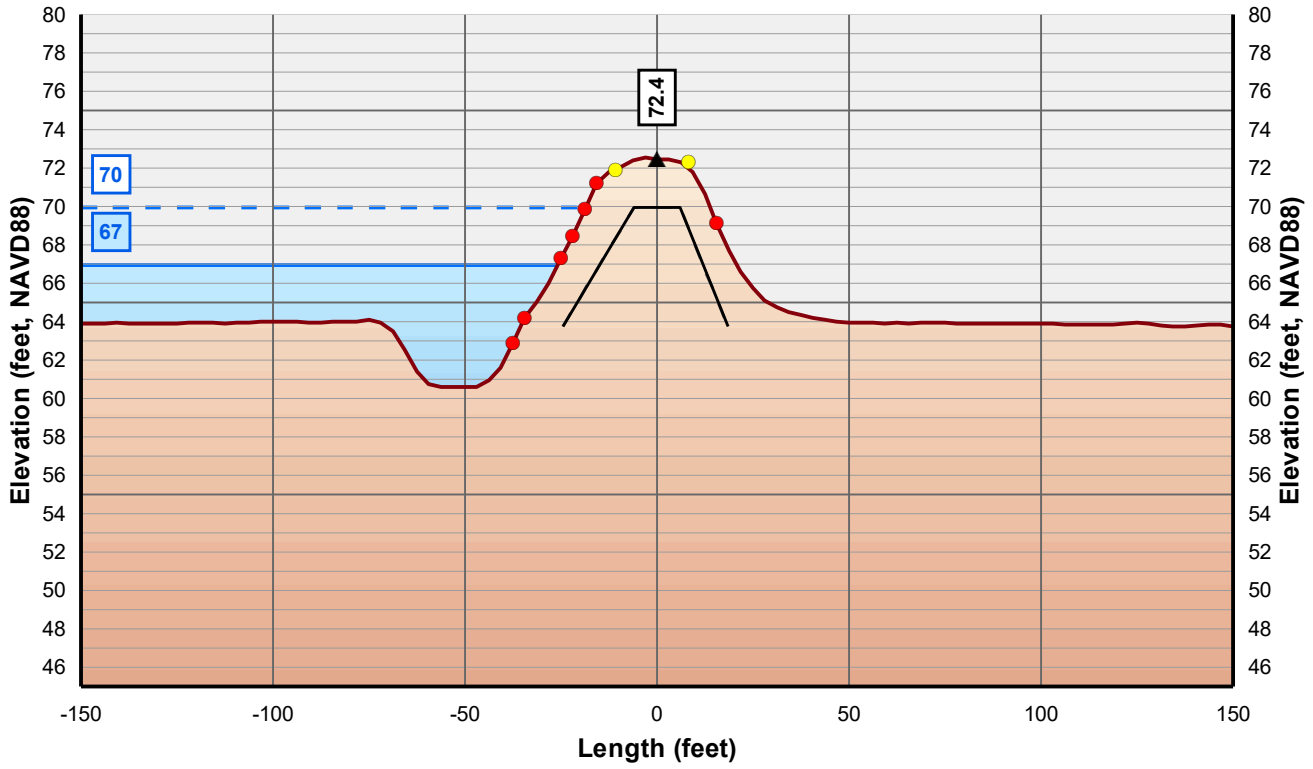
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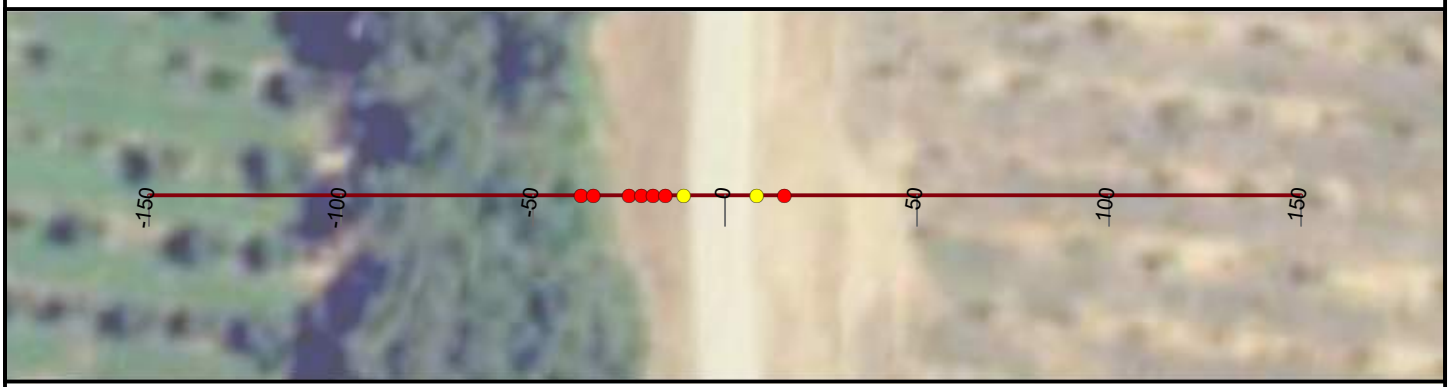
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Cross Section: Yankee Slough 228+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

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CALIFORNIA

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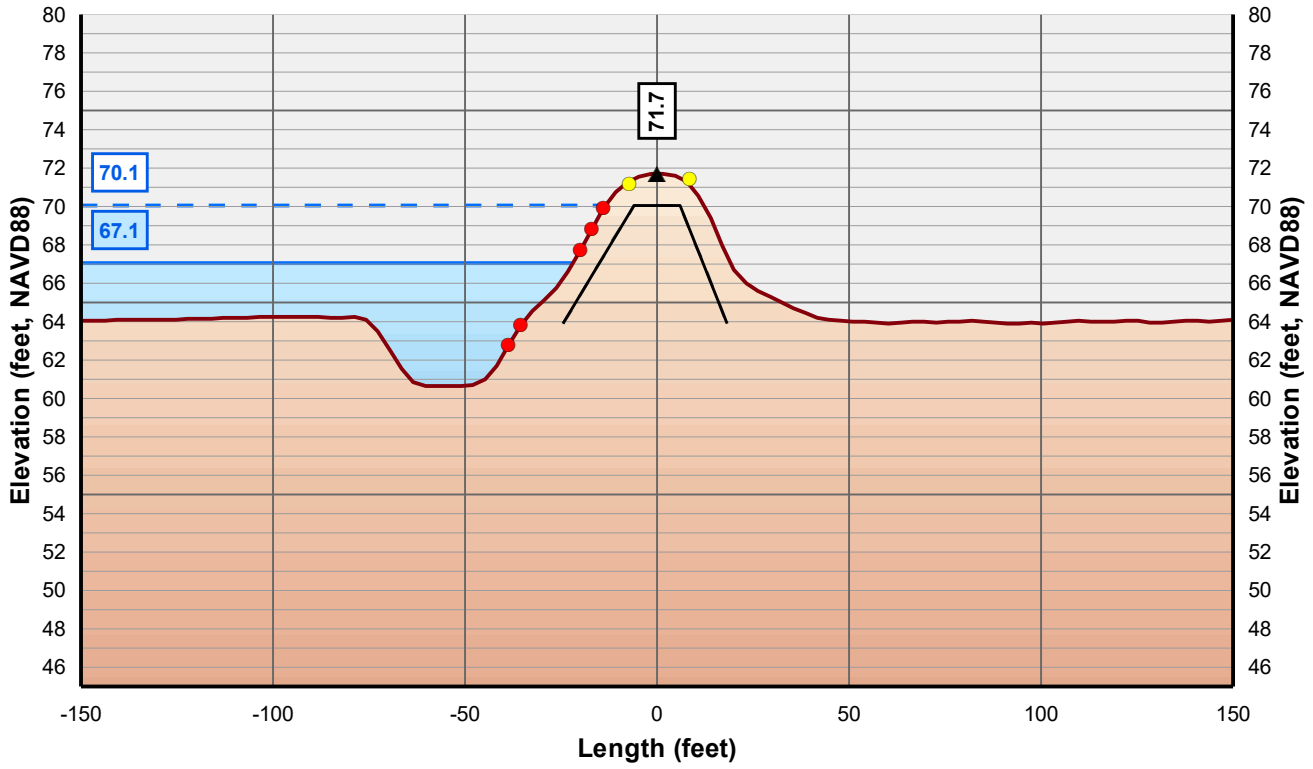
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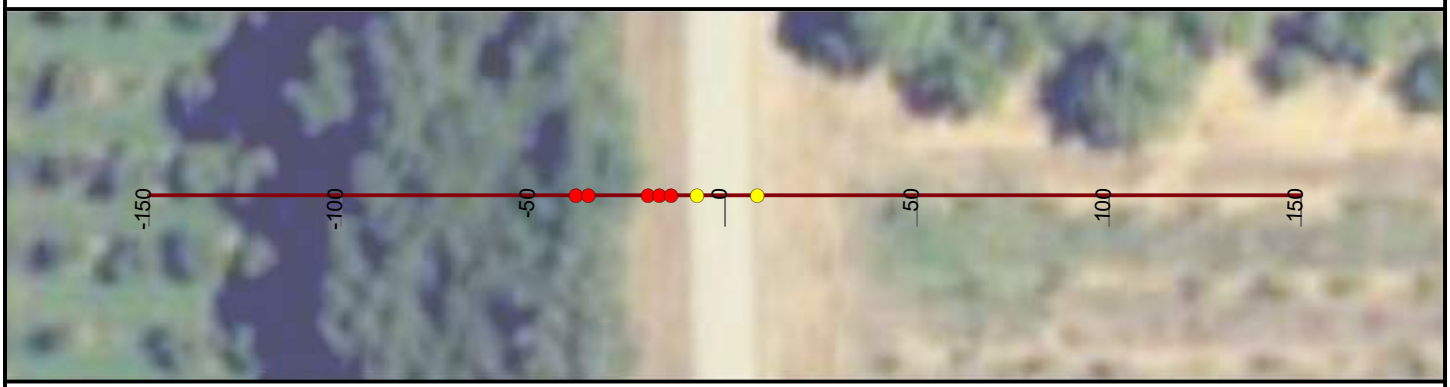
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Cross Section: Yankee Slough 229+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

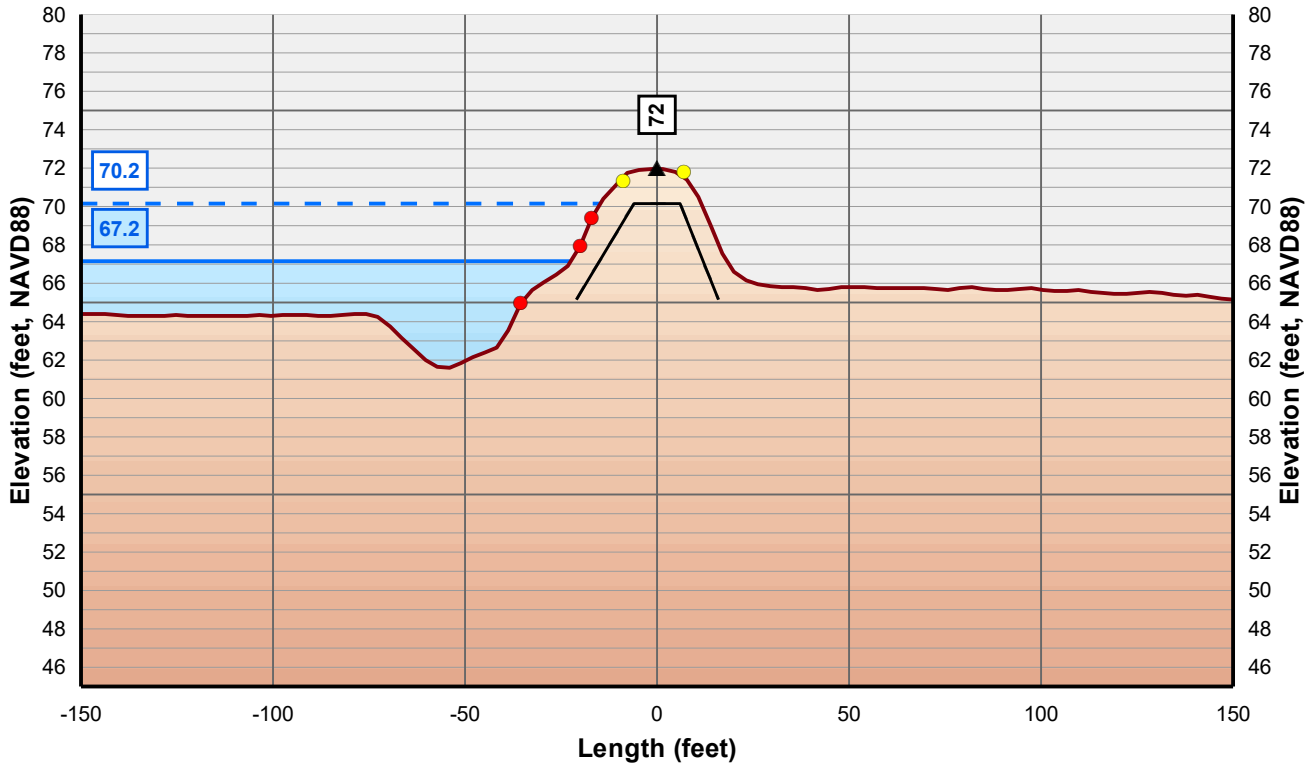
FEET

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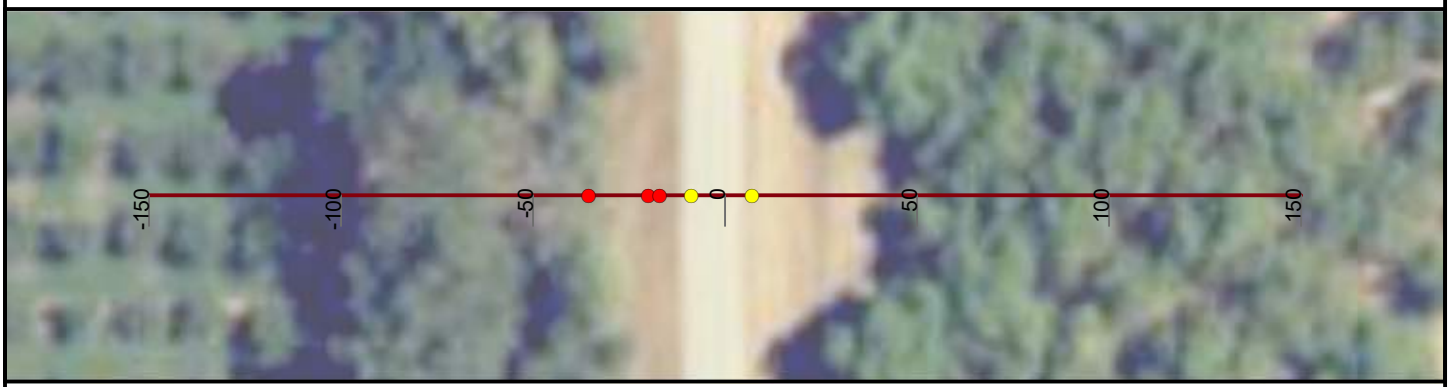
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Cross Section: Yankee Slough 230+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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- Theoretical Levee Prism Preliminary
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

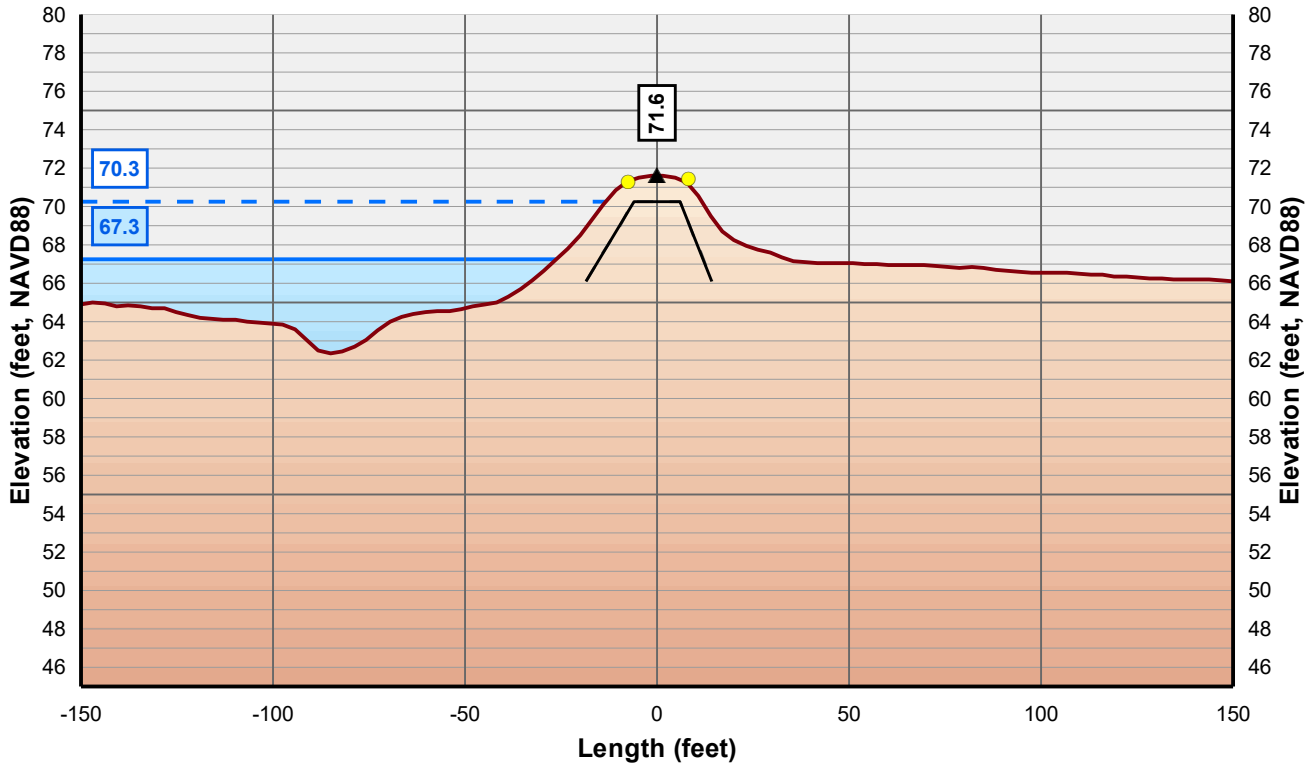
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Cross Section: Yankee Slough 231+00



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- Control Line
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FEASIBILITY STUDY

YANKEE SLOUGH LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

FEET

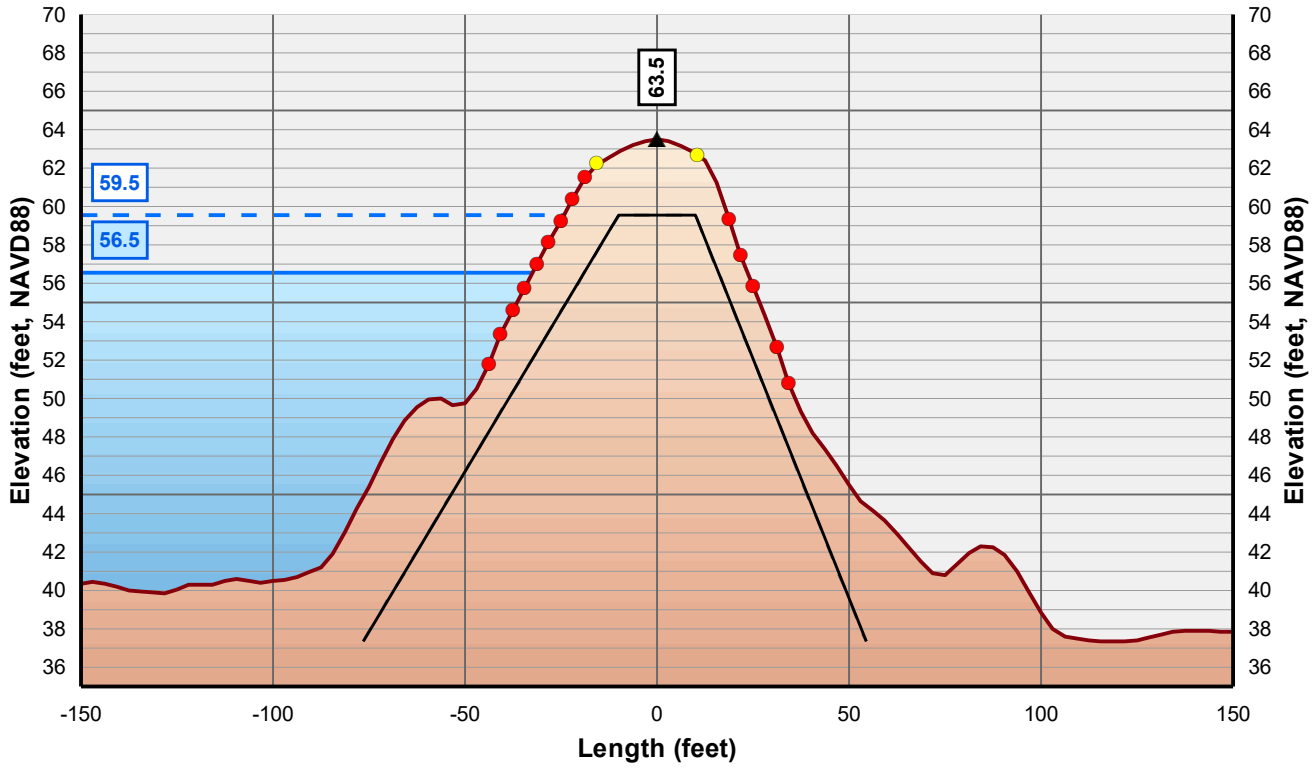
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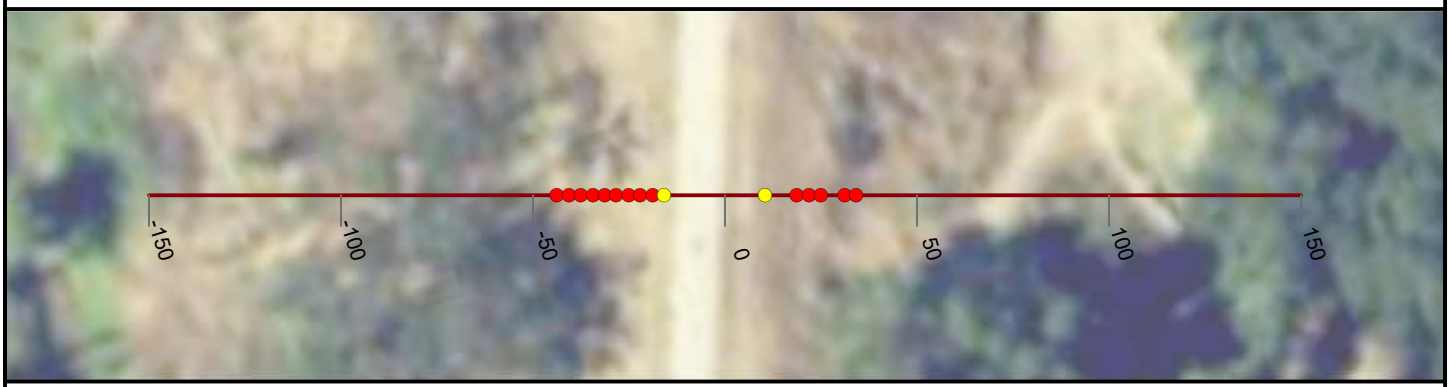
Freeboard and Geometry Analyses – Bear River East Levee

Cross Section: Bear River 00+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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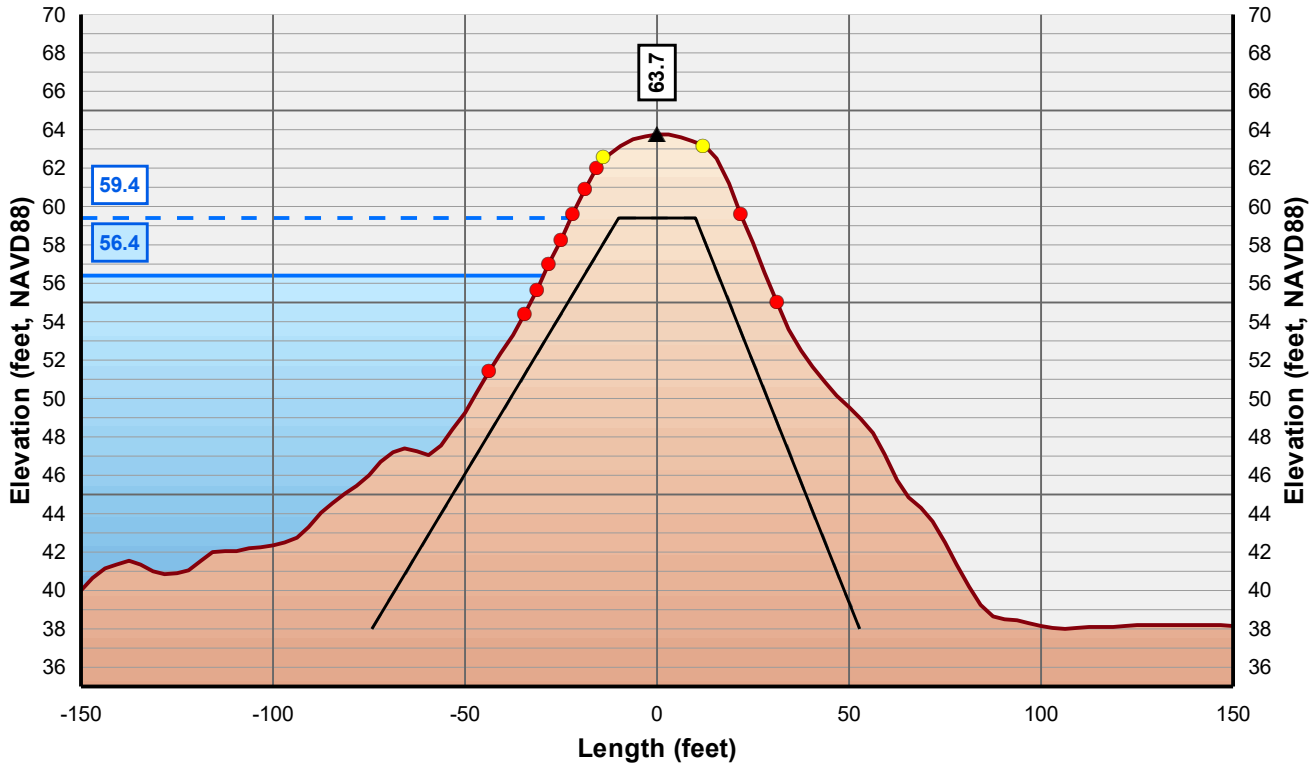
FEET

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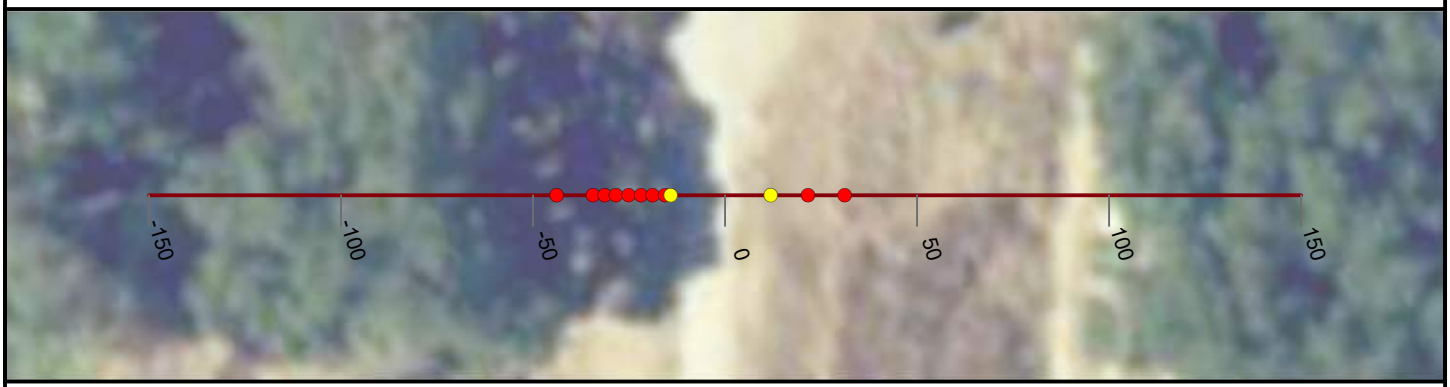
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Cross Section: Bear River 01+00



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BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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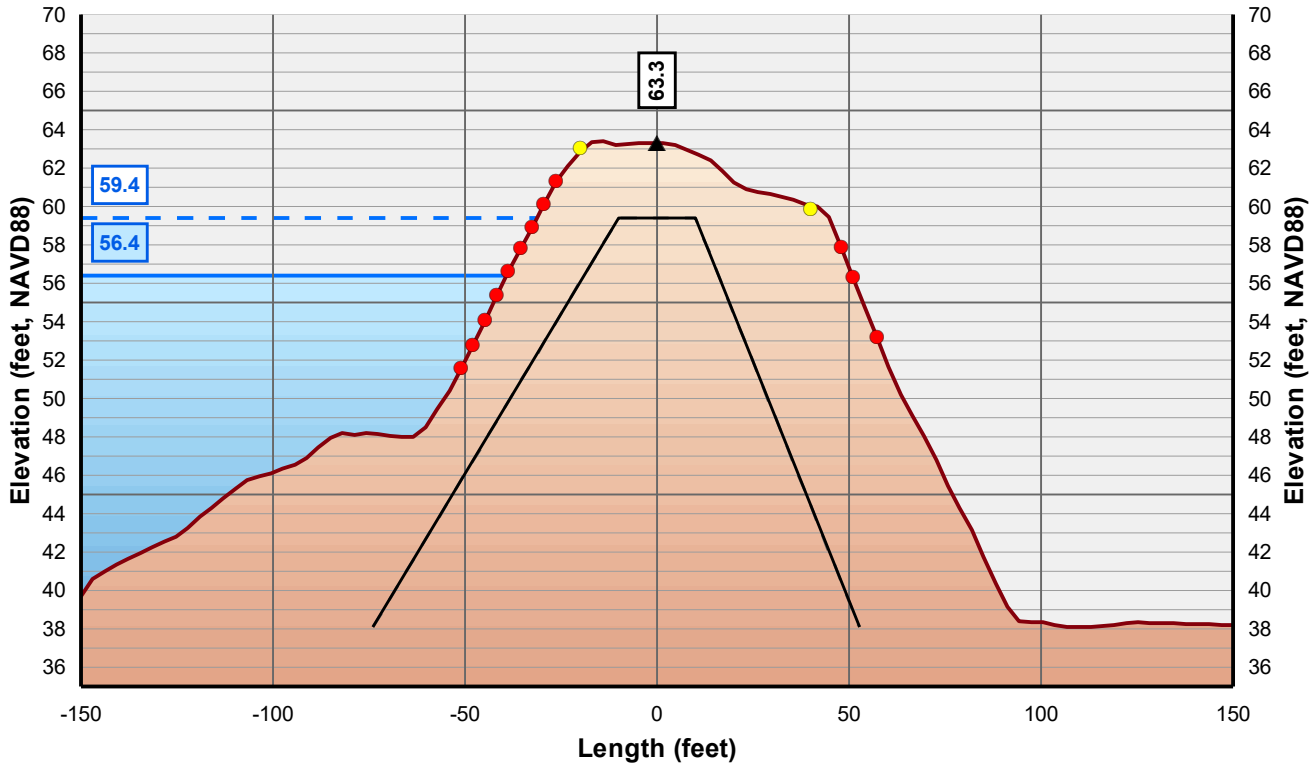
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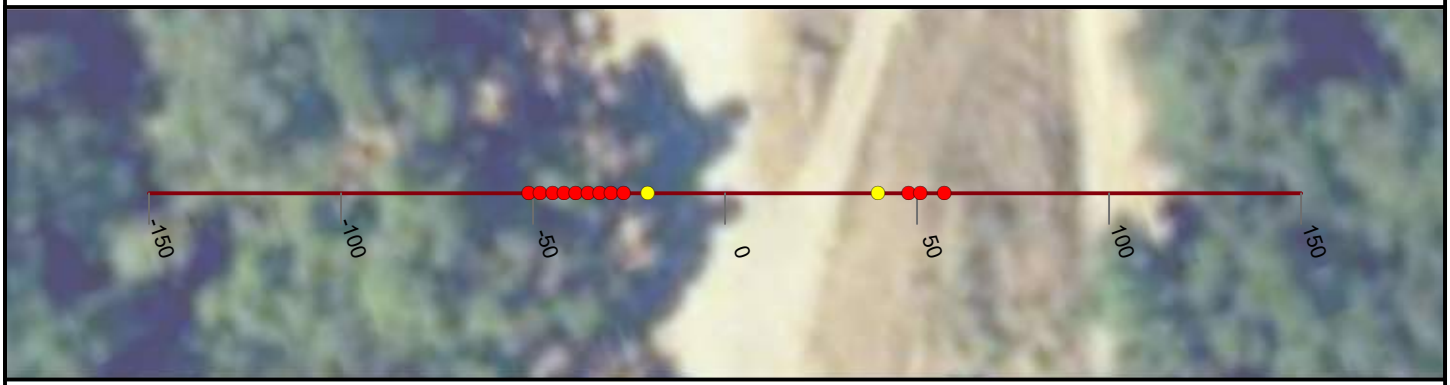
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Cross Section: Bear River 02+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

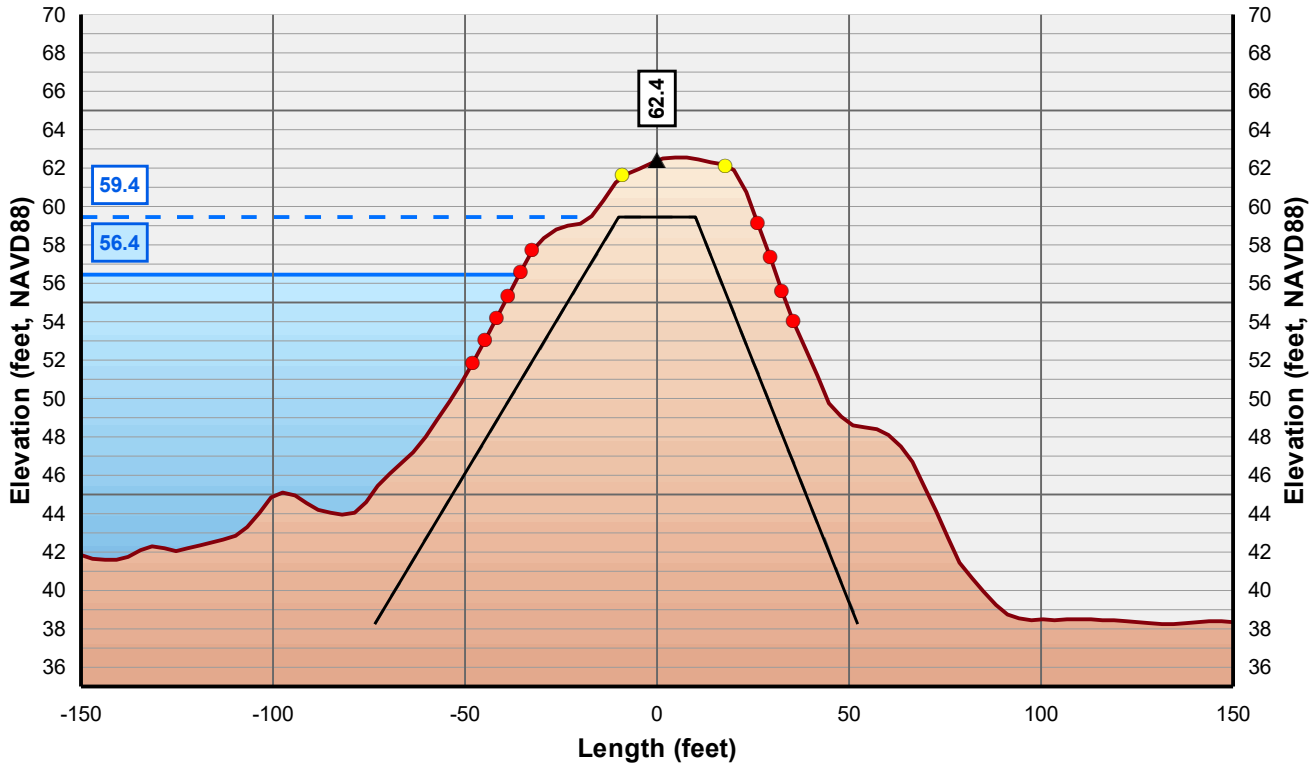
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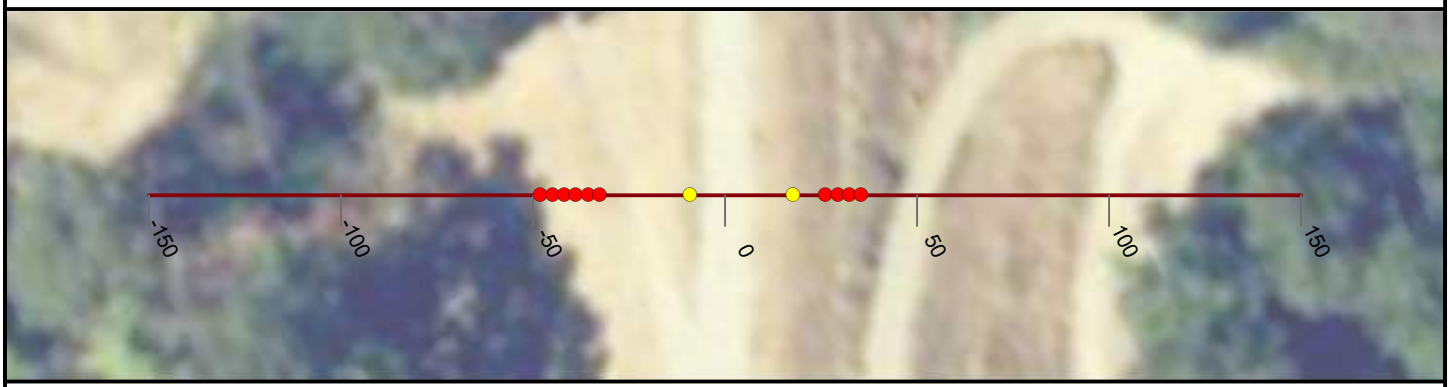
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Cross Section: Bear River 03+00



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- Control Line
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- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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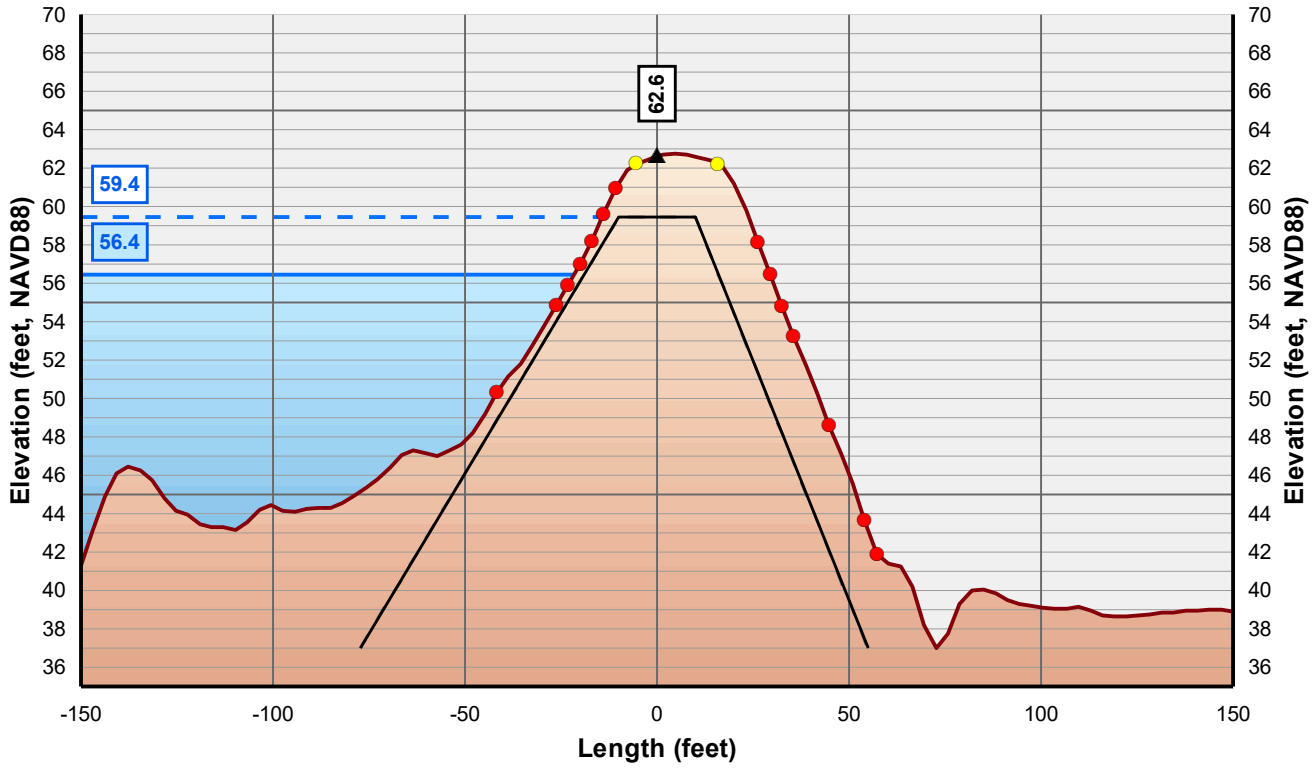
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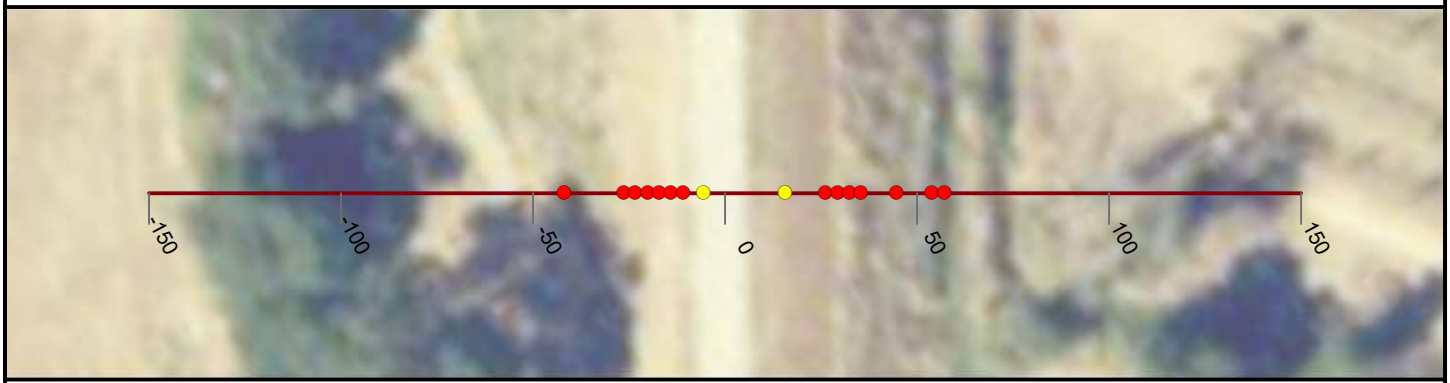
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Cross Section: Bear River 04+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

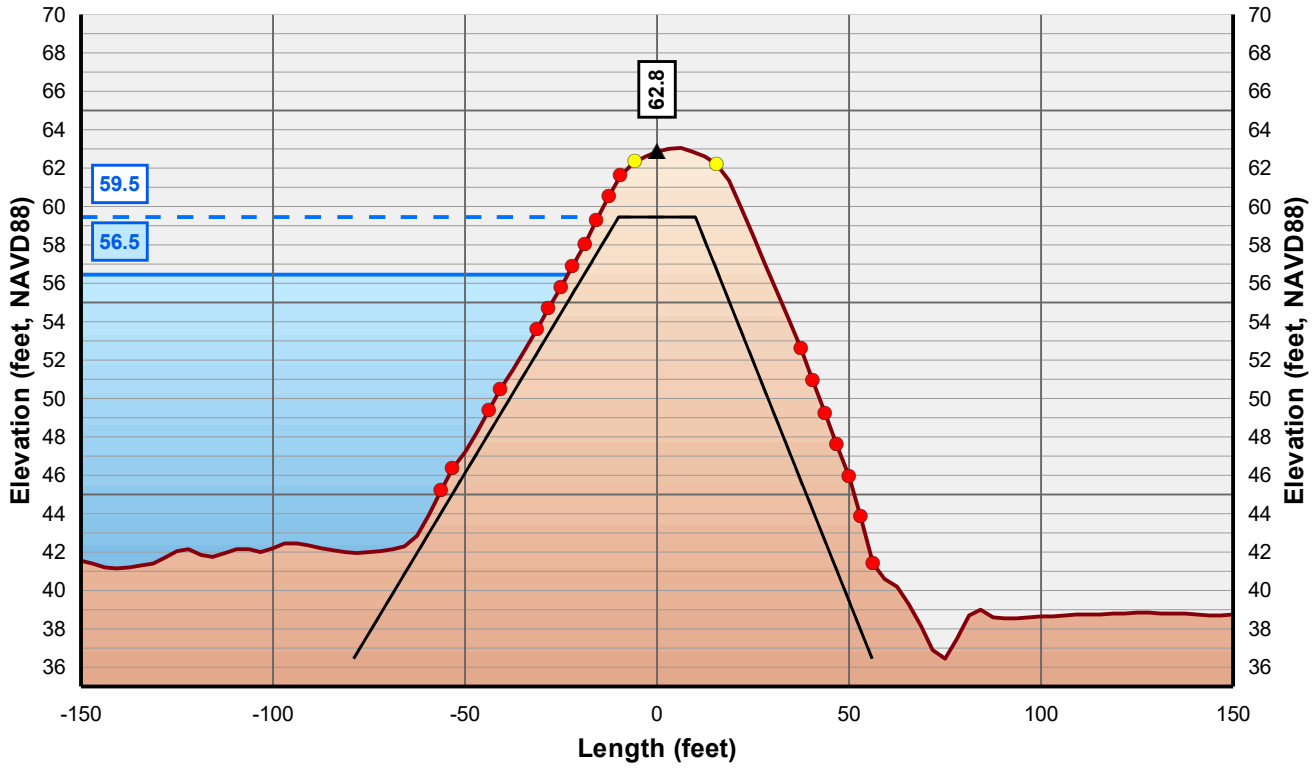
FEET

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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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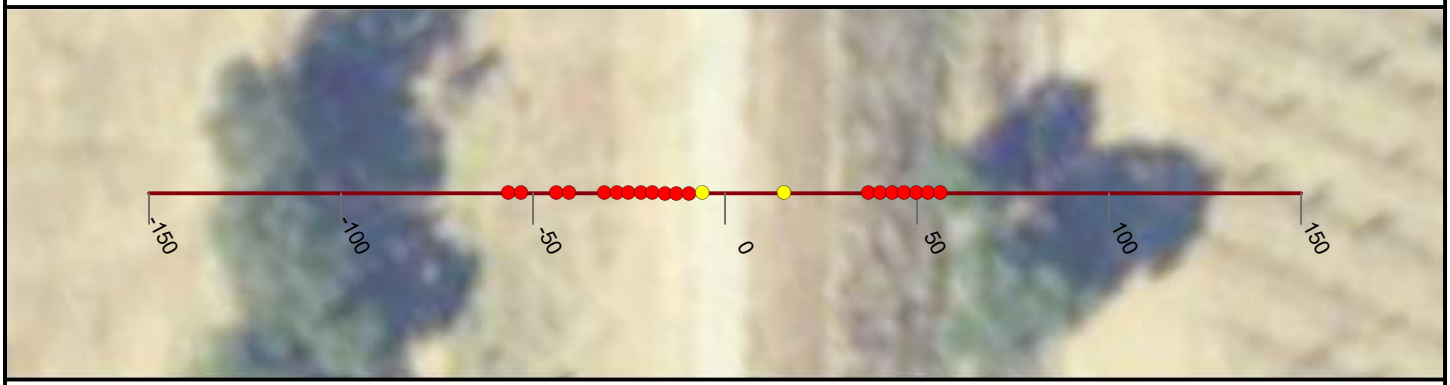
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Cross Section: Bear River 05+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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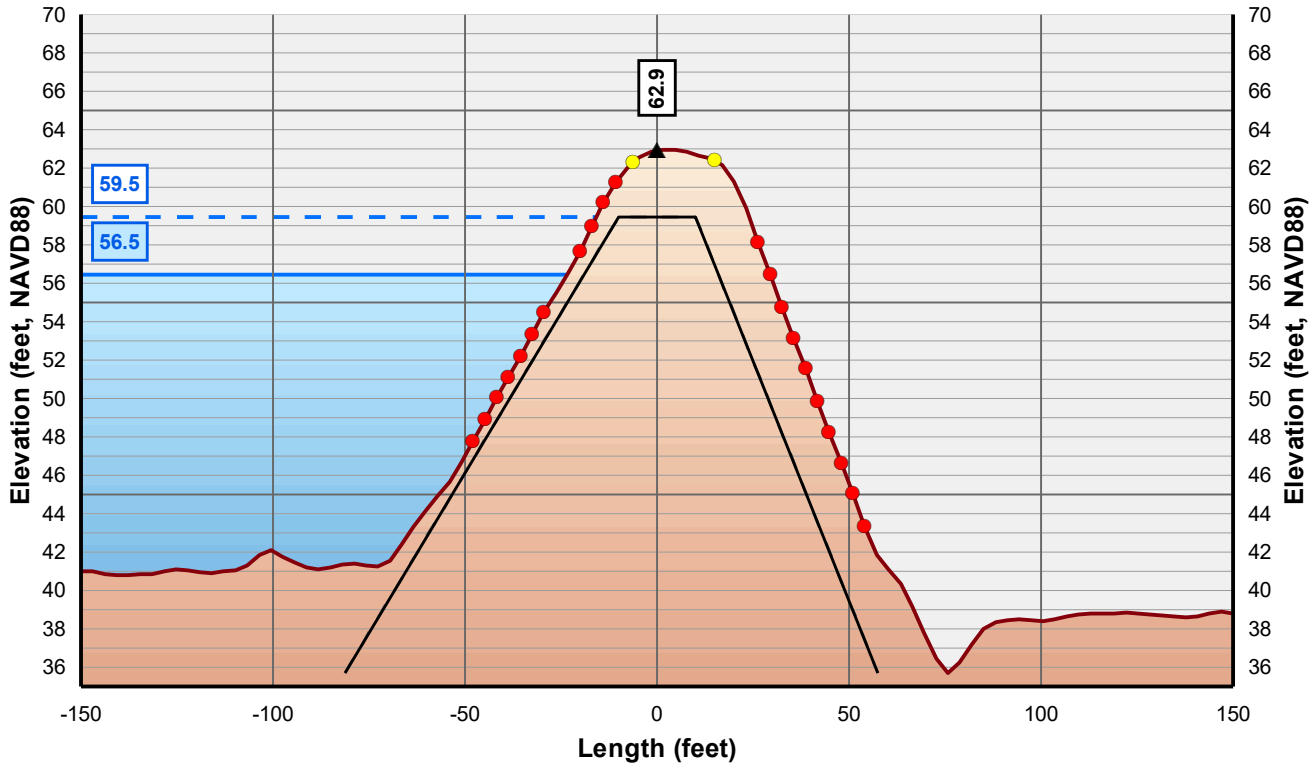
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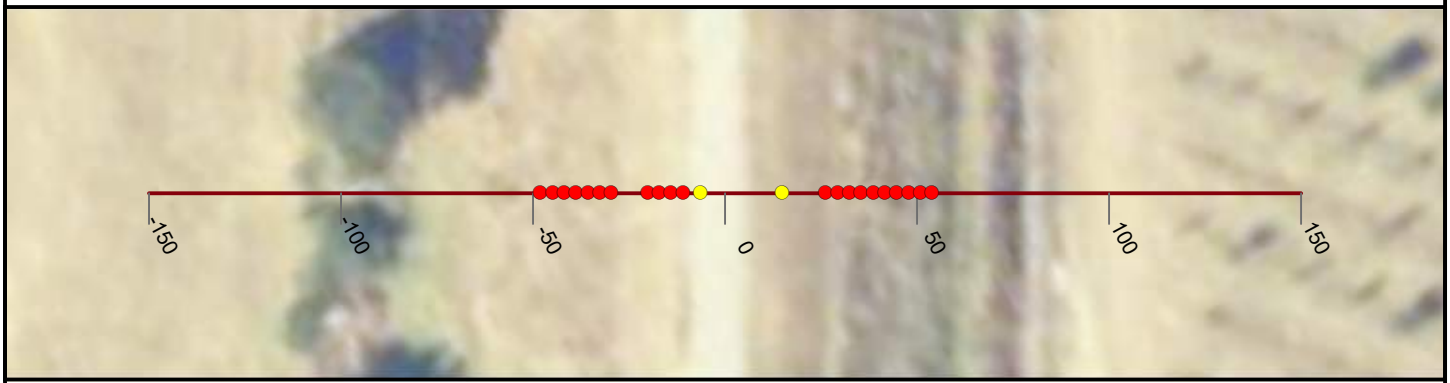
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Cross Section: Bear River 06+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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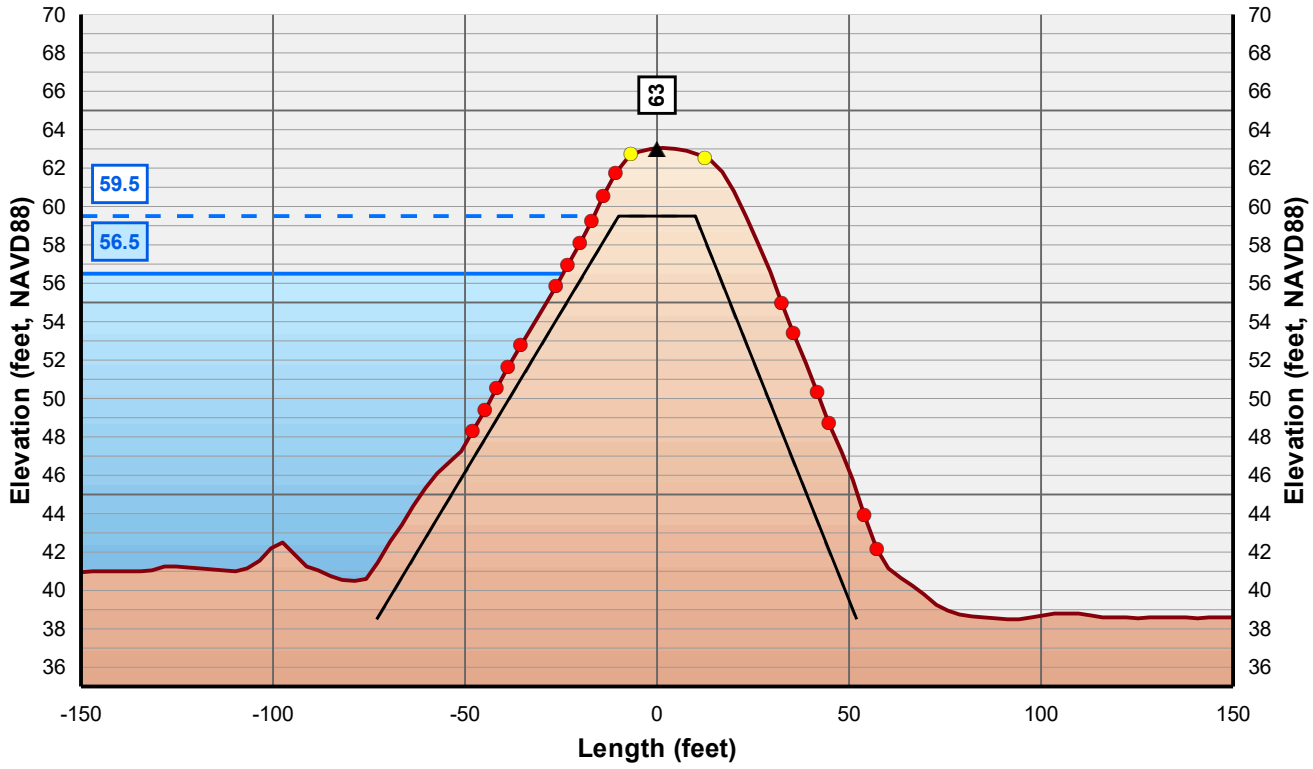
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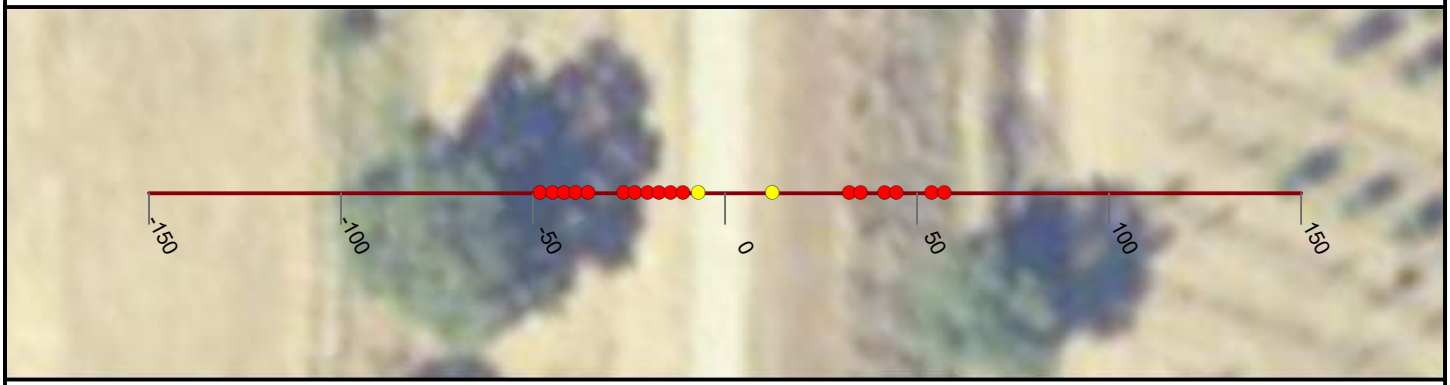
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Cross Section: Bear River 07+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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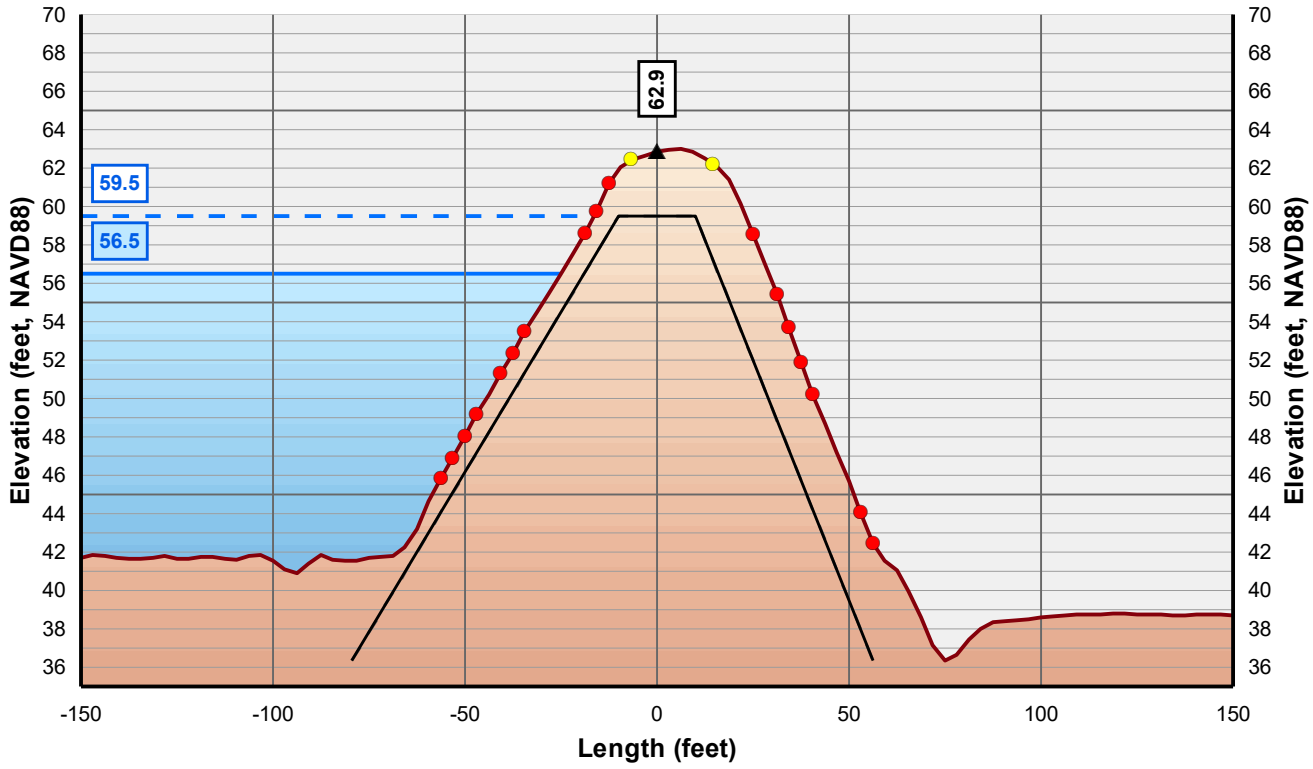
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Cross Section: Bear River 08+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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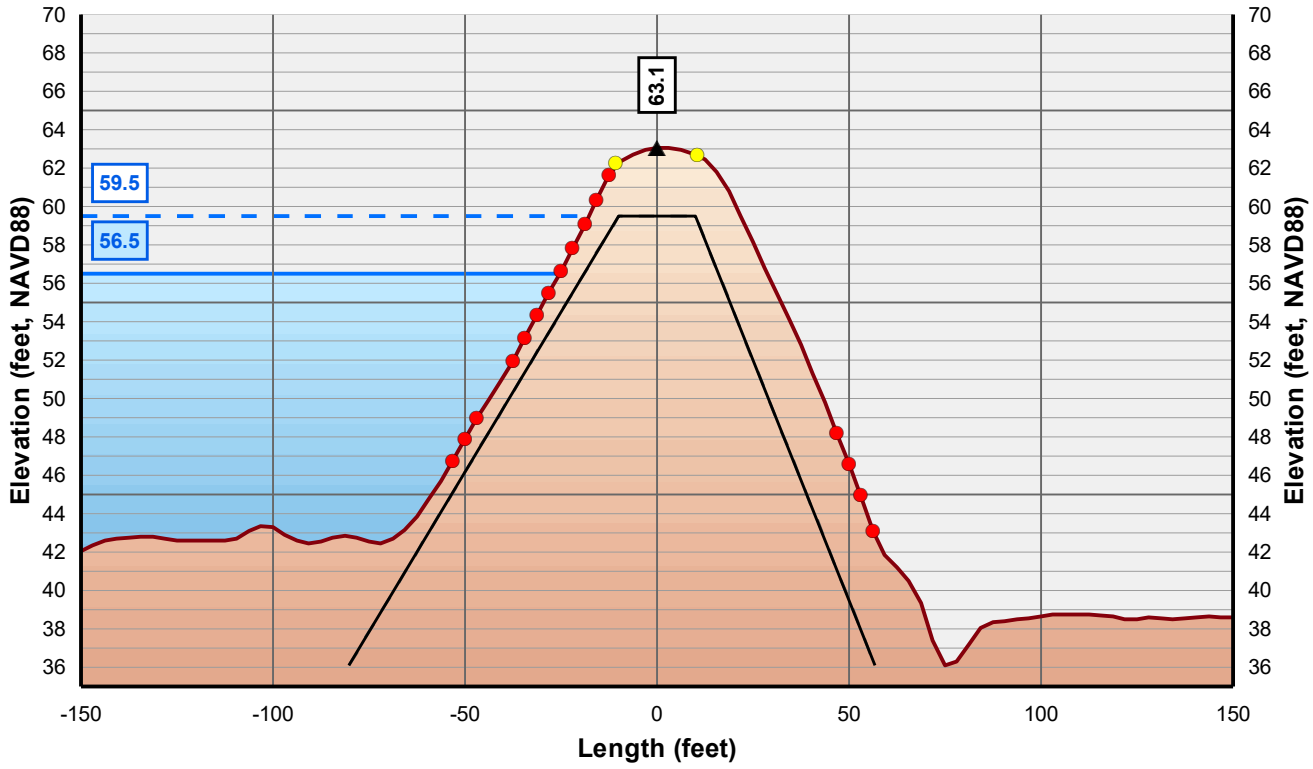
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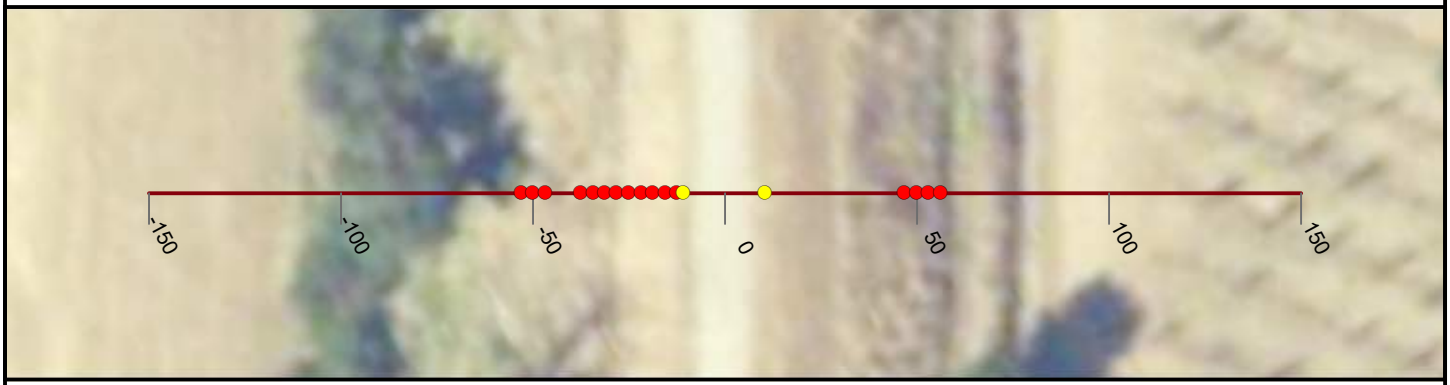
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Cross Section: Bear River 09+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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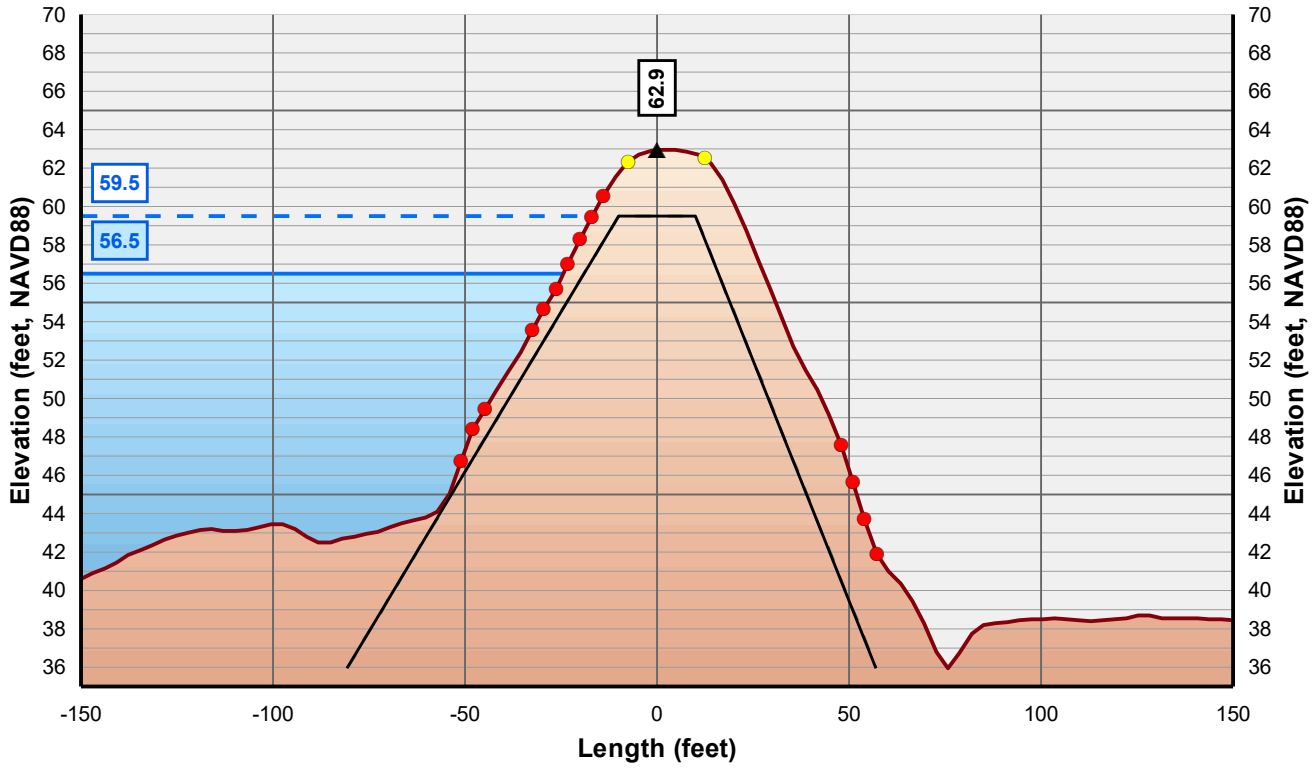
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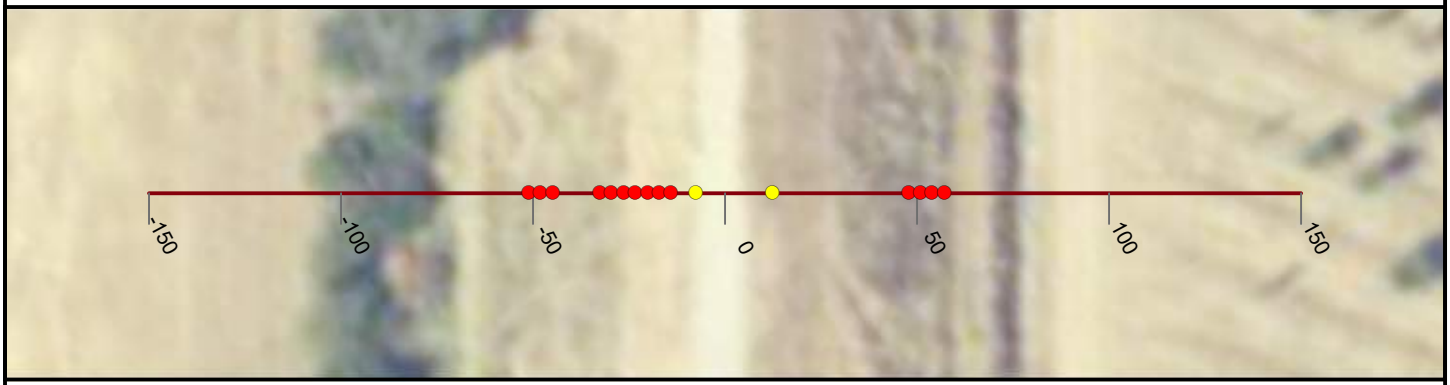
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Cross Section: Bear River 10+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

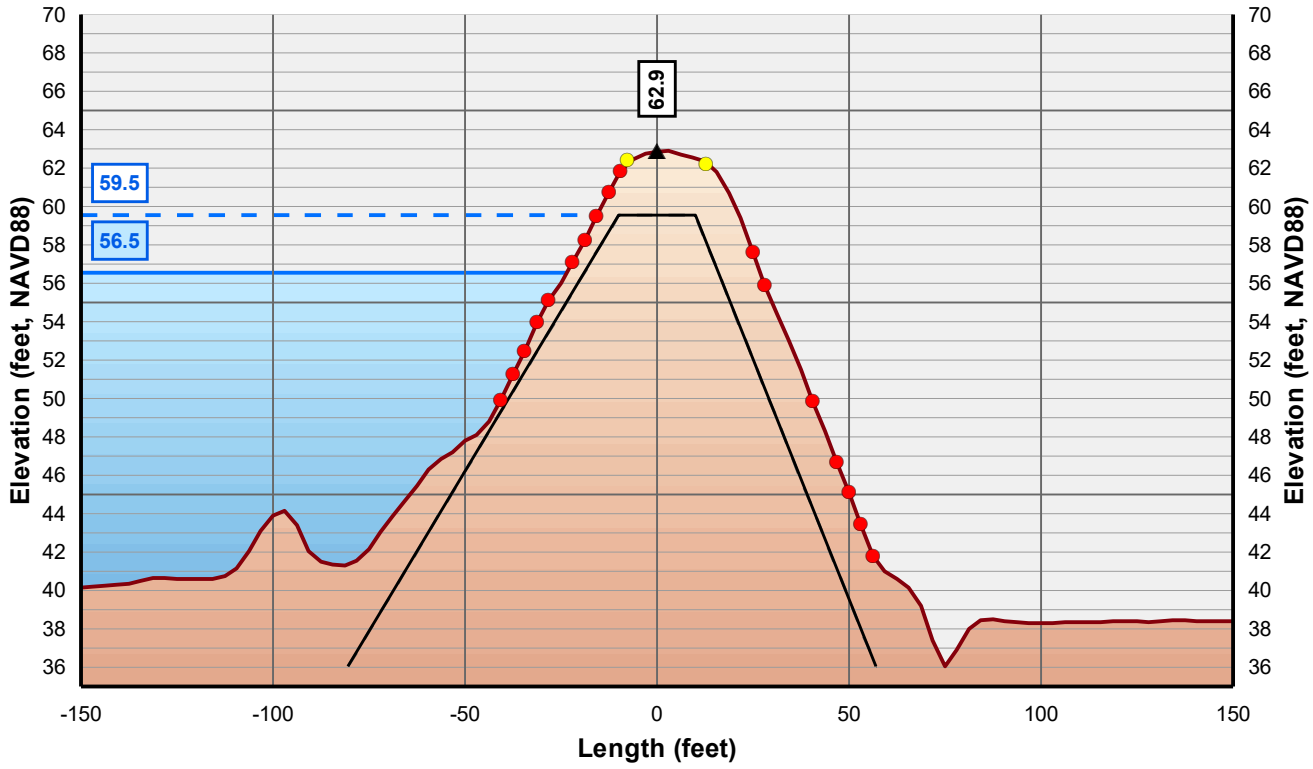
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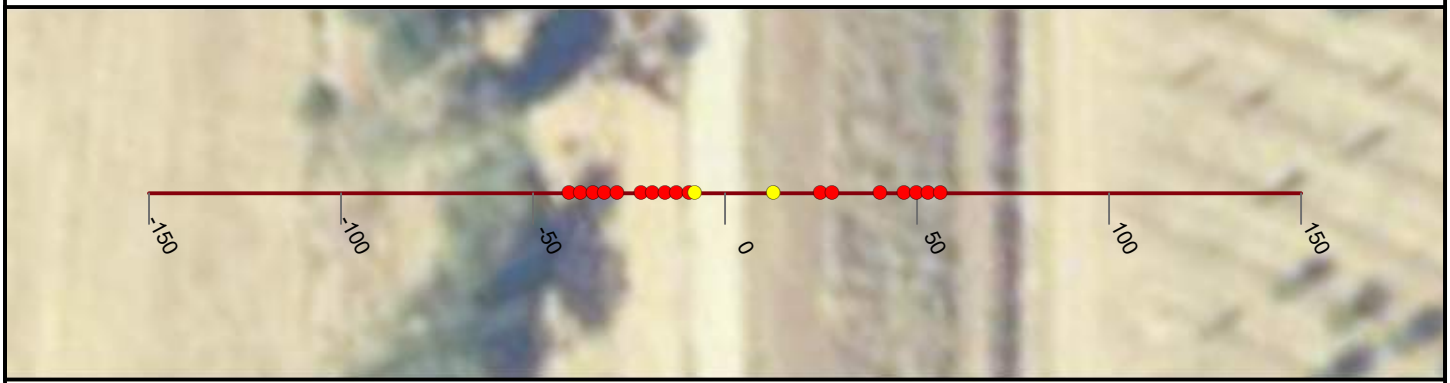
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Cross Section: Bear River 11+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

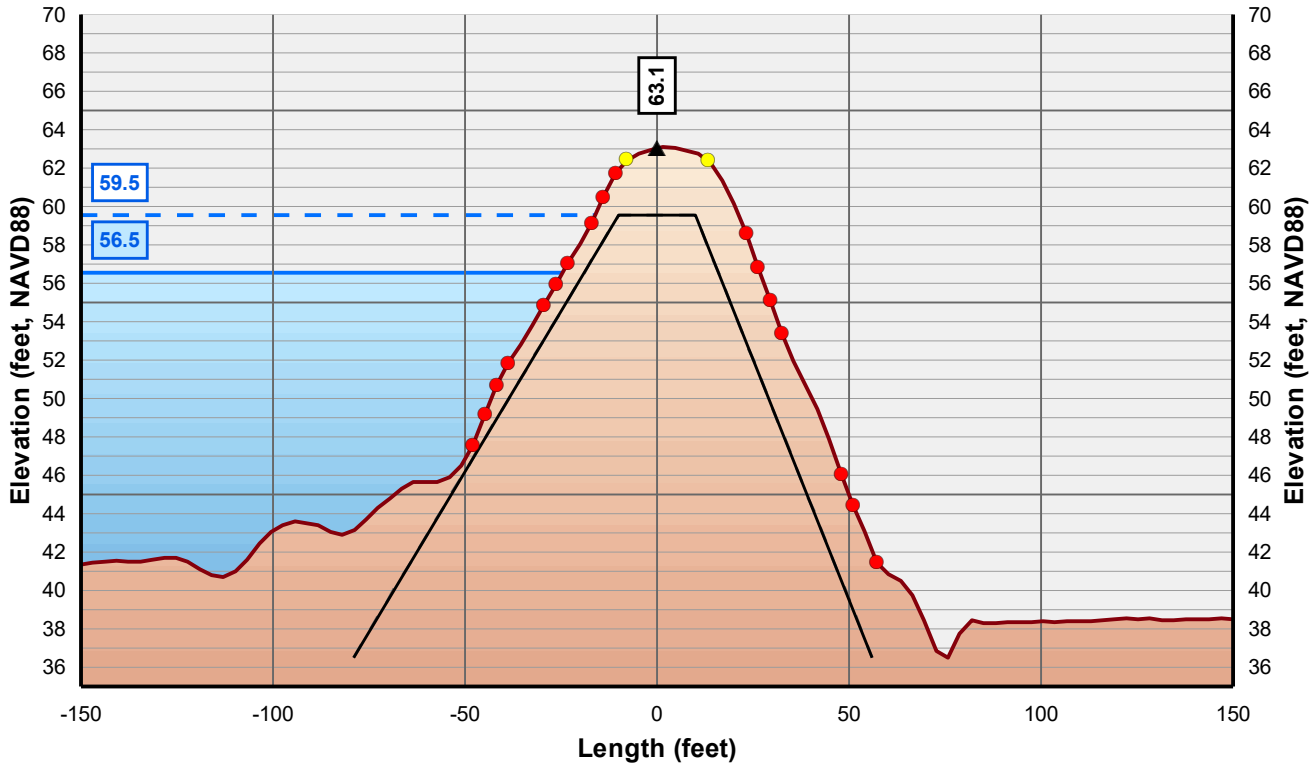
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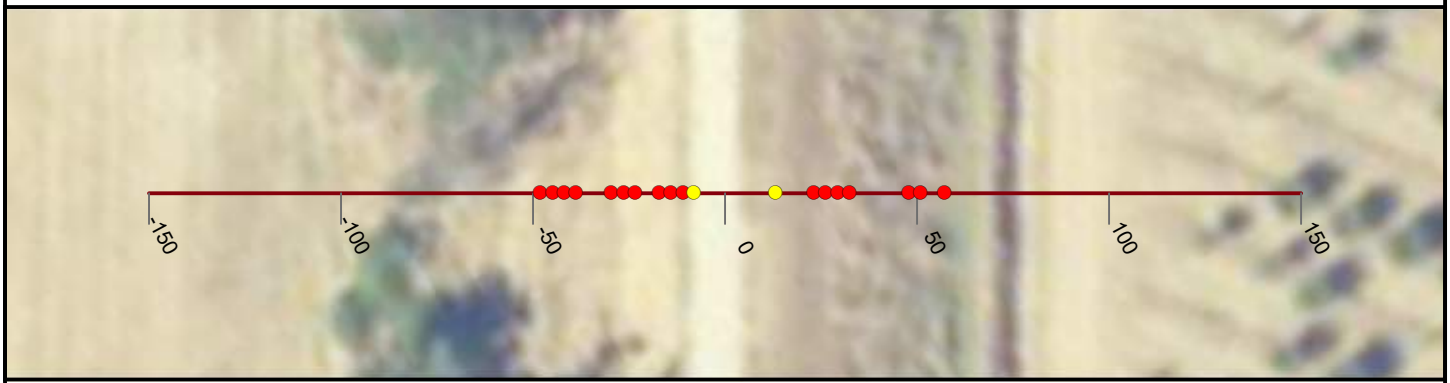
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Cross Section: Bear River 12+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

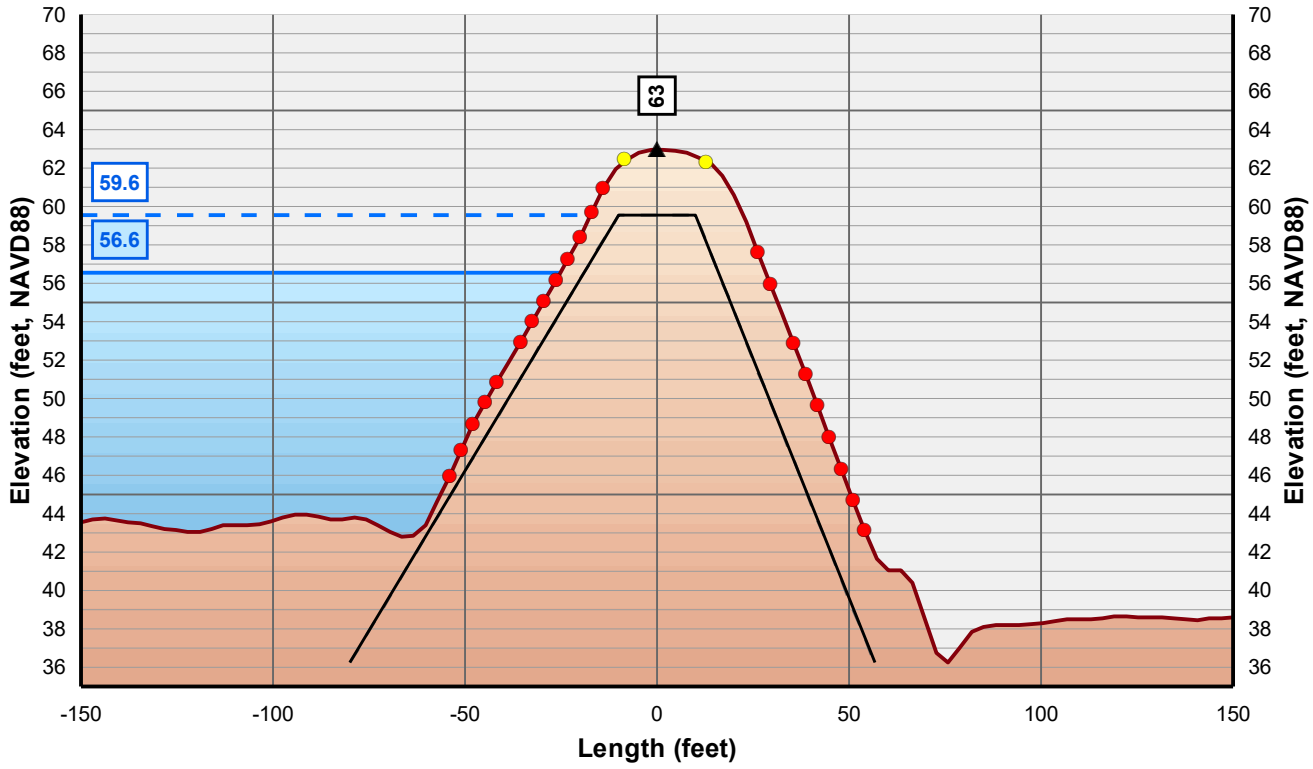
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Cross Section: Bear River 13+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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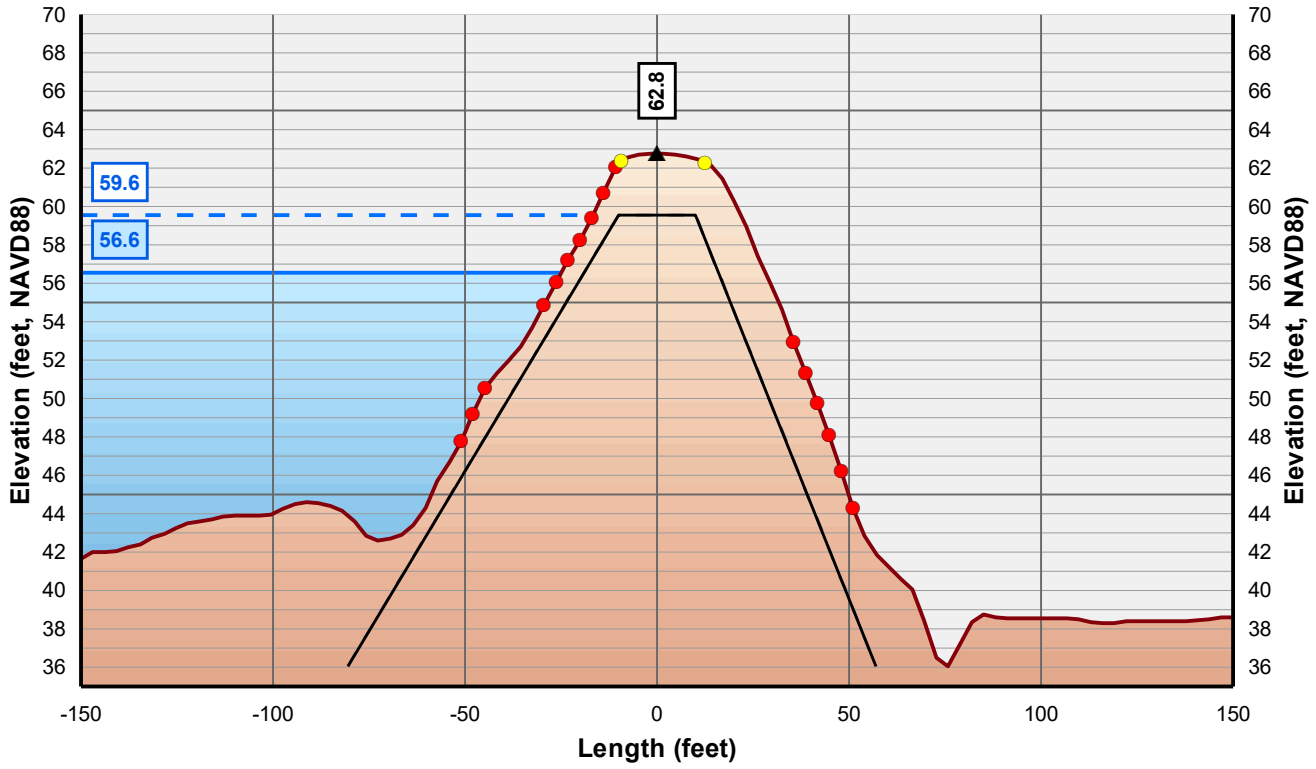
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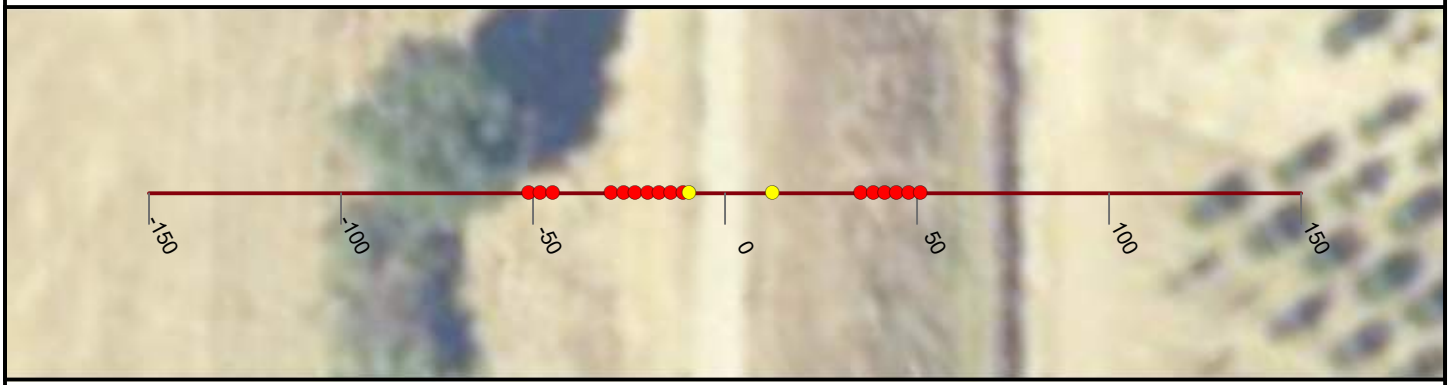
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Cross Section: Bear River 14+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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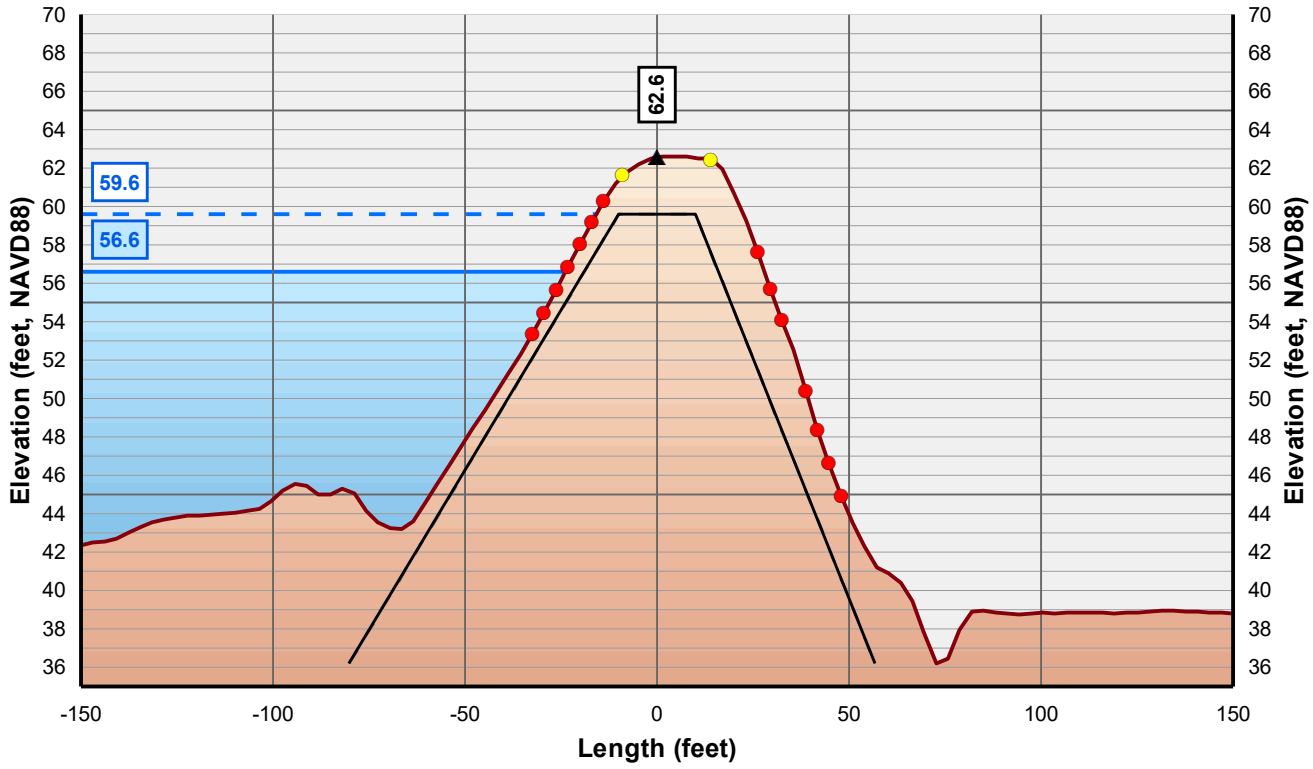
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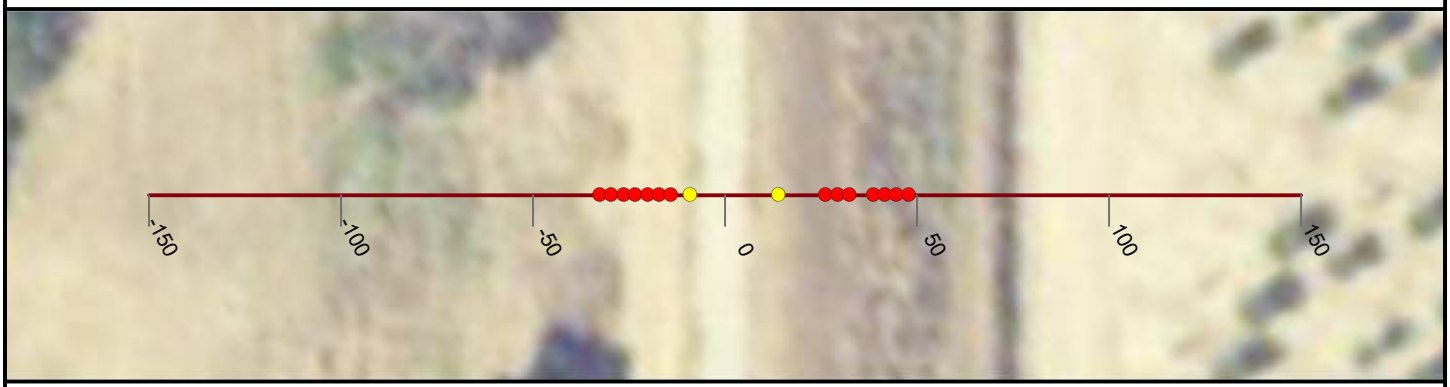
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Cross Section: Bear River 15+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

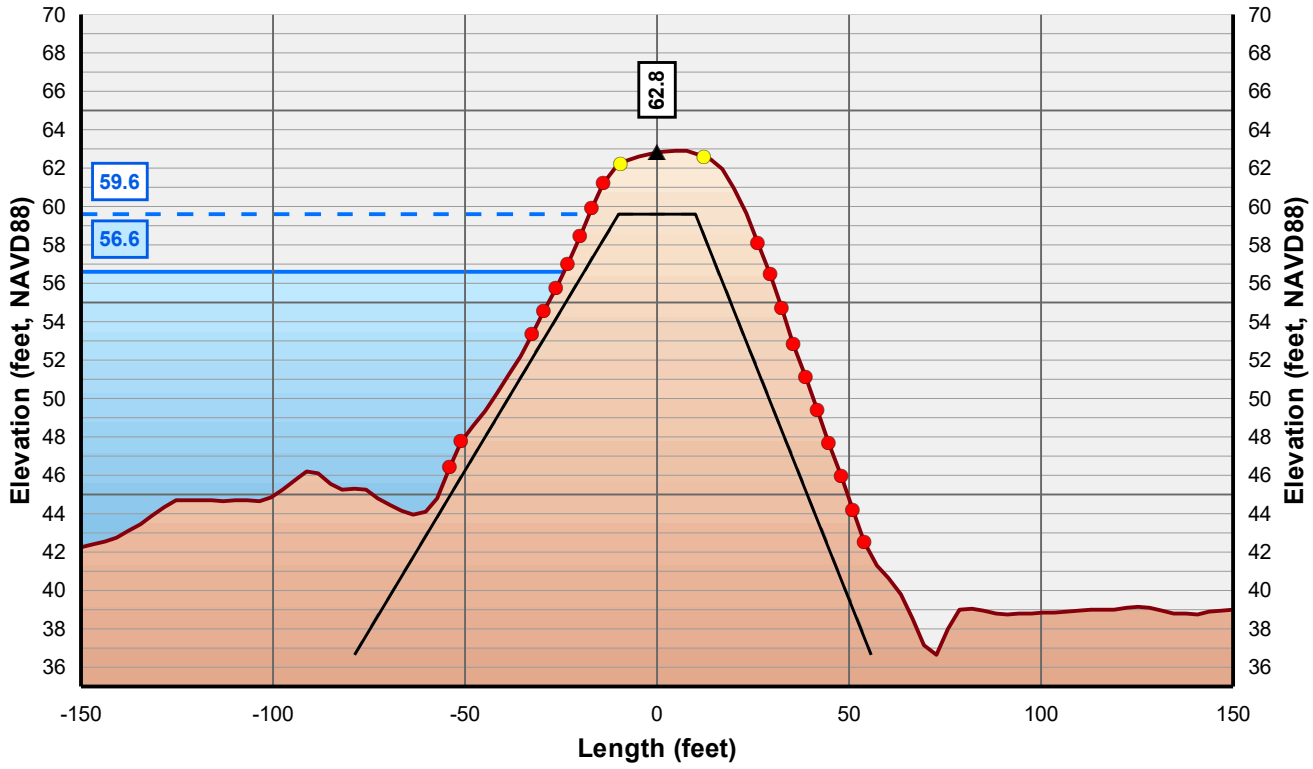
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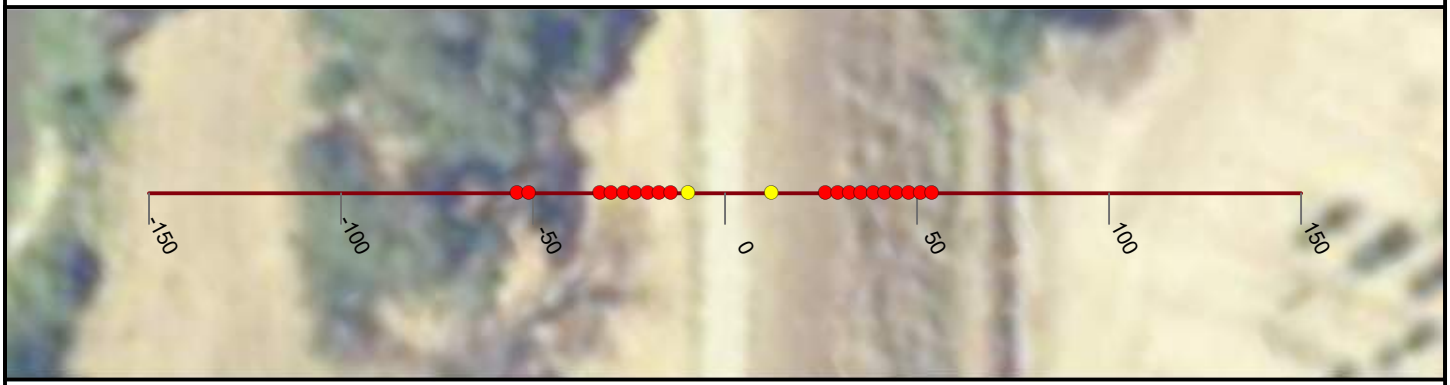
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Cross Section: Bear River 16+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

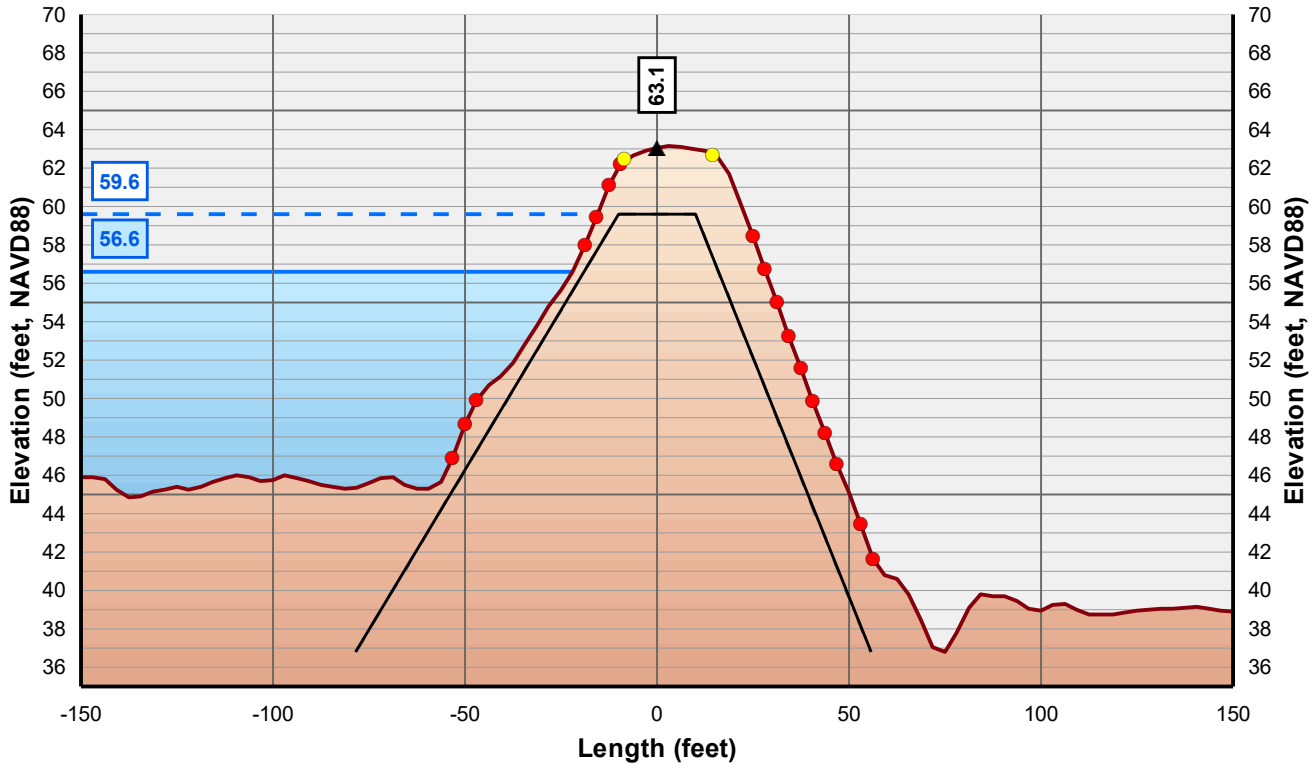
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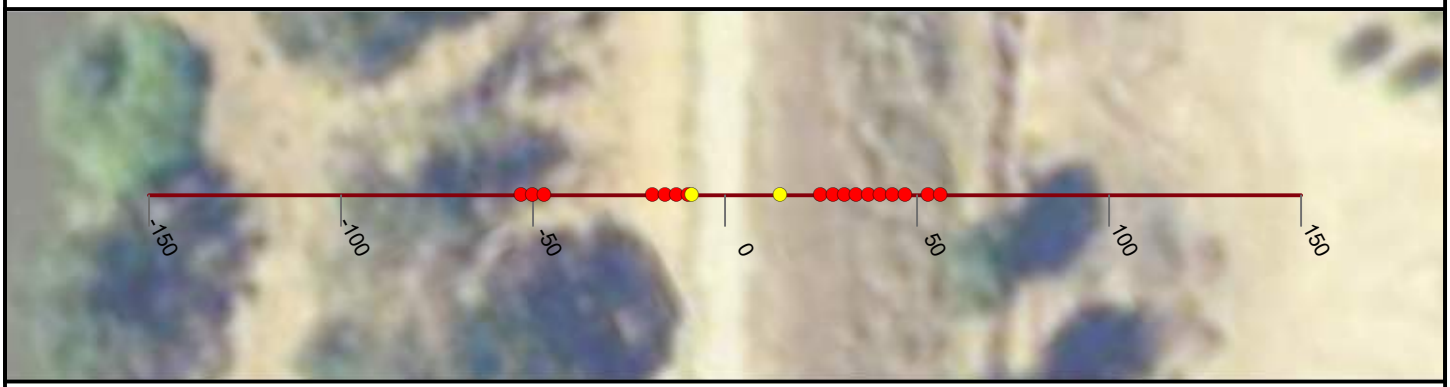
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Cross Section: Bear River 17+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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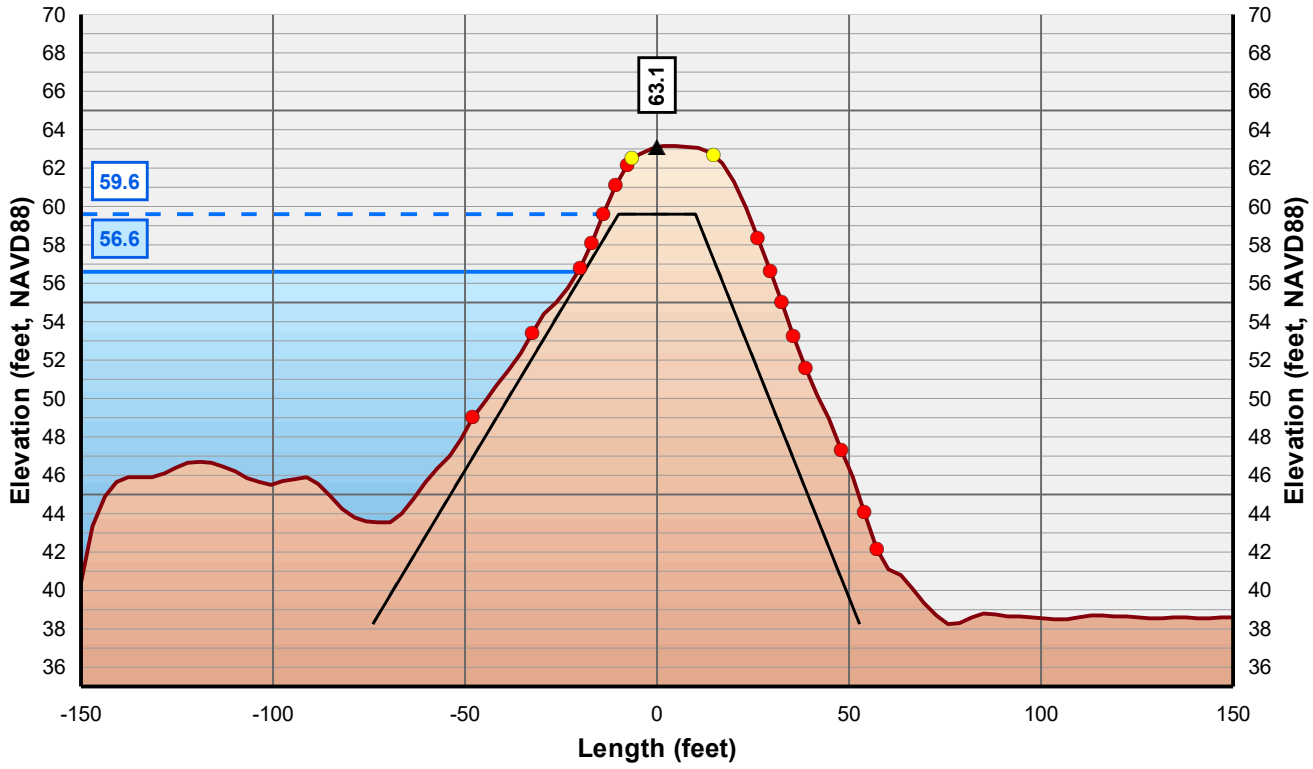
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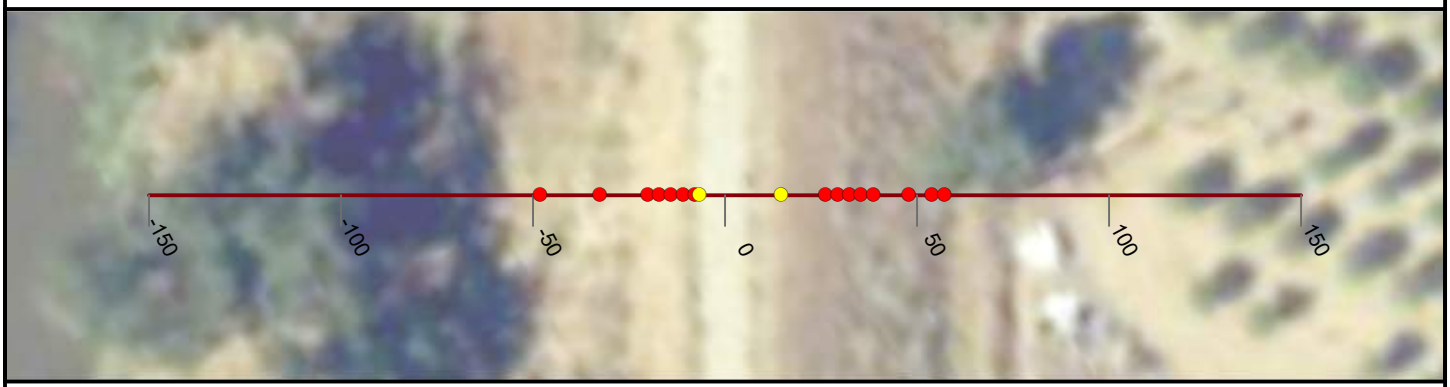
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Cross Section: Bear River 18+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

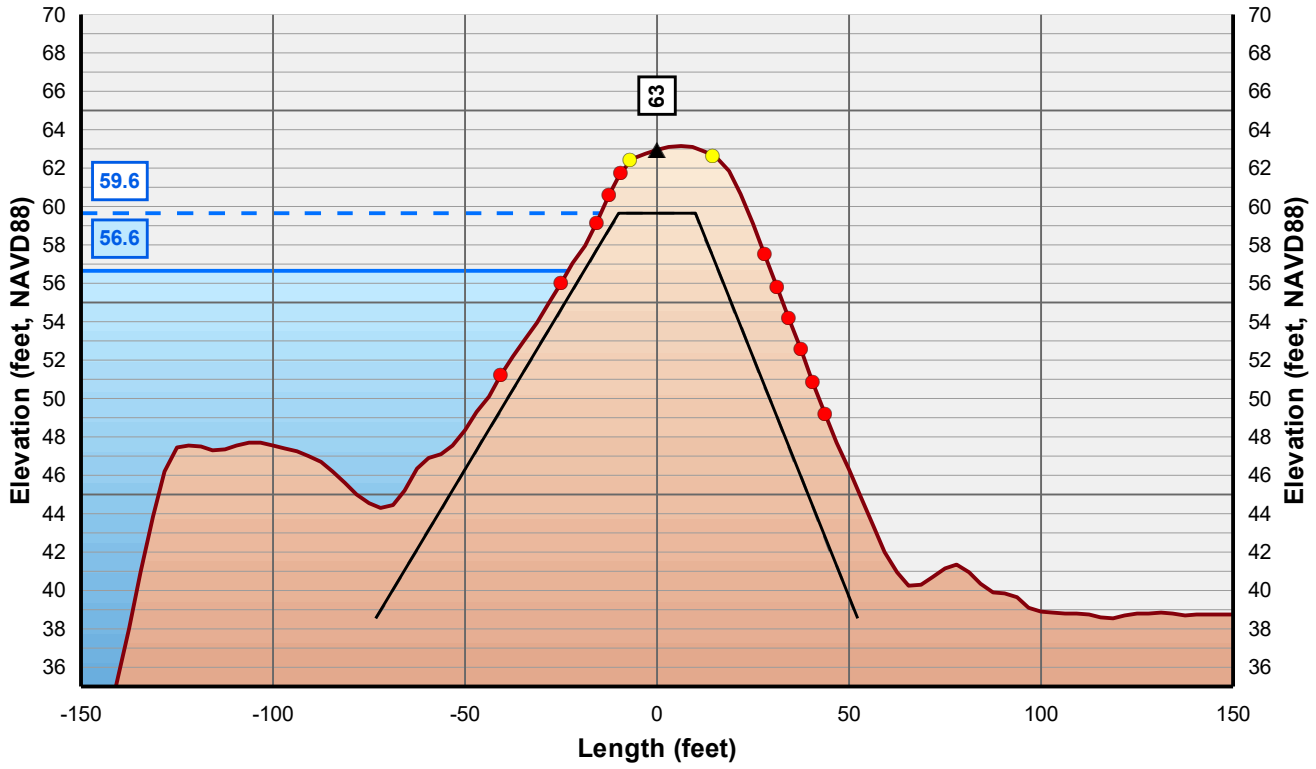
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Cross Section: Bear River 19+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

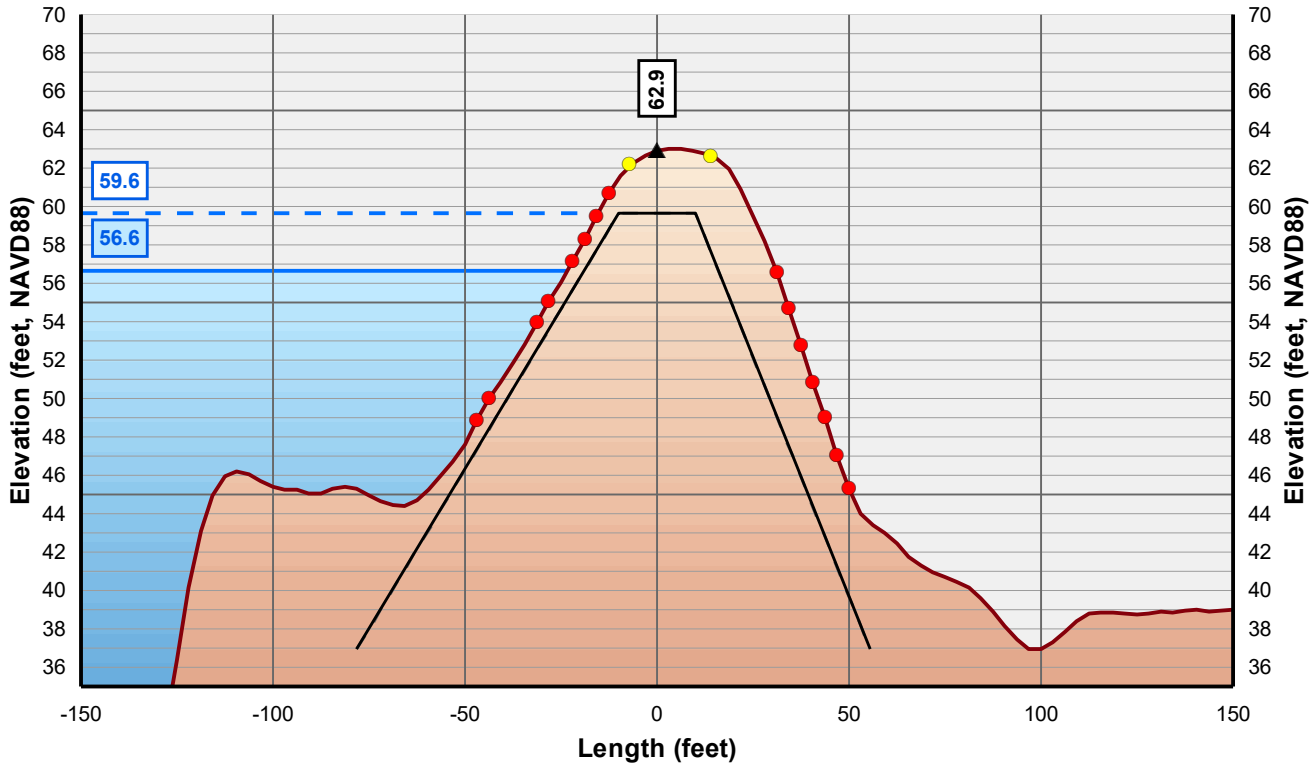
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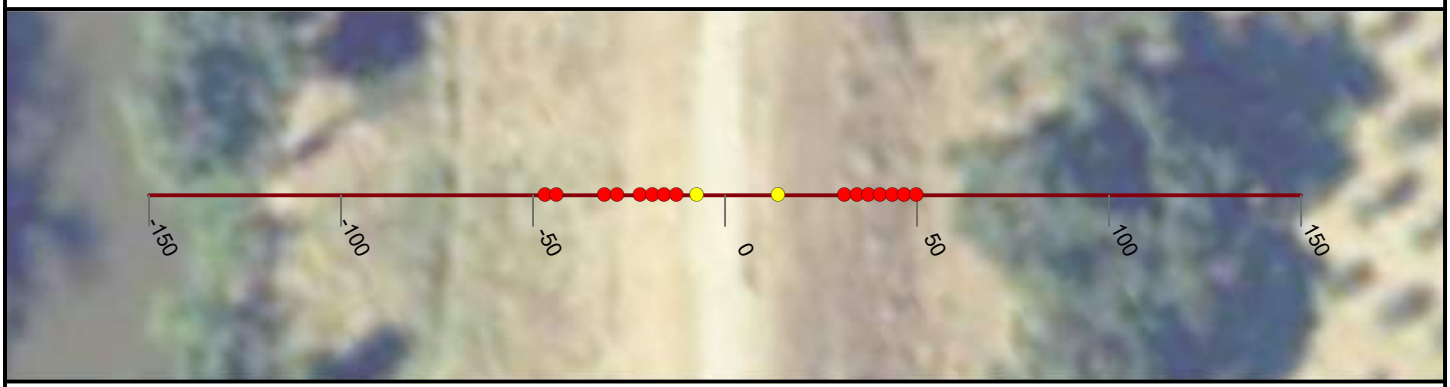
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Cross Section: Bear River 20+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

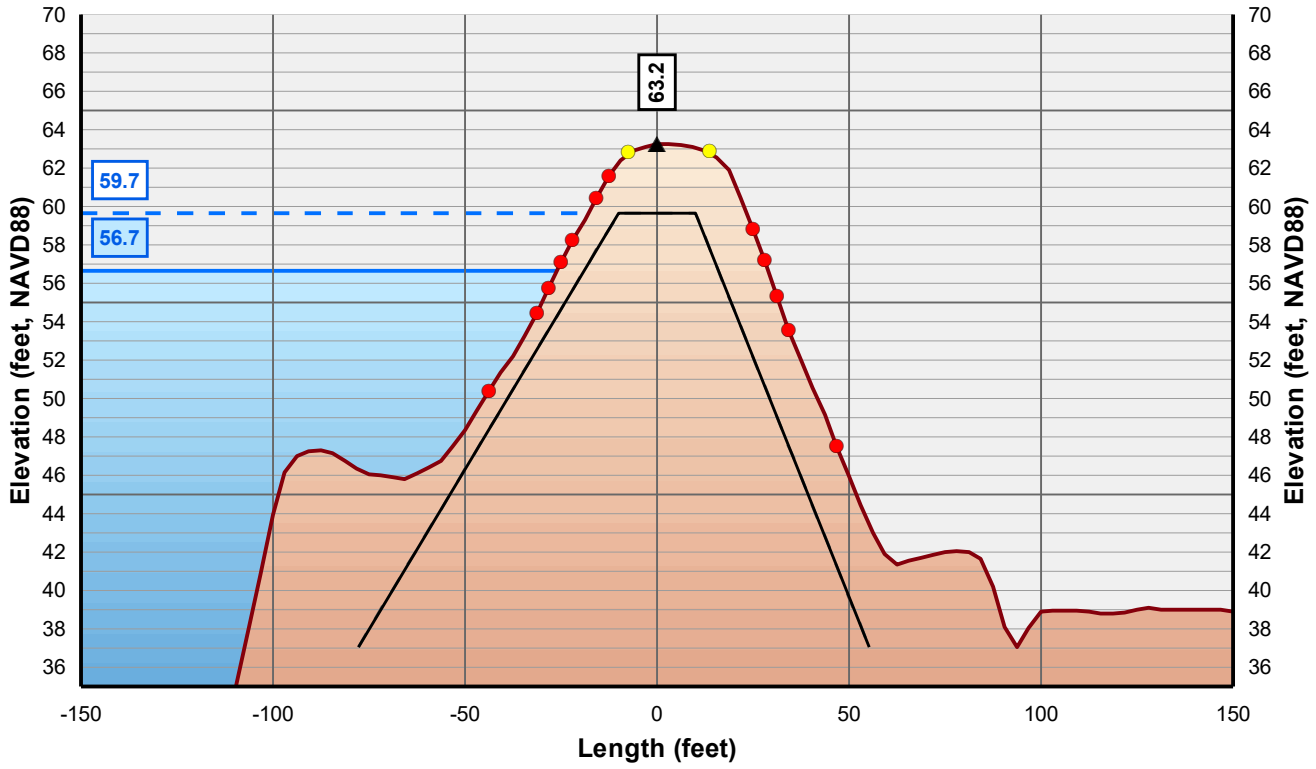
FEET

PRELIMINARY

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3301 C Street, Bldg 100-B
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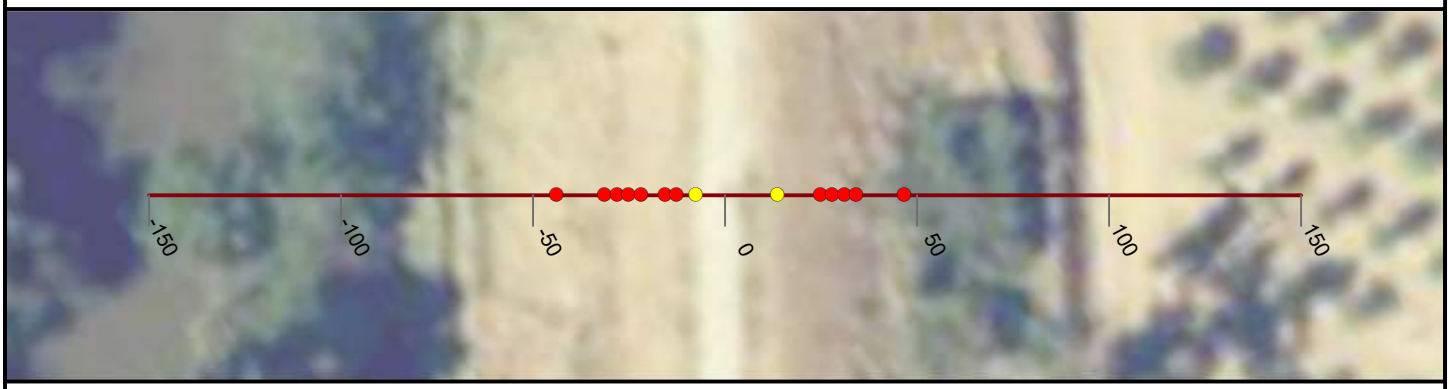
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Cross Section: Bear River 21+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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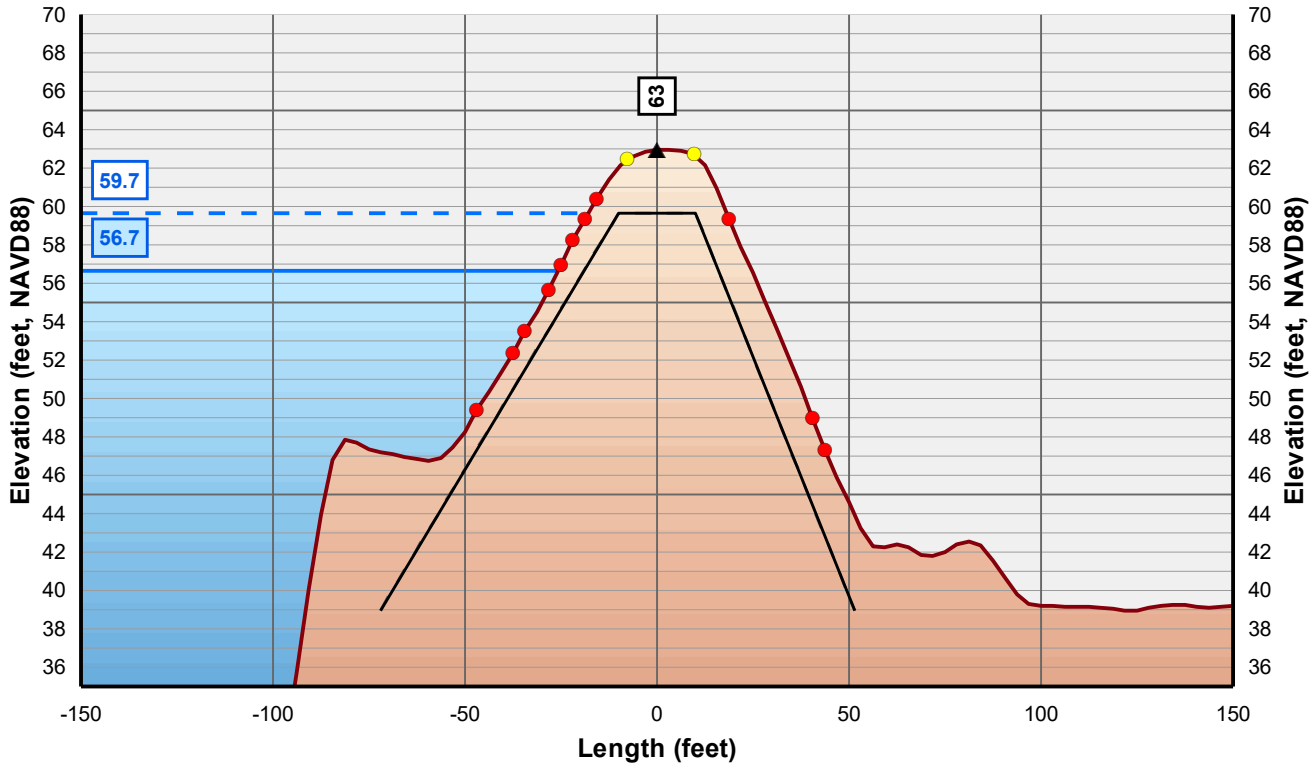
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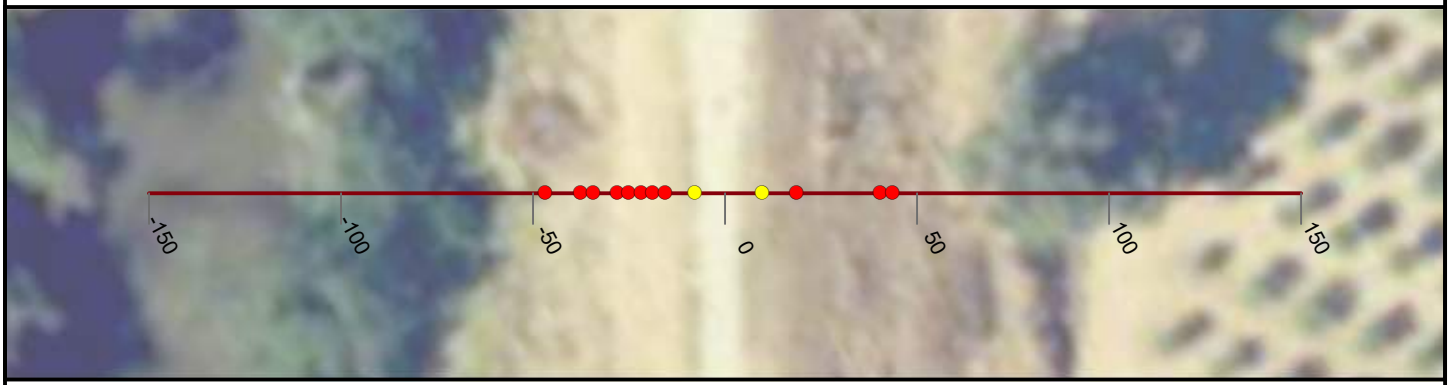
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Cross Section: Bear River 22+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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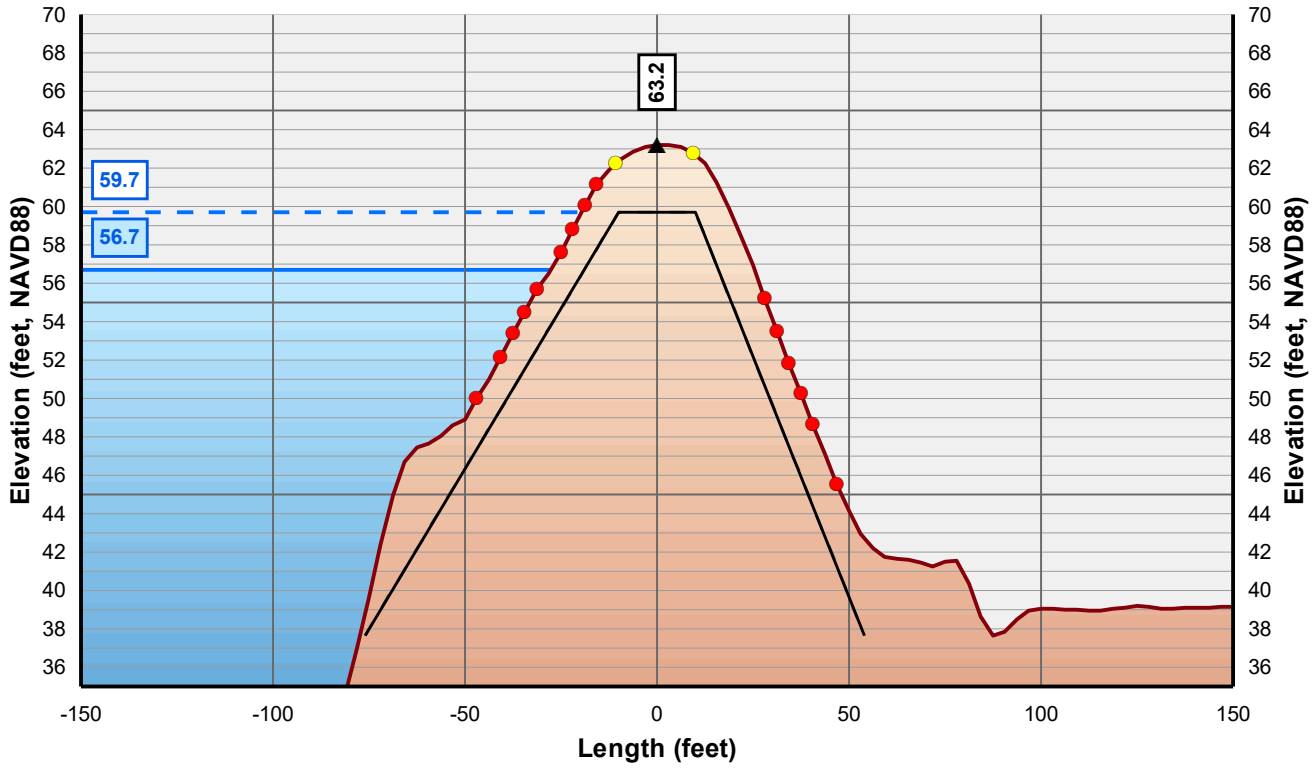
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Cross Section: Bear River 23+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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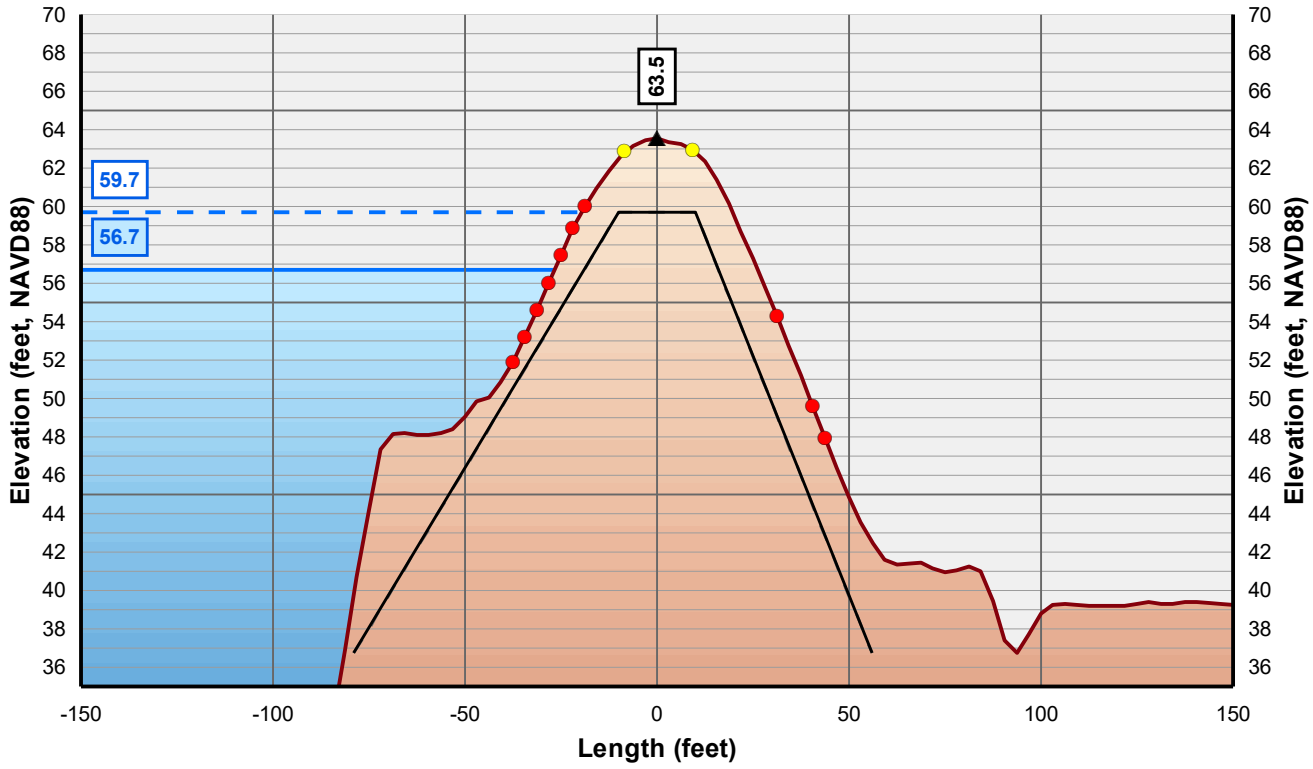
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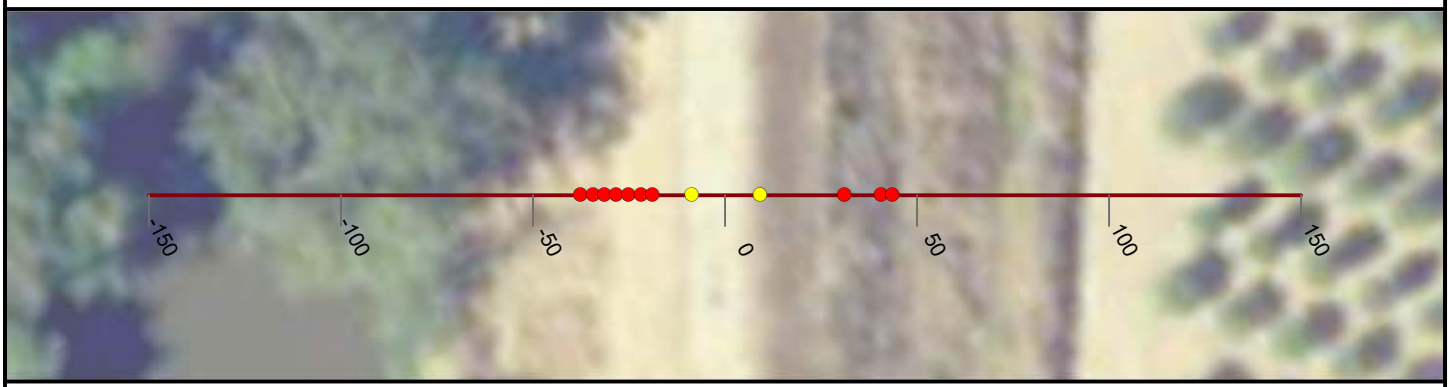
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Cross Section: Bear River 24+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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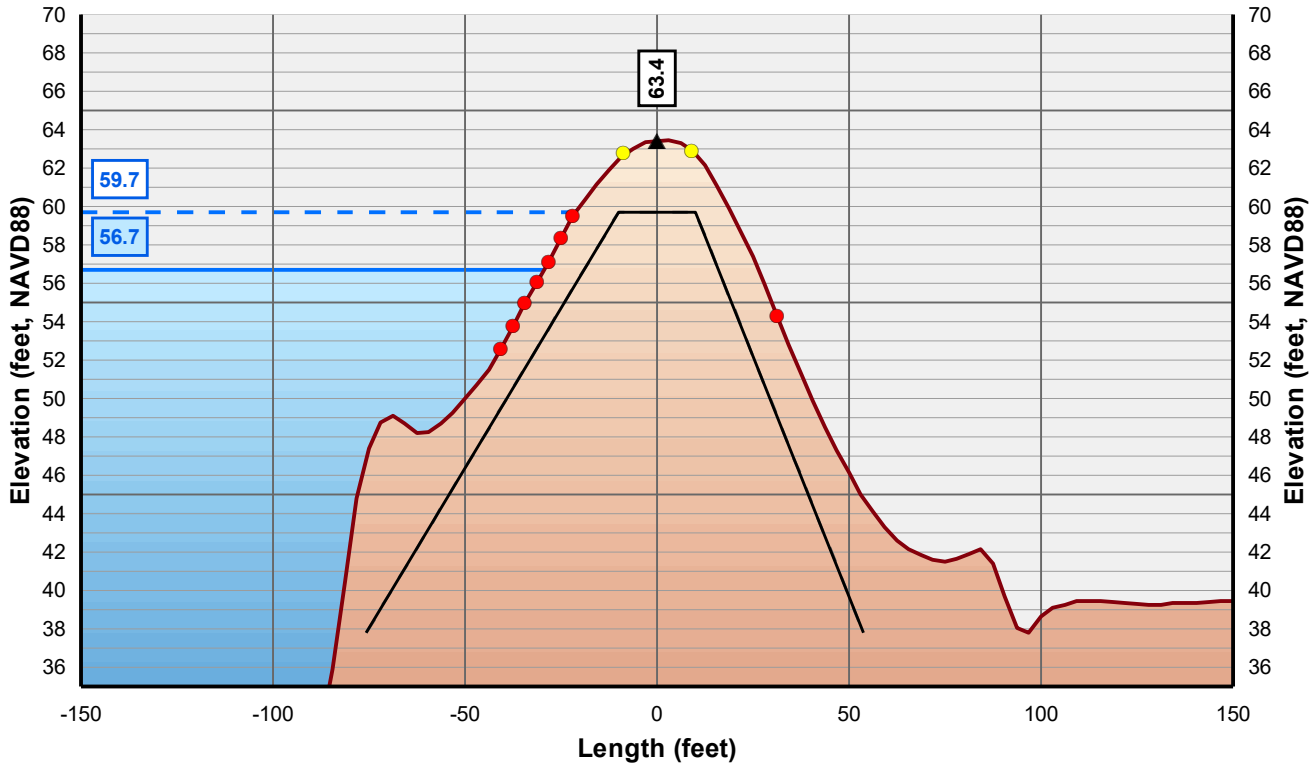
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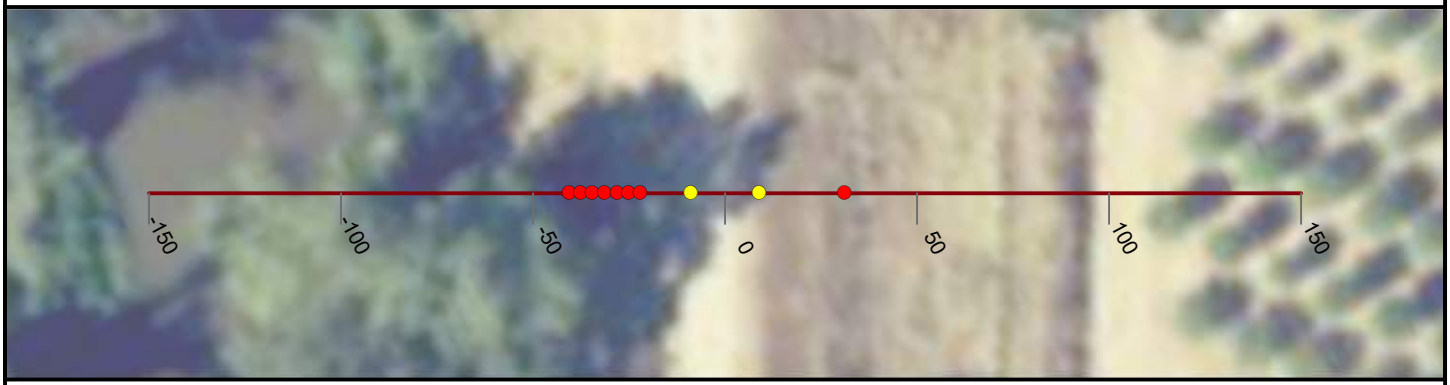
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Cross Section: Bear River 25+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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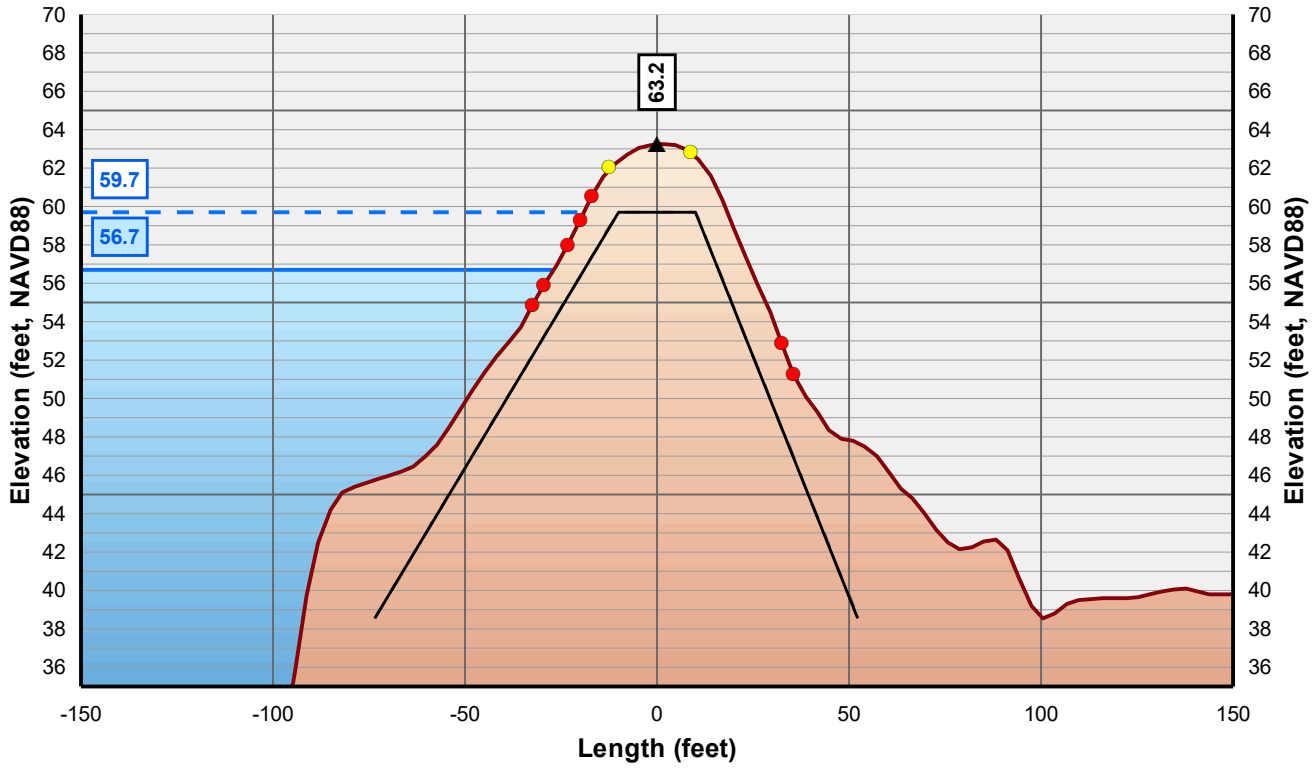
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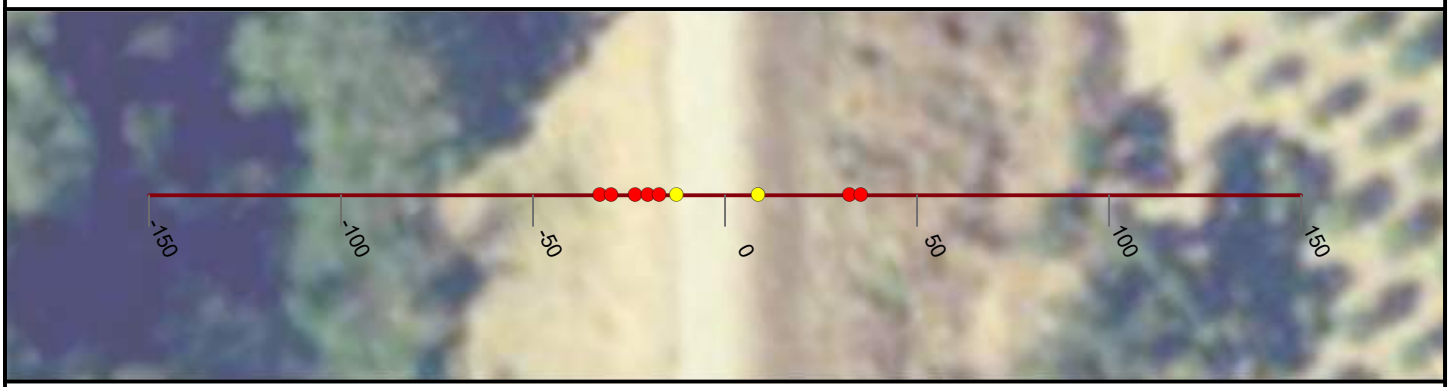
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Cross Section: Bear River 26+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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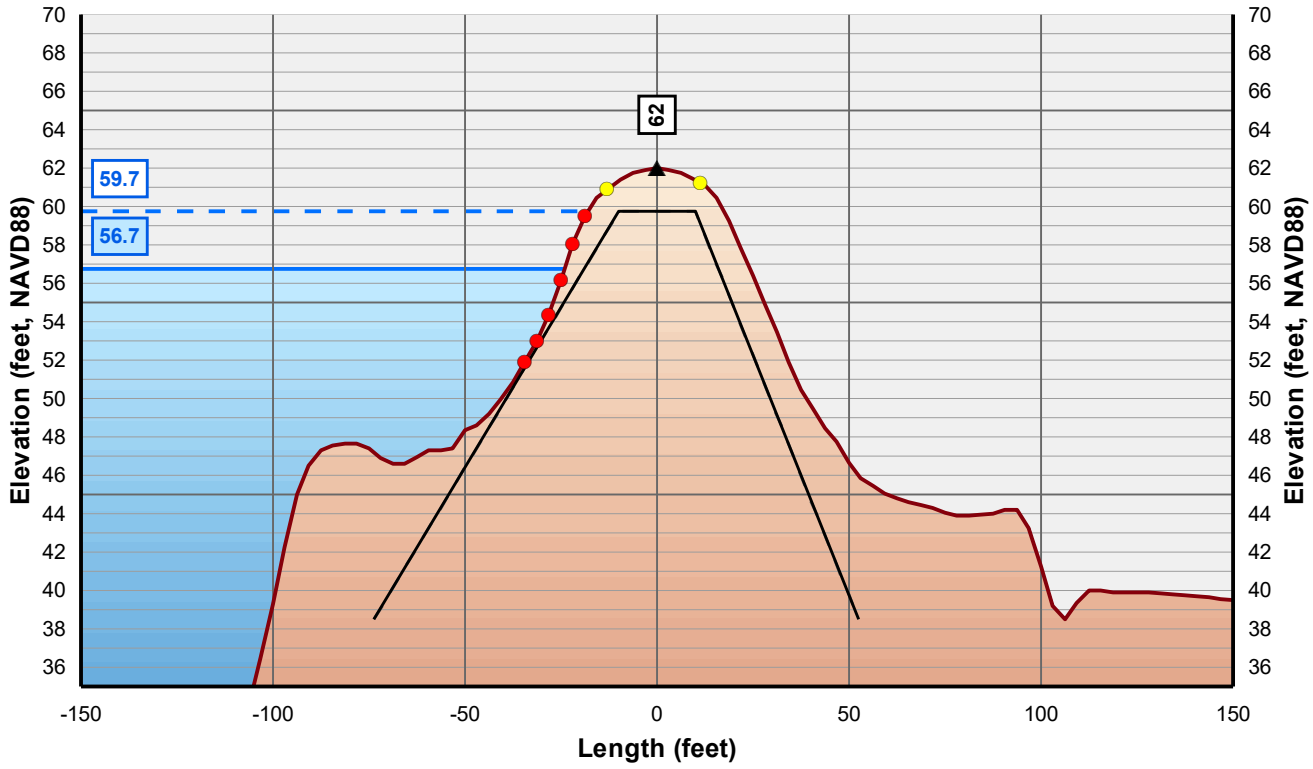
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Cross Section: Bear River 27+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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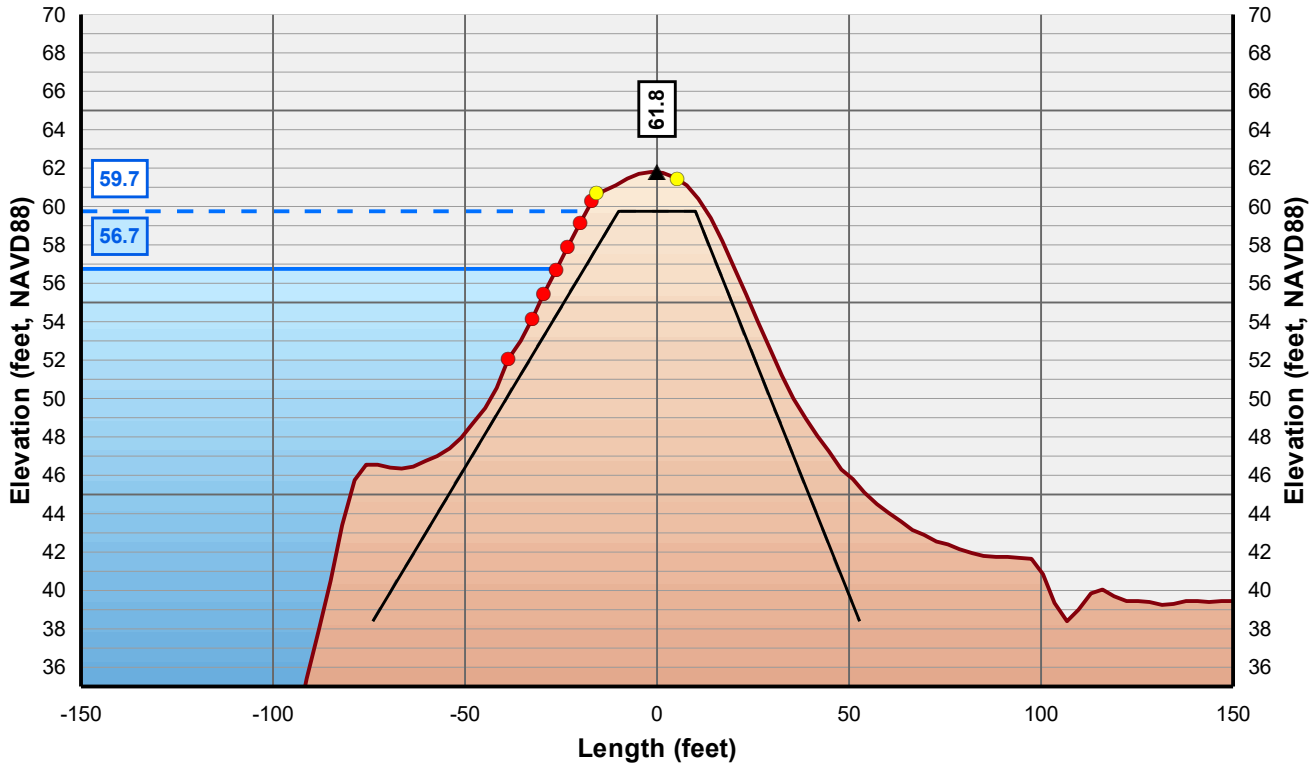
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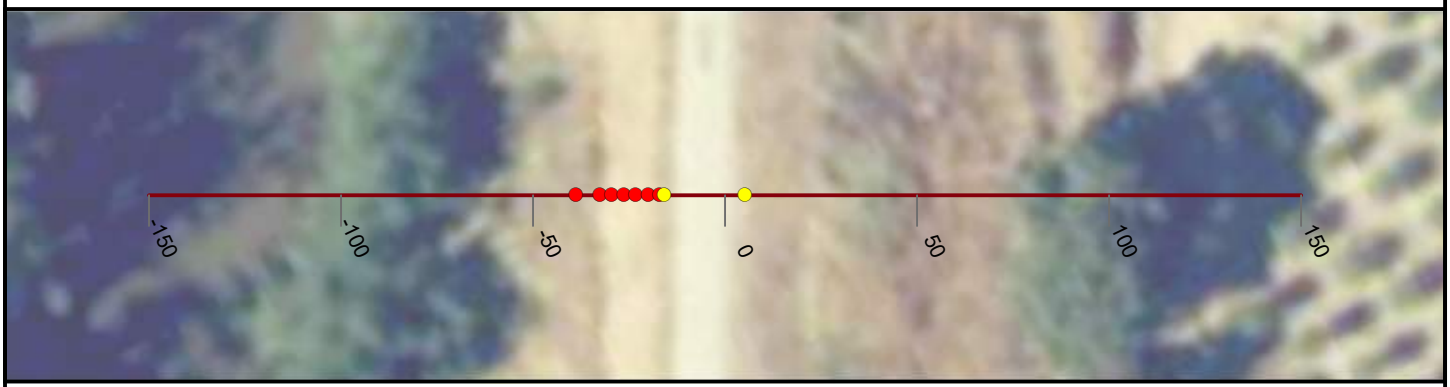
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Cross Section: Bear River 28+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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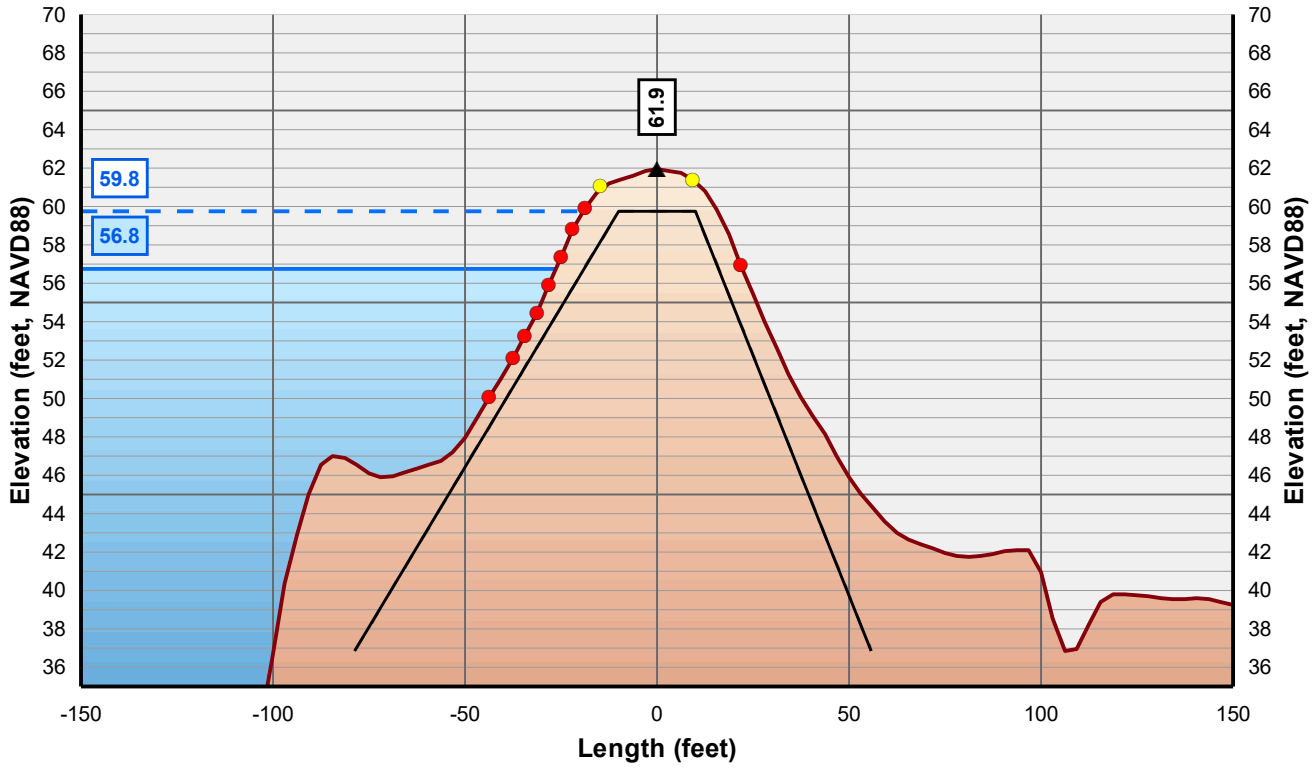
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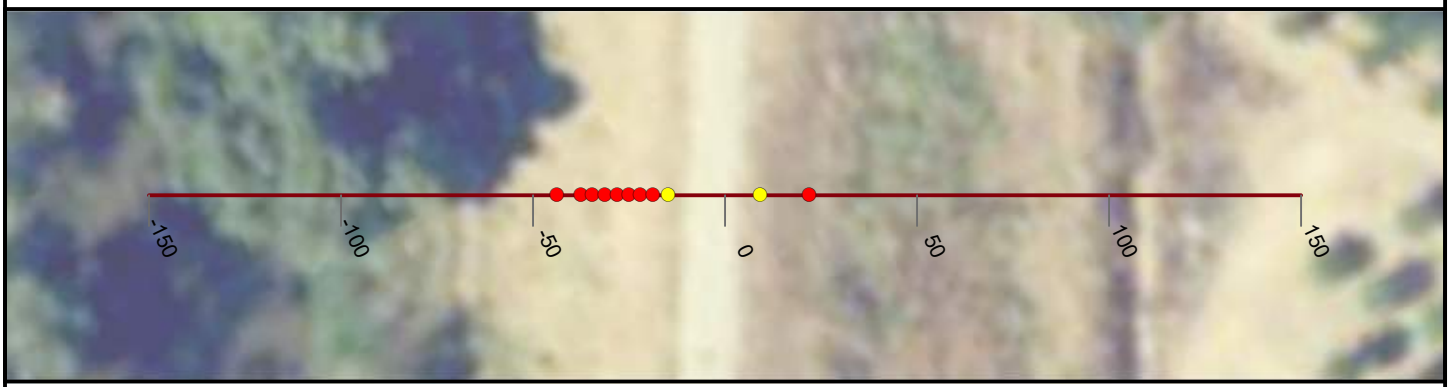
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Cross Section: Bear River 29+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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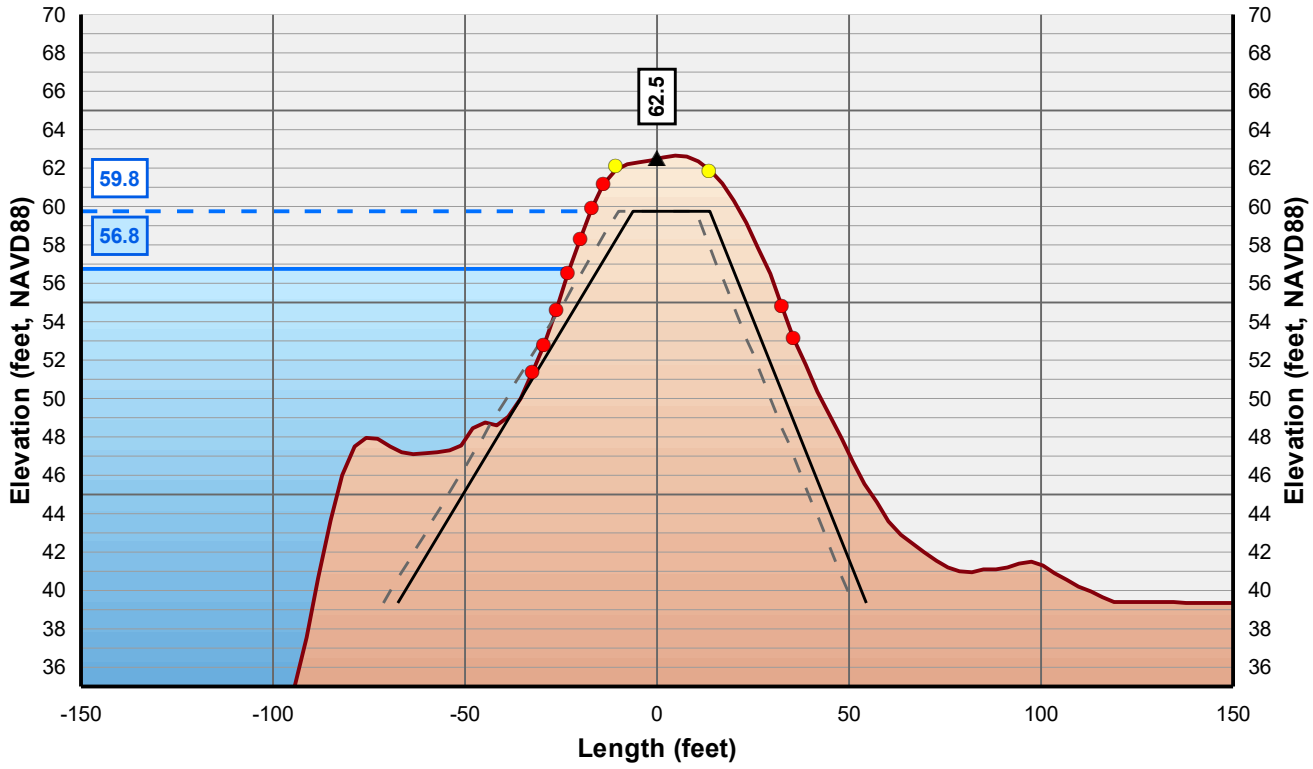
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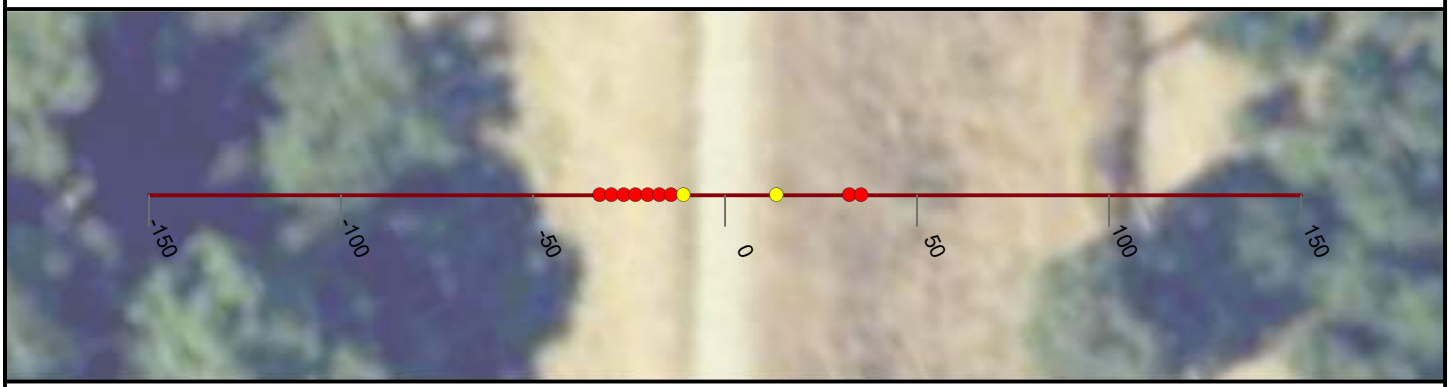
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Cross Section: Bear River 30+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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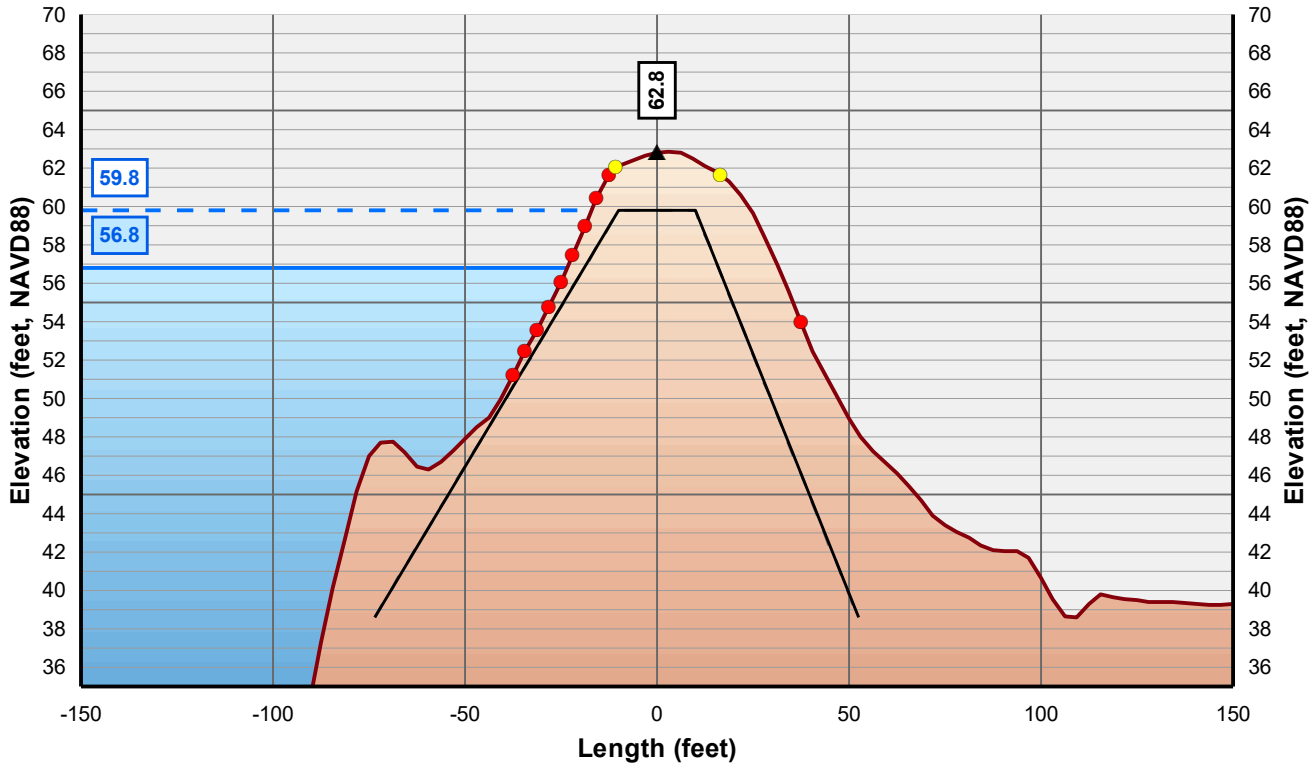
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Cross Section: Bear River 31+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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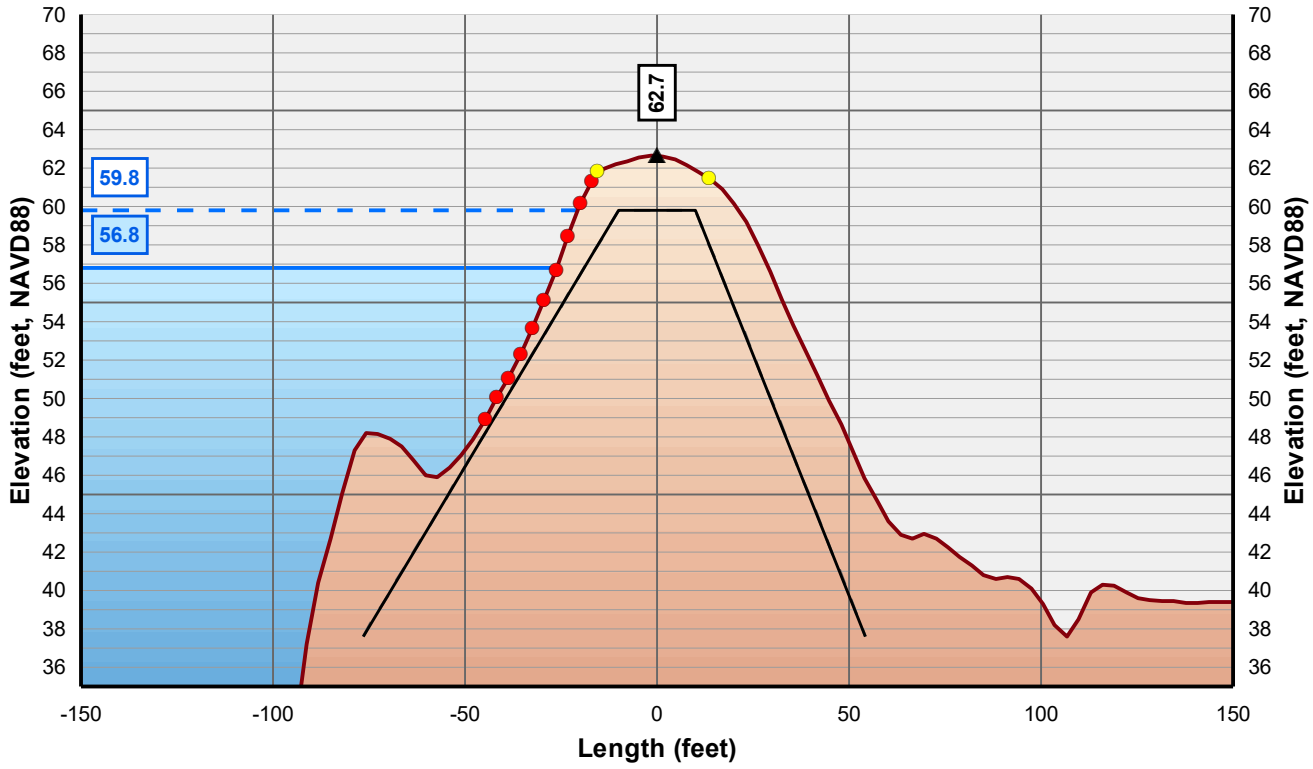
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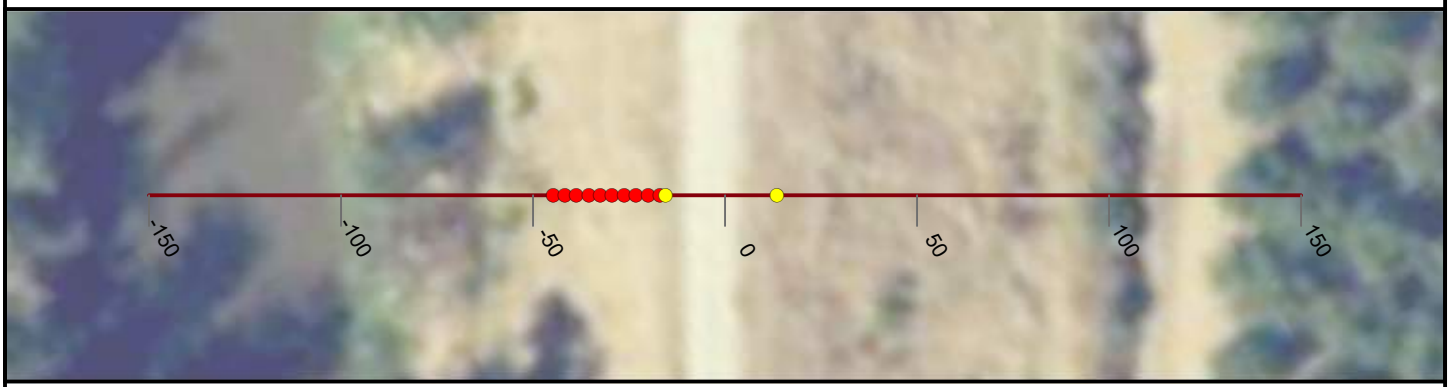
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Cross Section: Bear River 32+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

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AUGUST, 2019

NORTH

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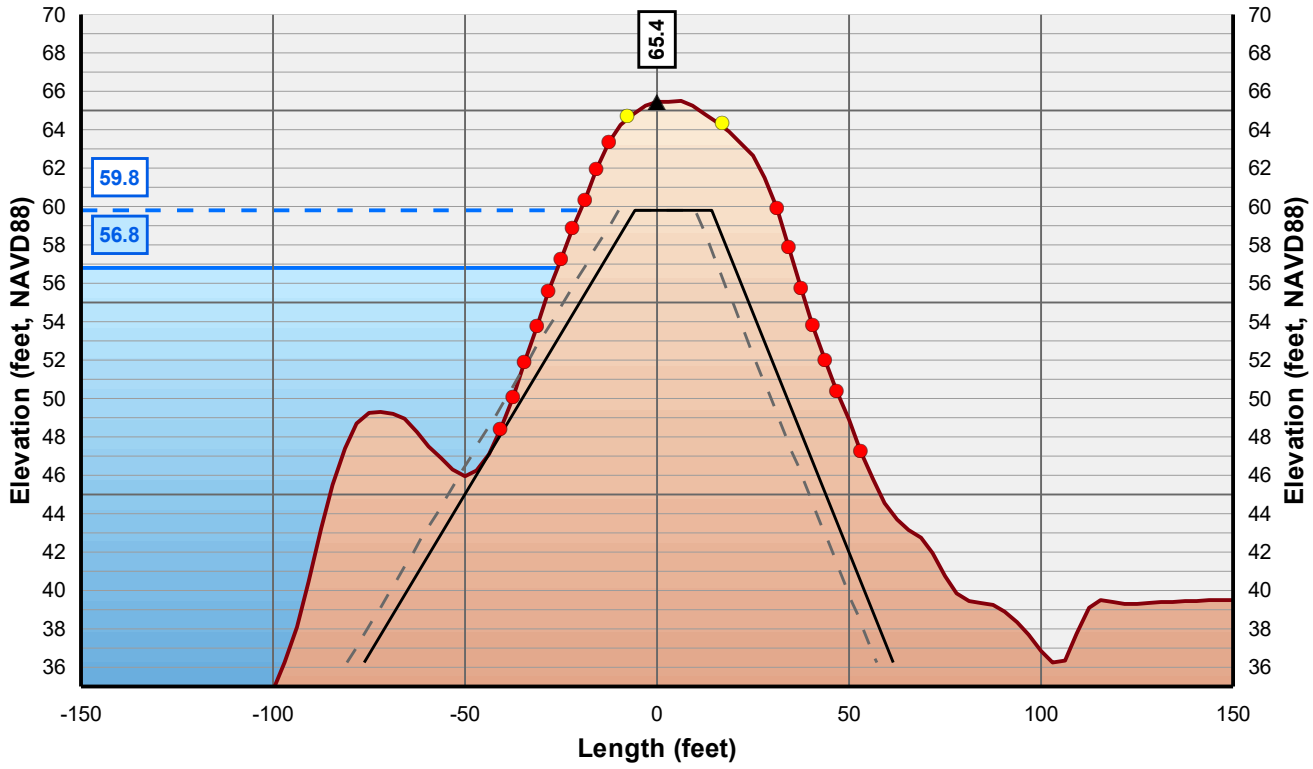
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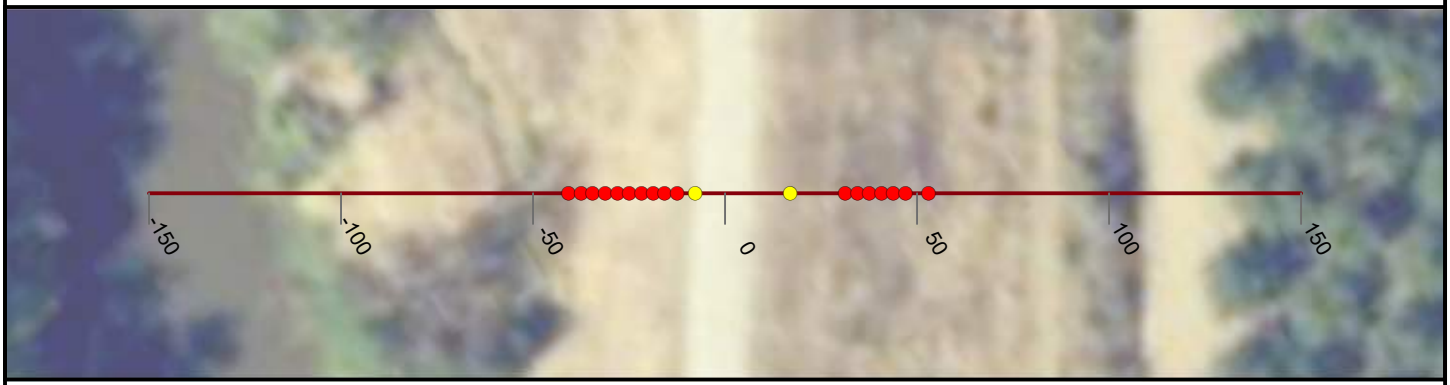
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Cross Section: Bear River 33+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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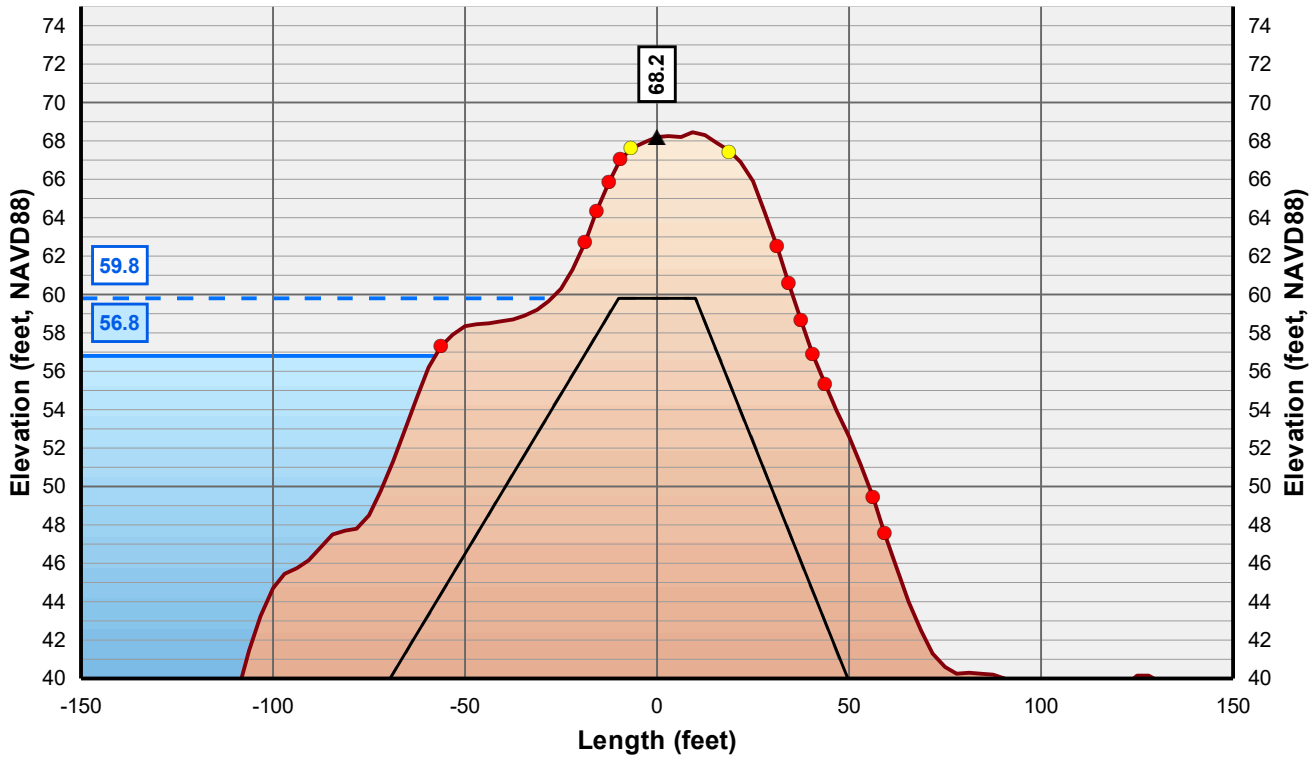
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Cross Section: Bear River 34+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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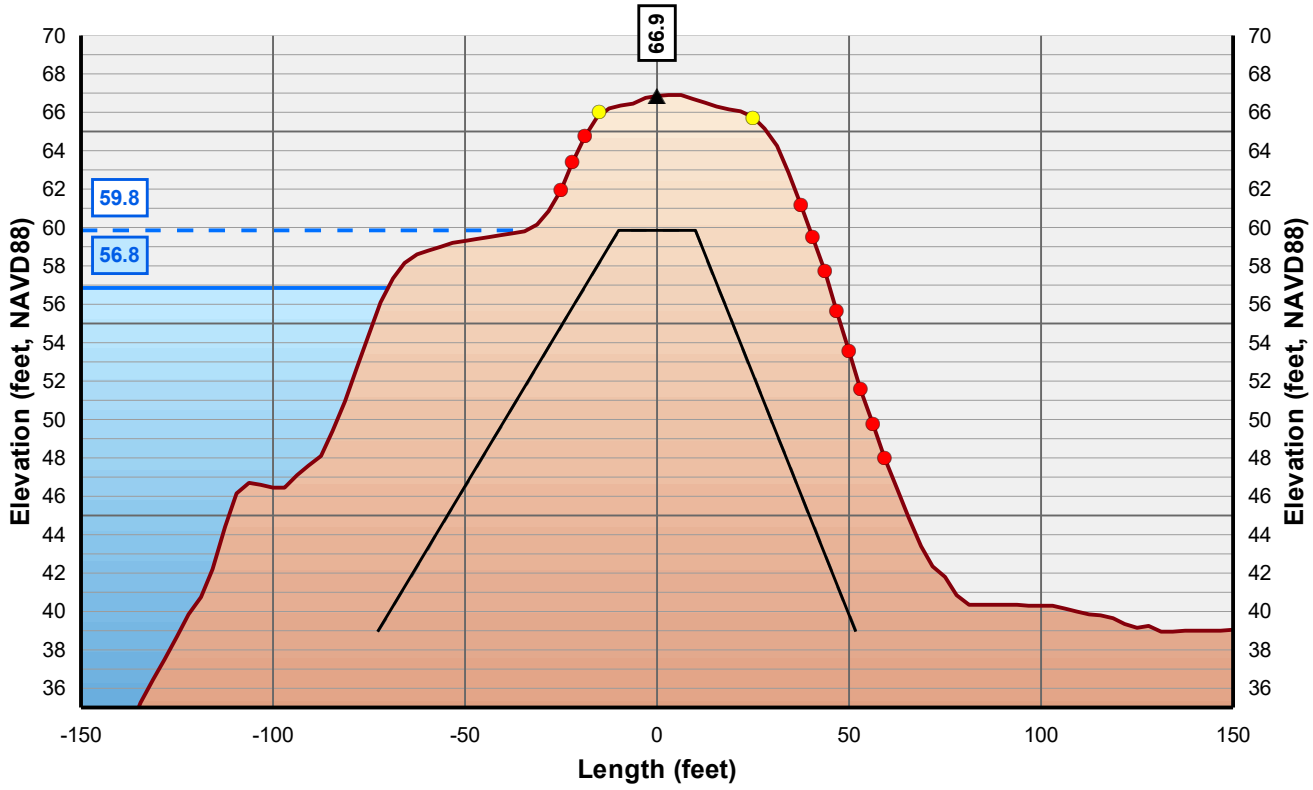
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Cross Section: Bear River 35+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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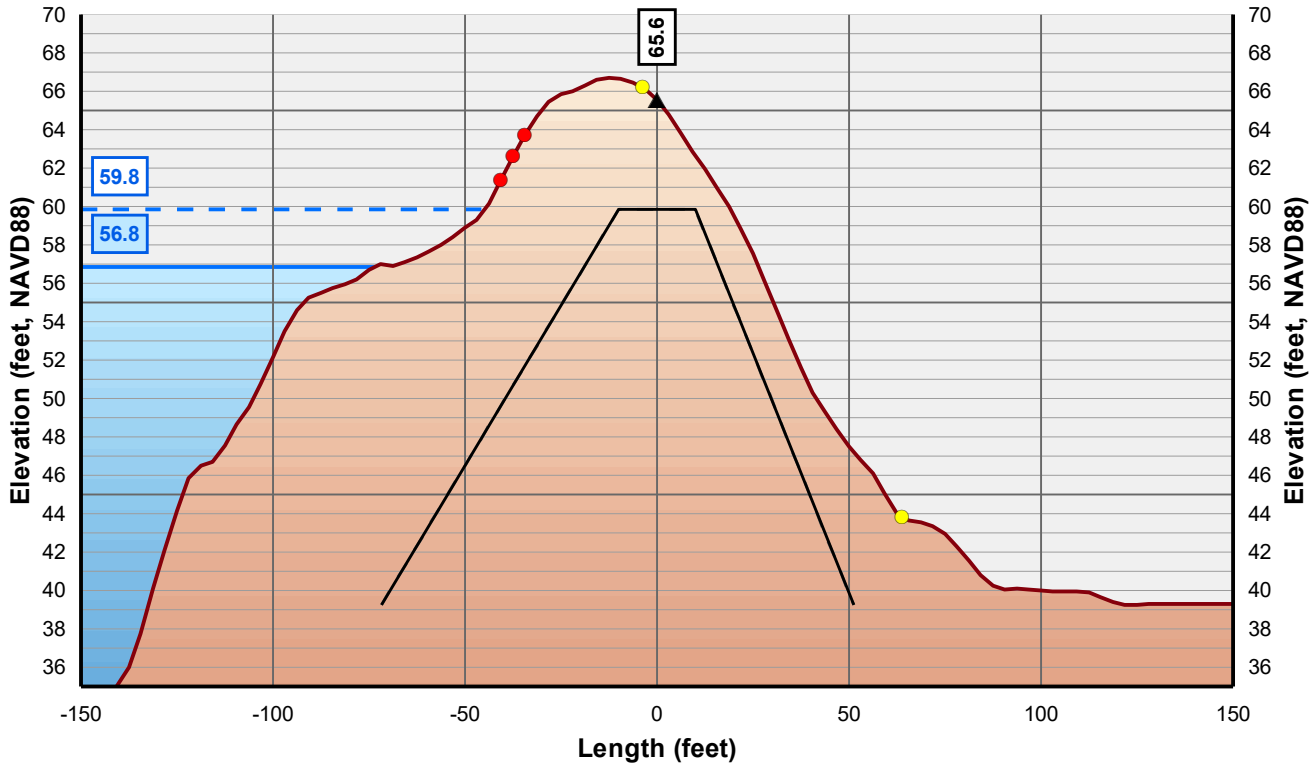
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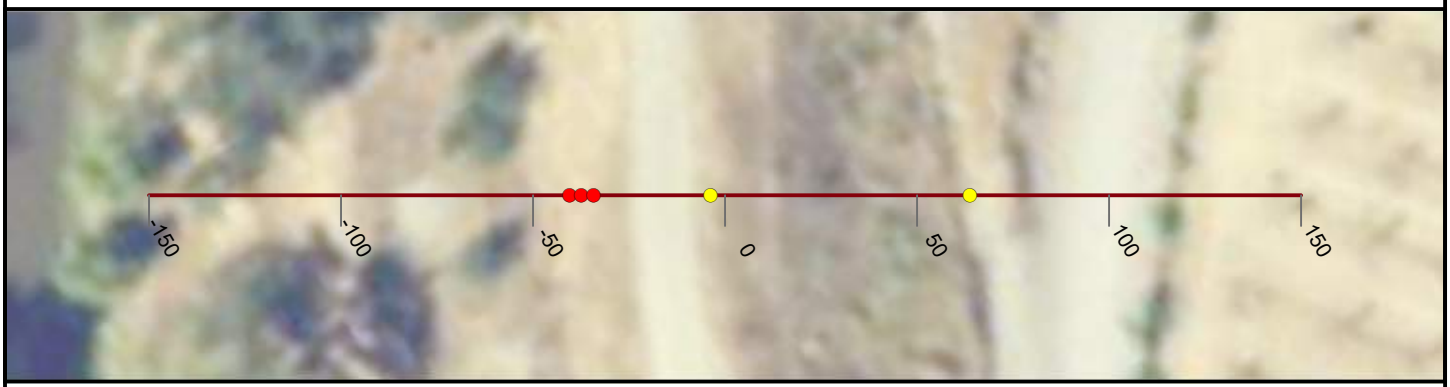
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Cross Section: Bear River 36+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

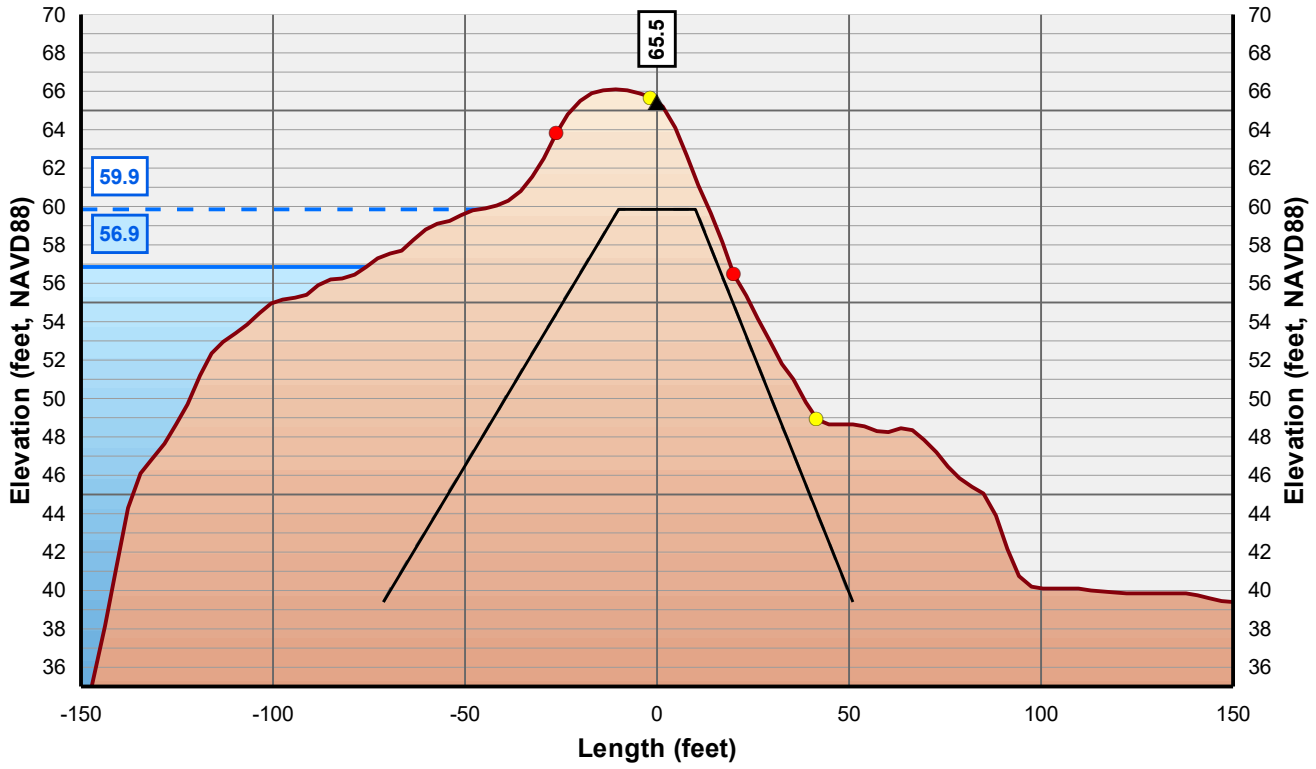
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

J:\3000-s\3614_MBK_Engineers\3614004_Wheatland_FS\GIS\Tasks\Profile_Slope_Analysis_Bear_River_20190322.mxd

Cross Section: Bear River 37+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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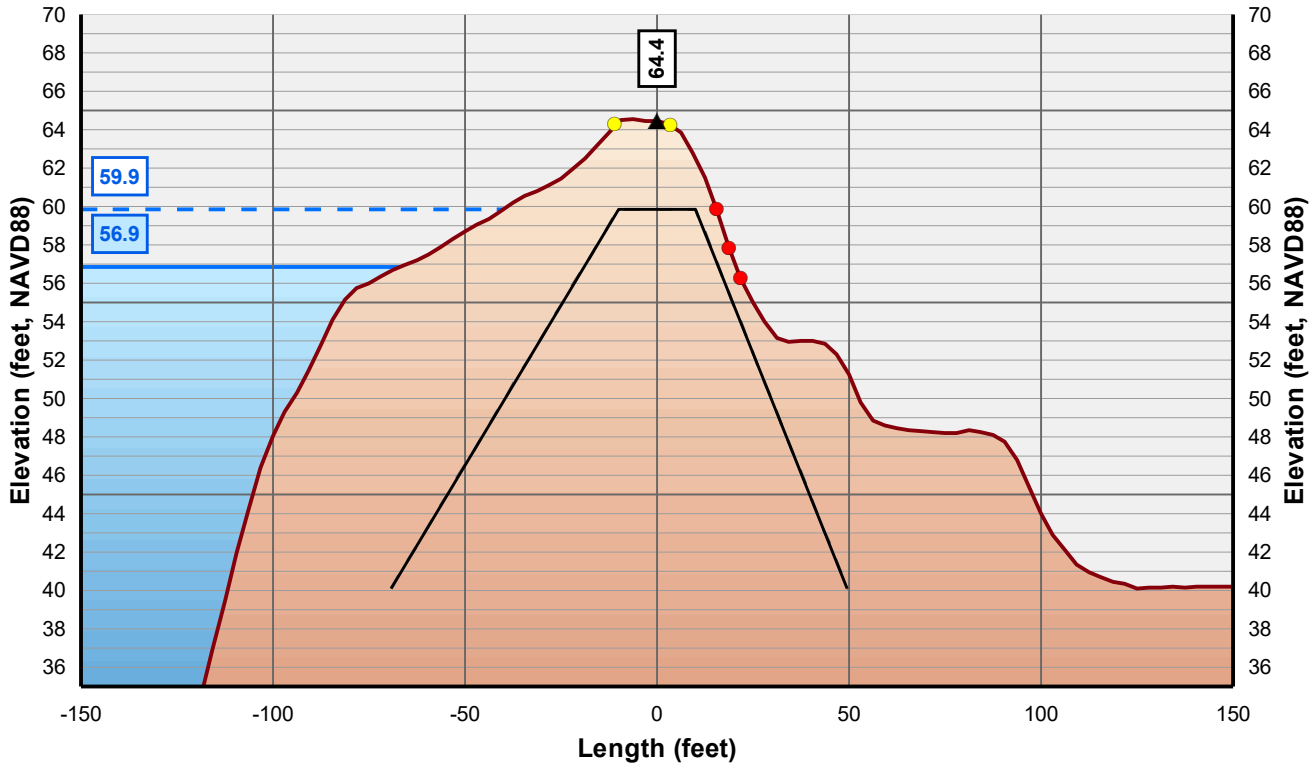
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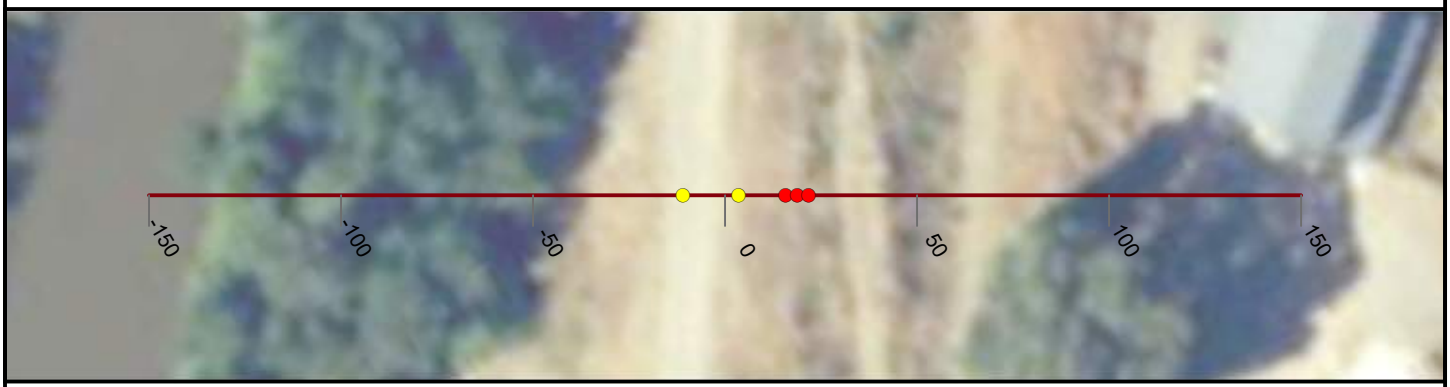
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Cross Section: Bear River 38+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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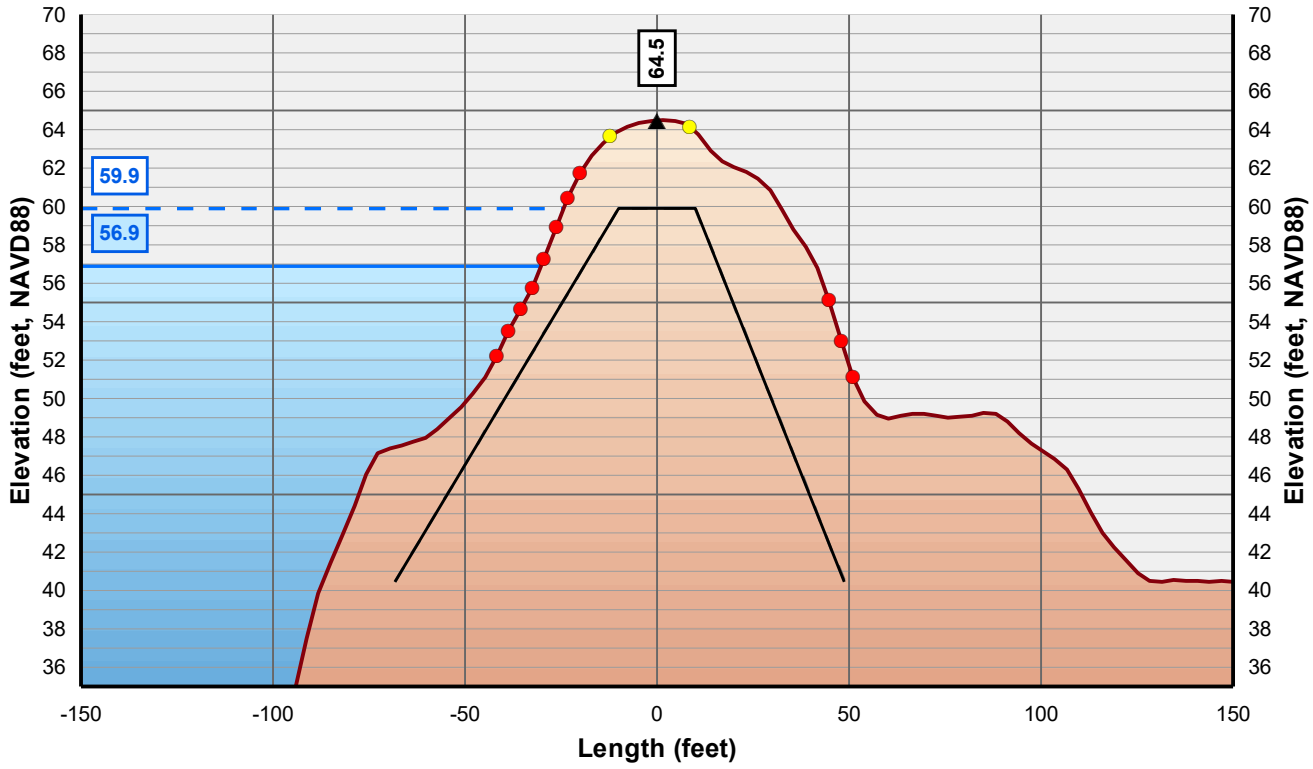
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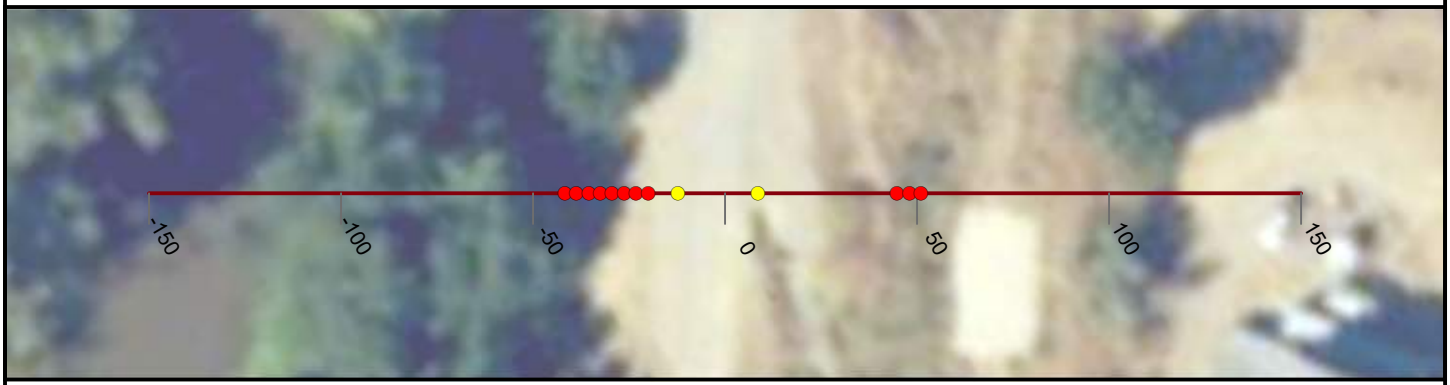
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Cross Section: Bear River 39+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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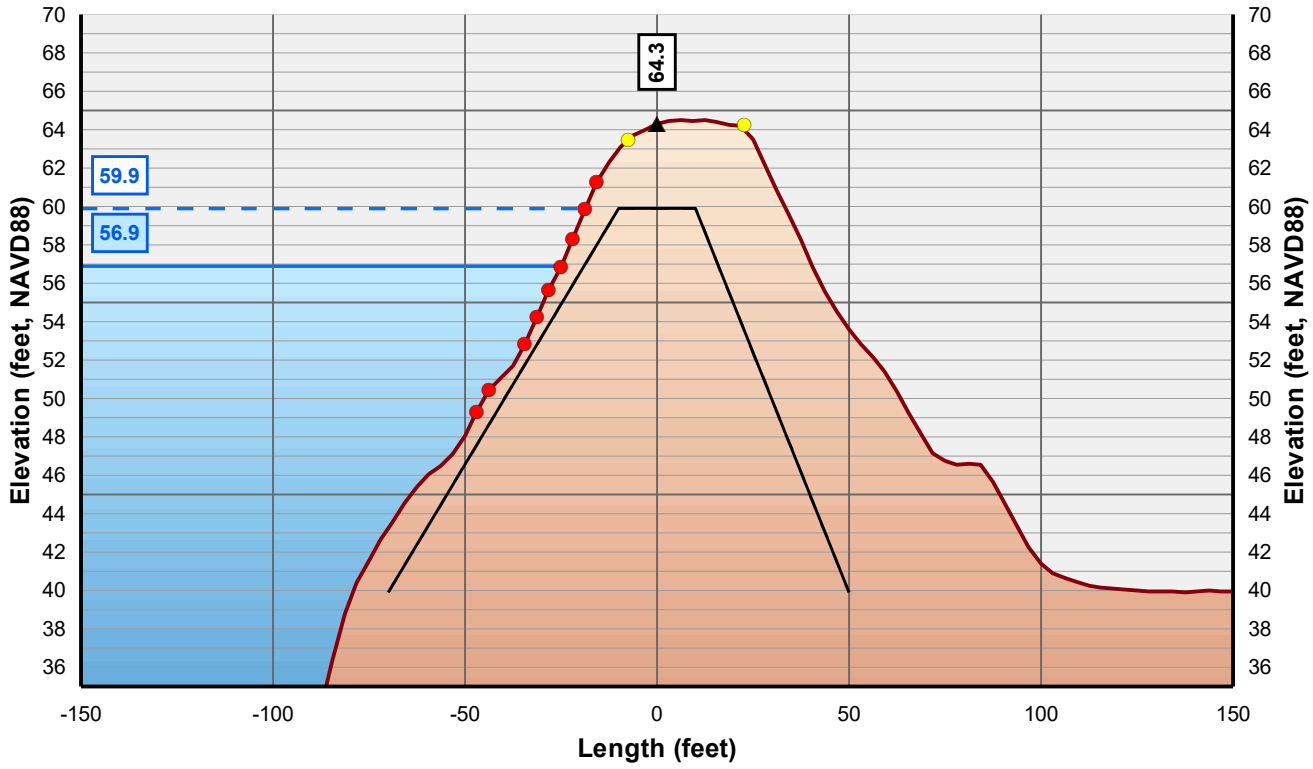
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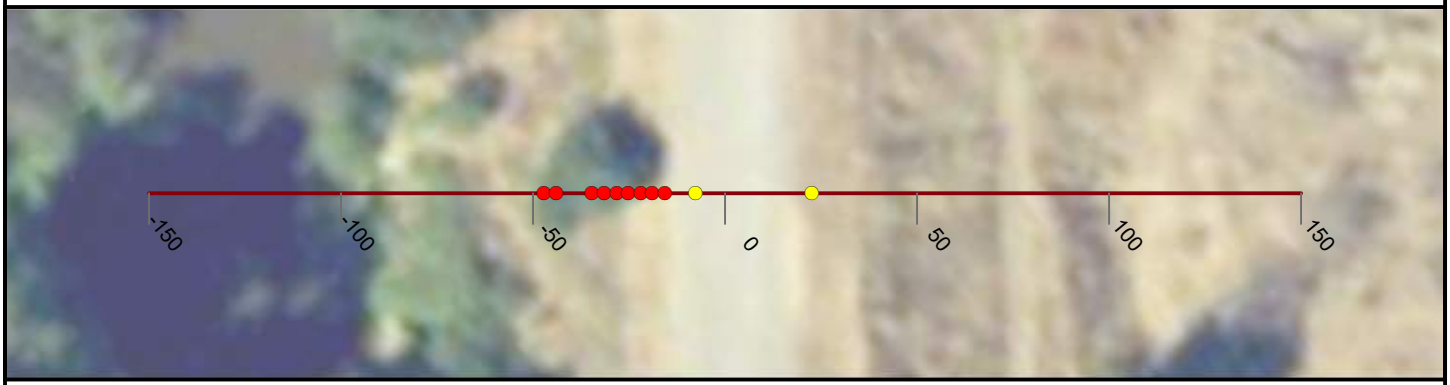
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Cross Section: Bear River 40+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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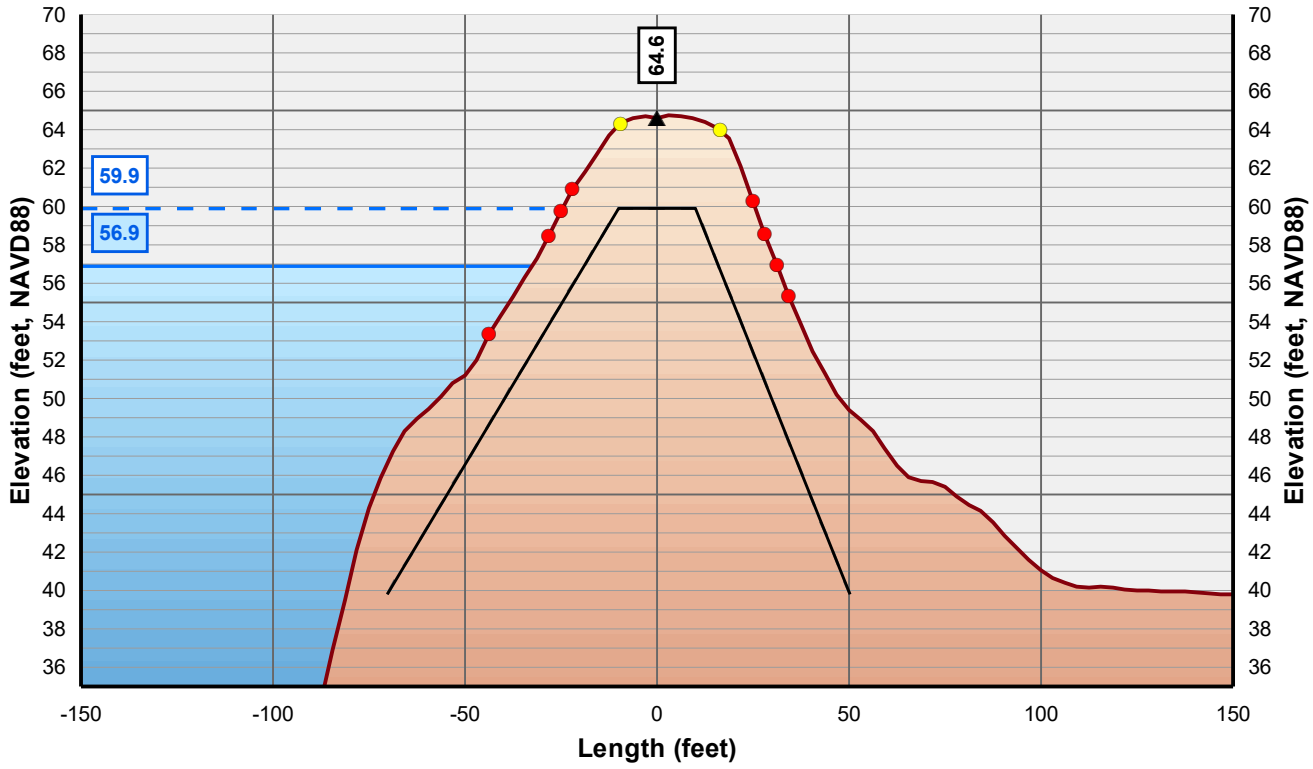
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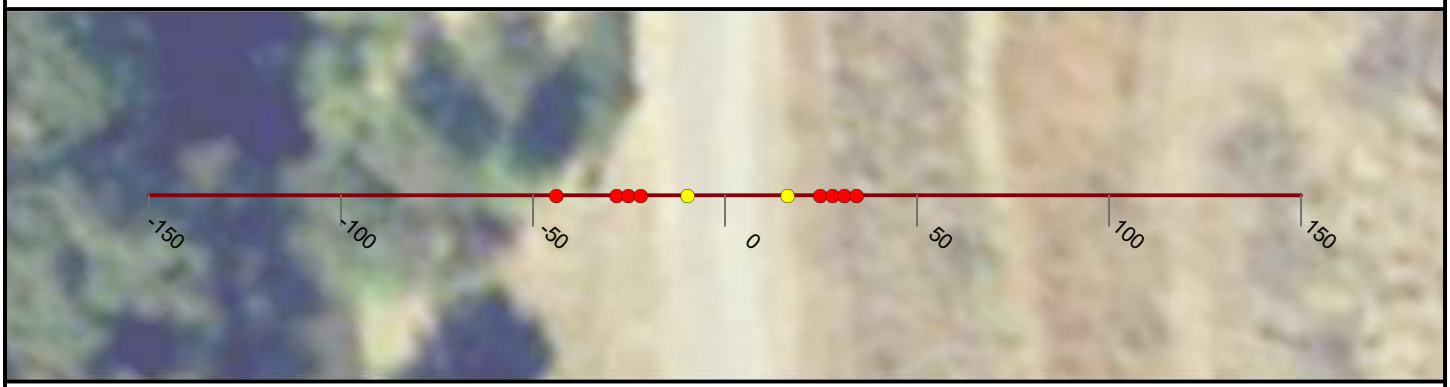
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Cross Section: Bear River 41+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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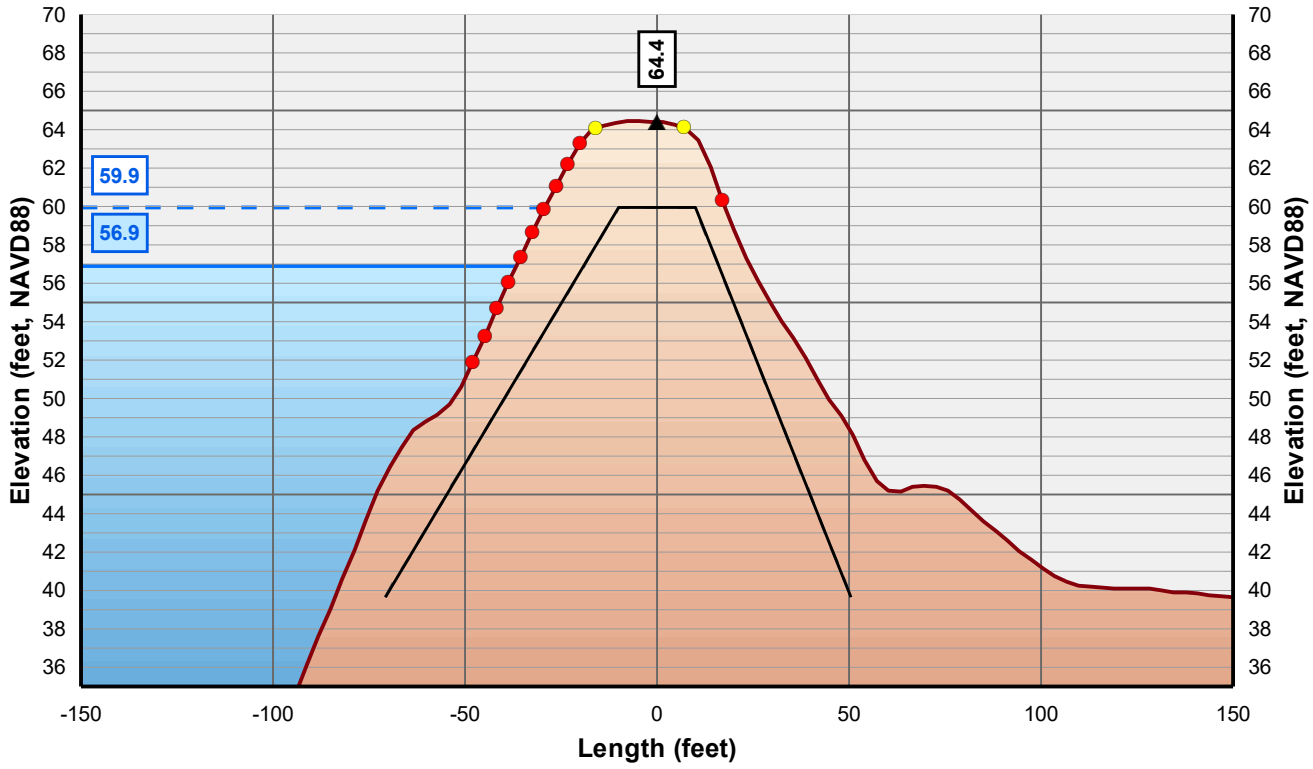
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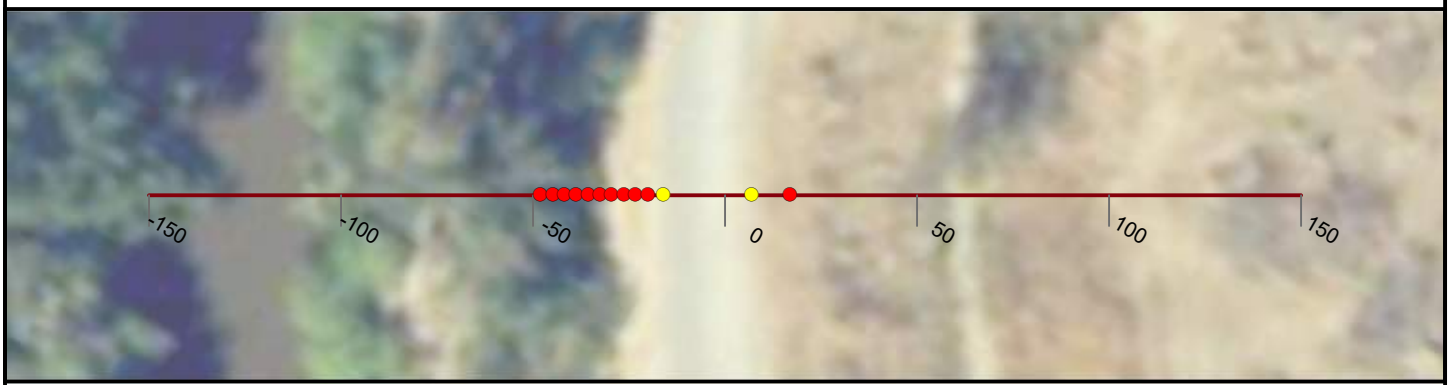
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Cross Section: Bear River 42+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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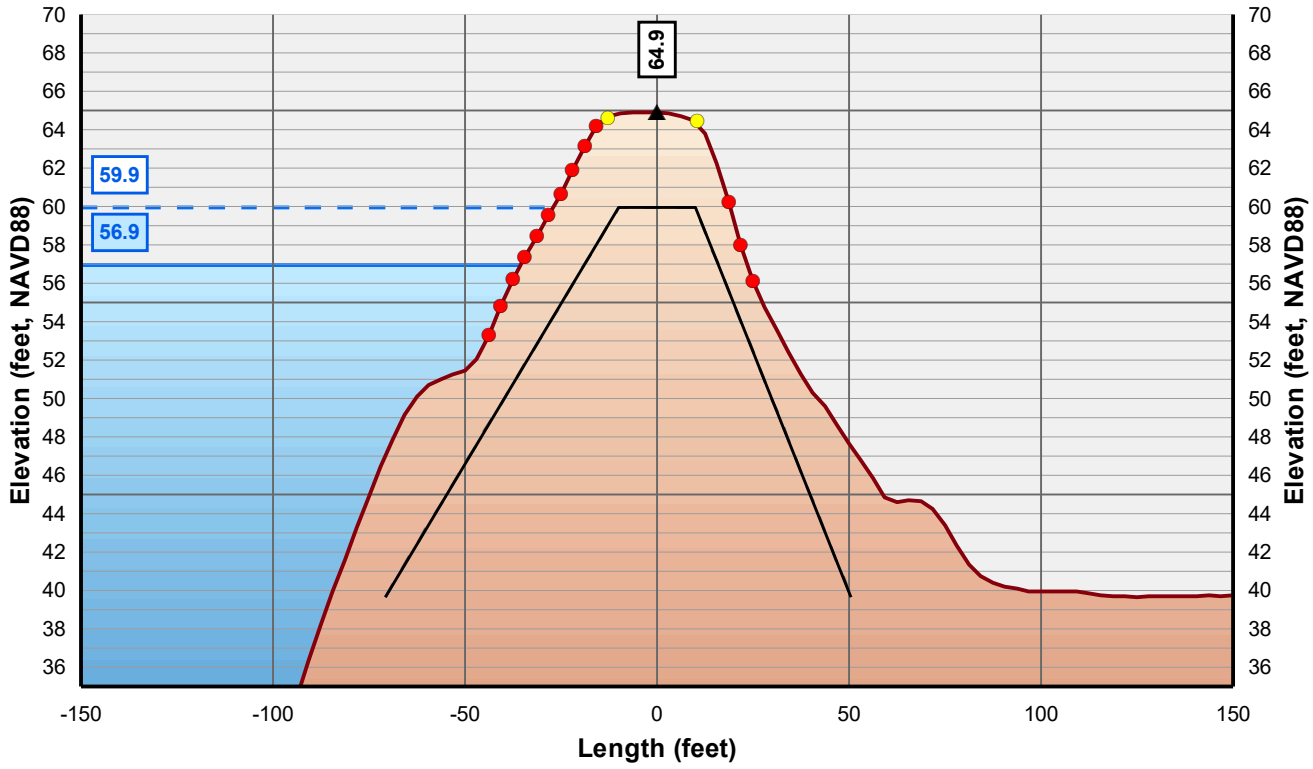
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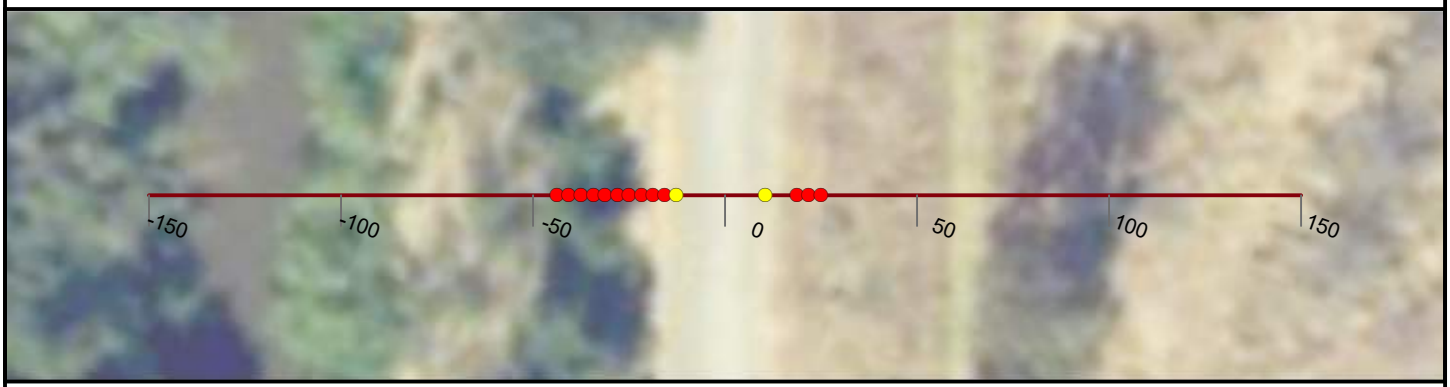
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Cross Section: Bear River 43+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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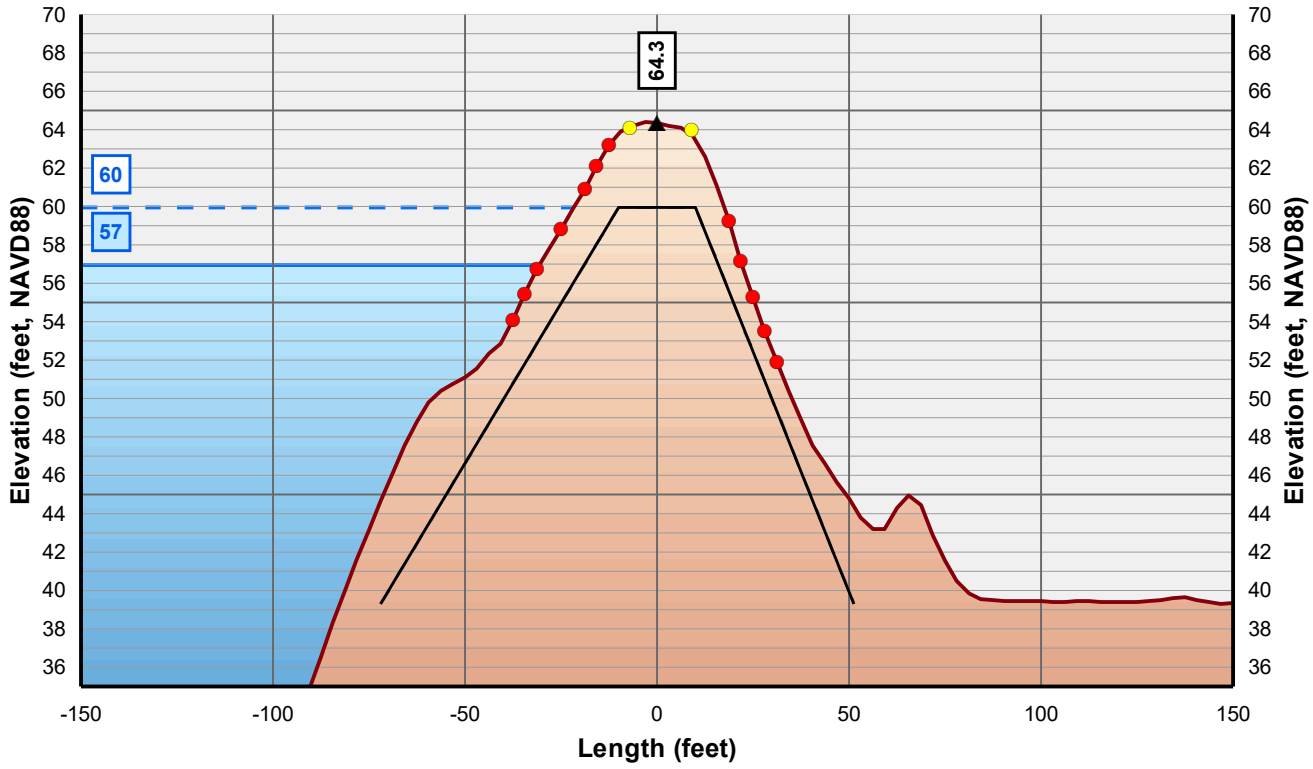
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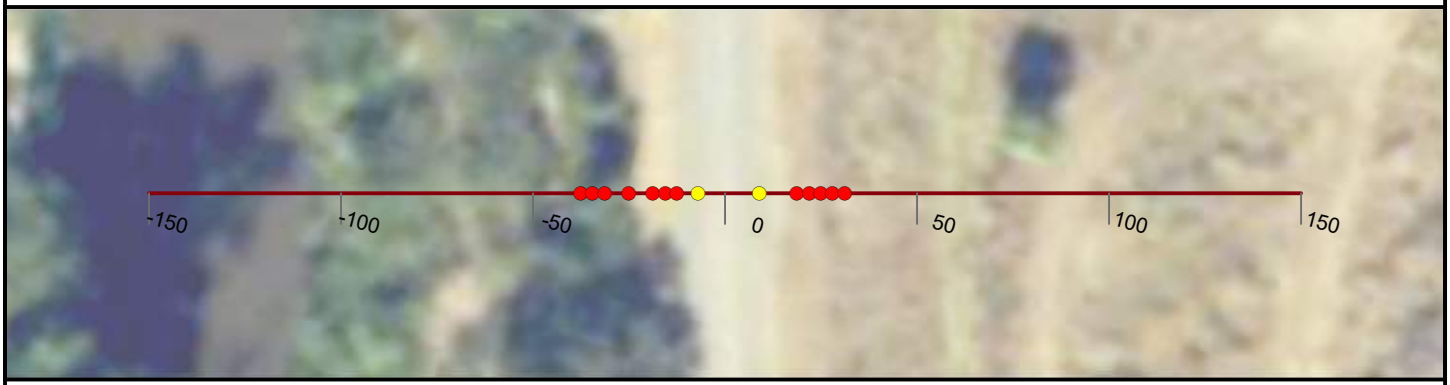
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Cross Section: Bear River 44+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

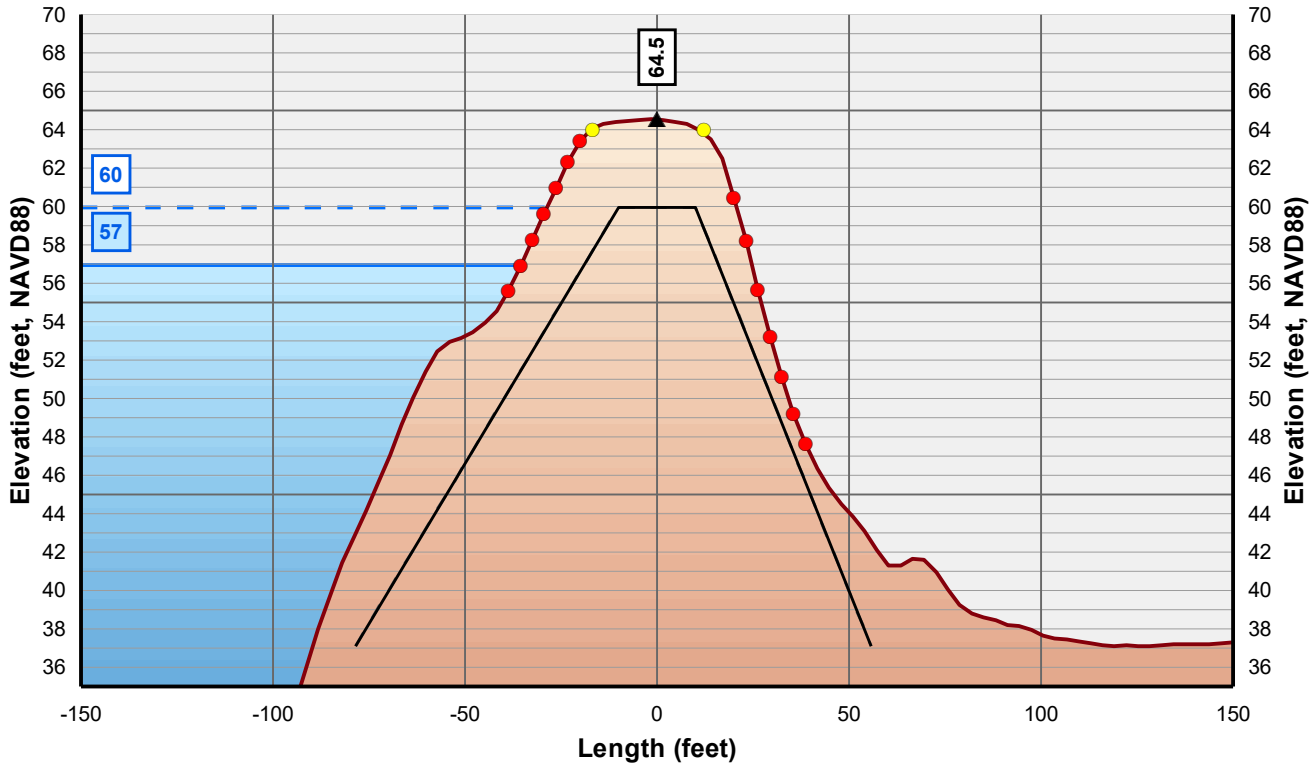
FEET

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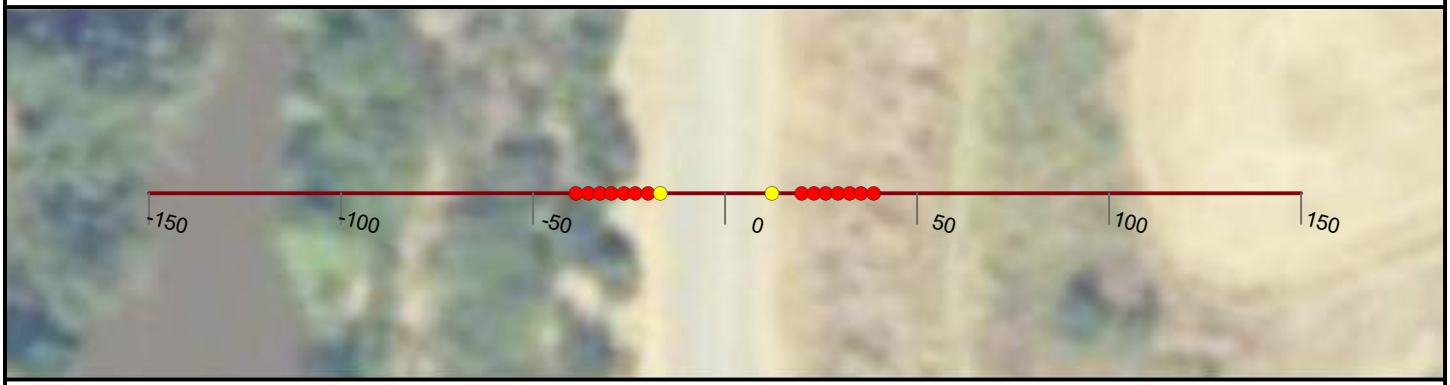
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Cross Section: Bear River 45+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

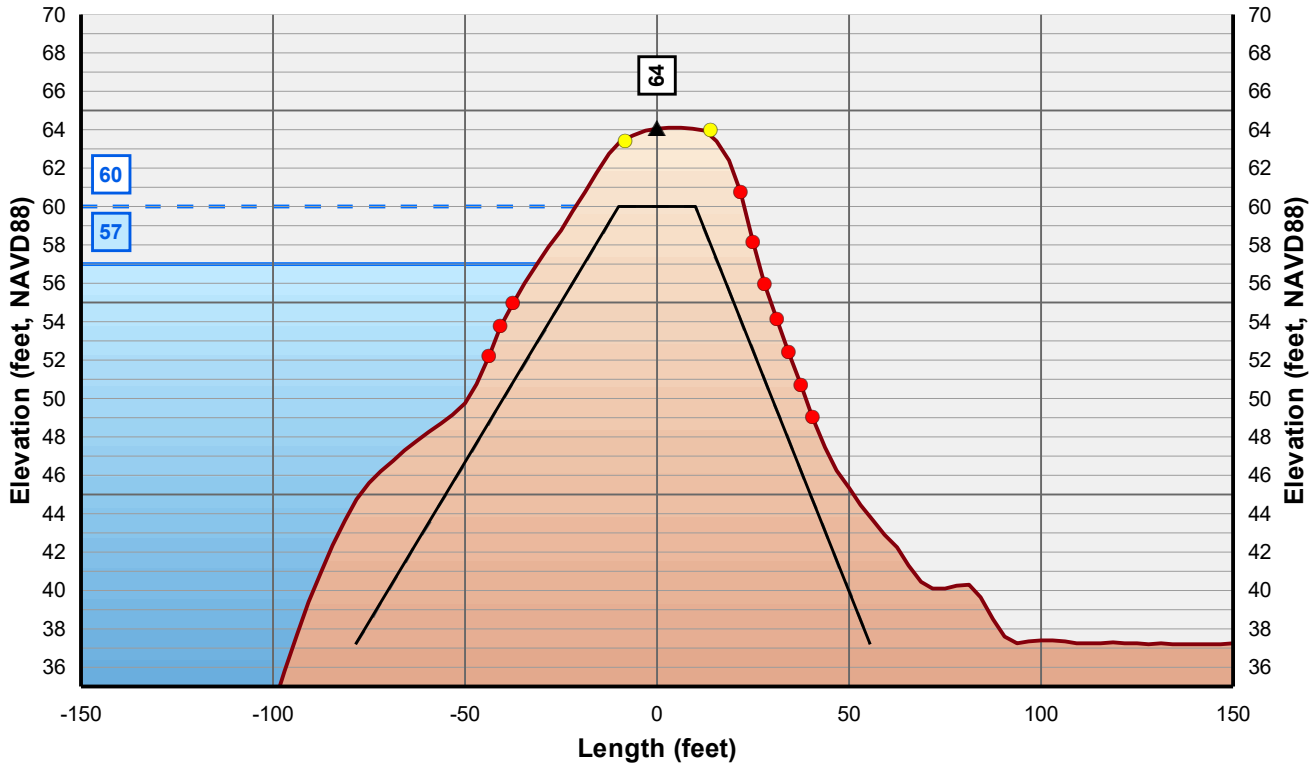
FEET

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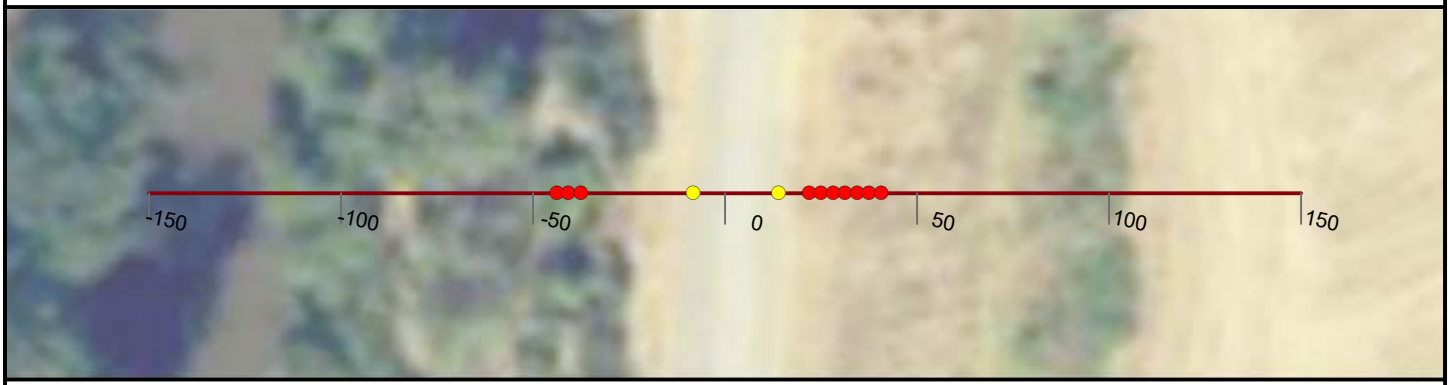
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Cross Section: Bear River 46+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

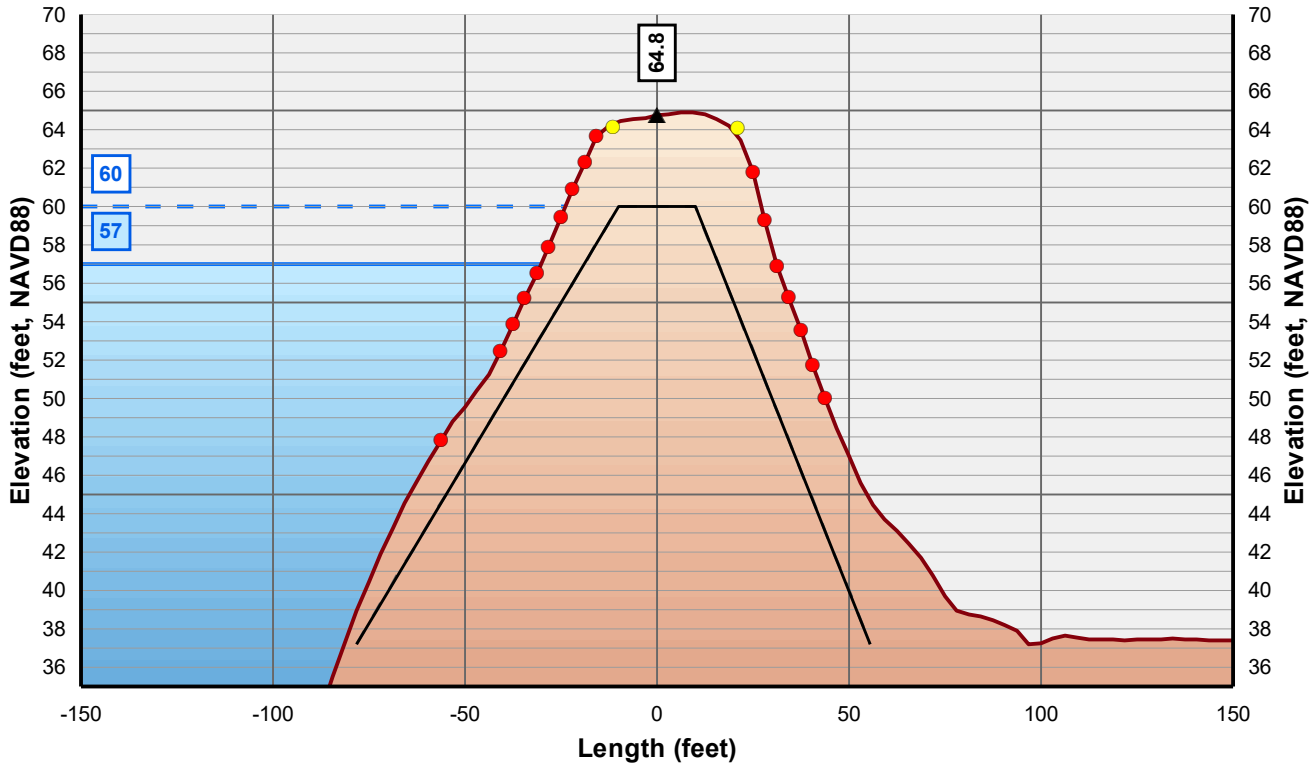
FEET

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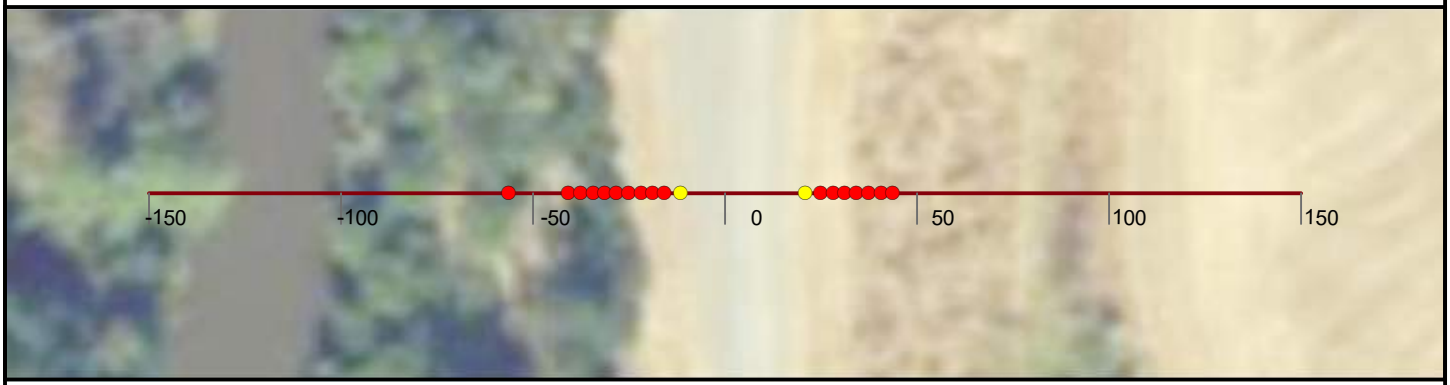
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Cross Section: Bear River 47+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

Control Line
Crown Point
Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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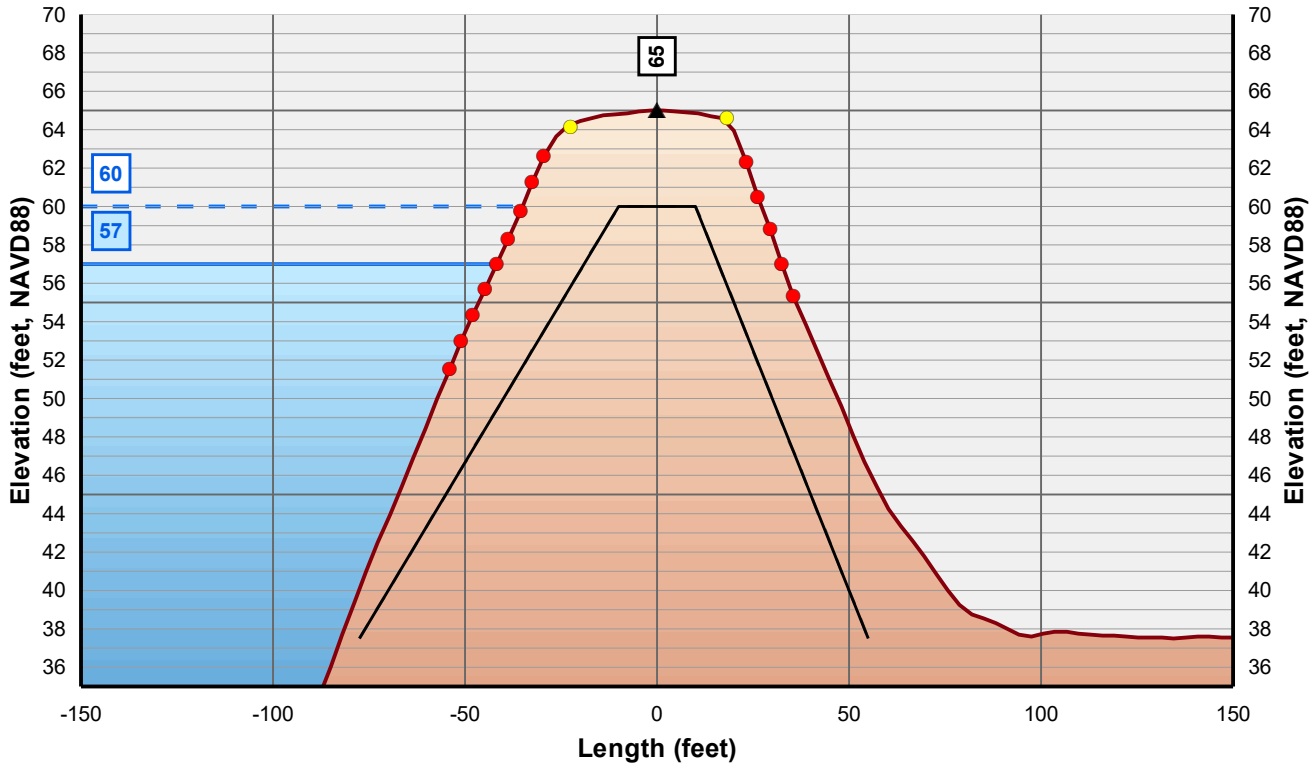
FEET

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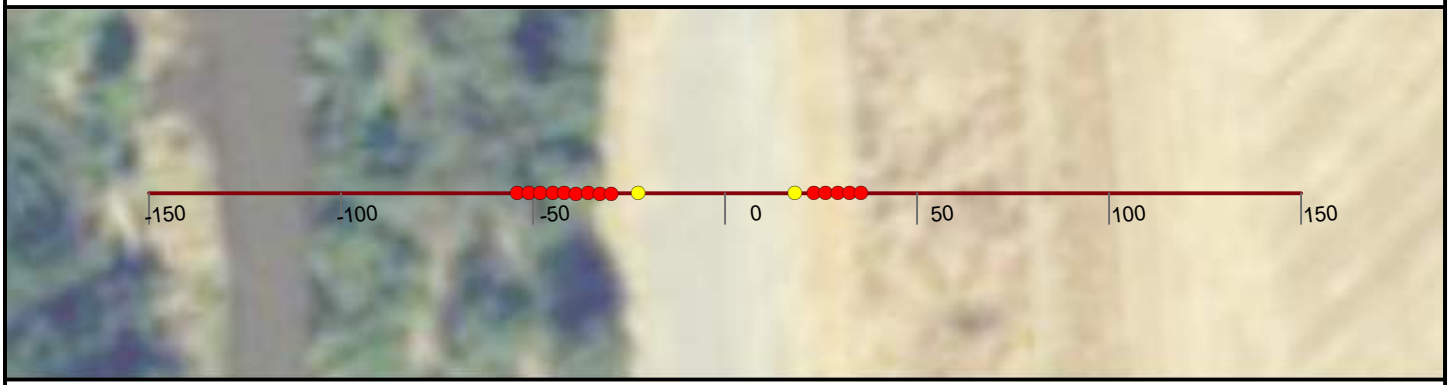
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Cross Section: Bear River 48+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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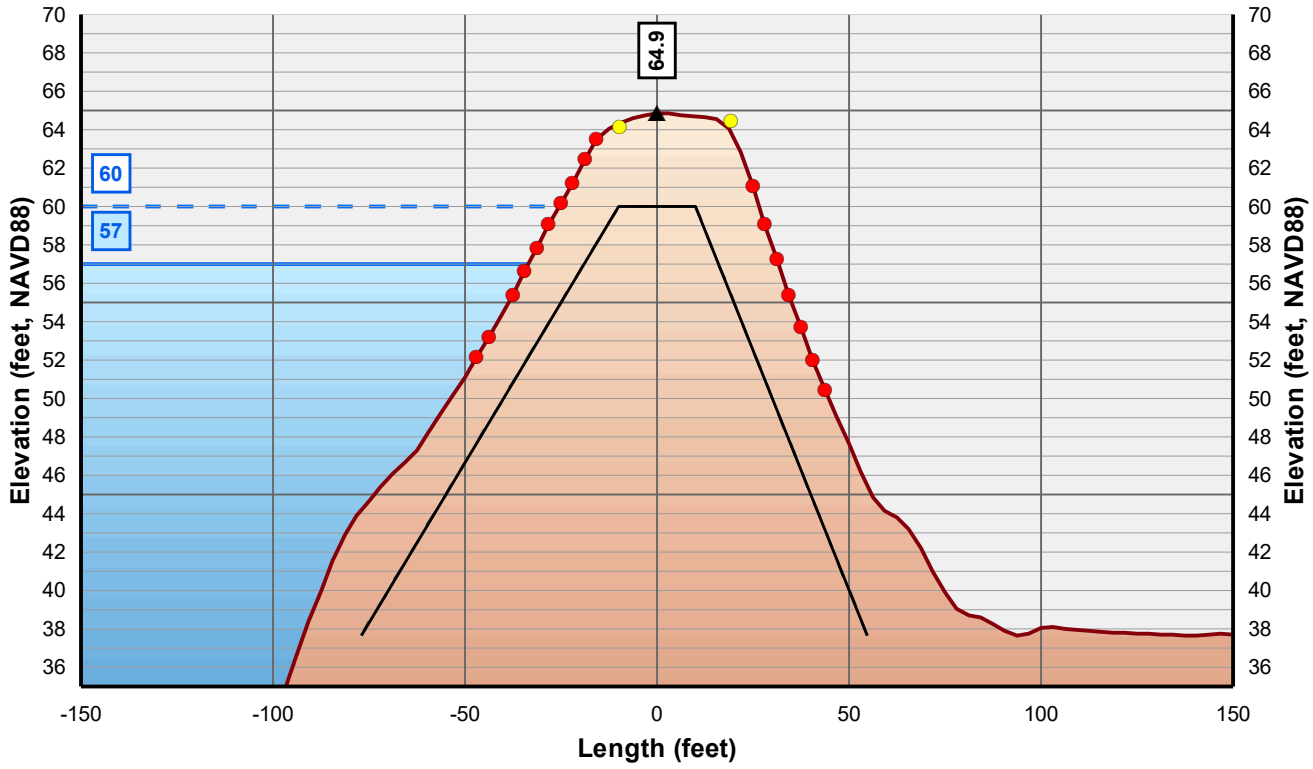
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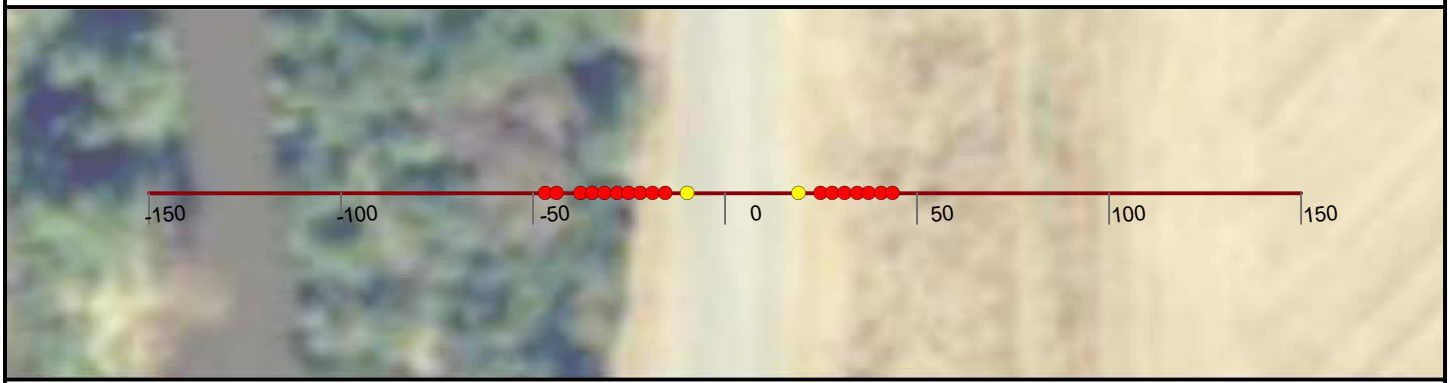
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Cross Section: Bear River 49+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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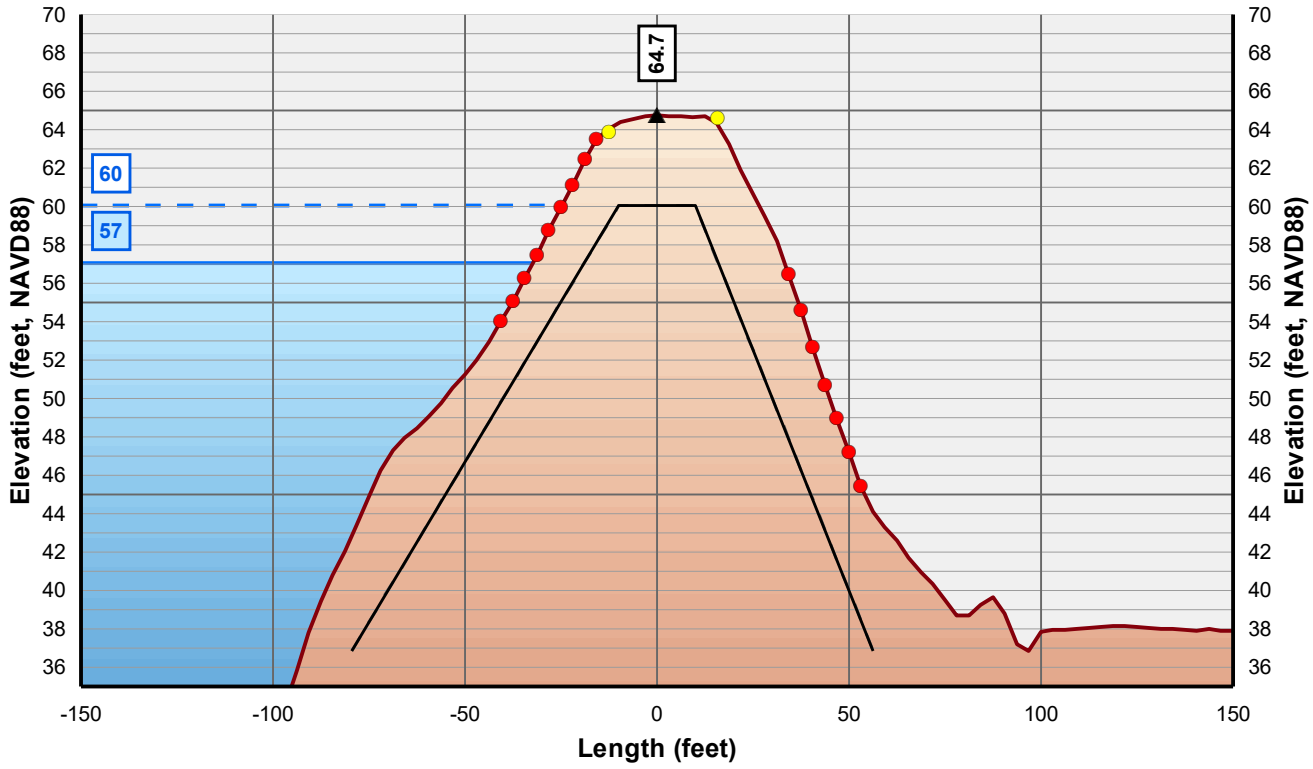
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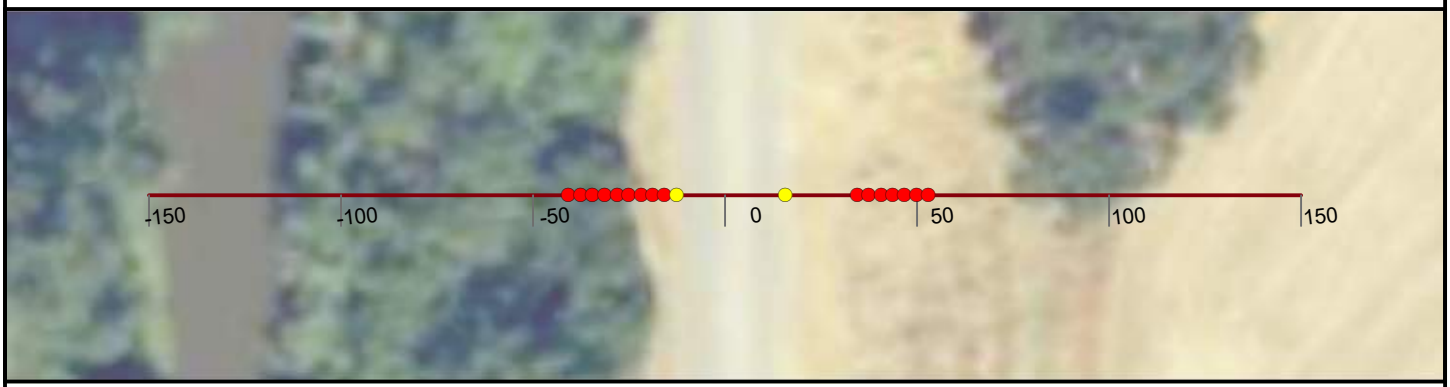
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Cross Section: Bear River 50+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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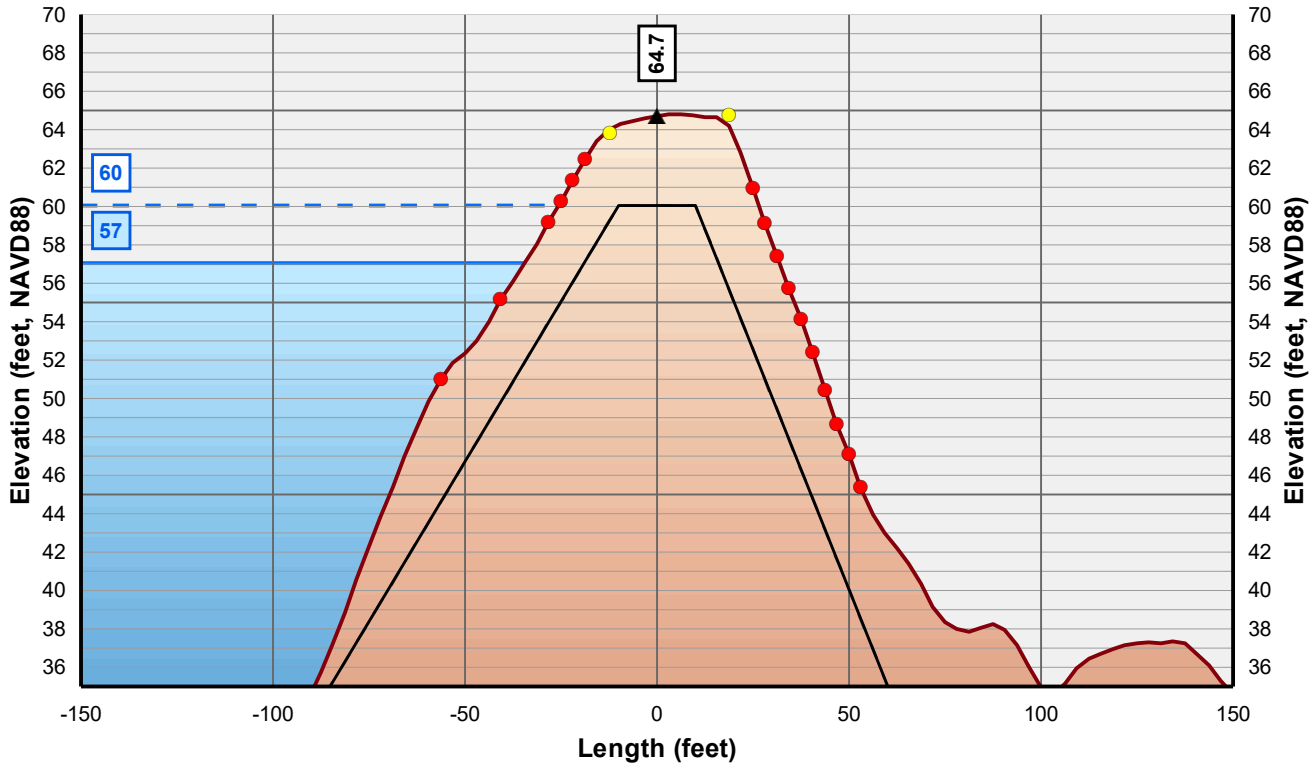
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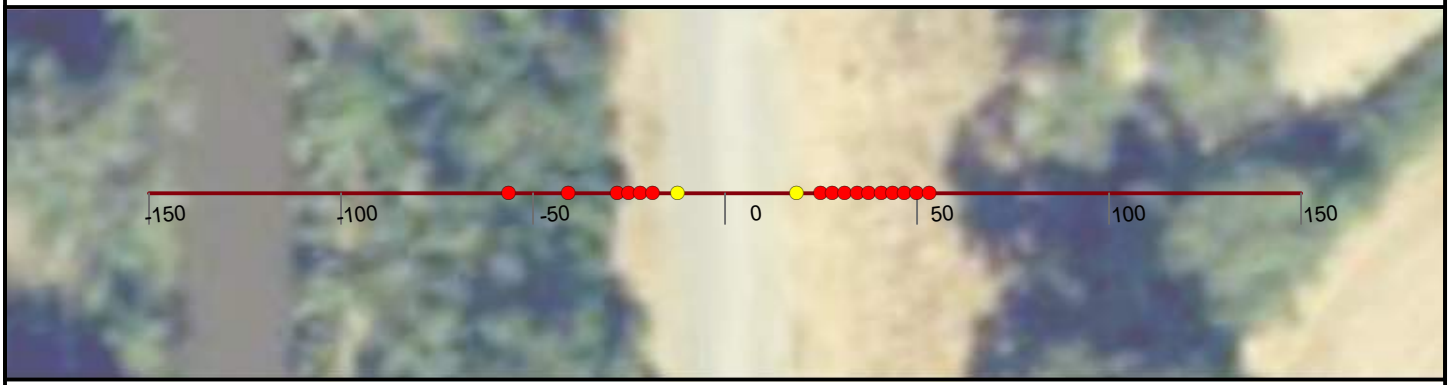
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Cross Section: Bear River 51+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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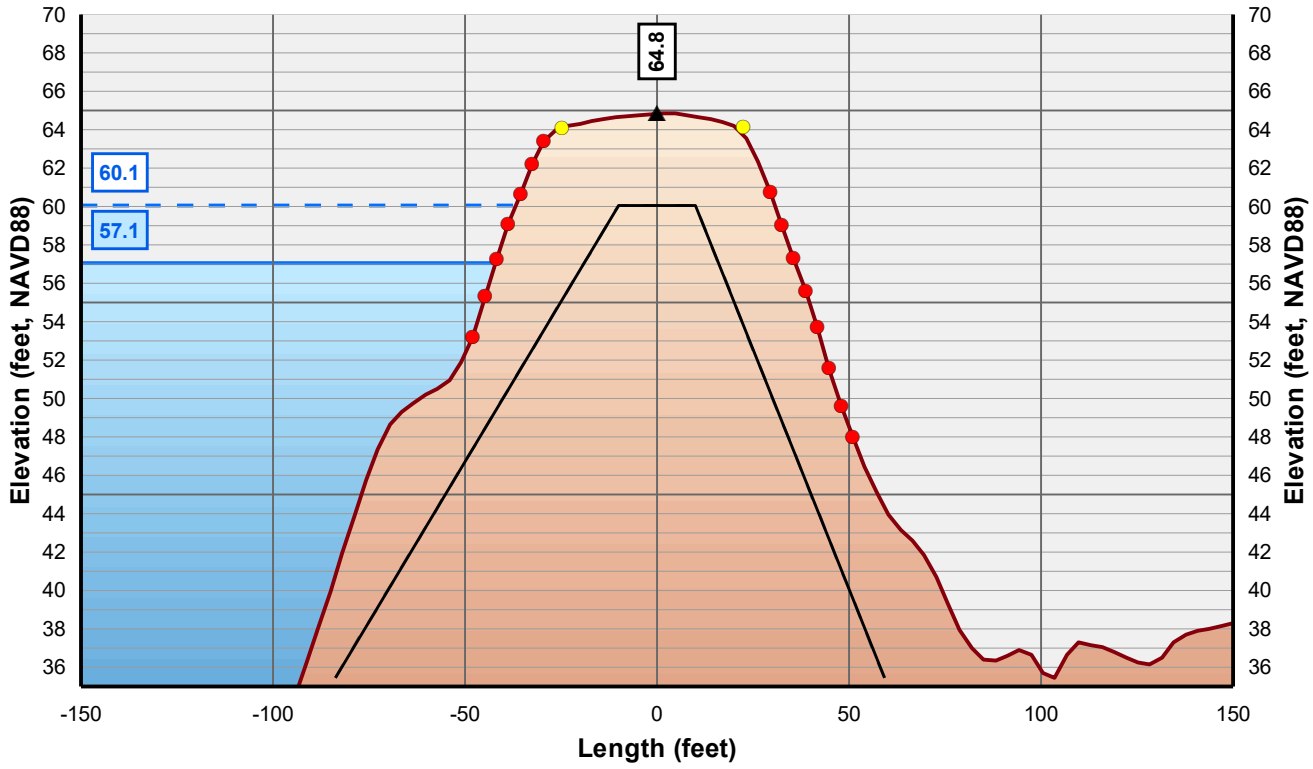
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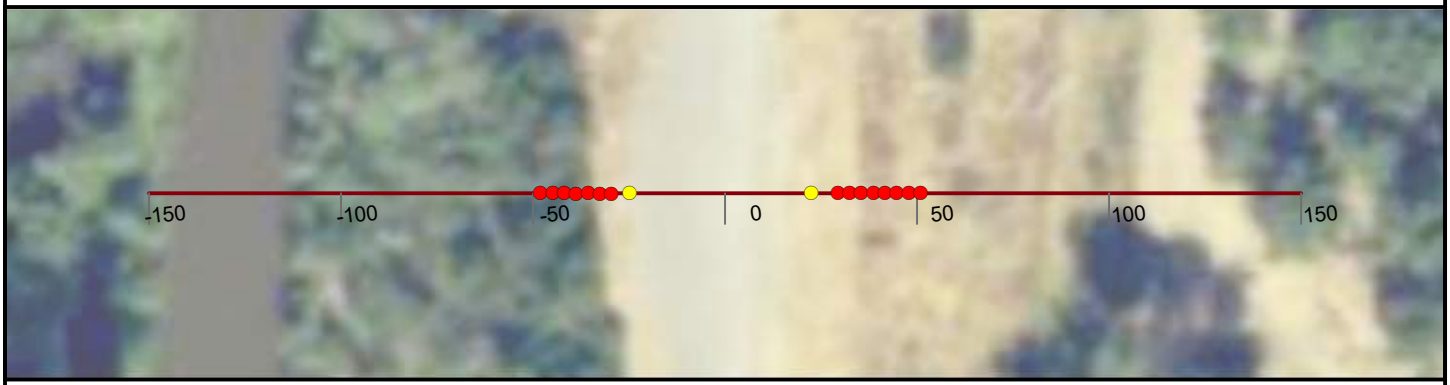
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Cross Section: Bear River 52+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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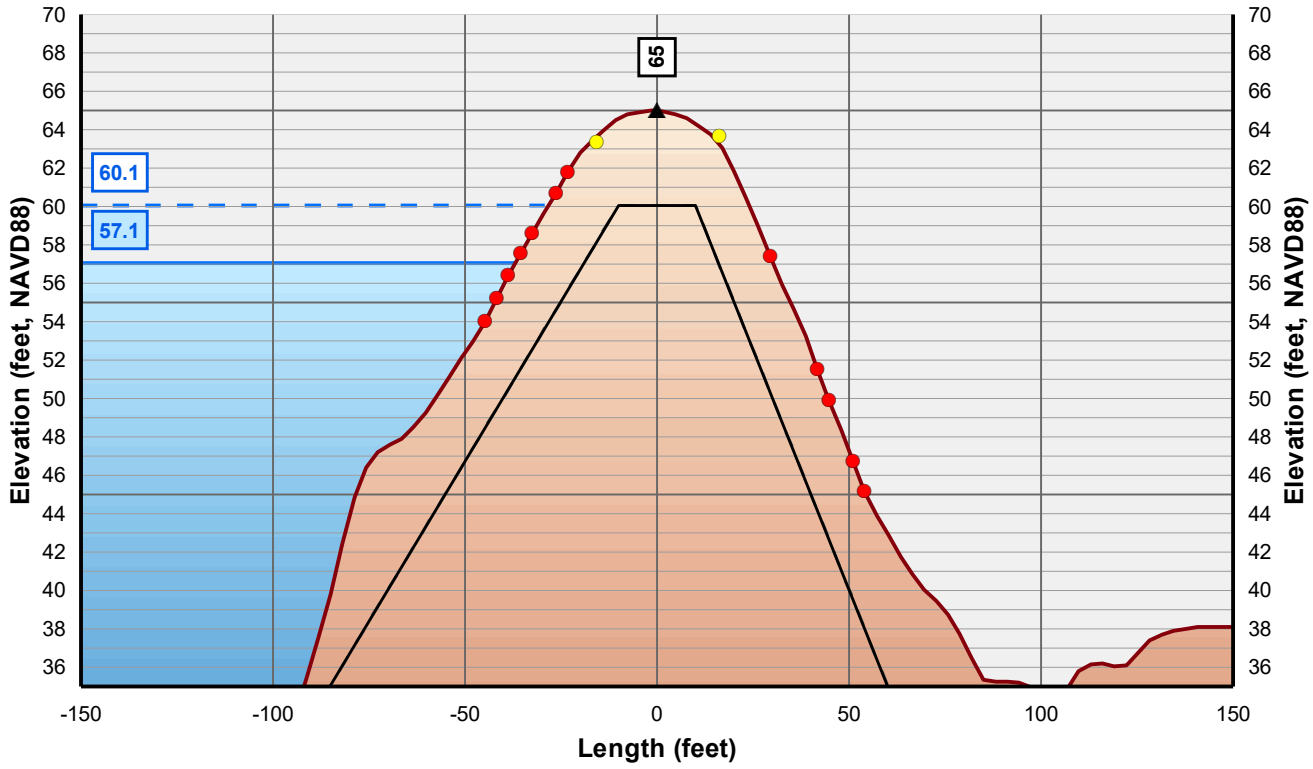
FEET

PRELIMINARY

WOOD RODGERS
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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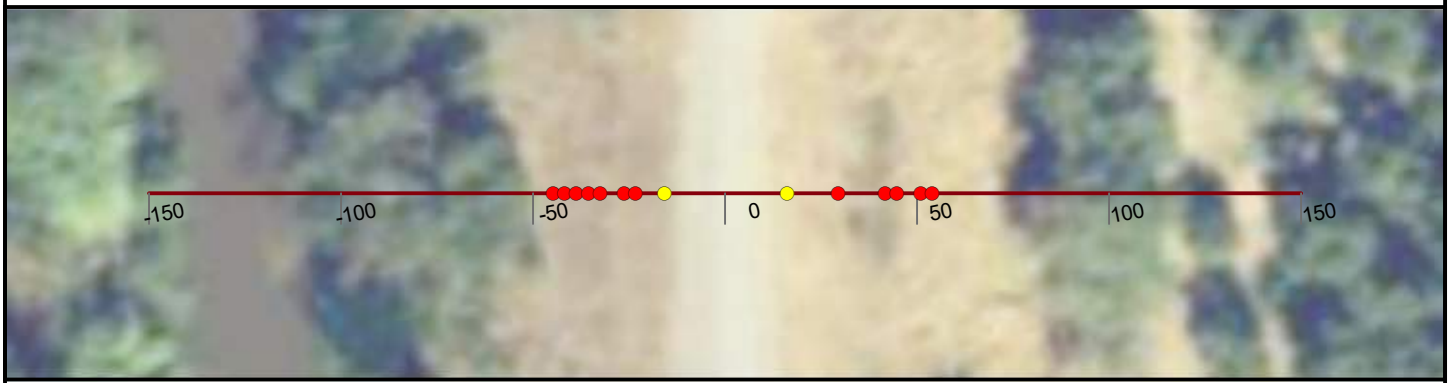
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Cross Section: Bear River 53+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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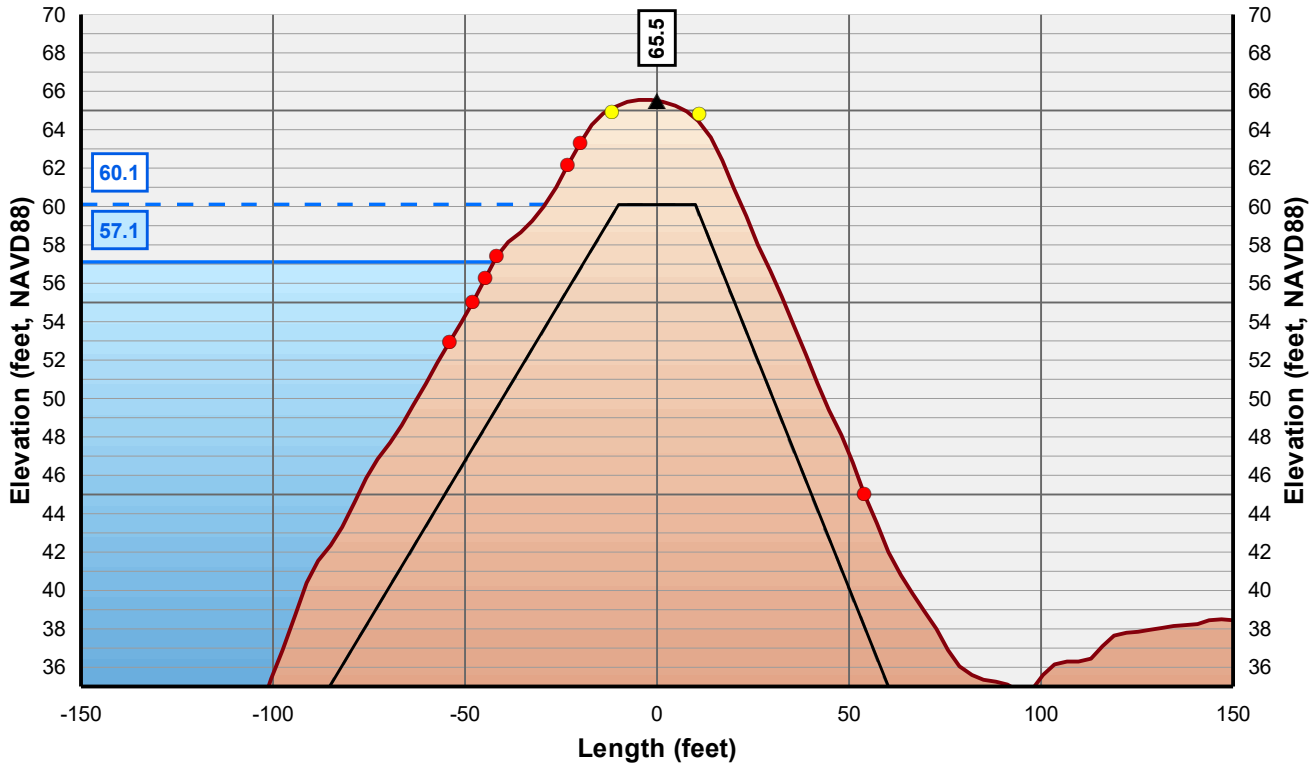
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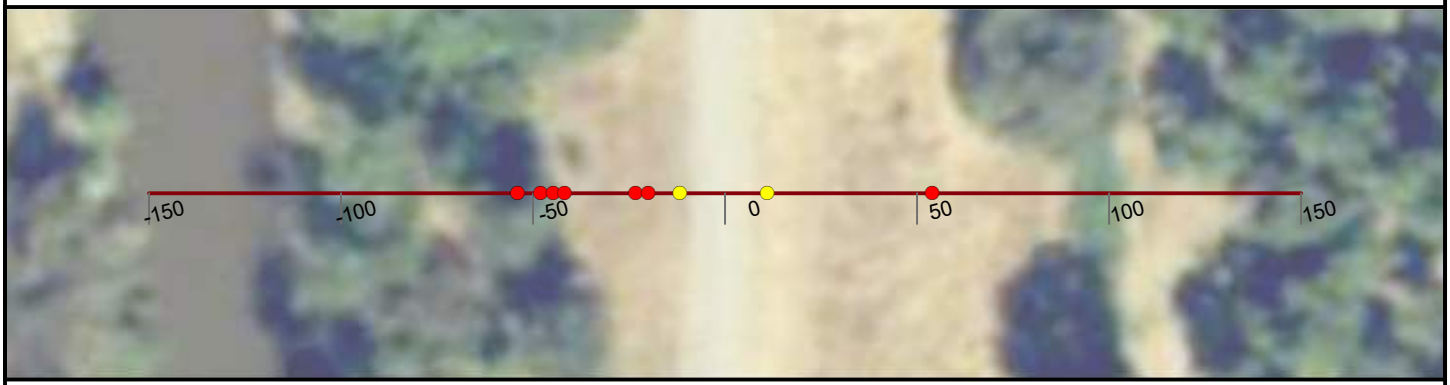
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Cross Section: Bear River 54+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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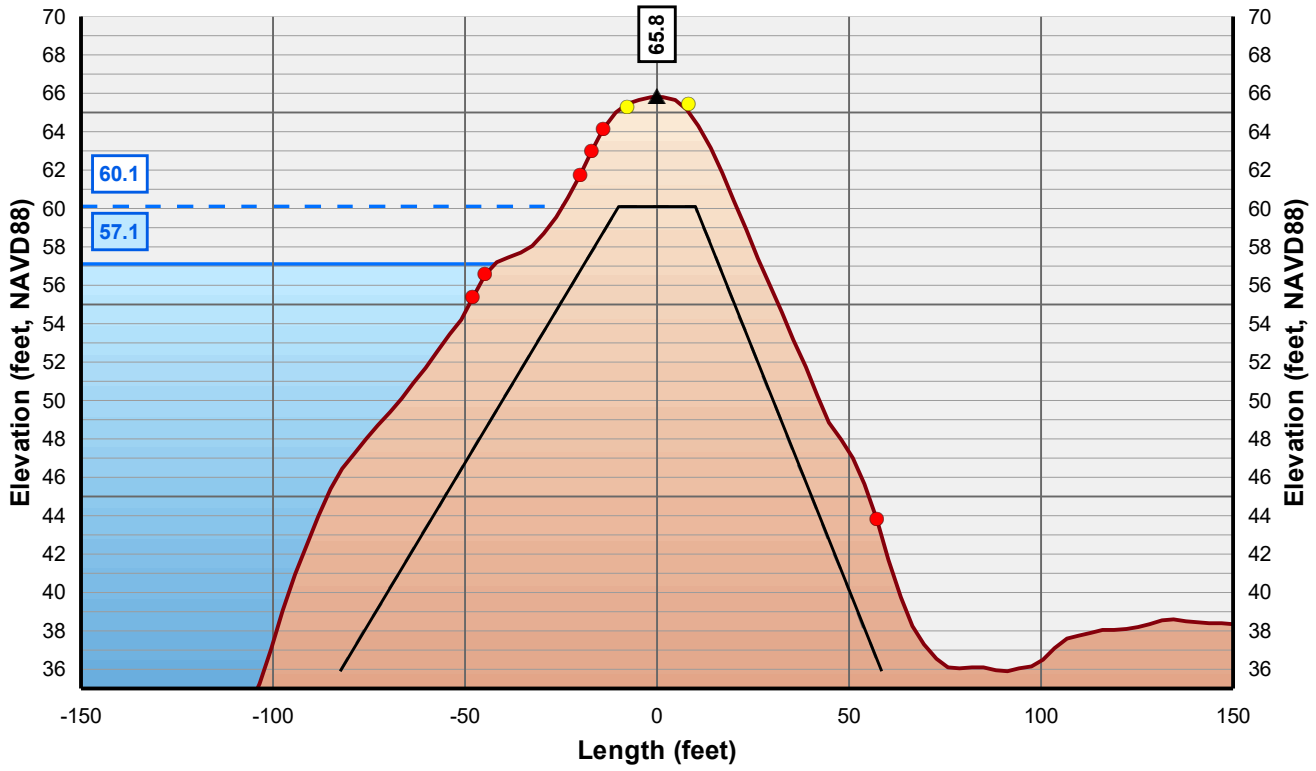
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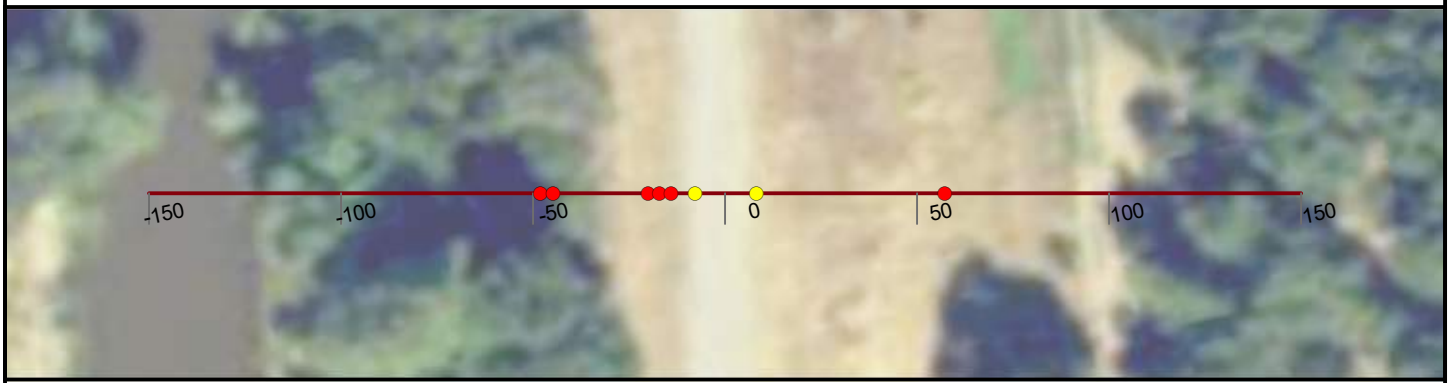
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Cross Section: Bear River 55+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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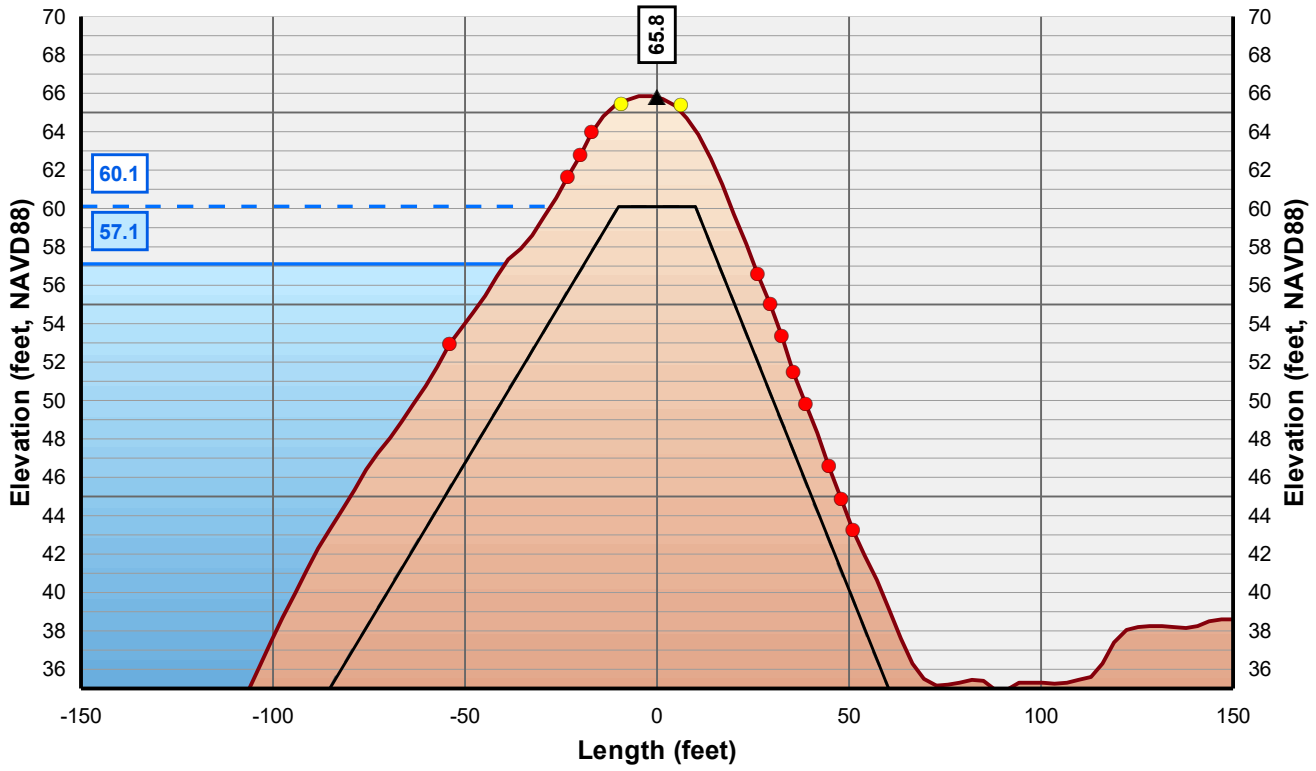
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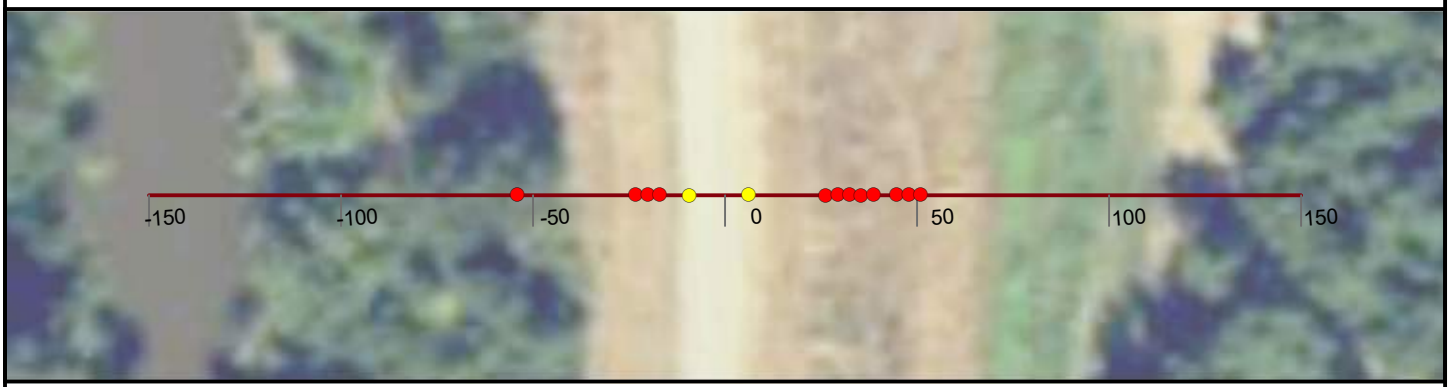
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Cross Section: Bear River 56+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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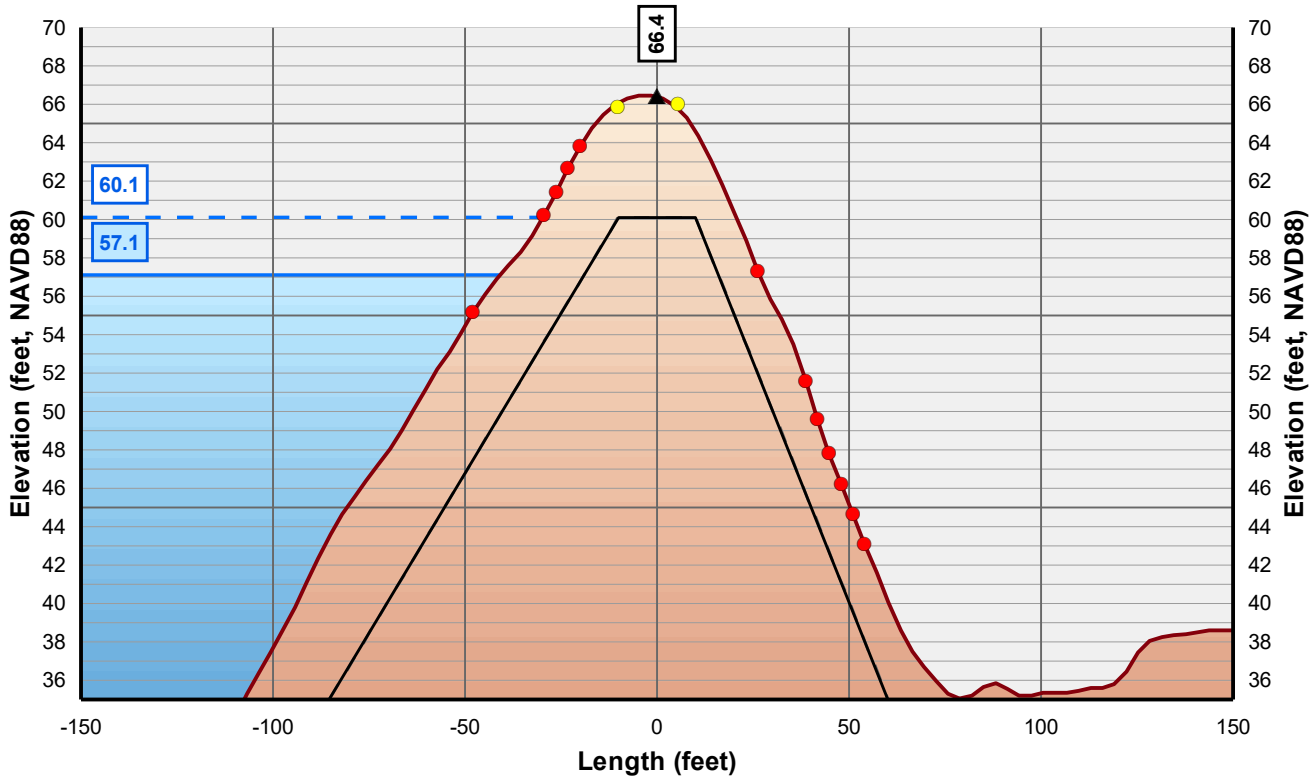
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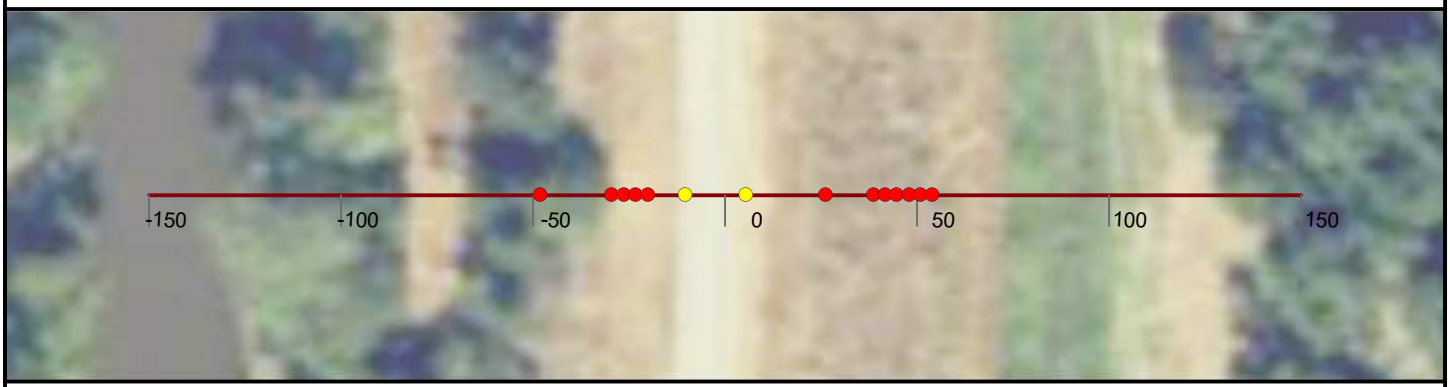
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Cross Section: Bear River 57+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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BEAR RIVER LEVEE

CALIFORNIA

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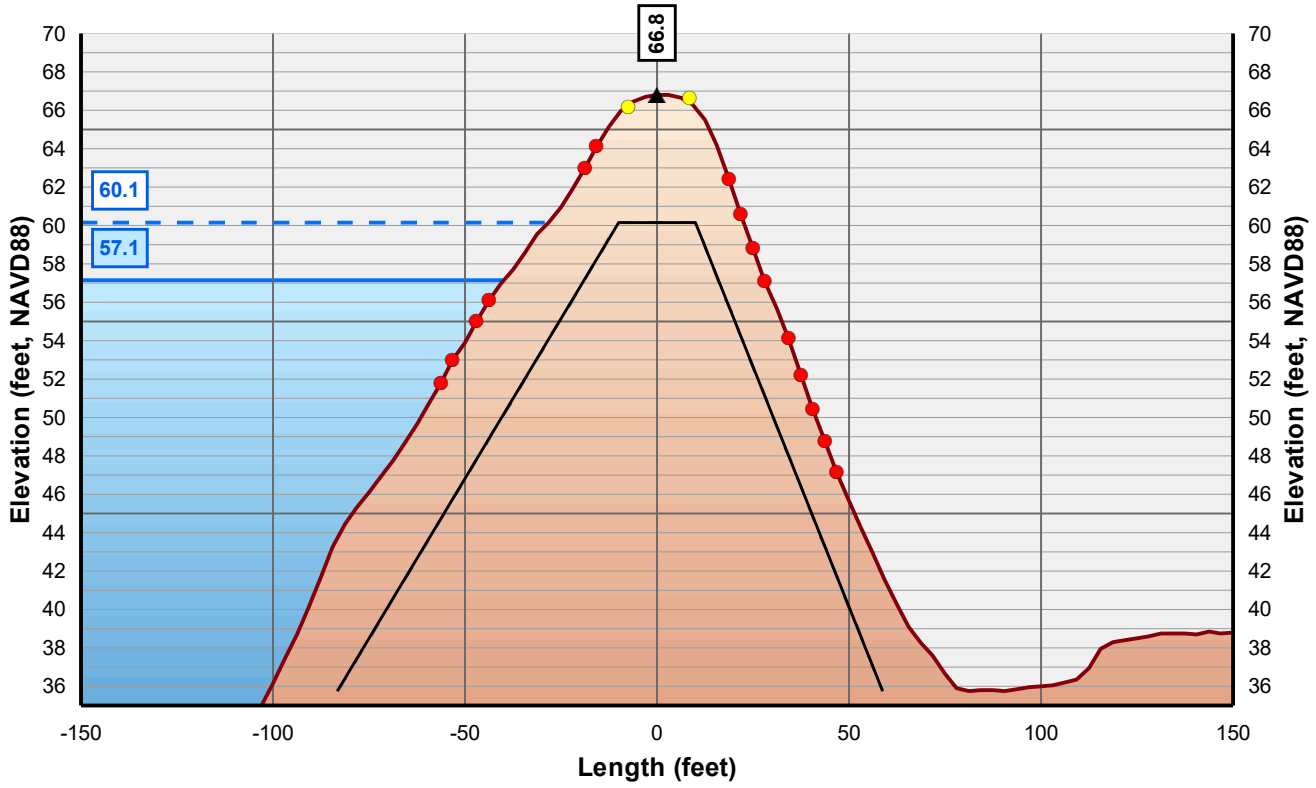
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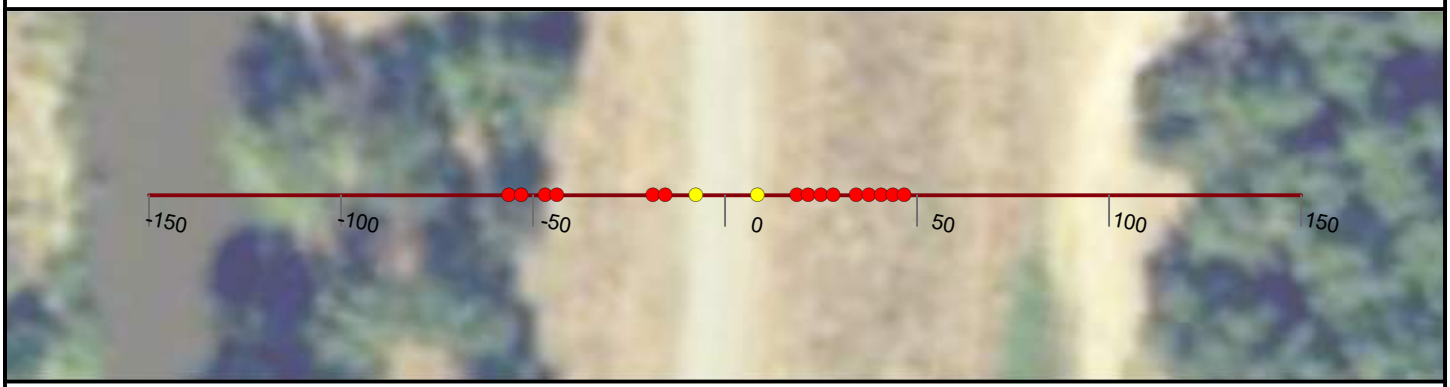
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Cross Section: Bear River 58+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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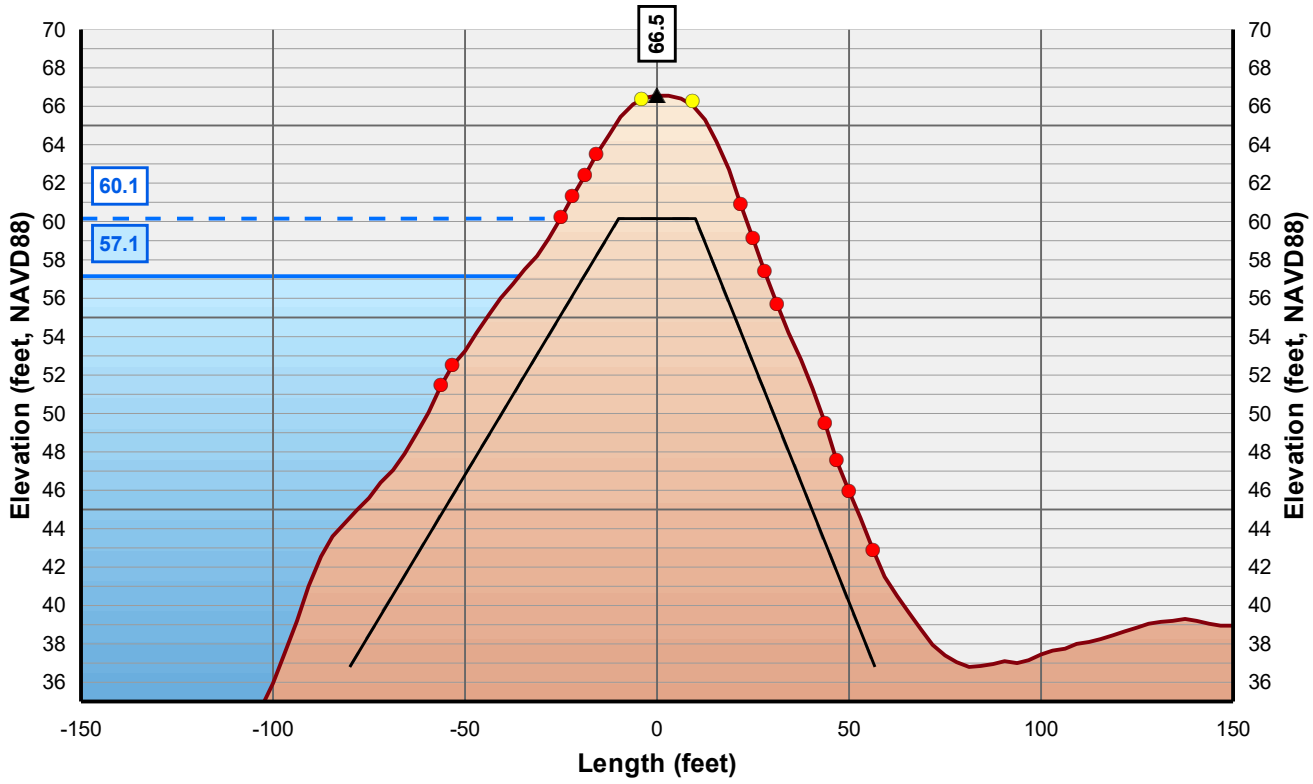
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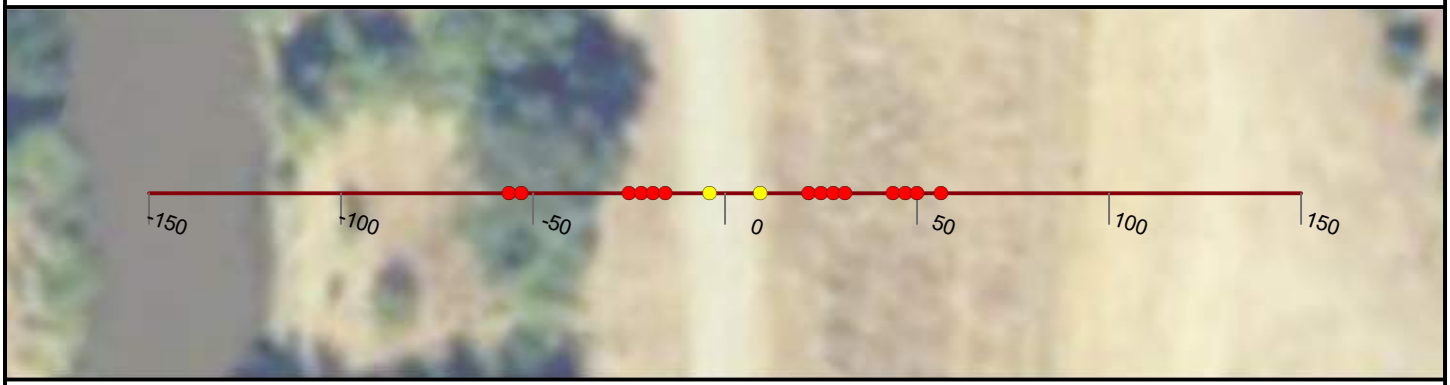
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Cross Section: Bear River 59+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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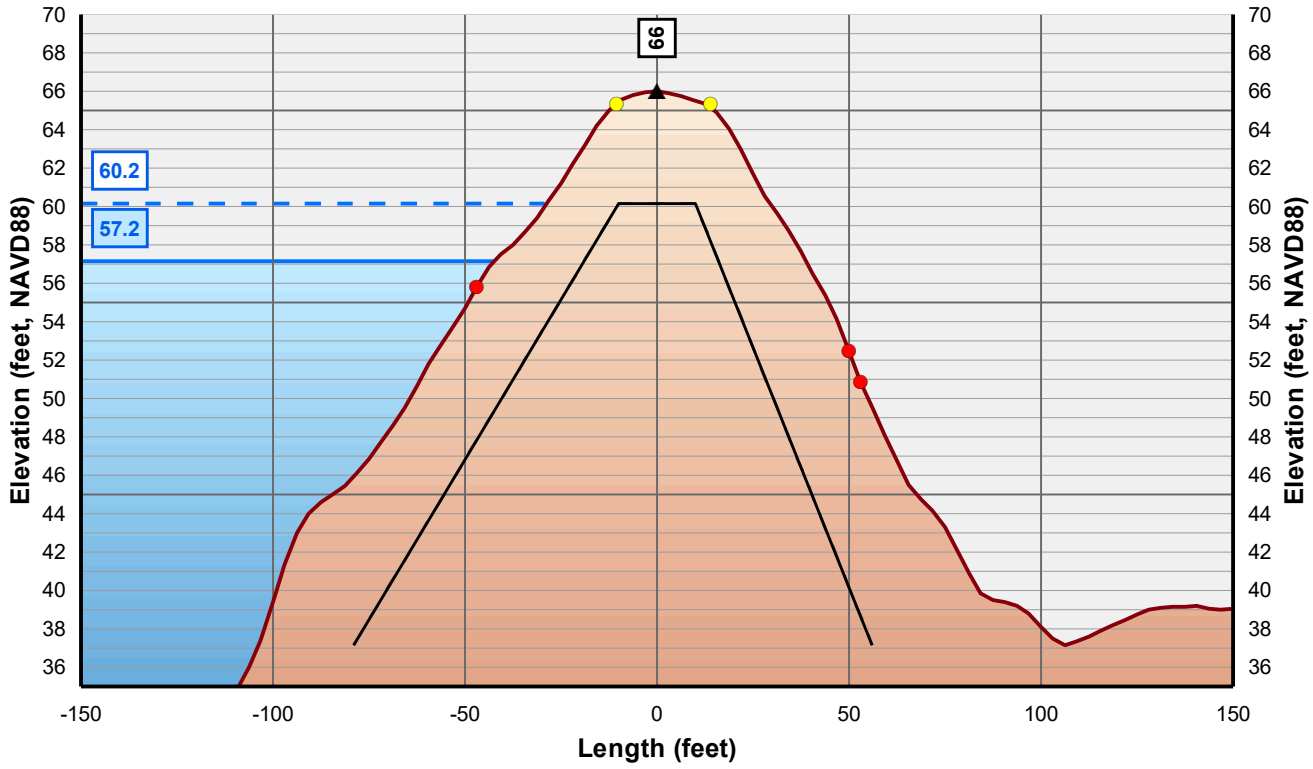
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Cross Section: Bear River 60+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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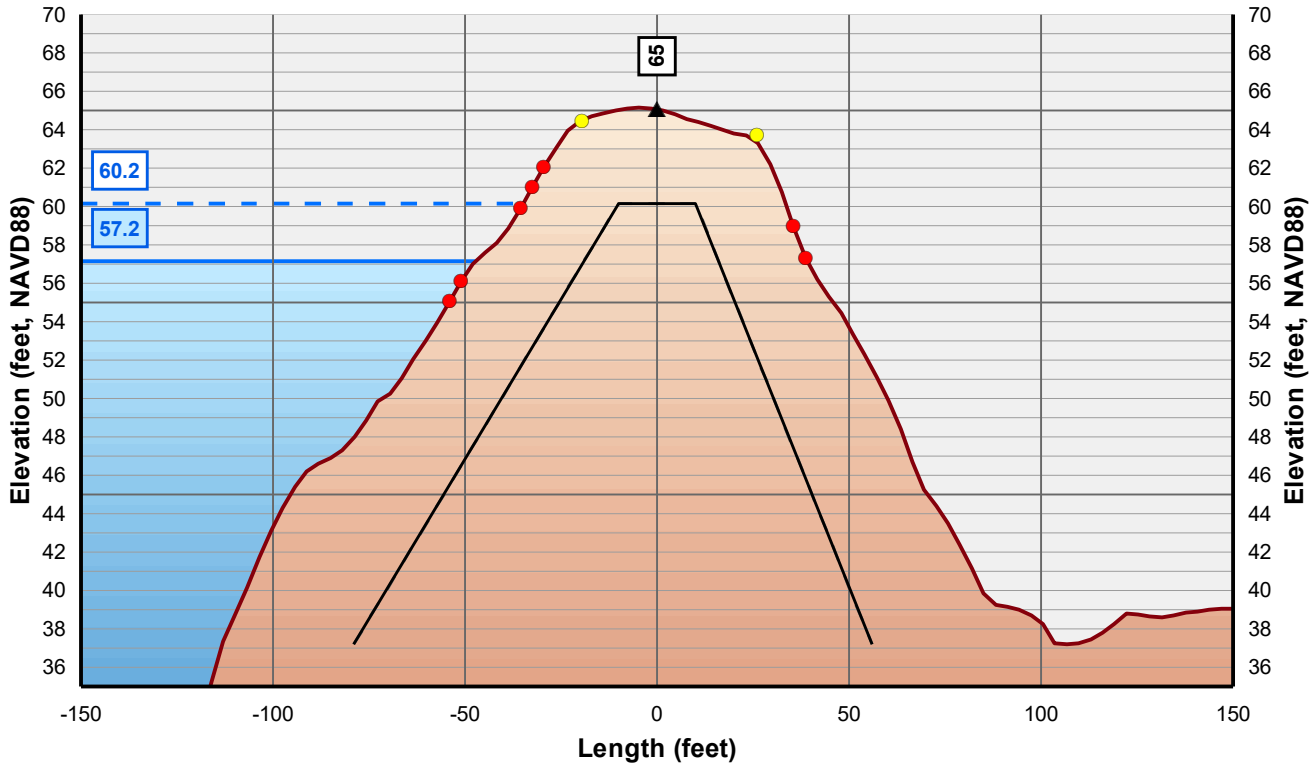
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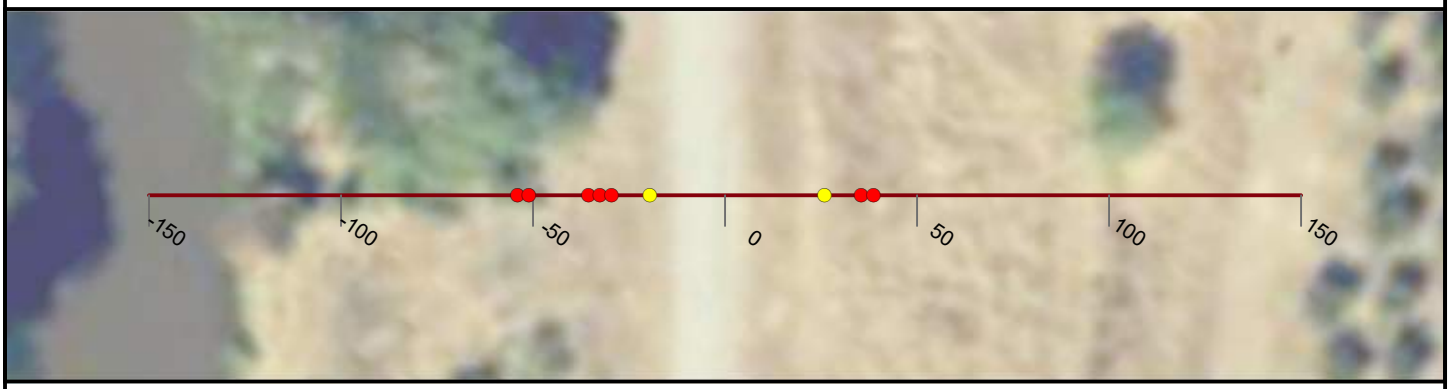
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Cross Section: Bear River 61+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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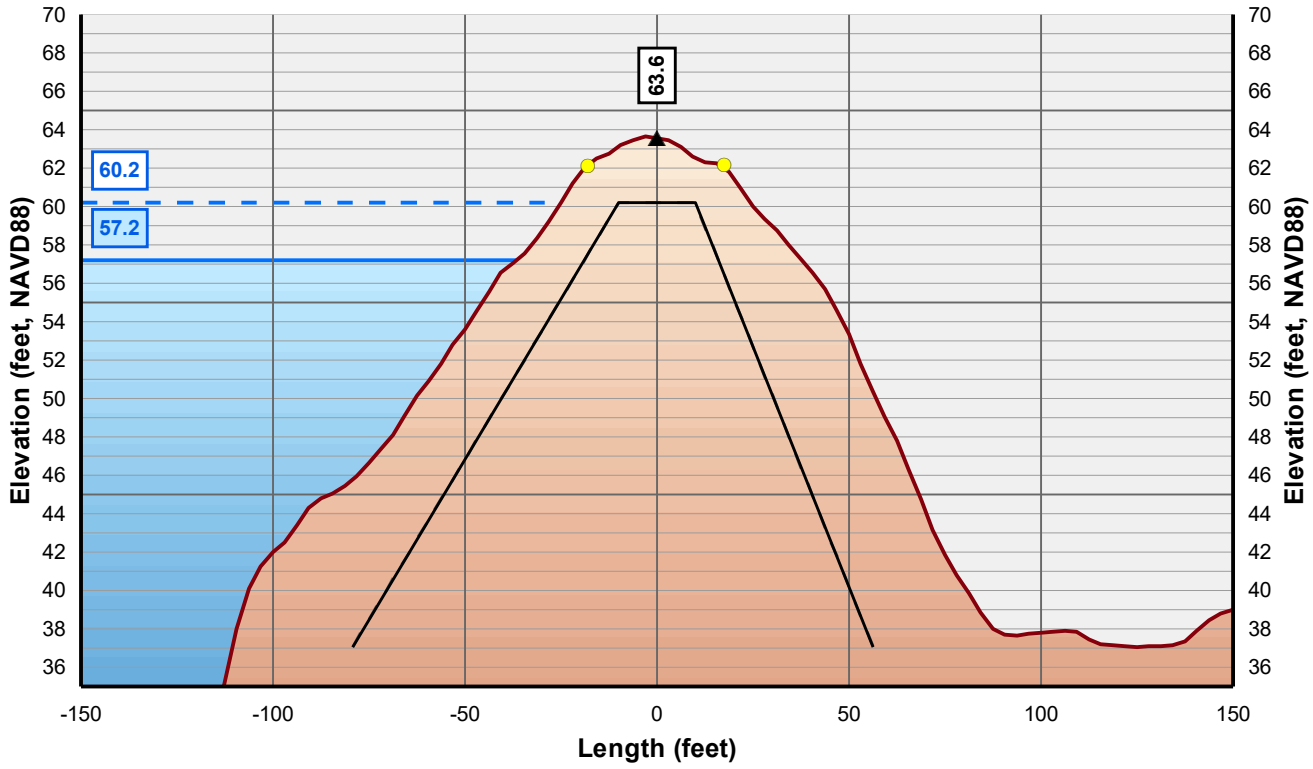
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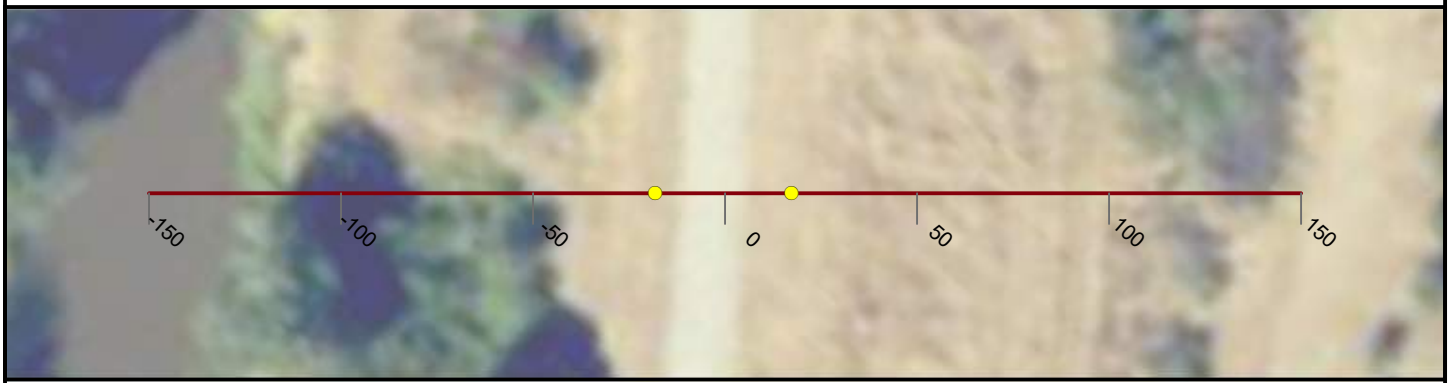
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Cross Section: Bear River 62+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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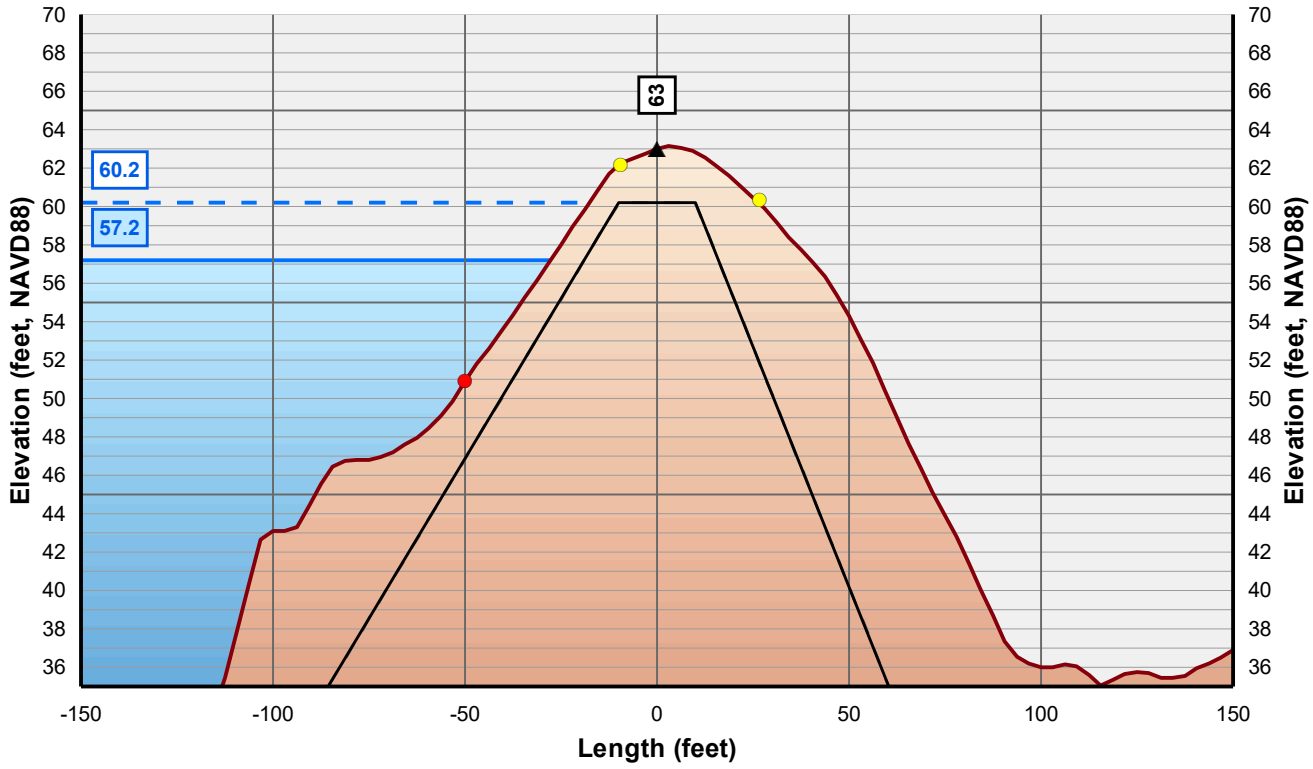
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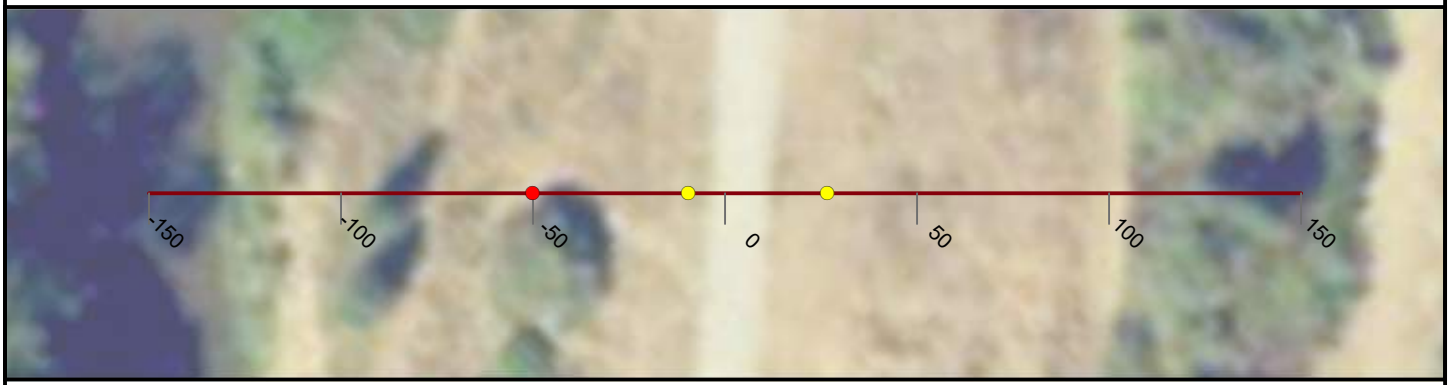
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Cross Section: Bear River 63+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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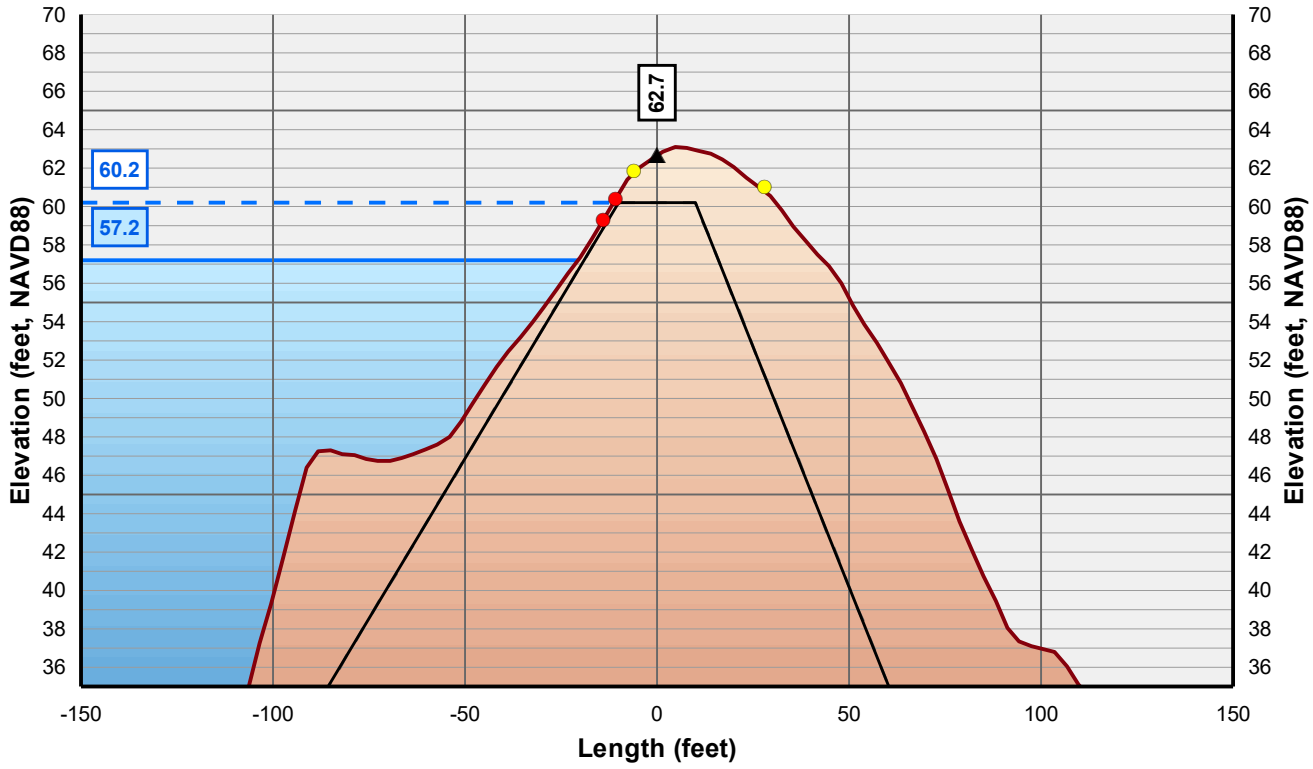
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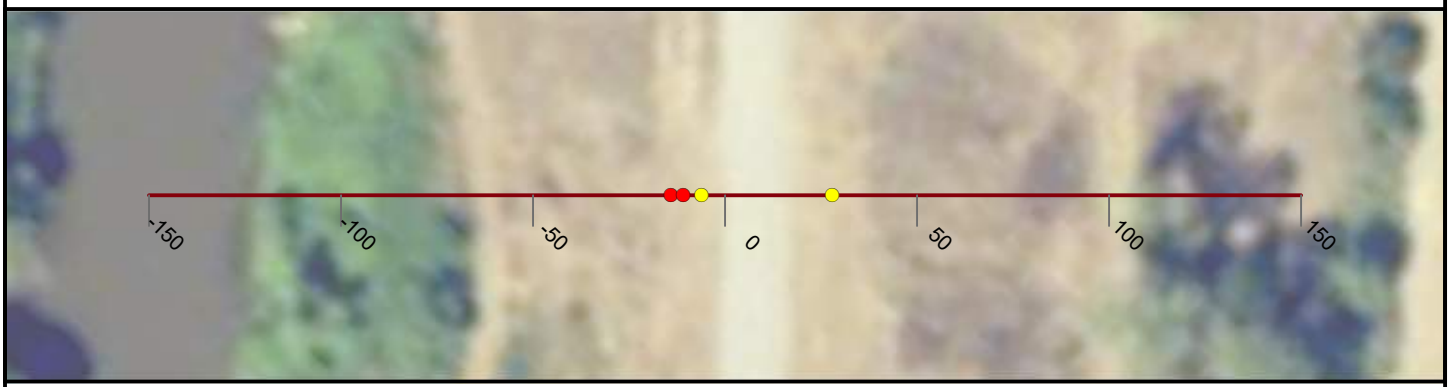
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Cross Section: Bear River 64+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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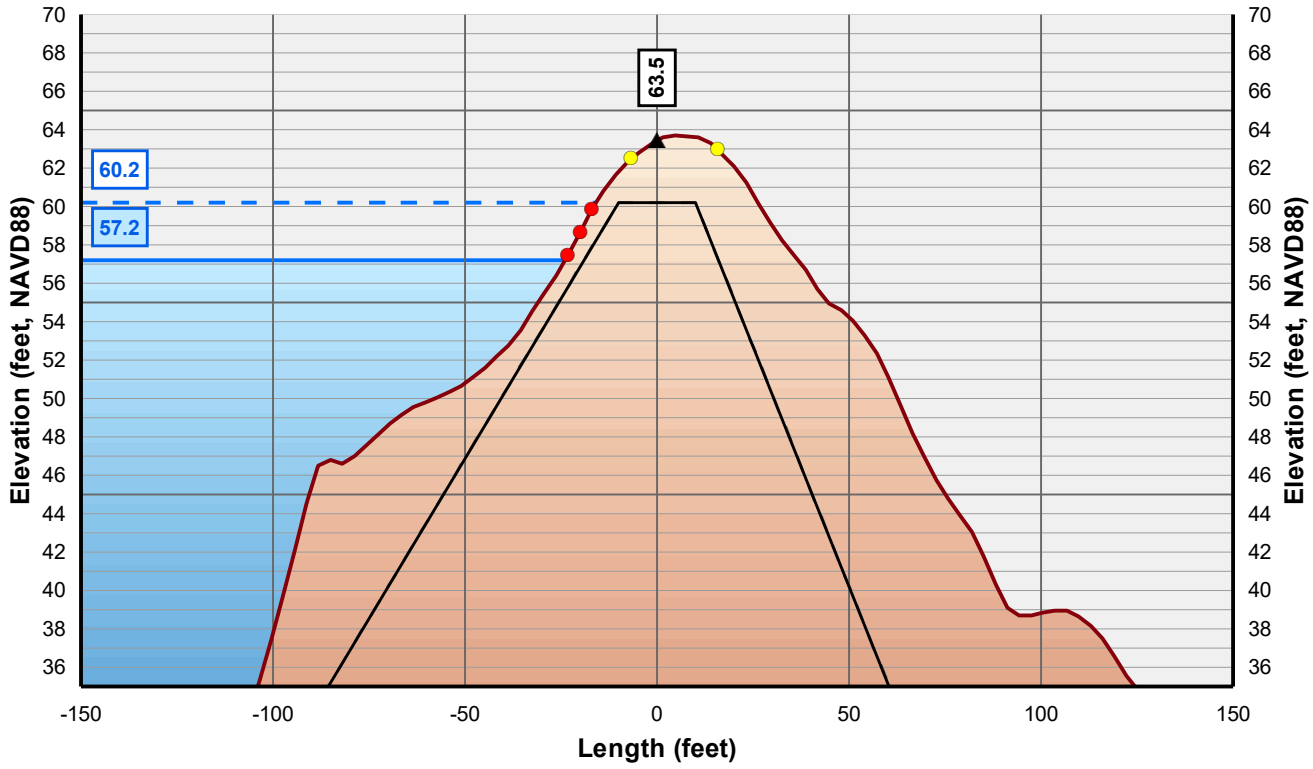
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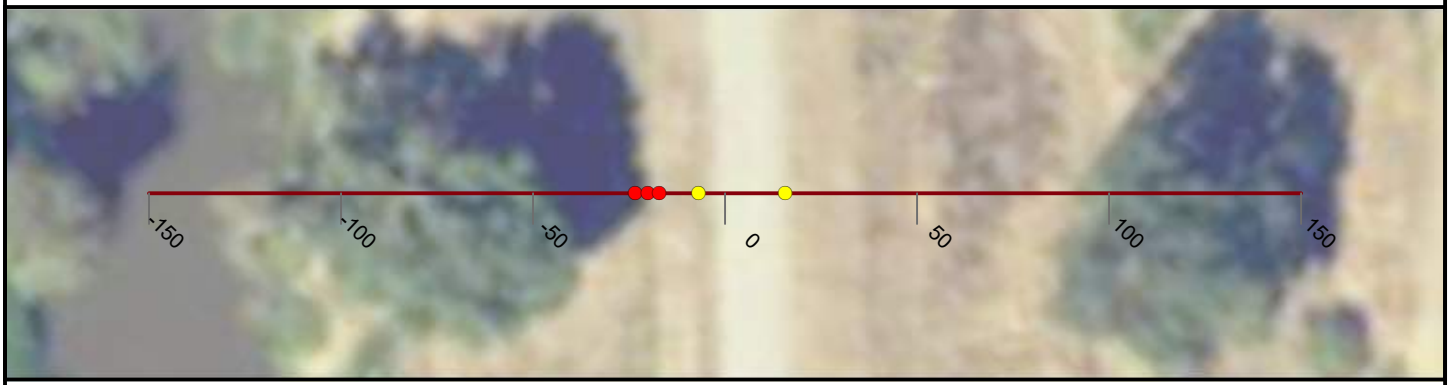
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Cross Section: Bear River 65+00



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- Control Line
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BEAR RIVER LEVEE

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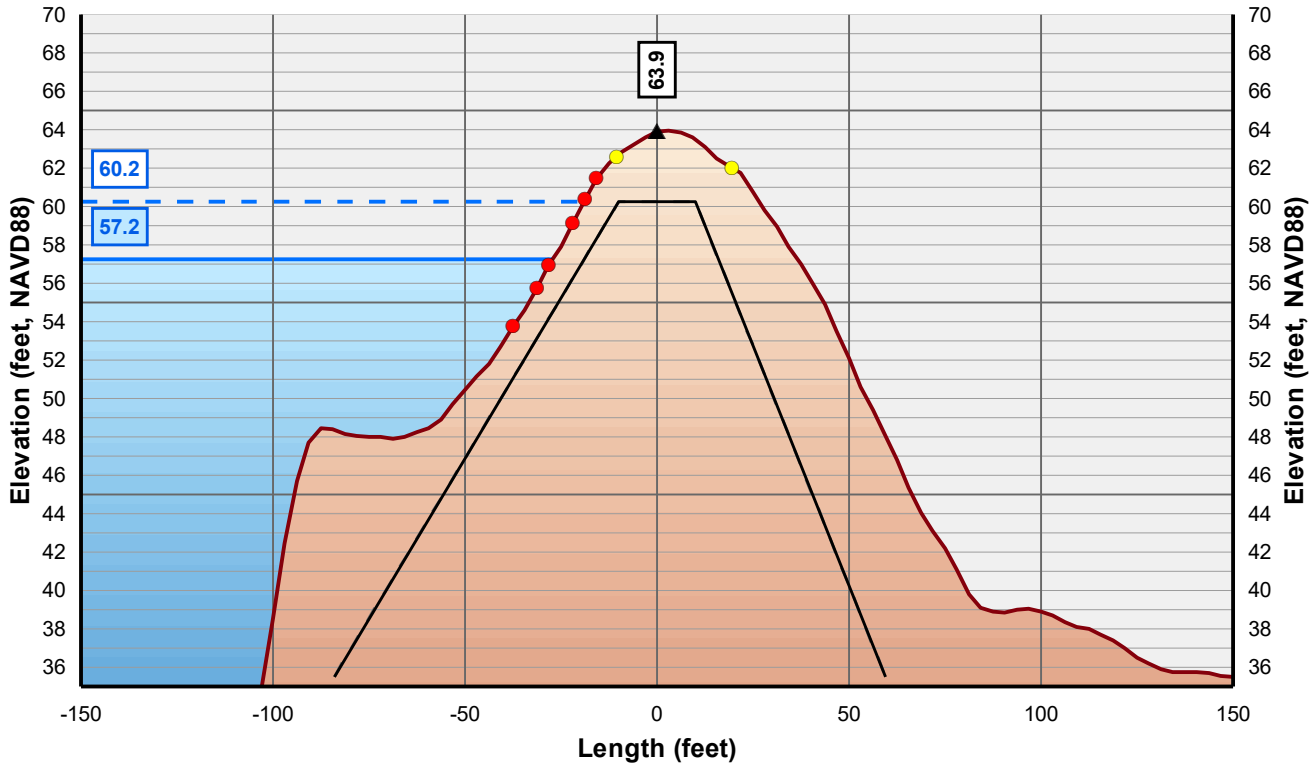
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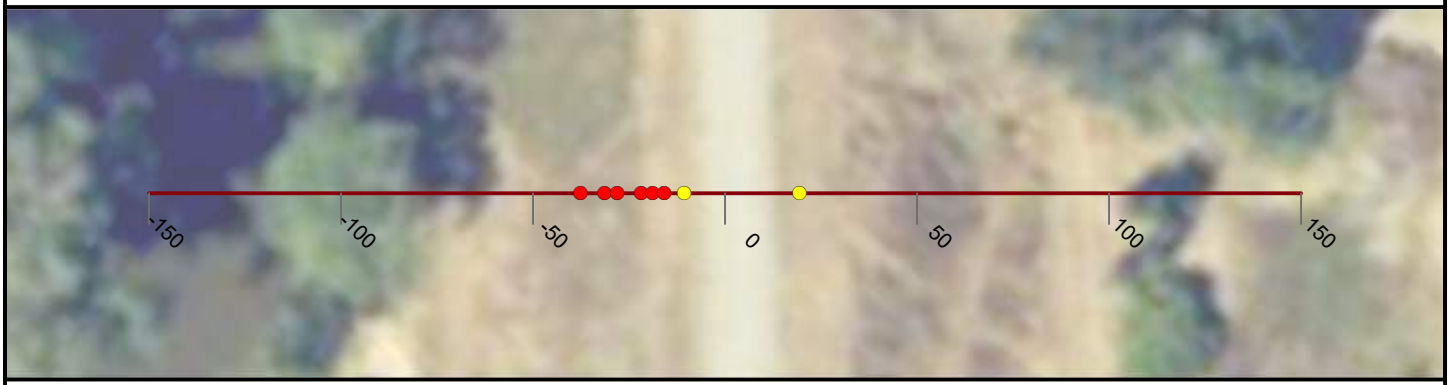
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Cross Section: Bear River 66+00



Horizontal Scale: 1 inch = 50 Feet
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BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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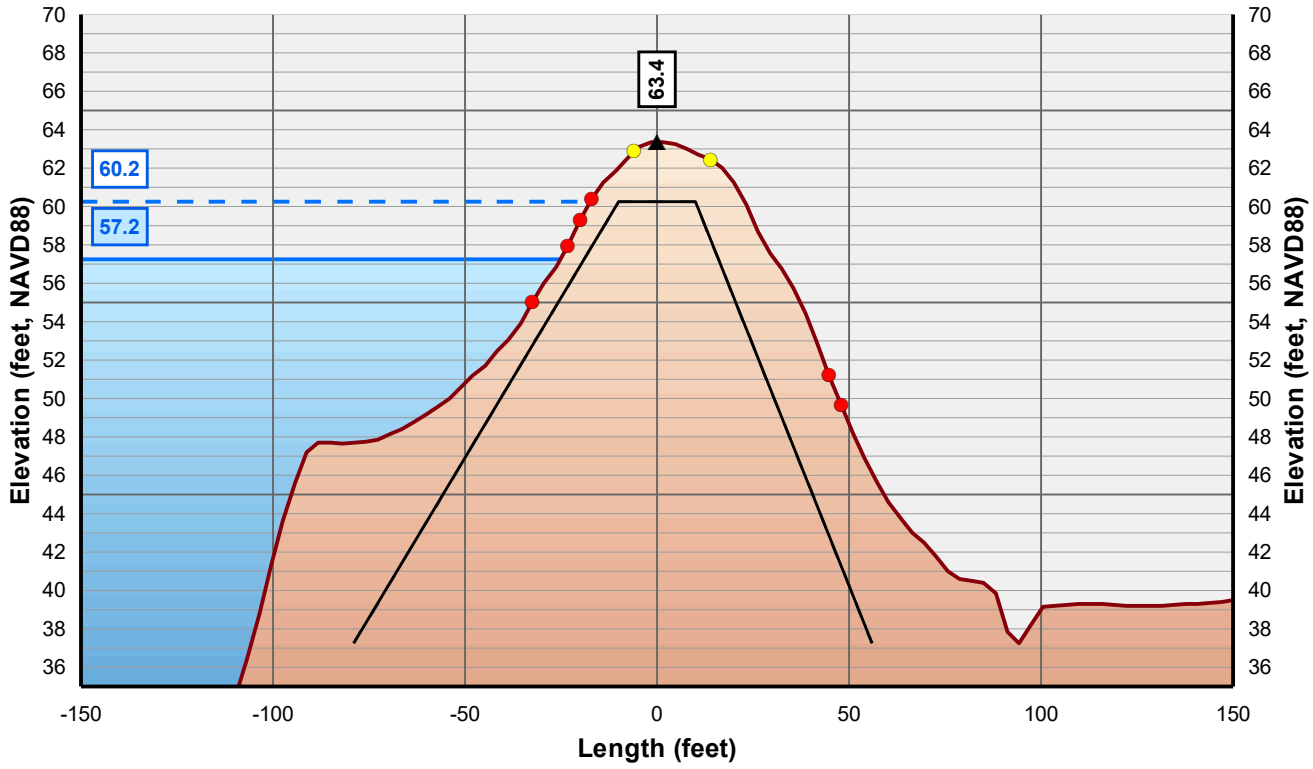
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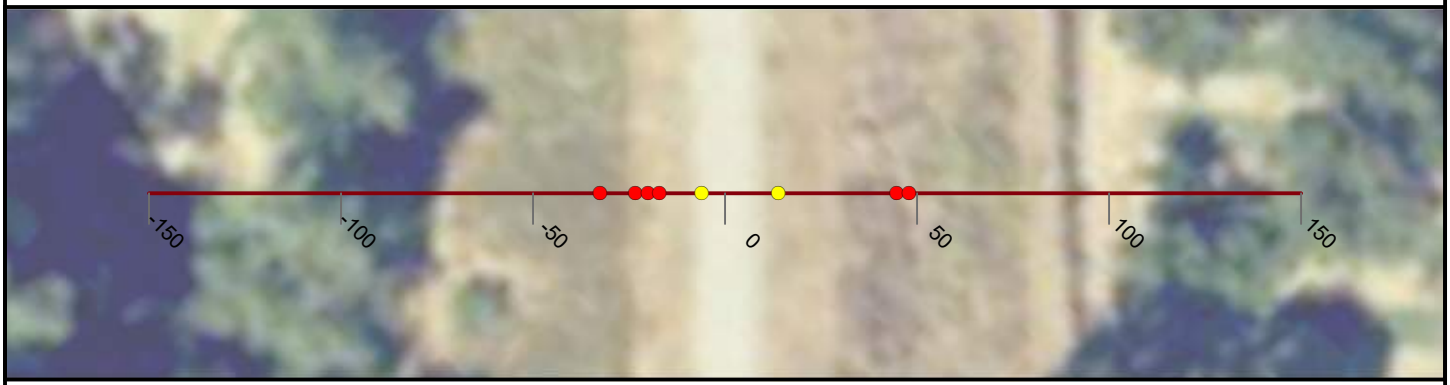
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Cross Section: Bear River 67+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

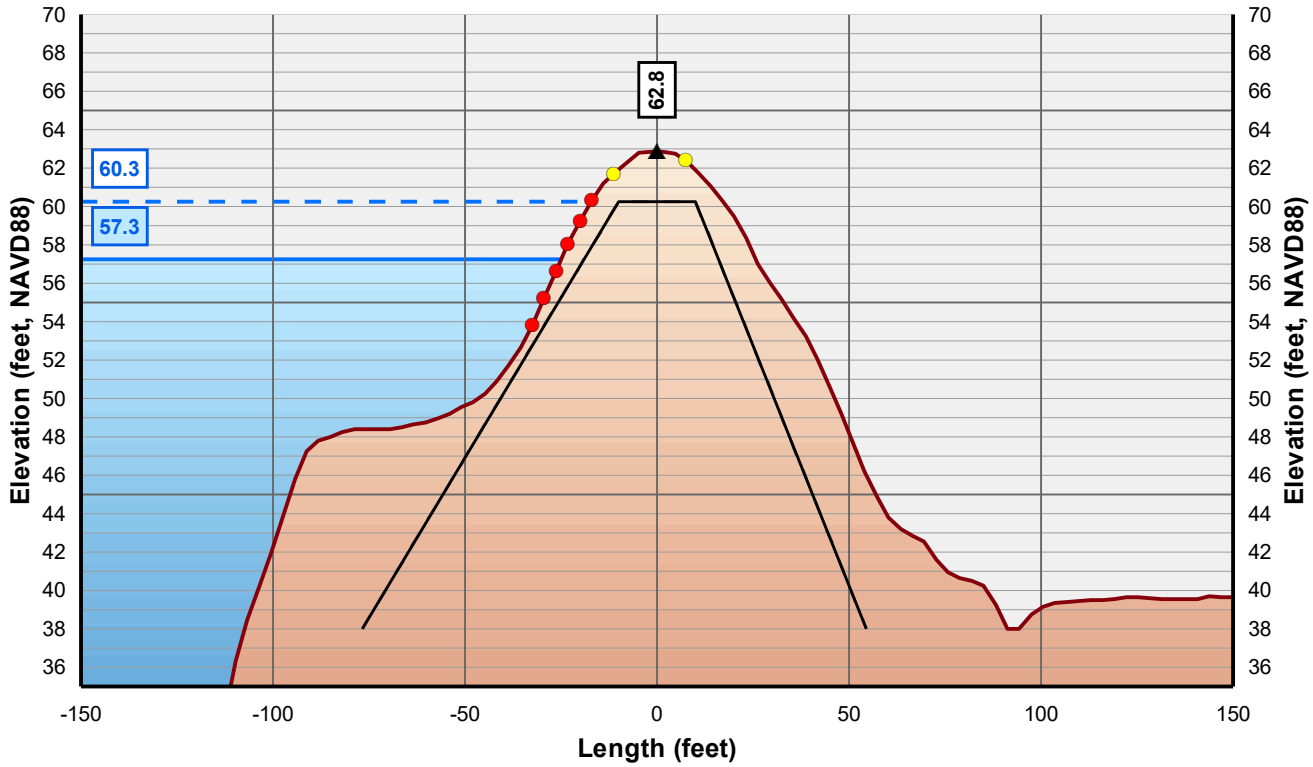
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
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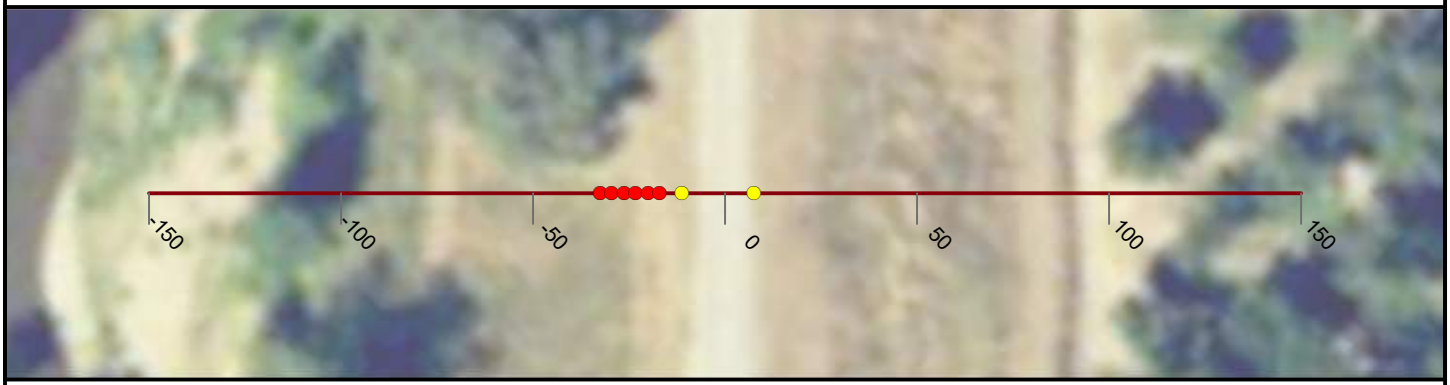
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Cross Section: Bear River 68+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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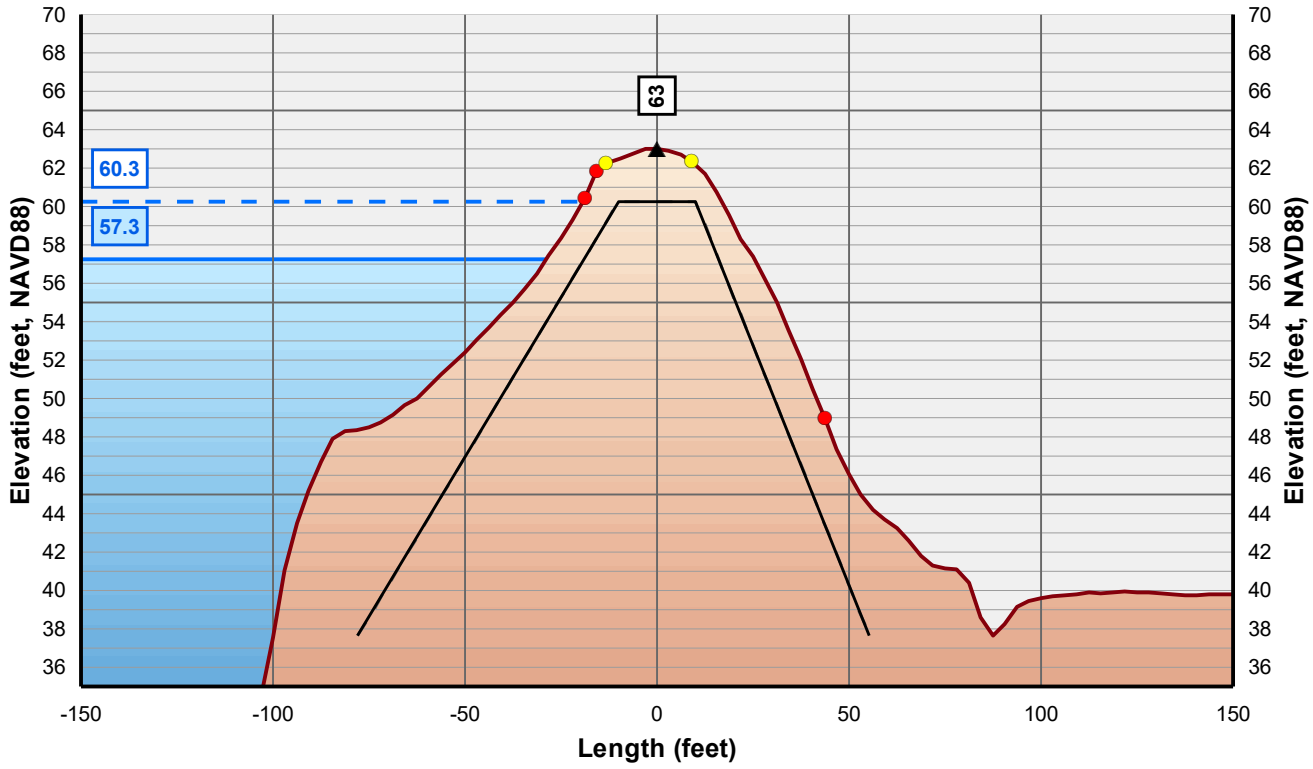
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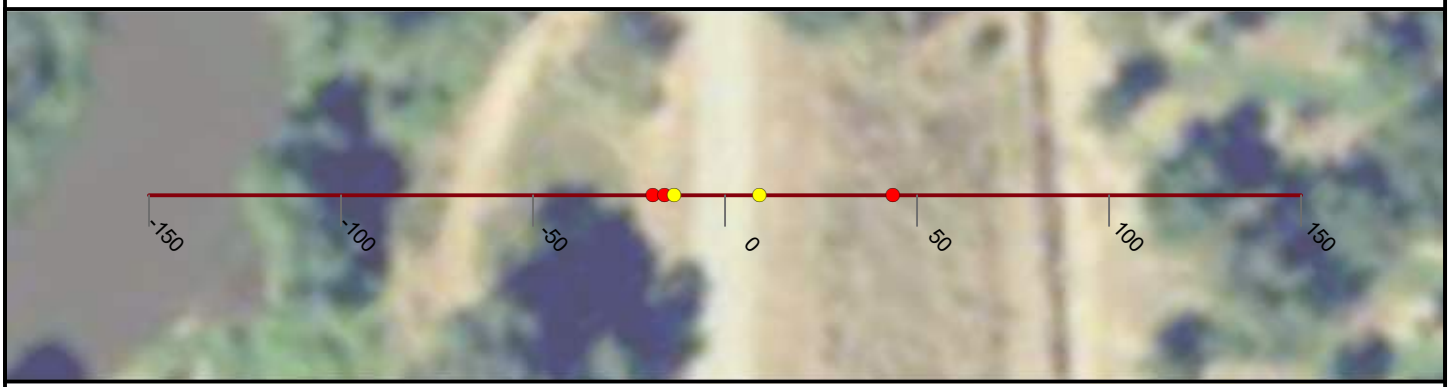
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Cross Section: Bear River 69+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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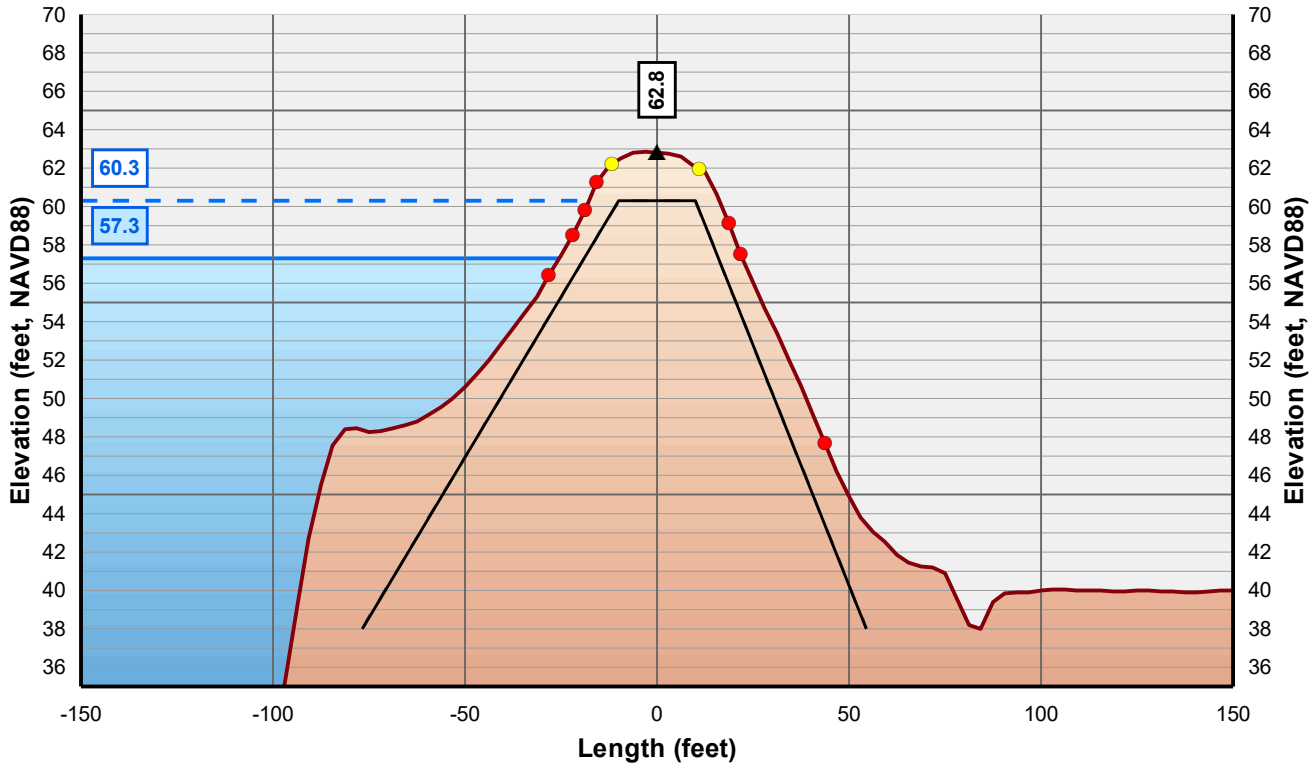
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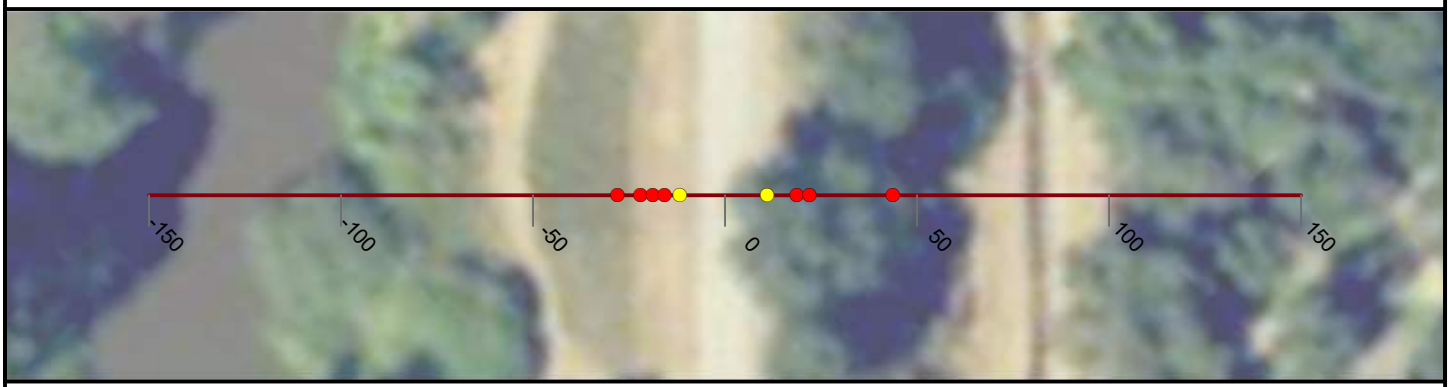
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Cross Section: Bear River 70+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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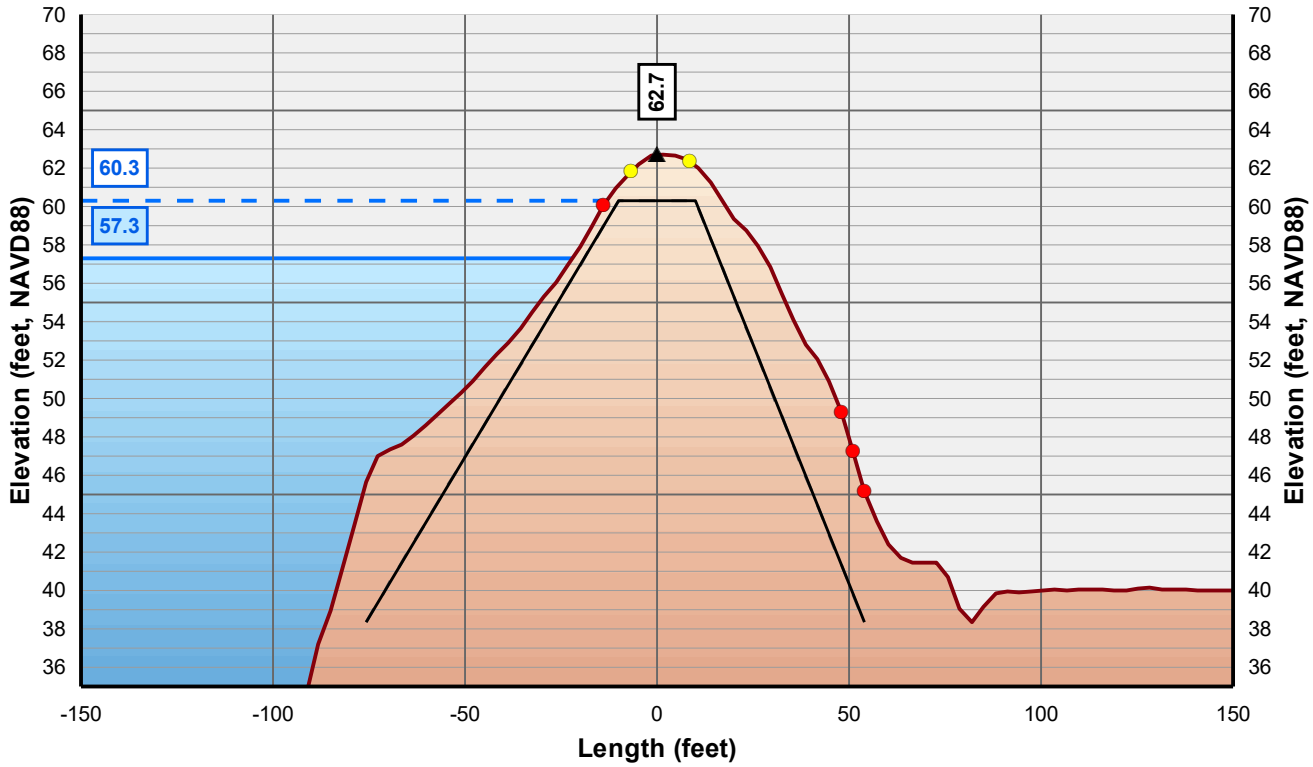
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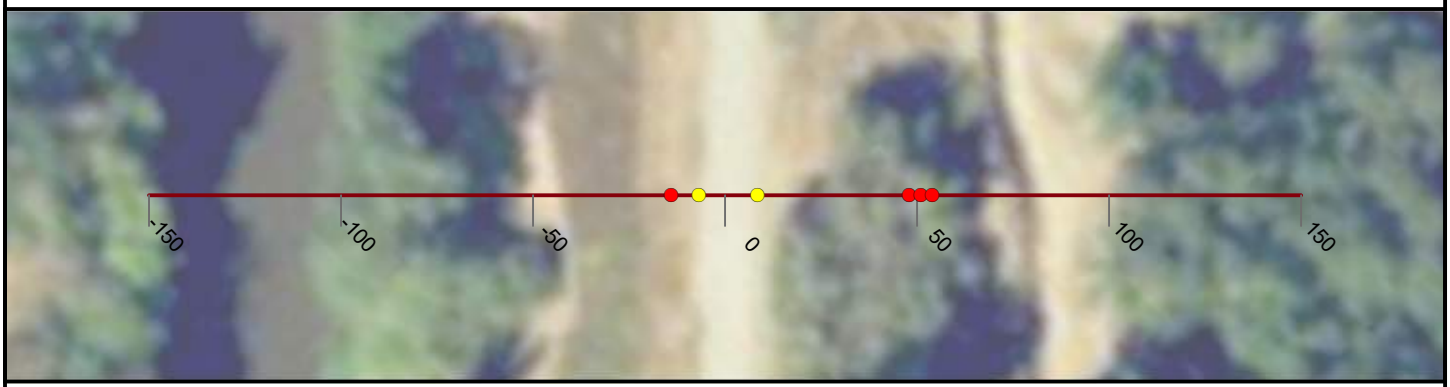
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Cross Section: Bear River 71+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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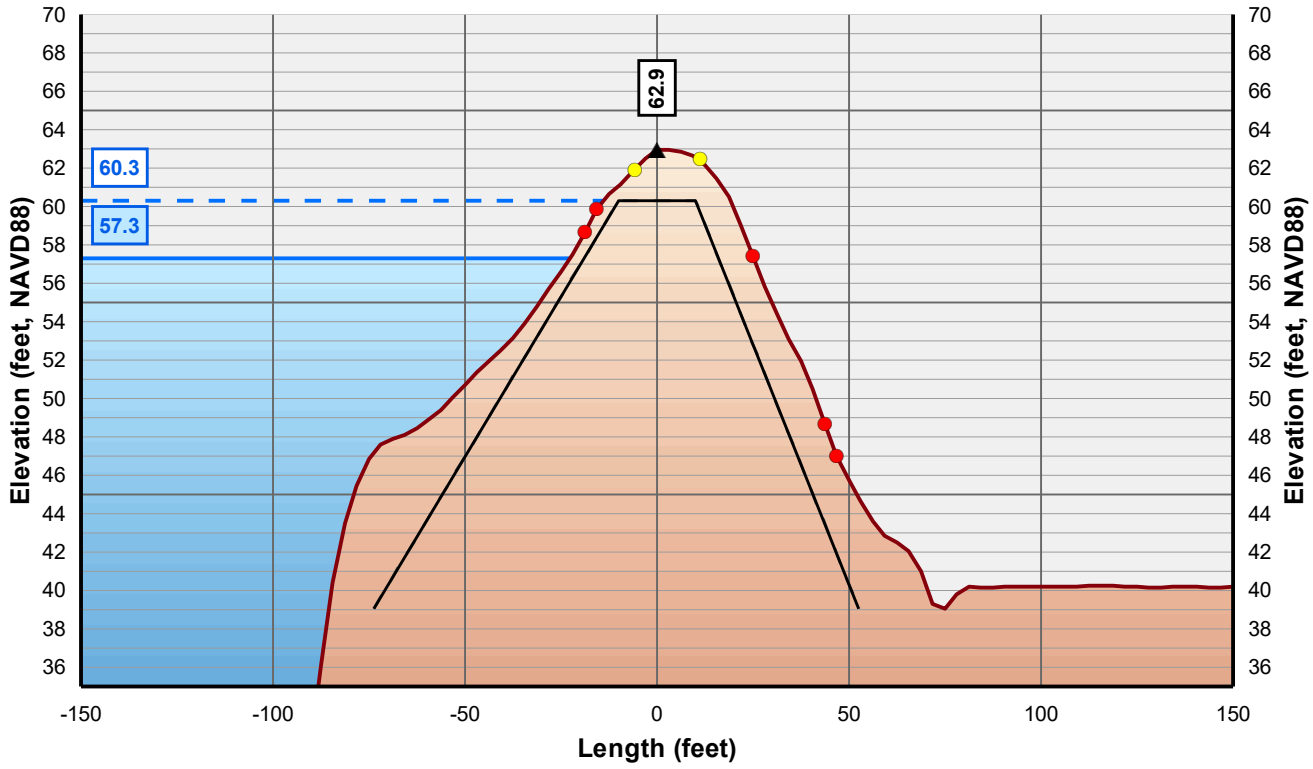
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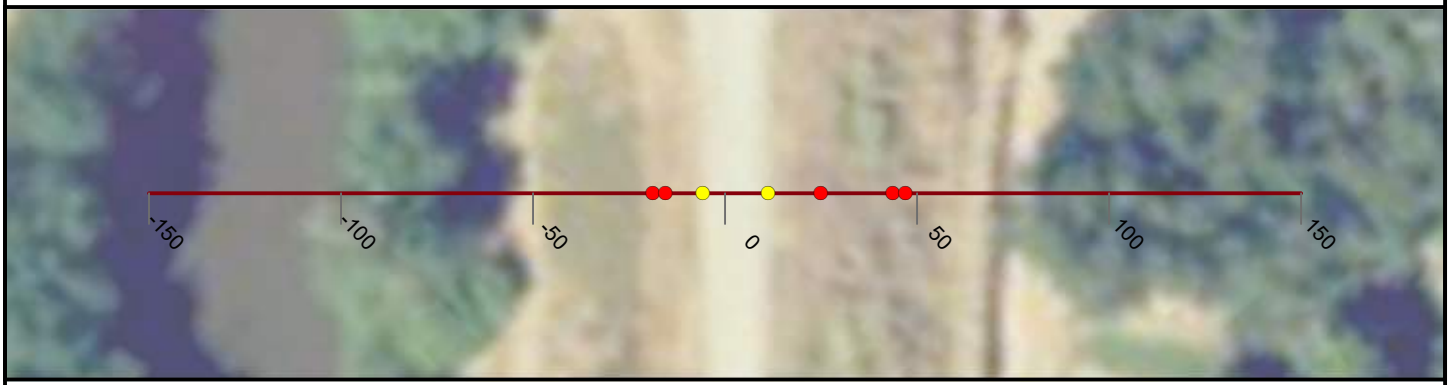
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Cross Section: Bear River 72+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

▲ Control Line
● Crown Point
● Issue Point
Existing Levee
Theoretical Levee Prism Preliminary
Theoretical Levee Prism Final
Water Surface Elevation + 3 Feet
Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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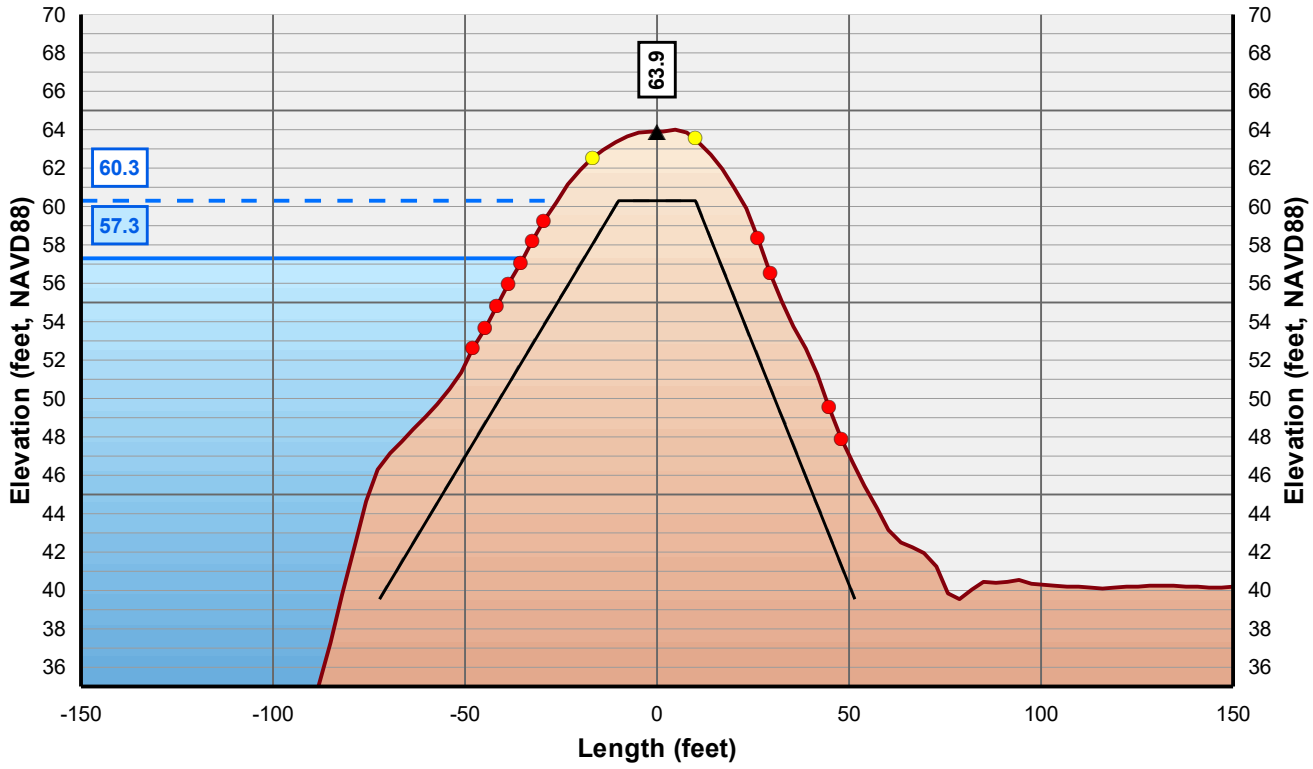
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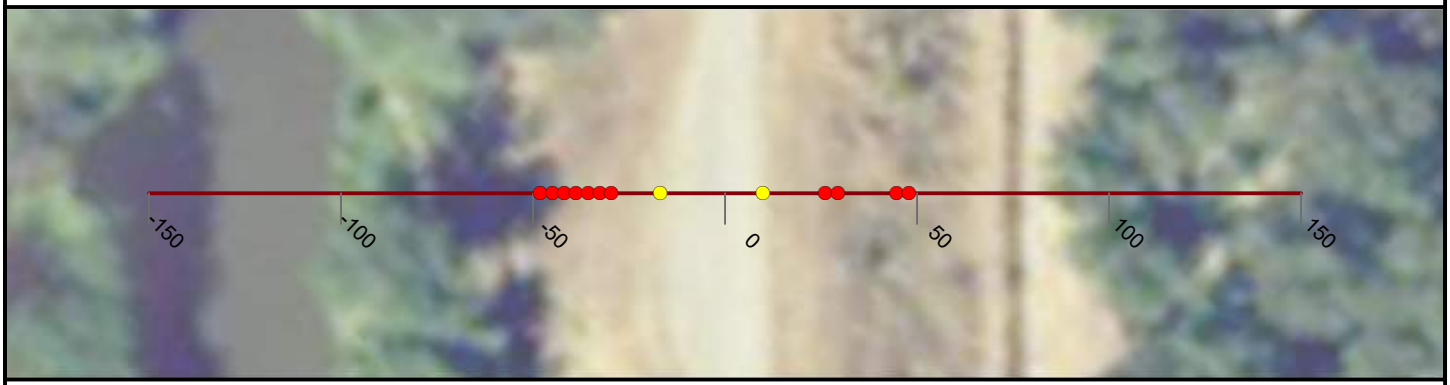
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Cross Section: Bear River 73+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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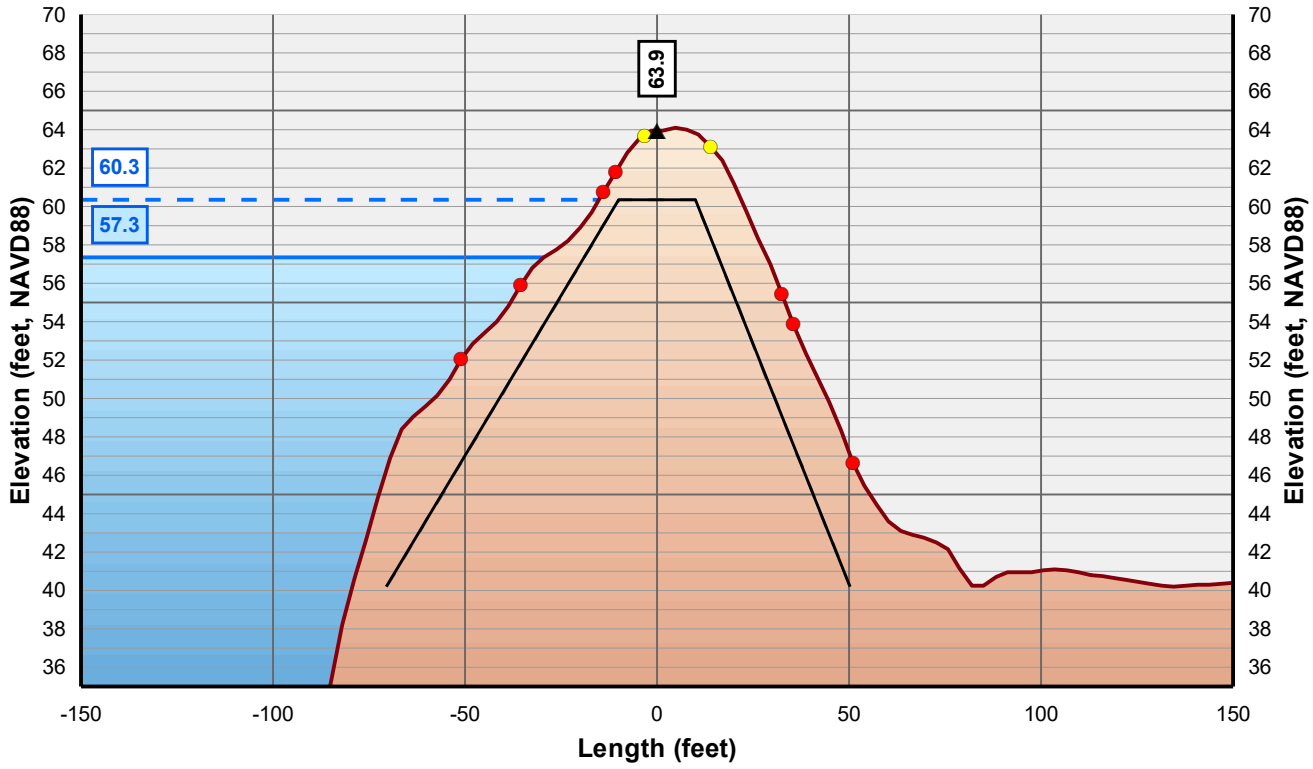
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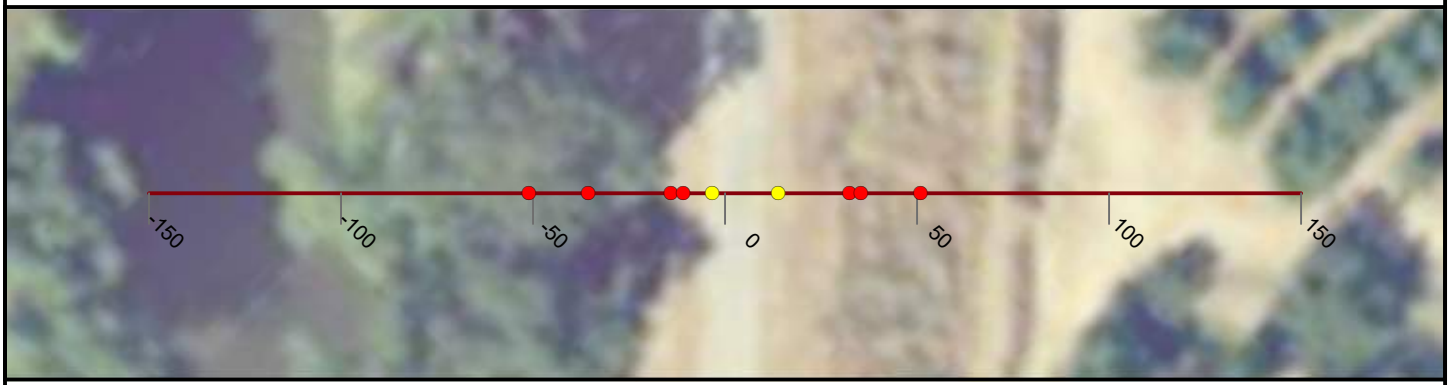
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Cross Section: Bear River 74+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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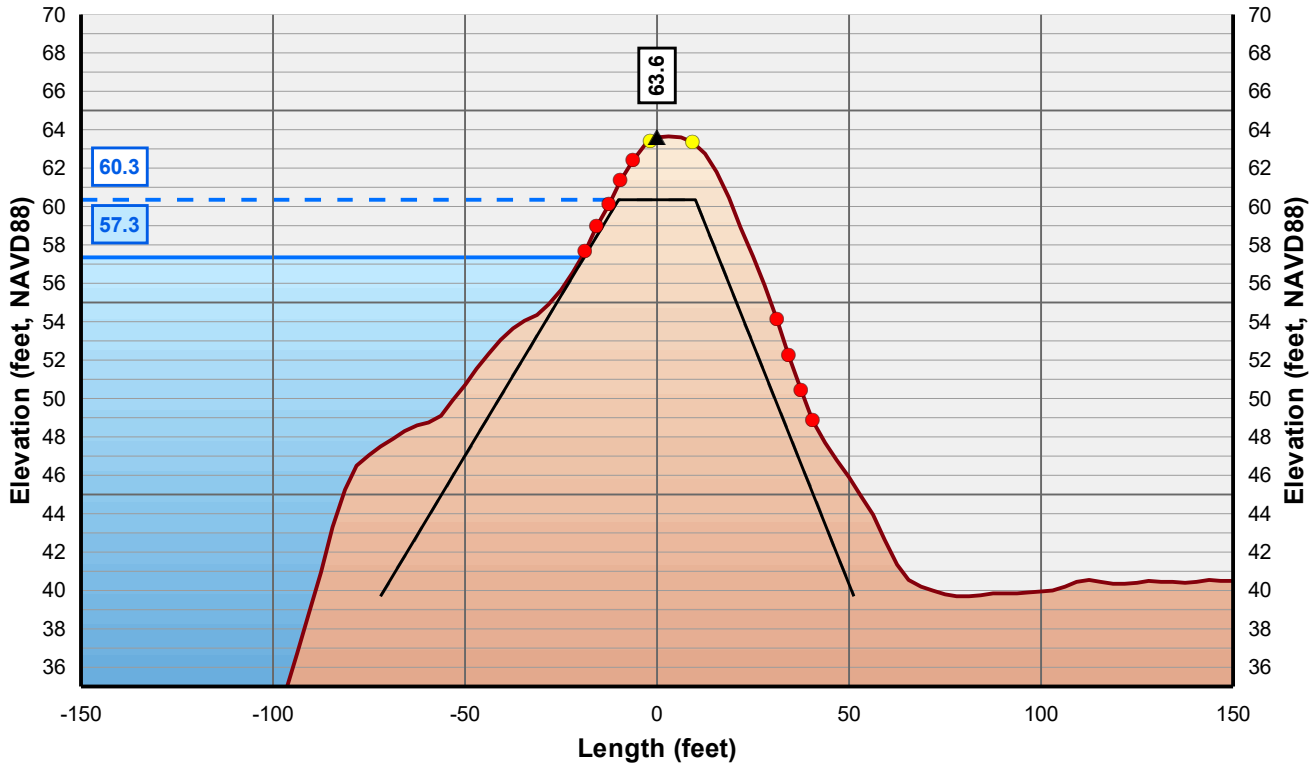
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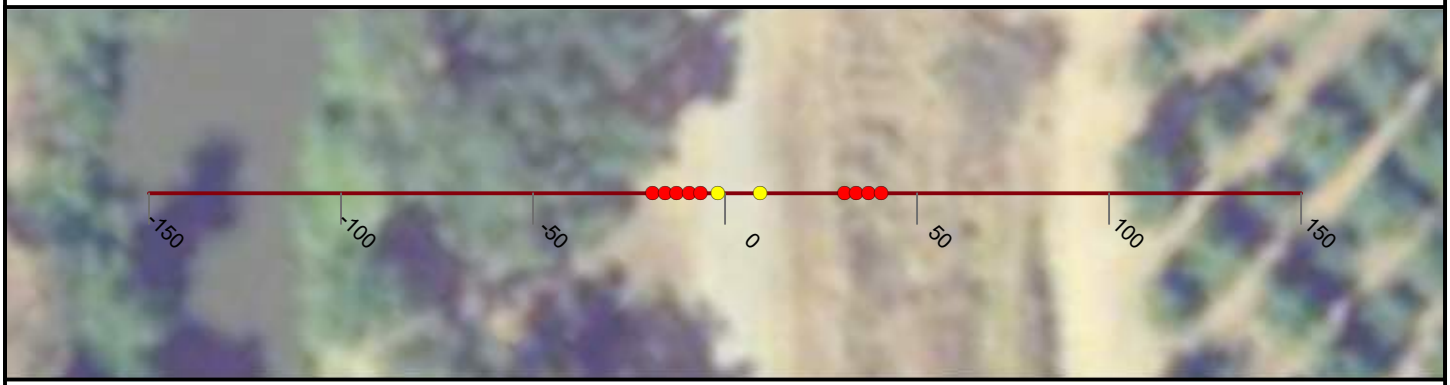
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Cross Section: Bear River 75+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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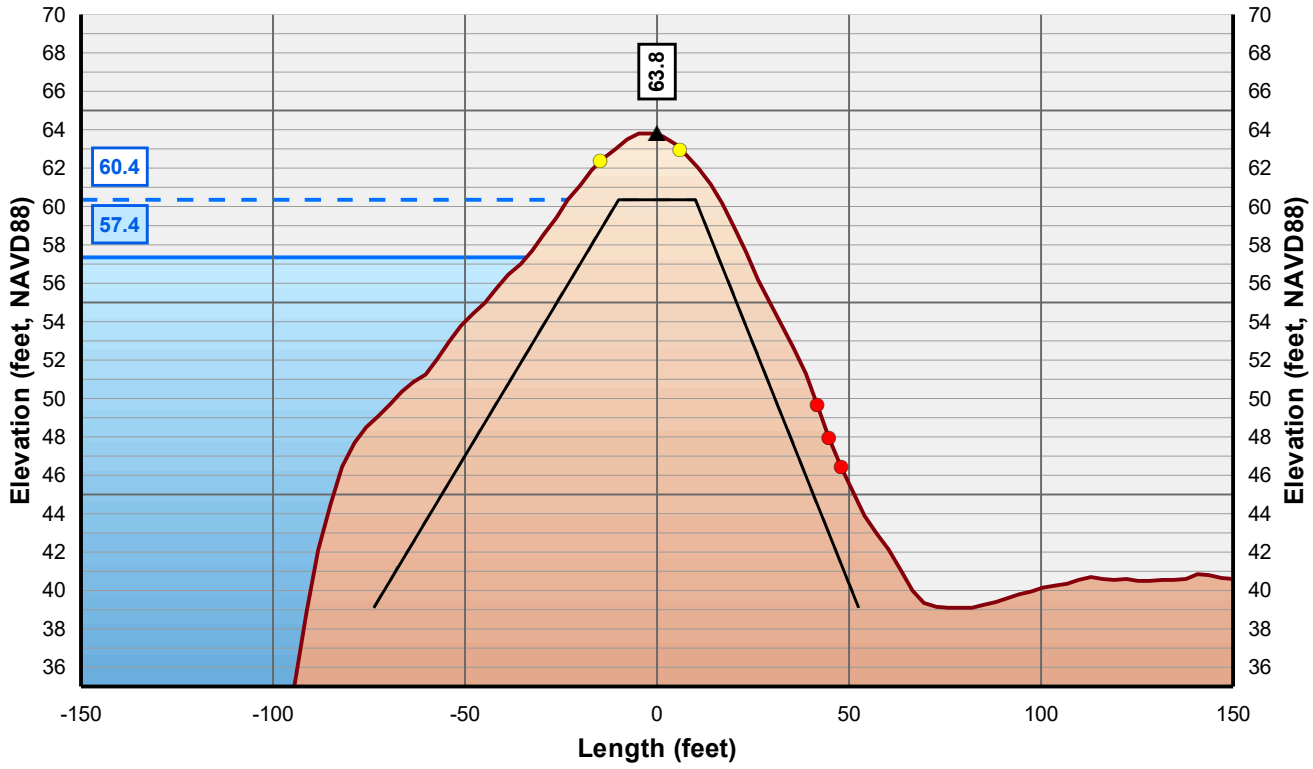
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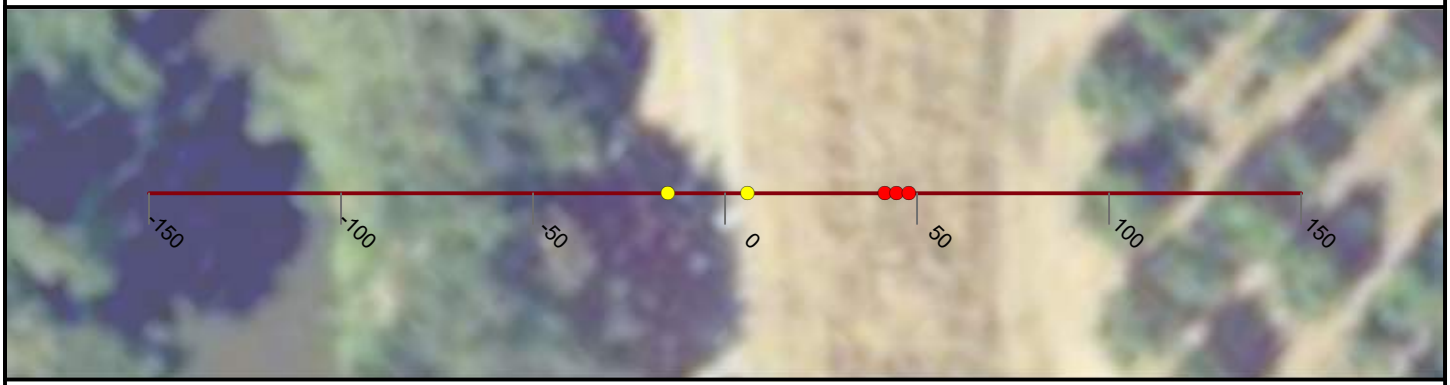
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Cross Section: Bear River 76+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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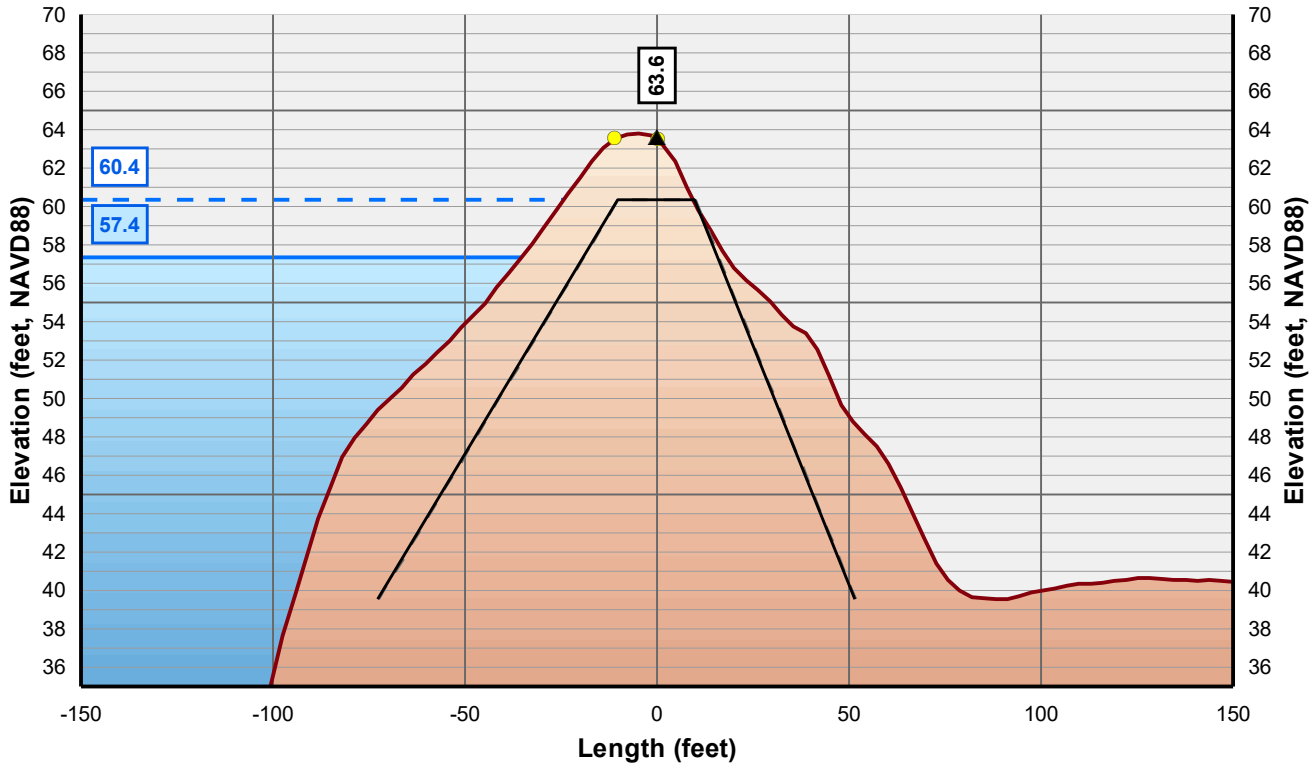
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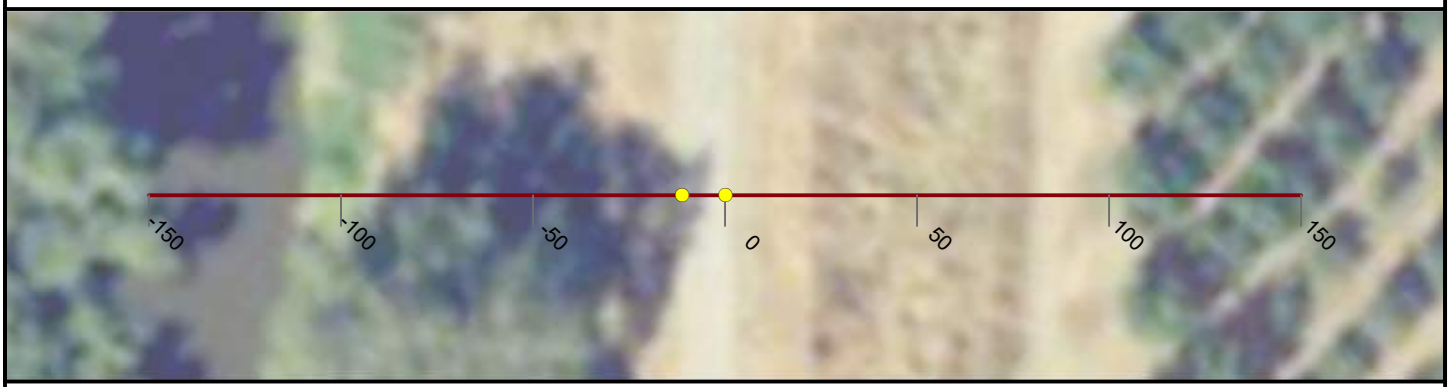
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Cross Section: Bear River 77+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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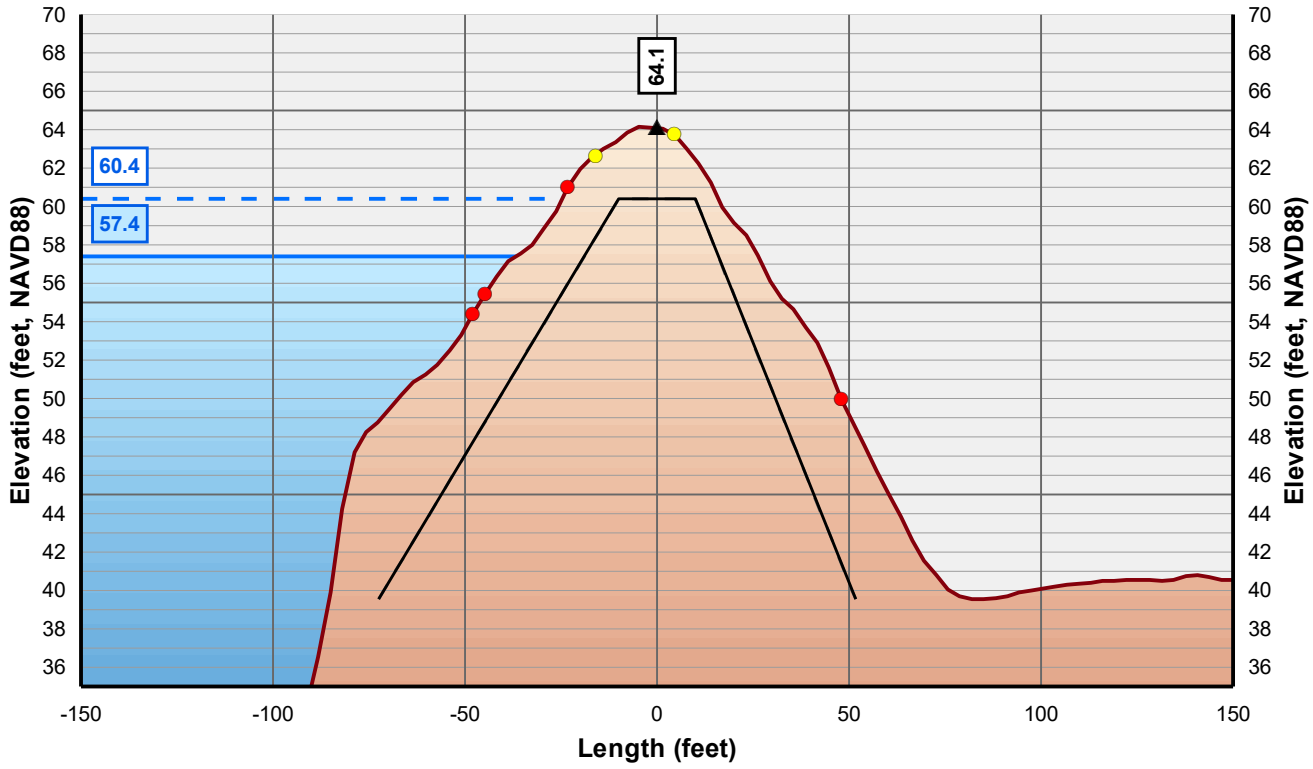
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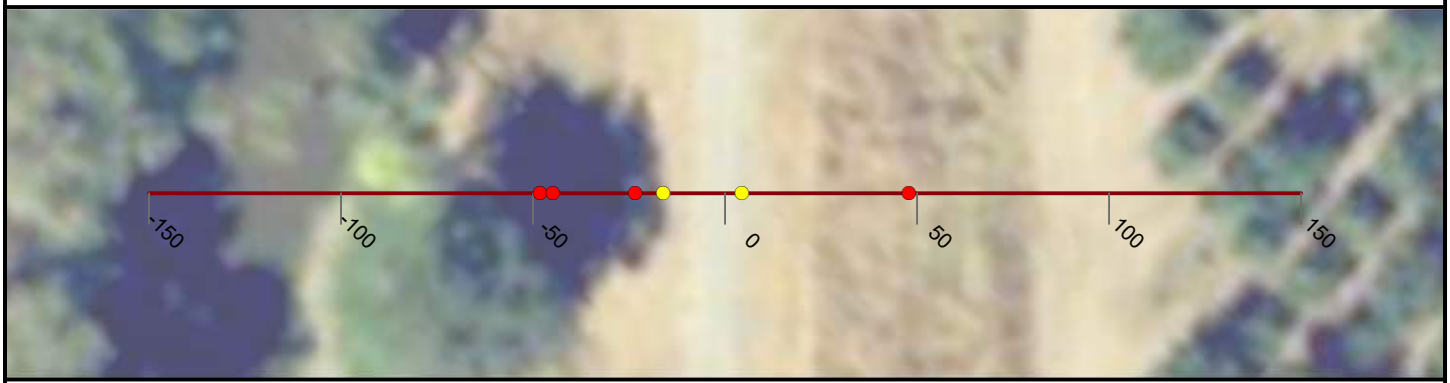
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Cross Section: Bear River 78+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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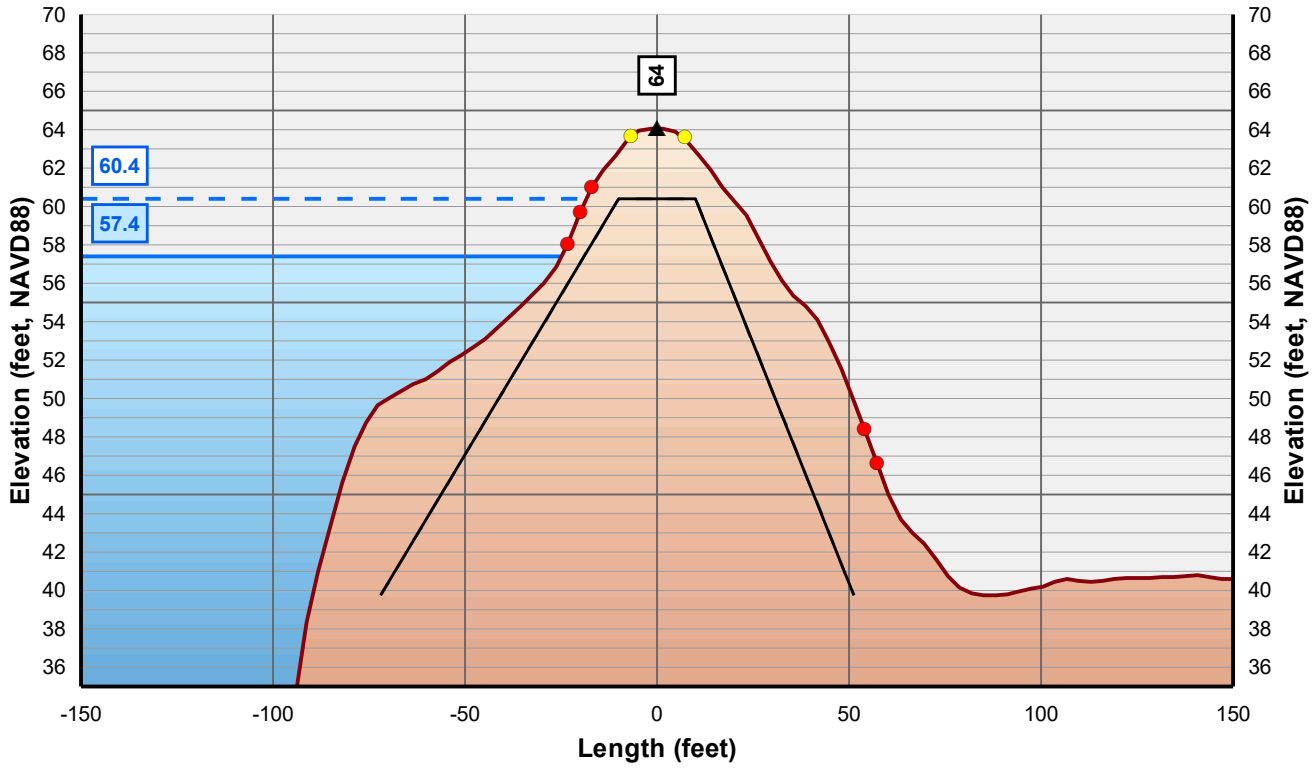
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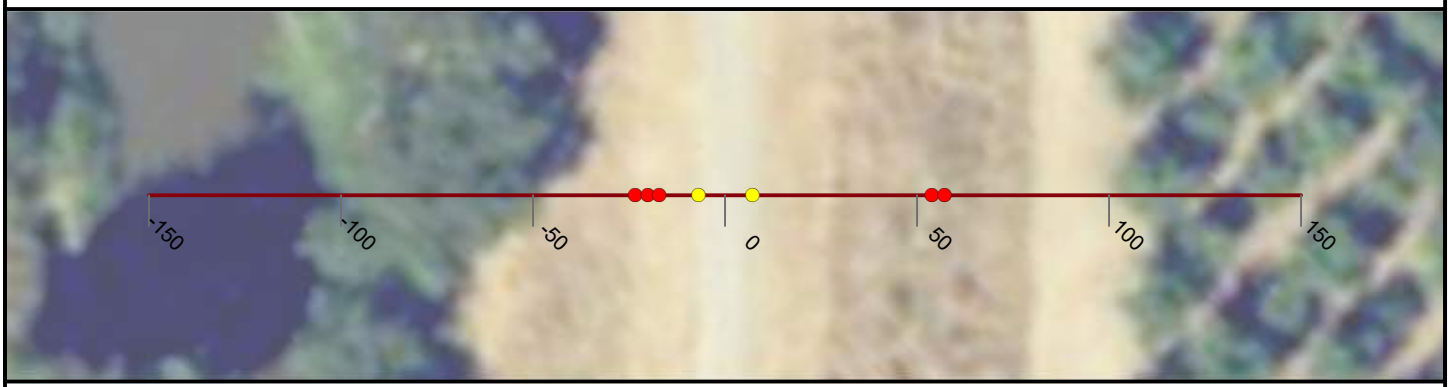
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Cross Section: Bear River 79+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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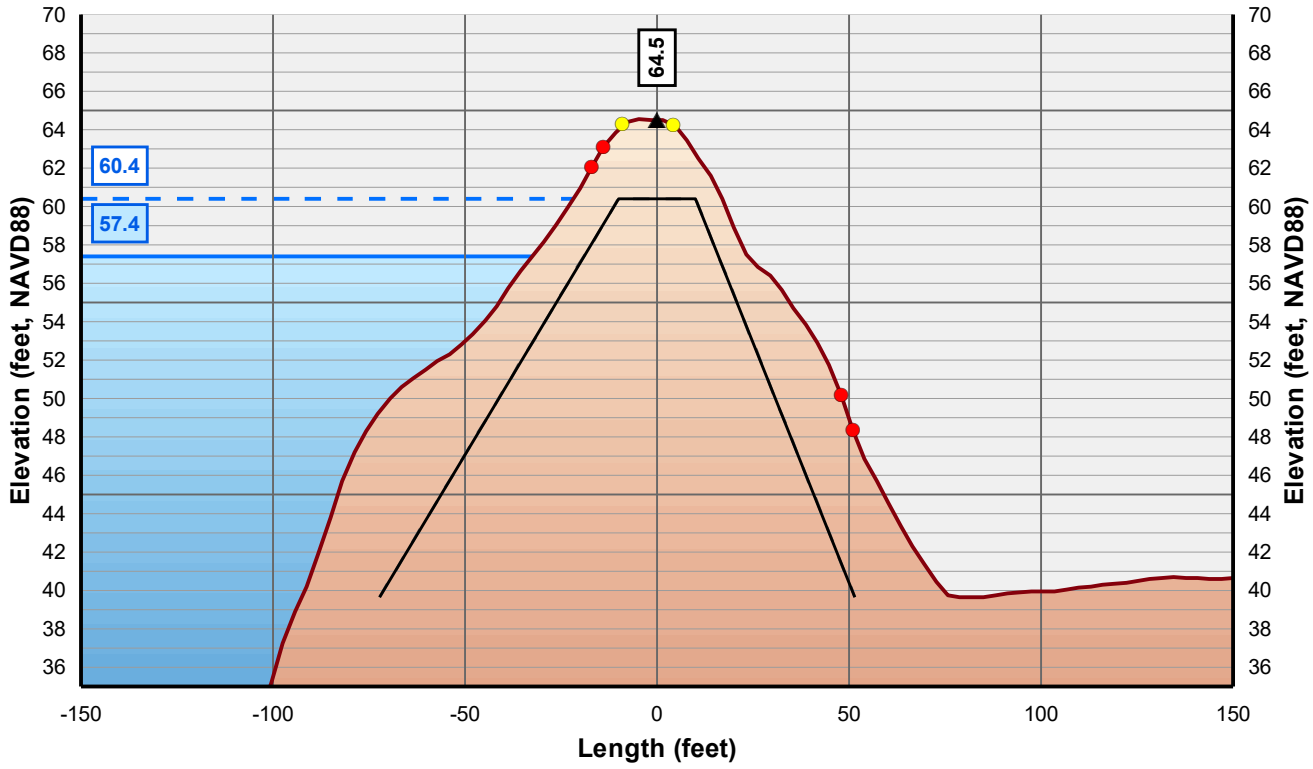
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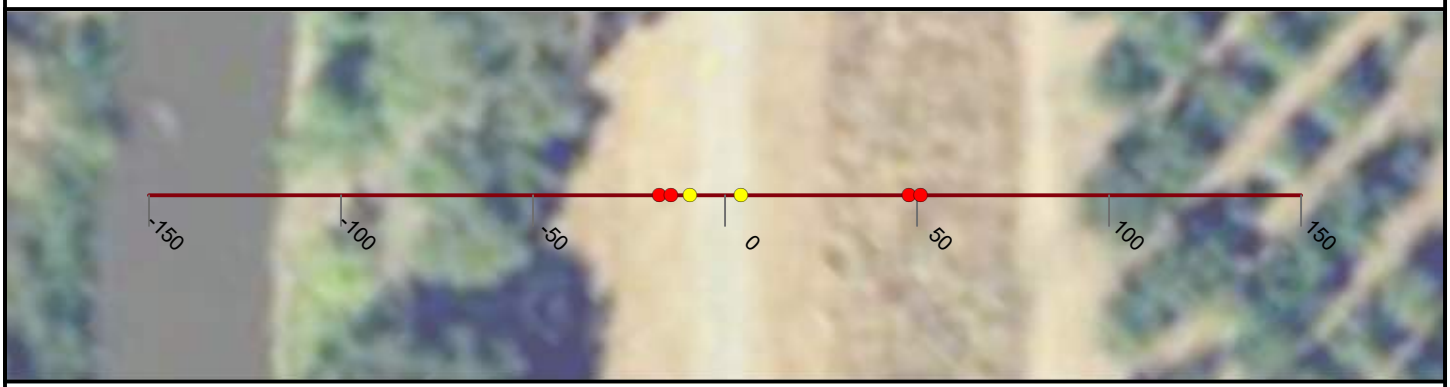
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Cross Section: Bear River 80+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

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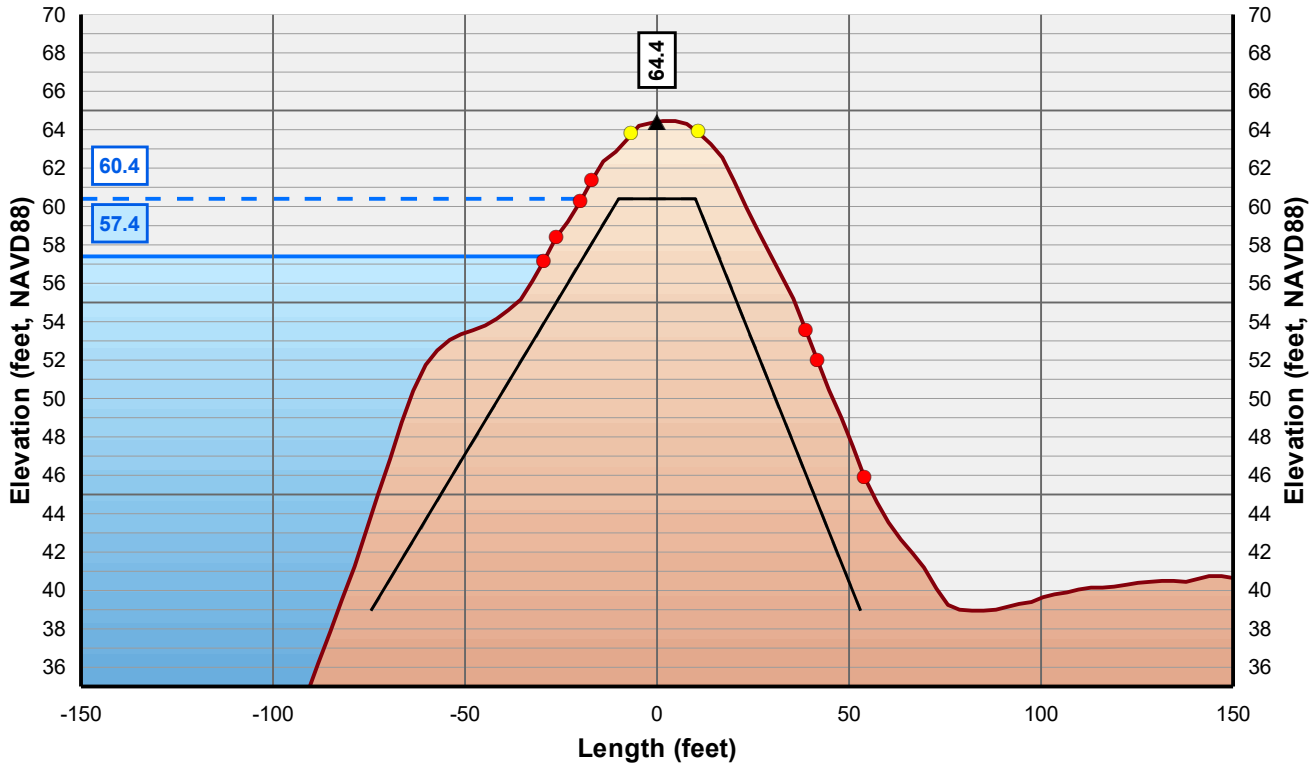
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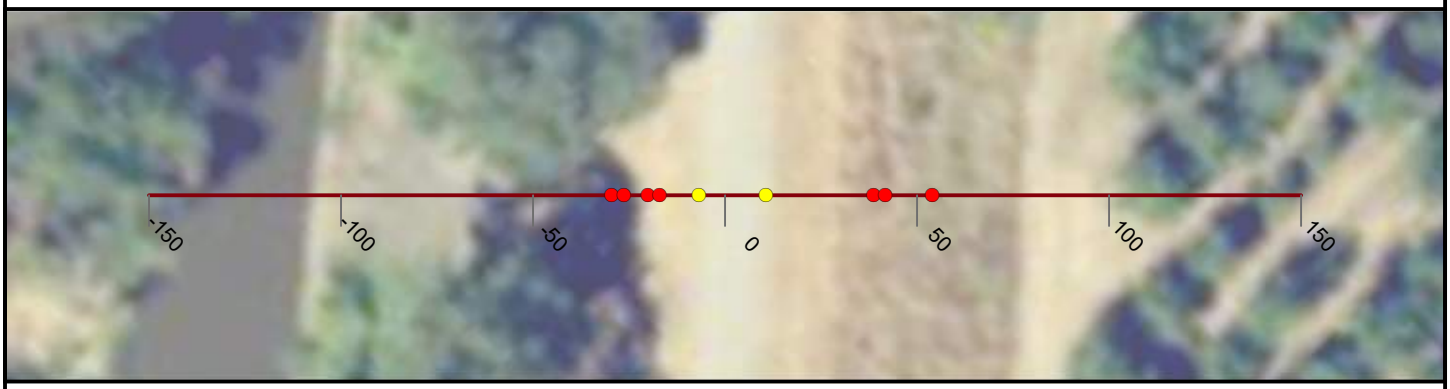
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Cross Section: Bear River 81+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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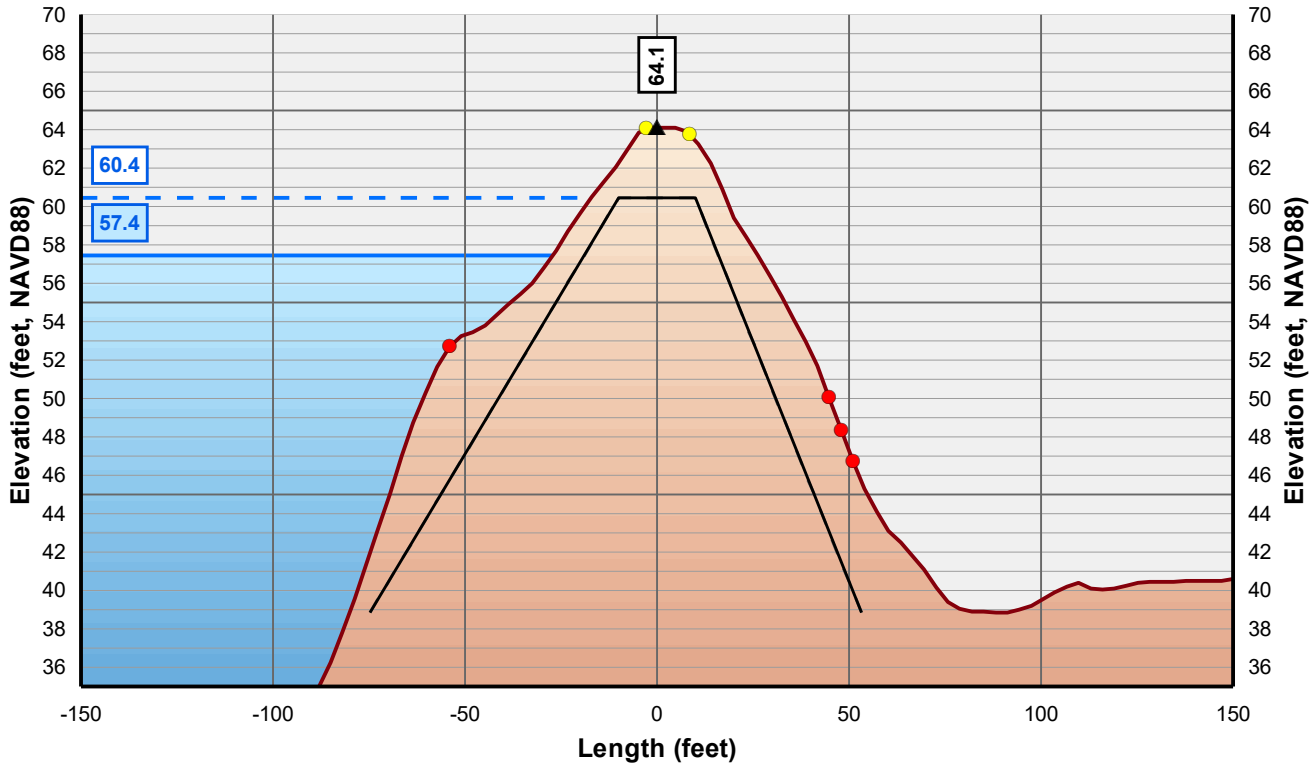
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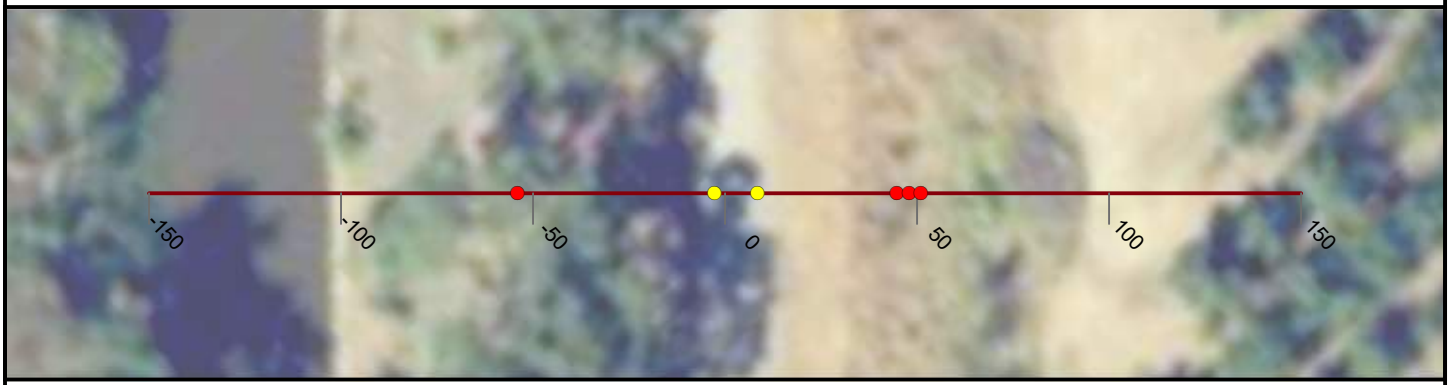
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Cross Section: Bear River 82+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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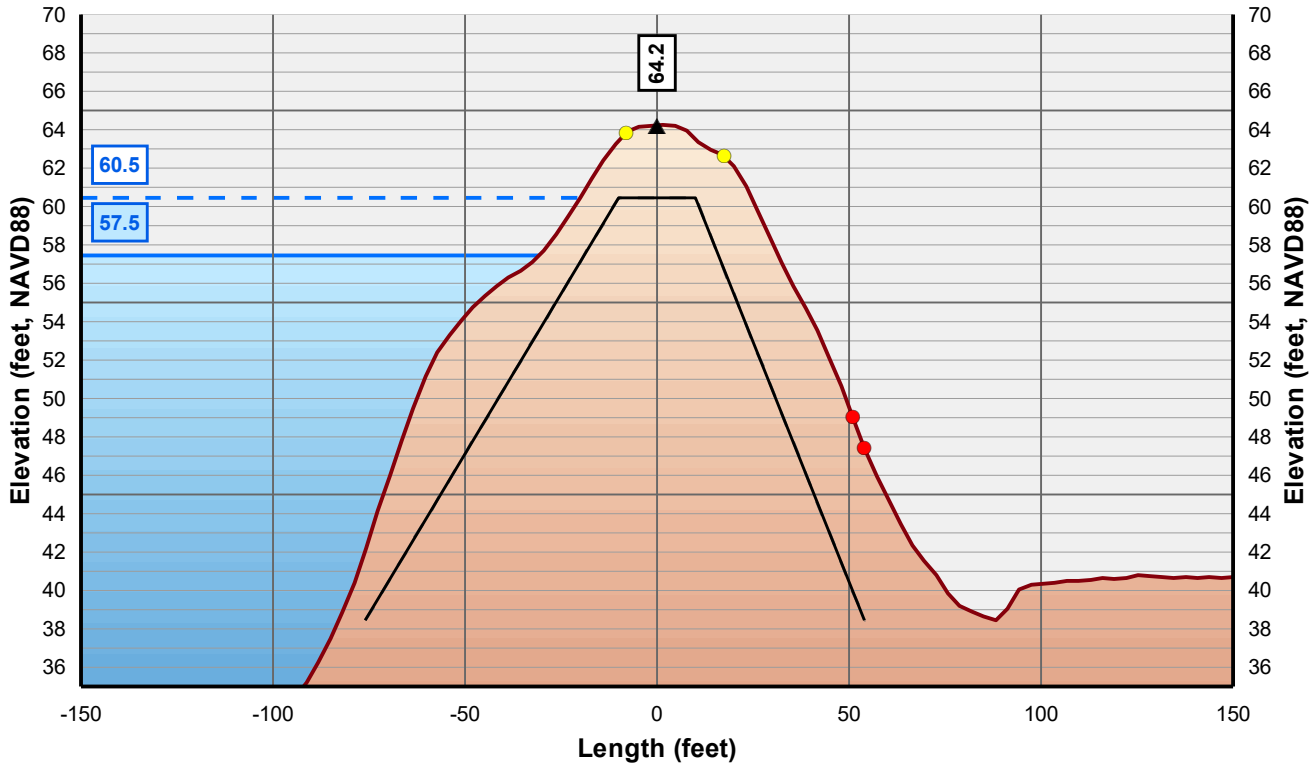
FEET

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WOOD RODGERS
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3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

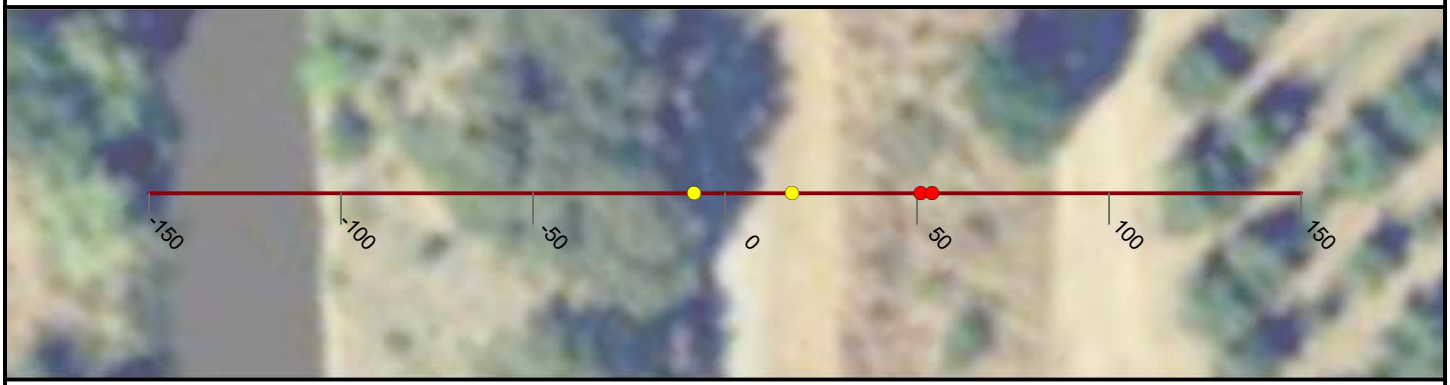
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Cross Section: Bear River 83+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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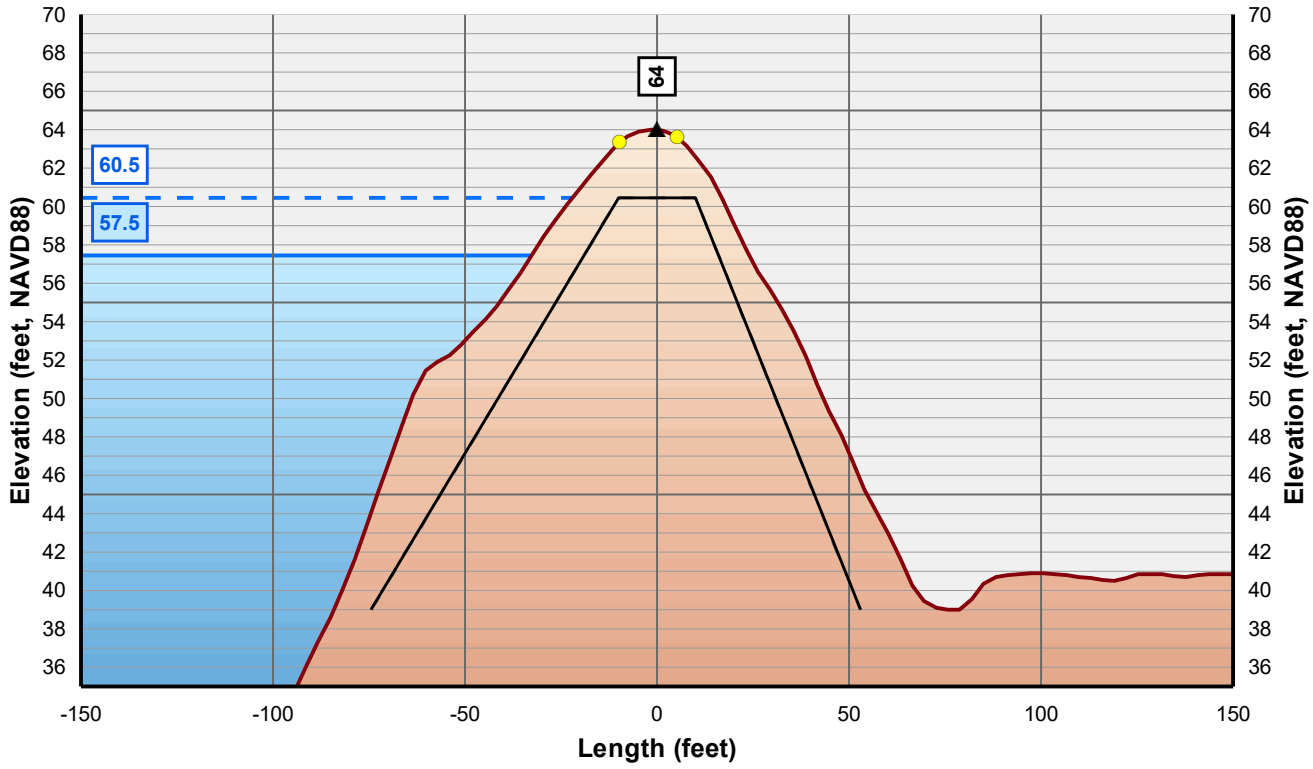
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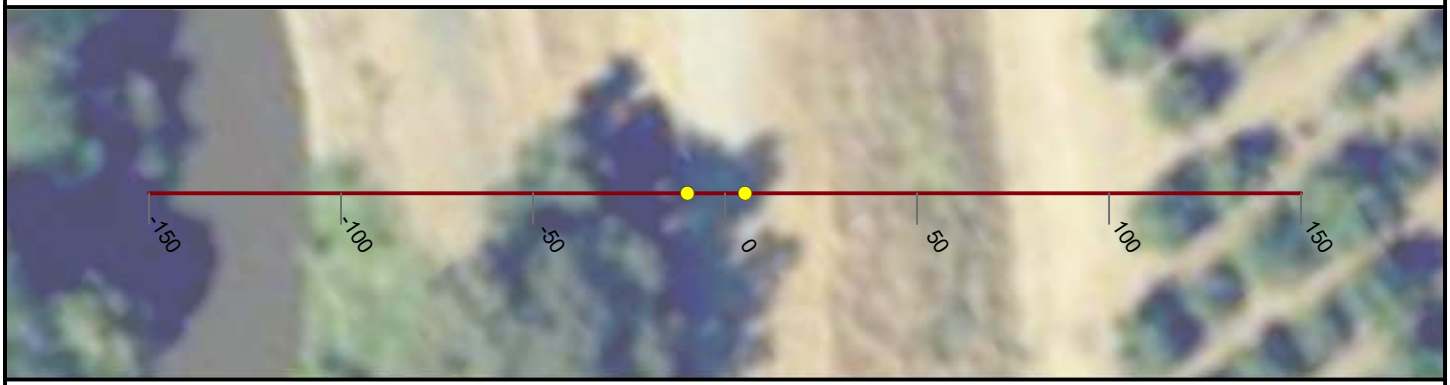
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Cross Section: Bear River 84+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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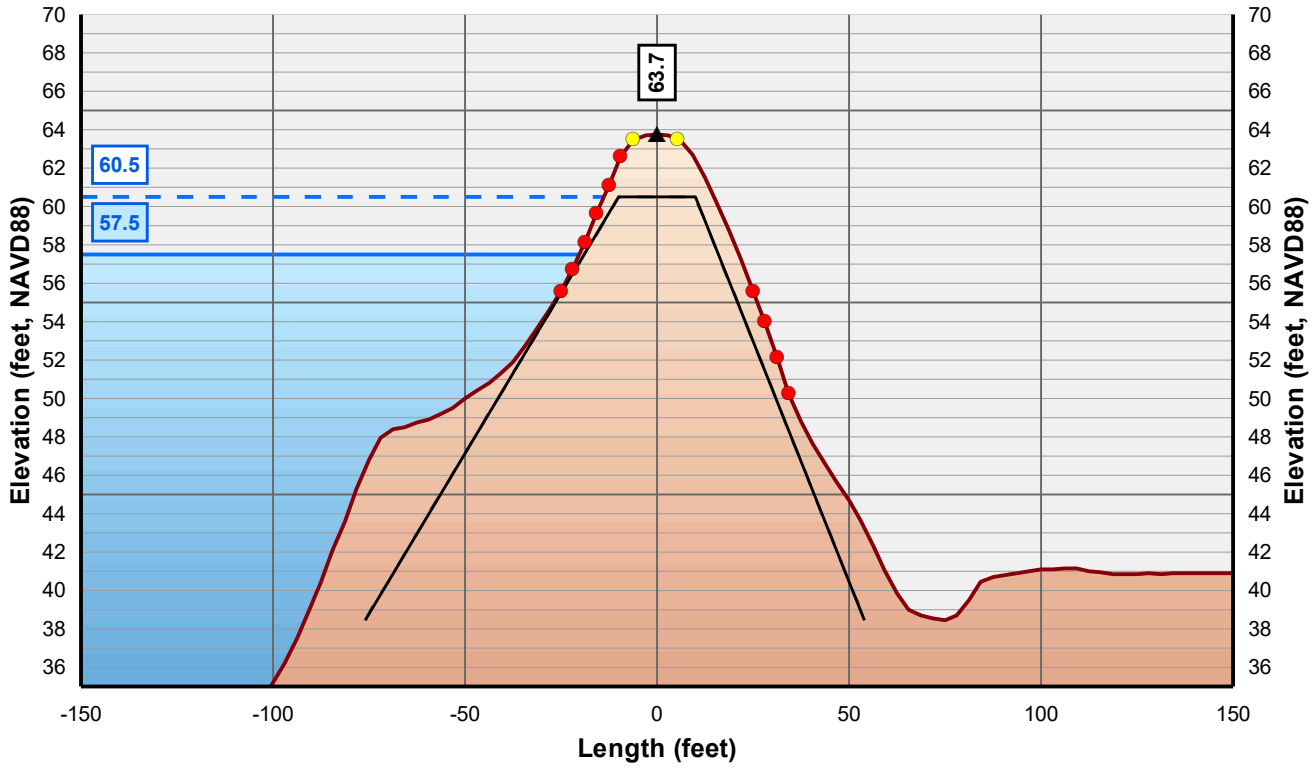
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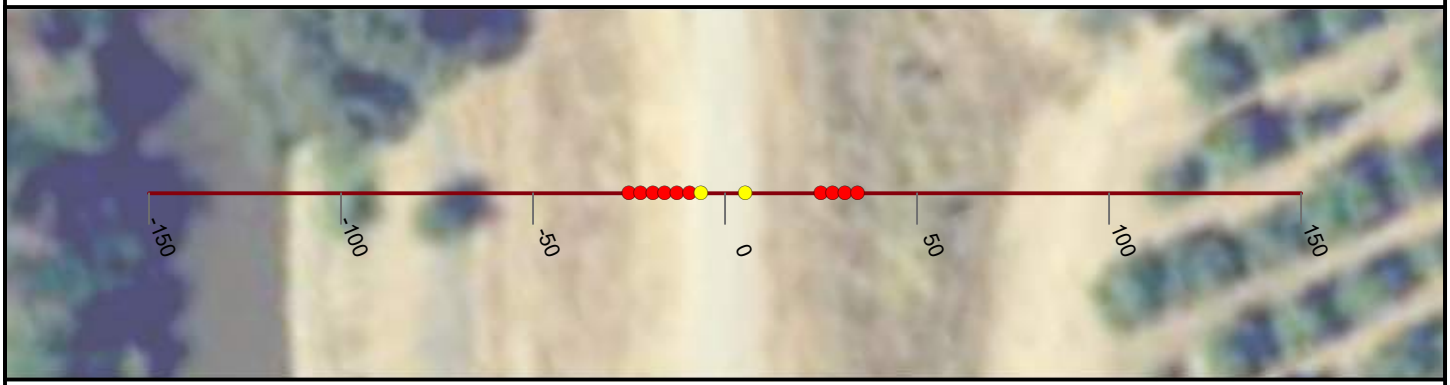
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Cross Section: Bear River 85+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
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- Theoretical Levee Prism Preliminary
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CALIFORNIA

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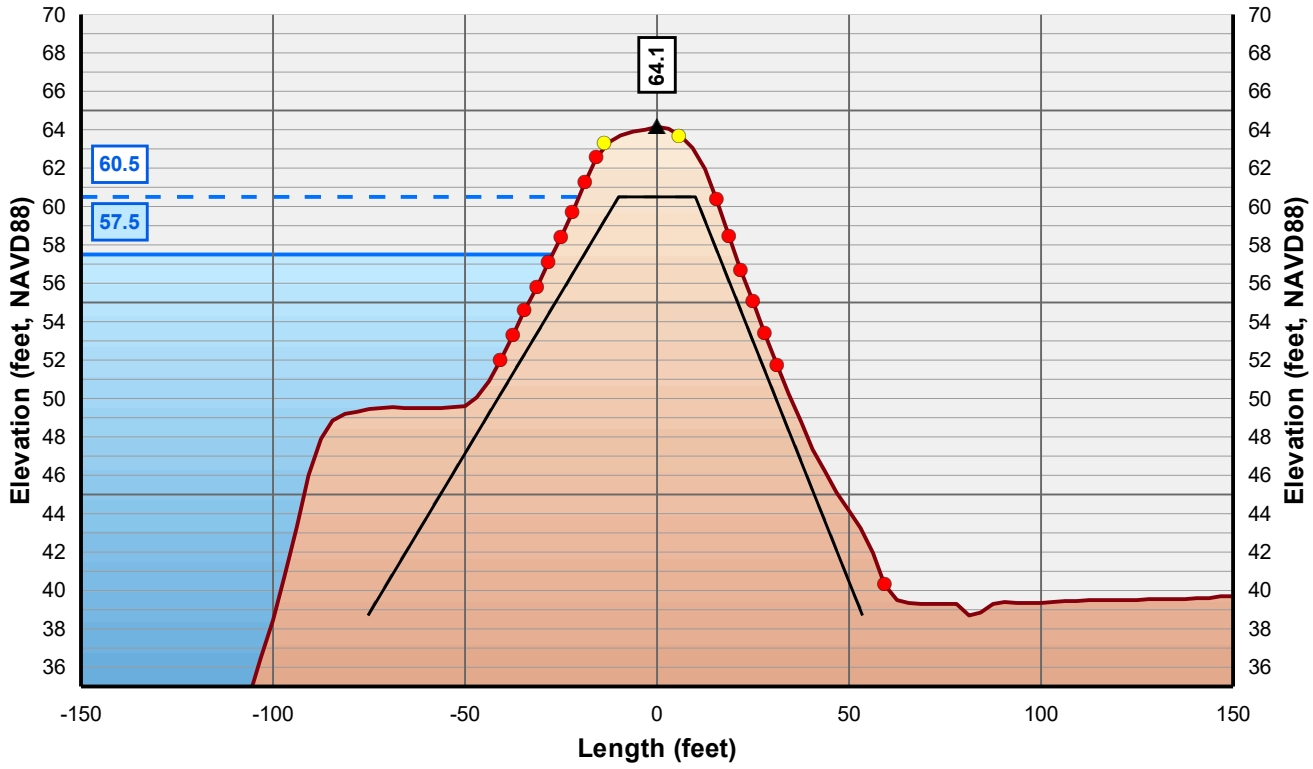
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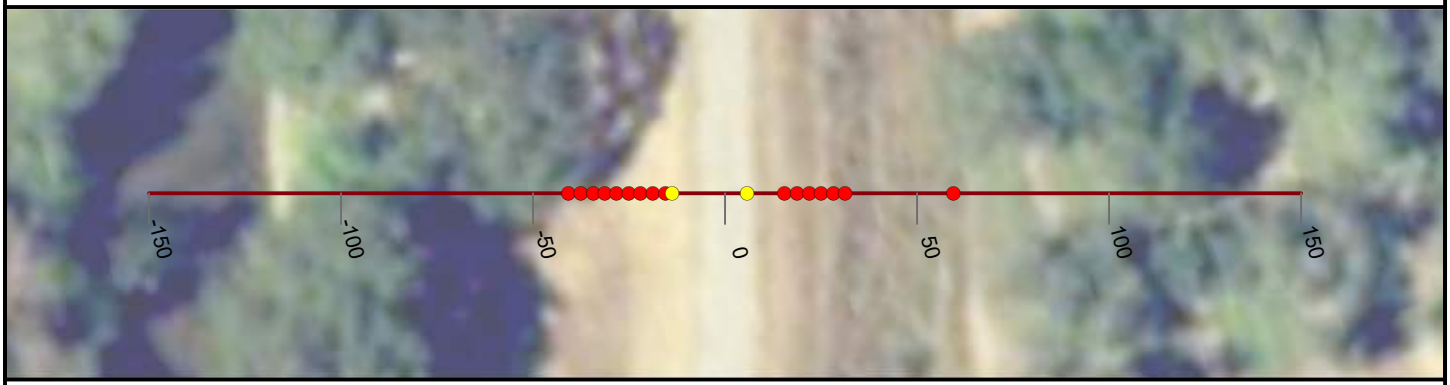
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Cross Section: Bear River 86+00



Horizontal Scale: 1 inch = 50 Feet
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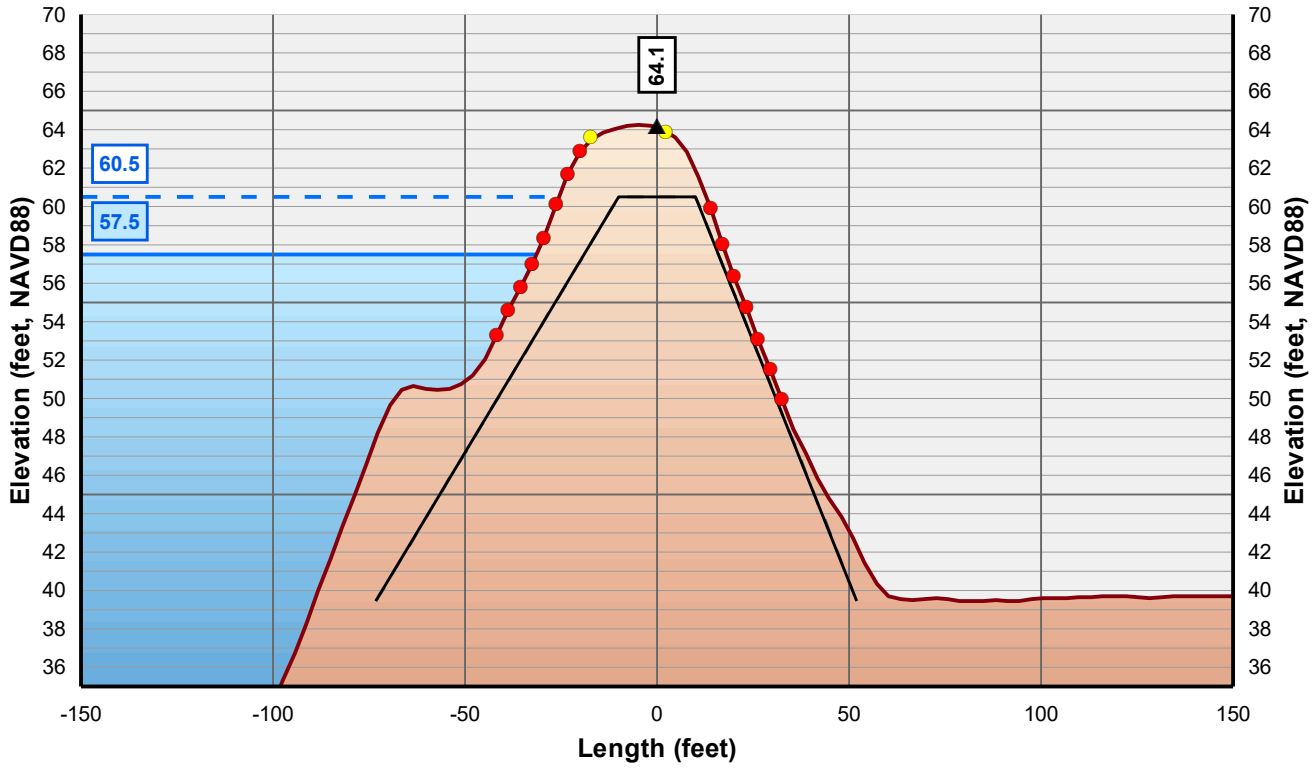
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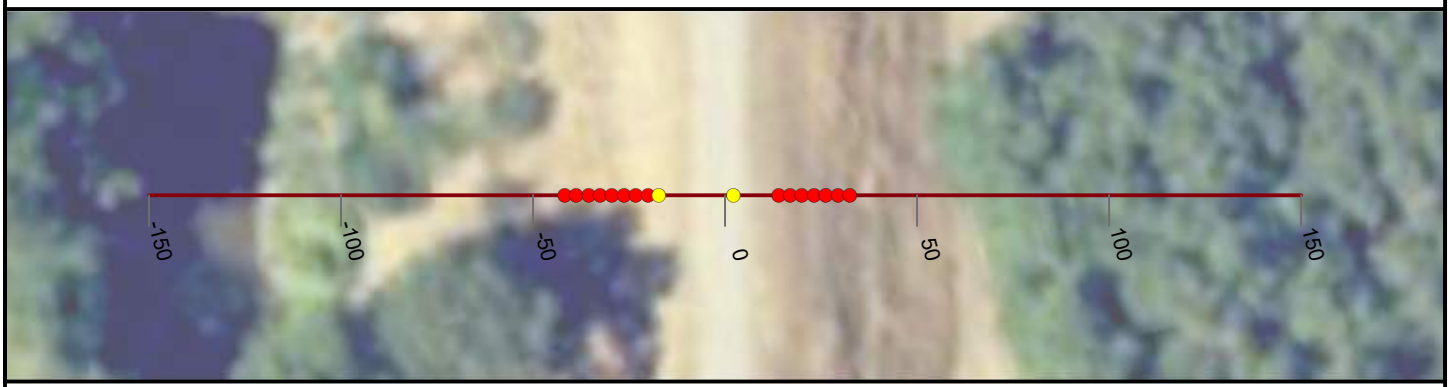
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Cross Section: Bear River 87+00



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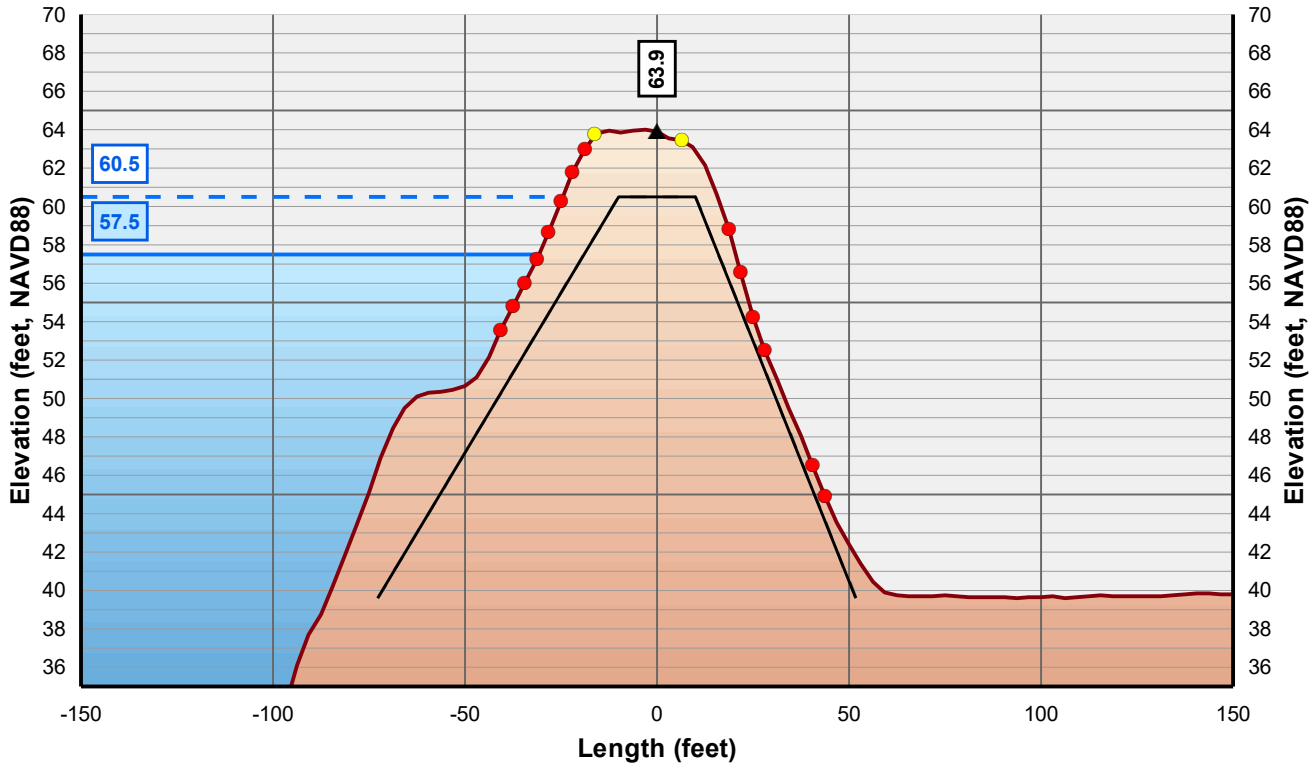
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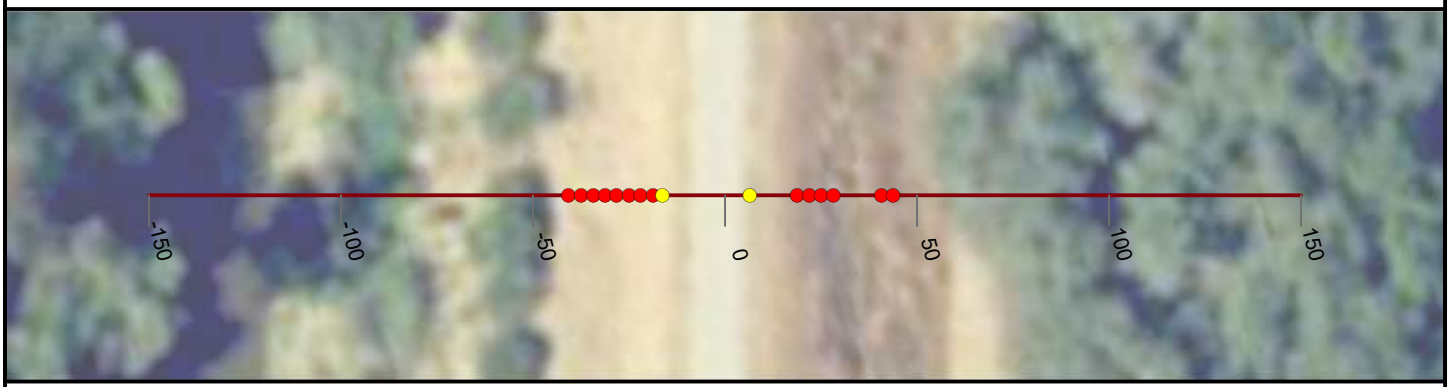
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Cross Section: Bear River 88+00



Horizontal Scale: 1 inch = 50 Feet
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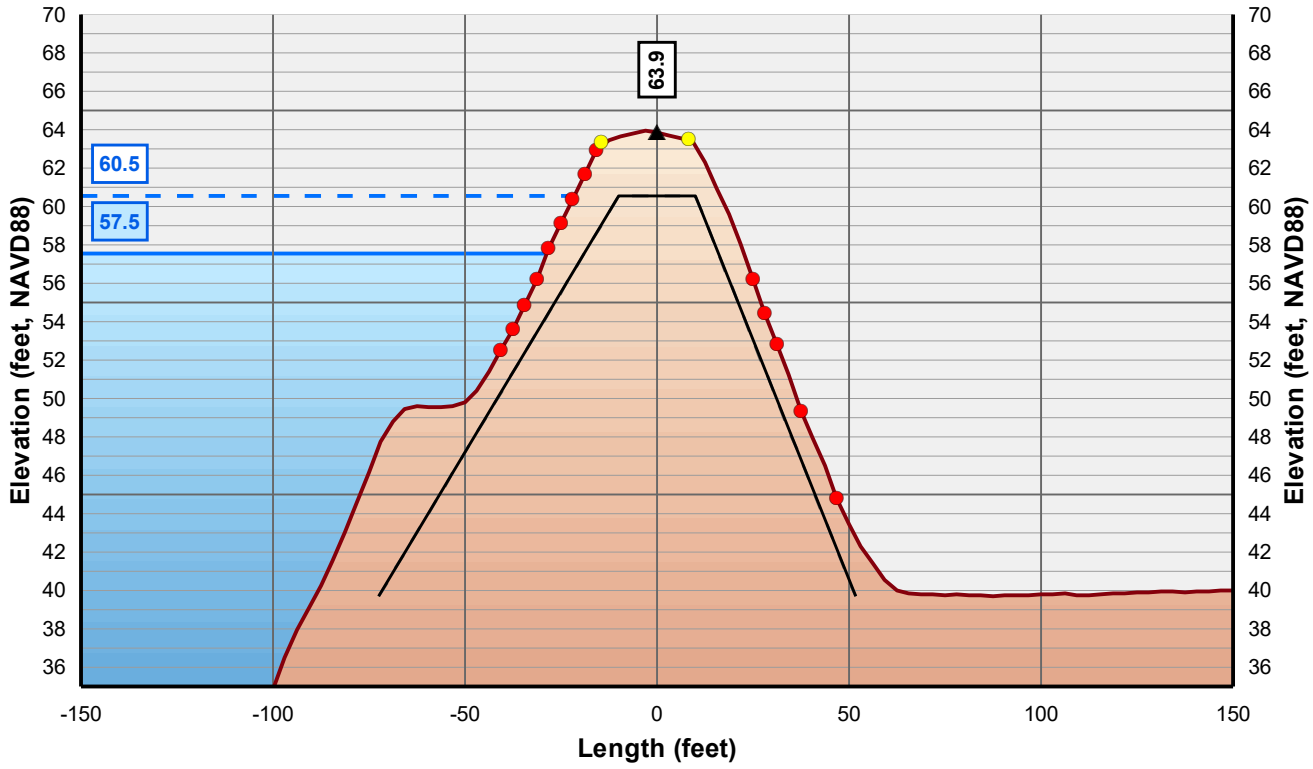
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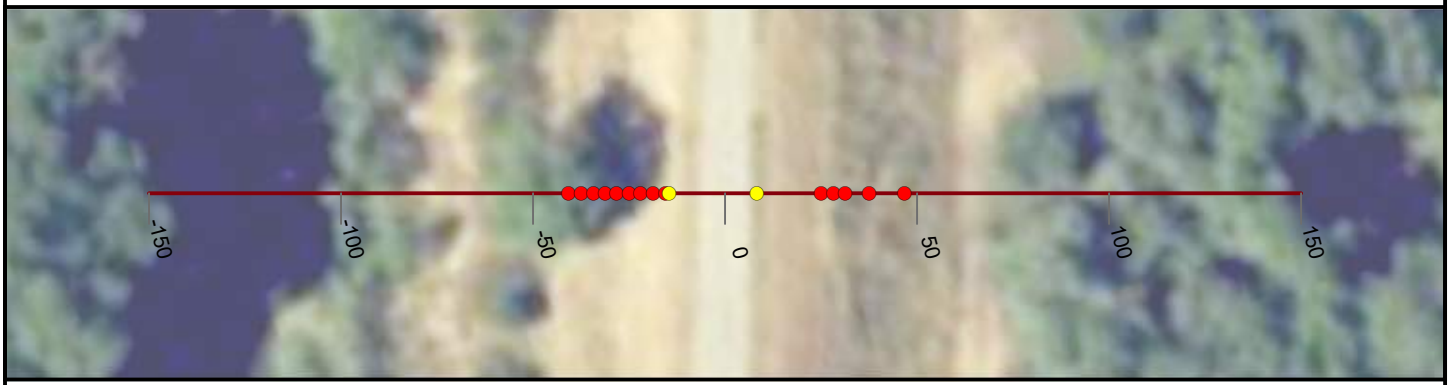
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Cross Section: Bear River 89+00



Horizontal Scale: 1 inch = 50 Feet
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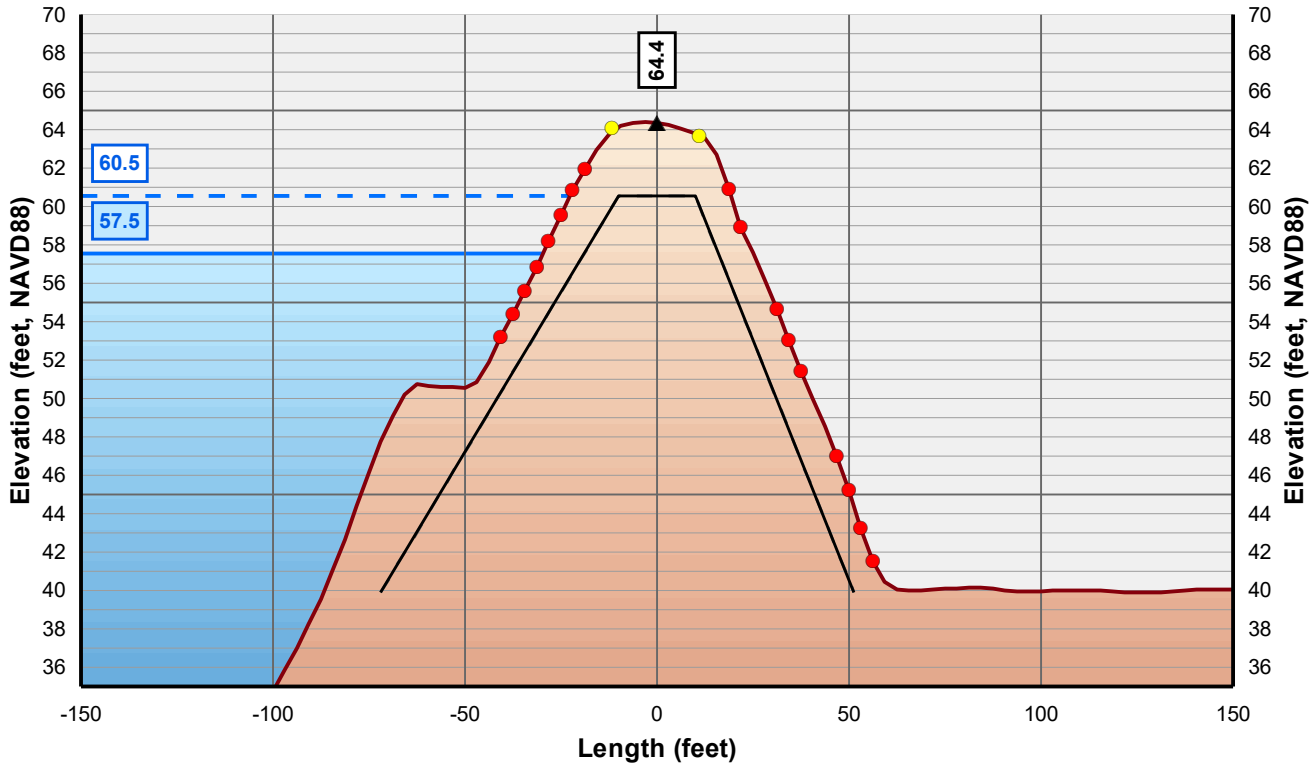
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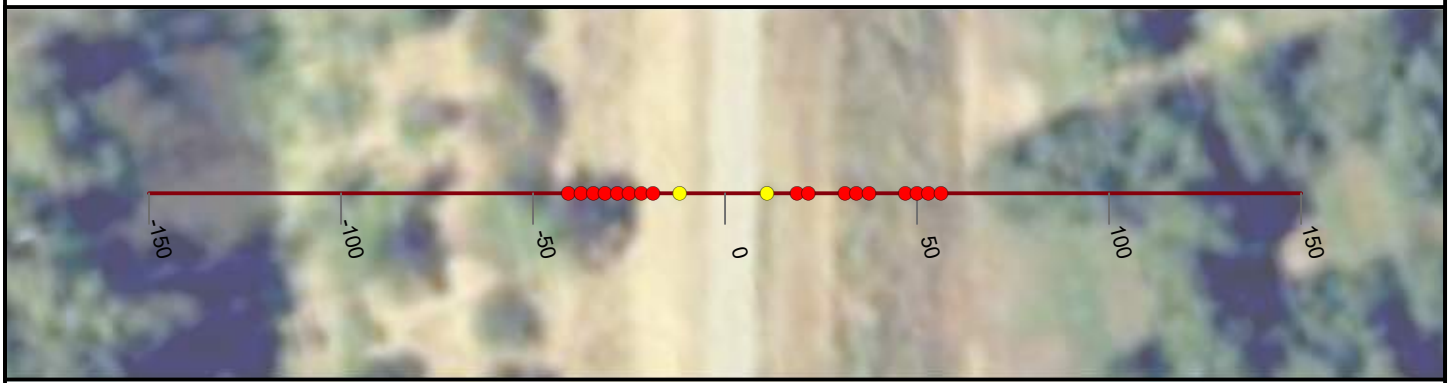
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Cross Section: Bear River 90+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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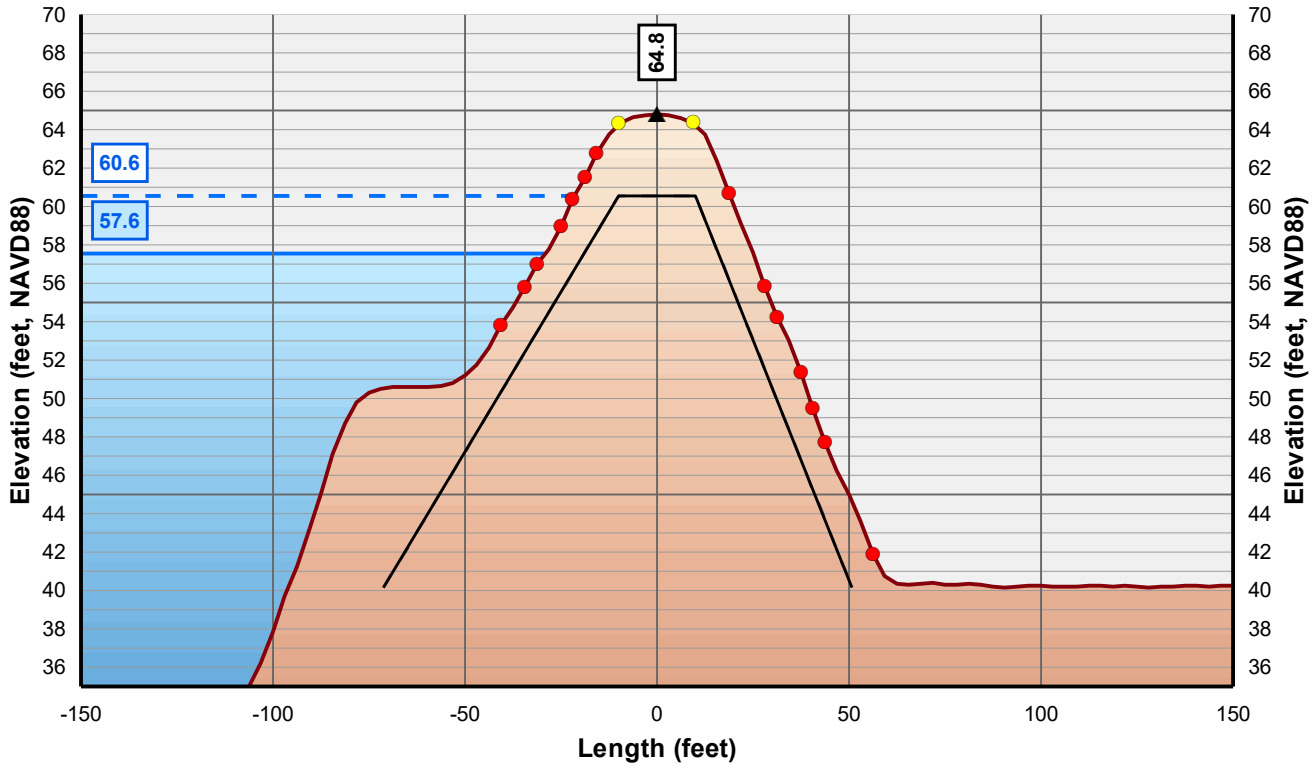
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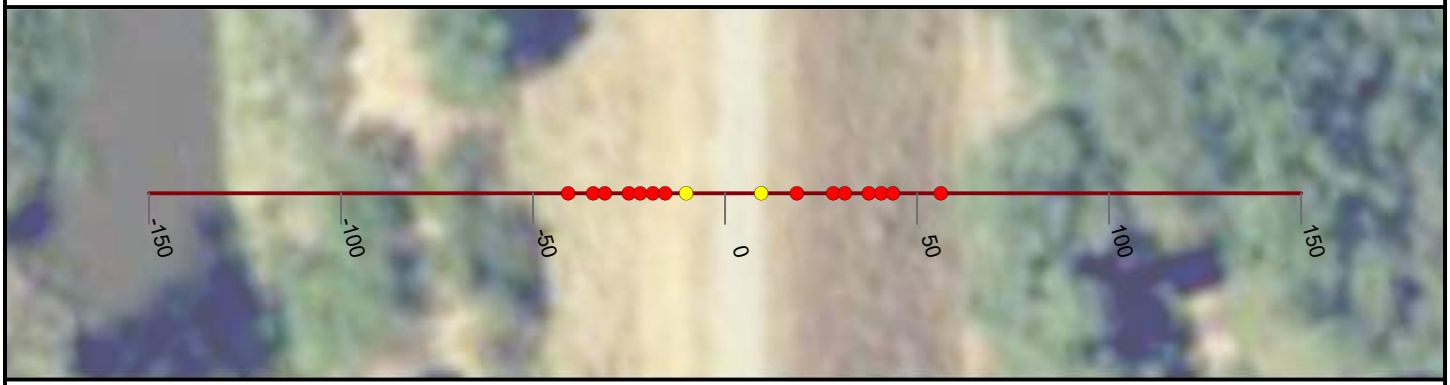
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Cross Section: Bear River 91+00



Horizontal Scale: 1 inch = 50 Feet
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BEAR RIVER LEVEE

CALIFORNIA

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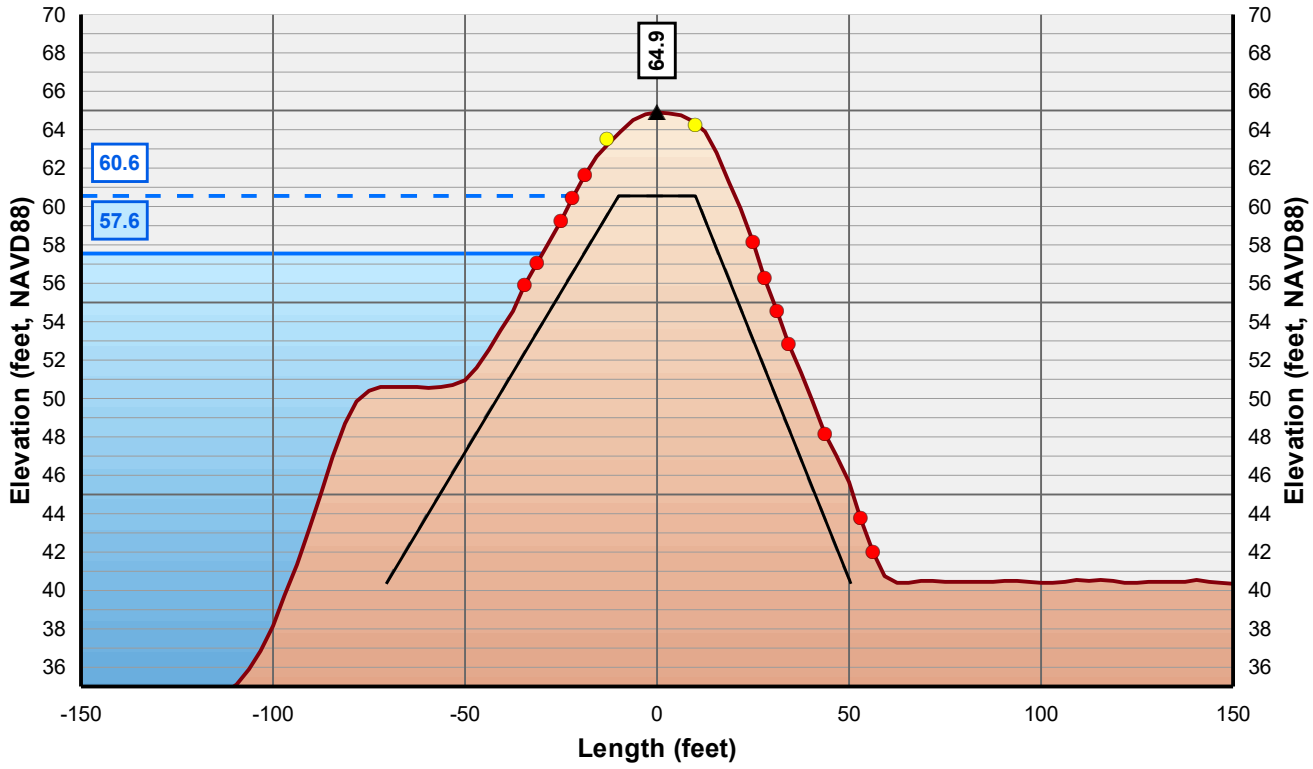
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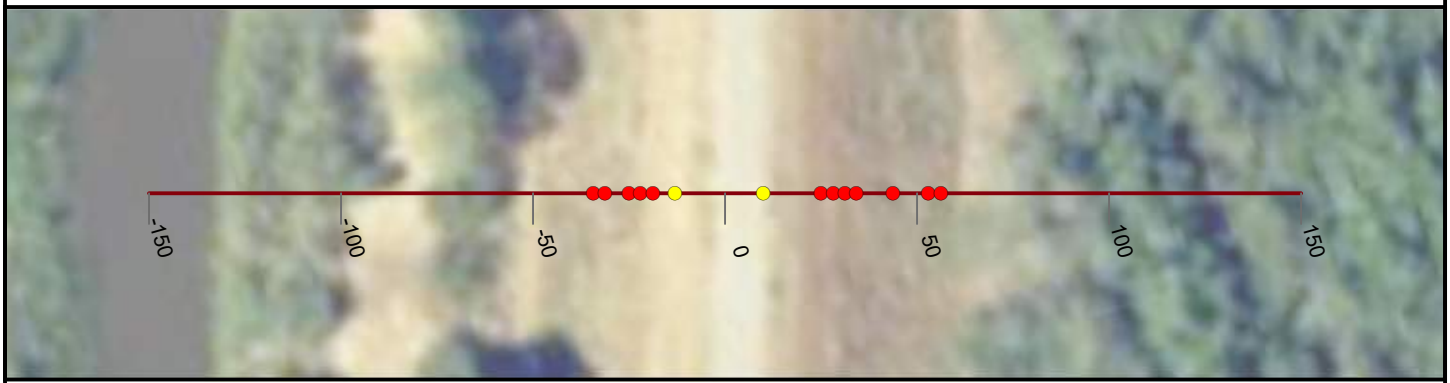
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Cross Section: Bear River 92+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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- Water Surface Elevation + 3 Feet
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BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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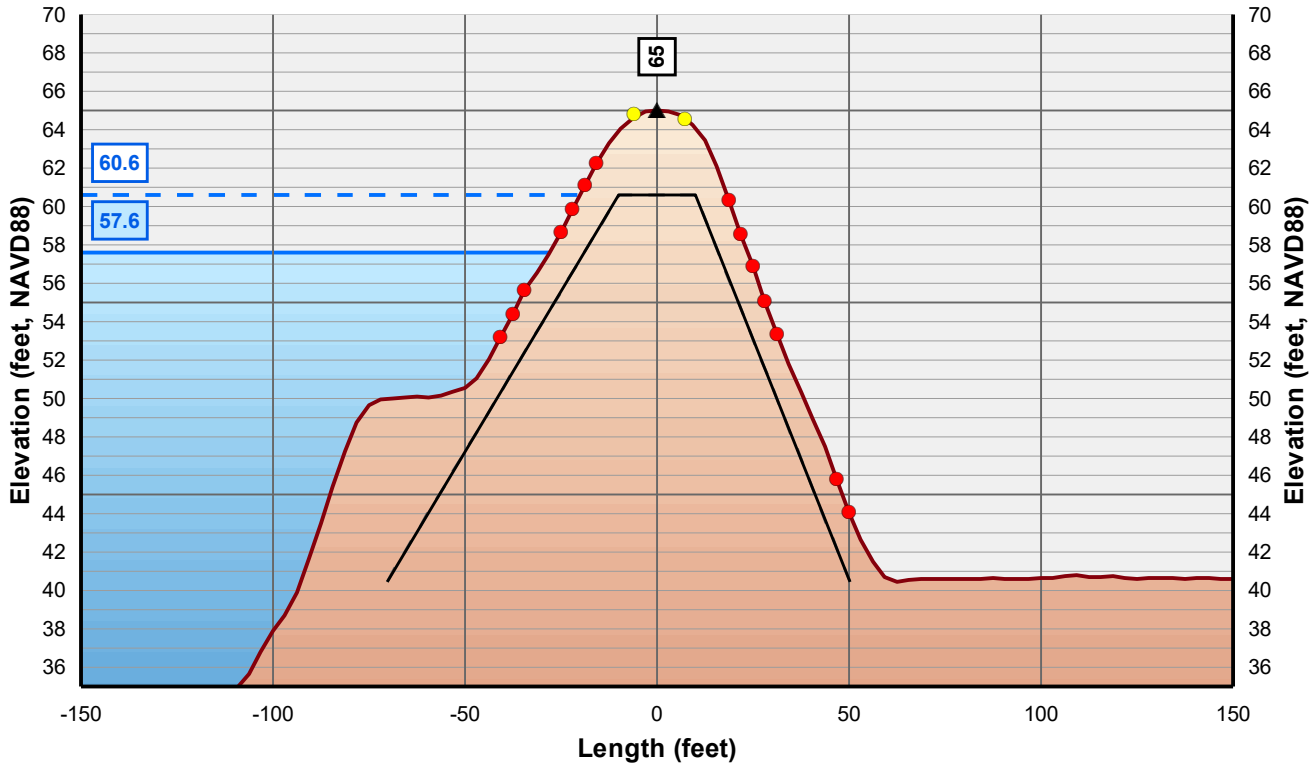
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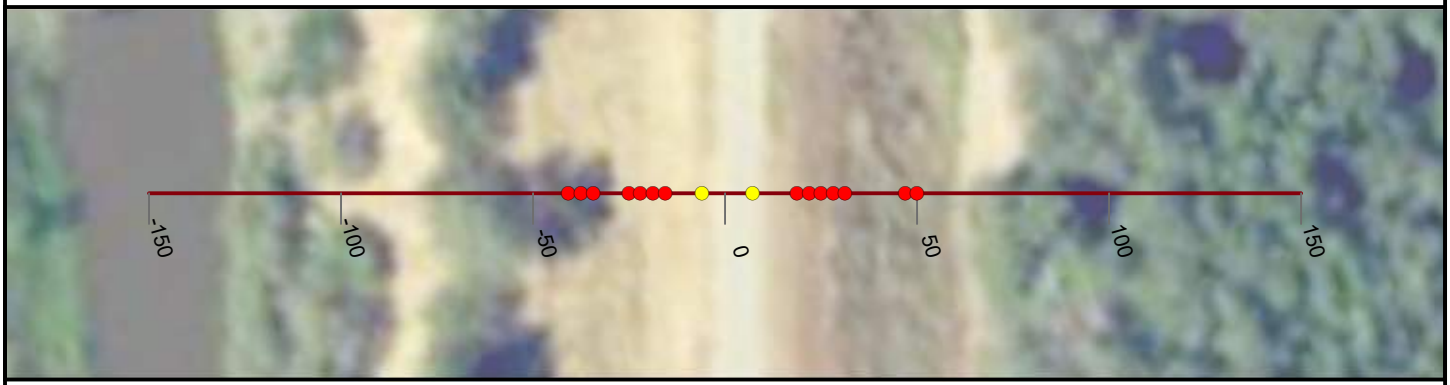
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Cross Section: Bear River 93+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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CALIFORNIA

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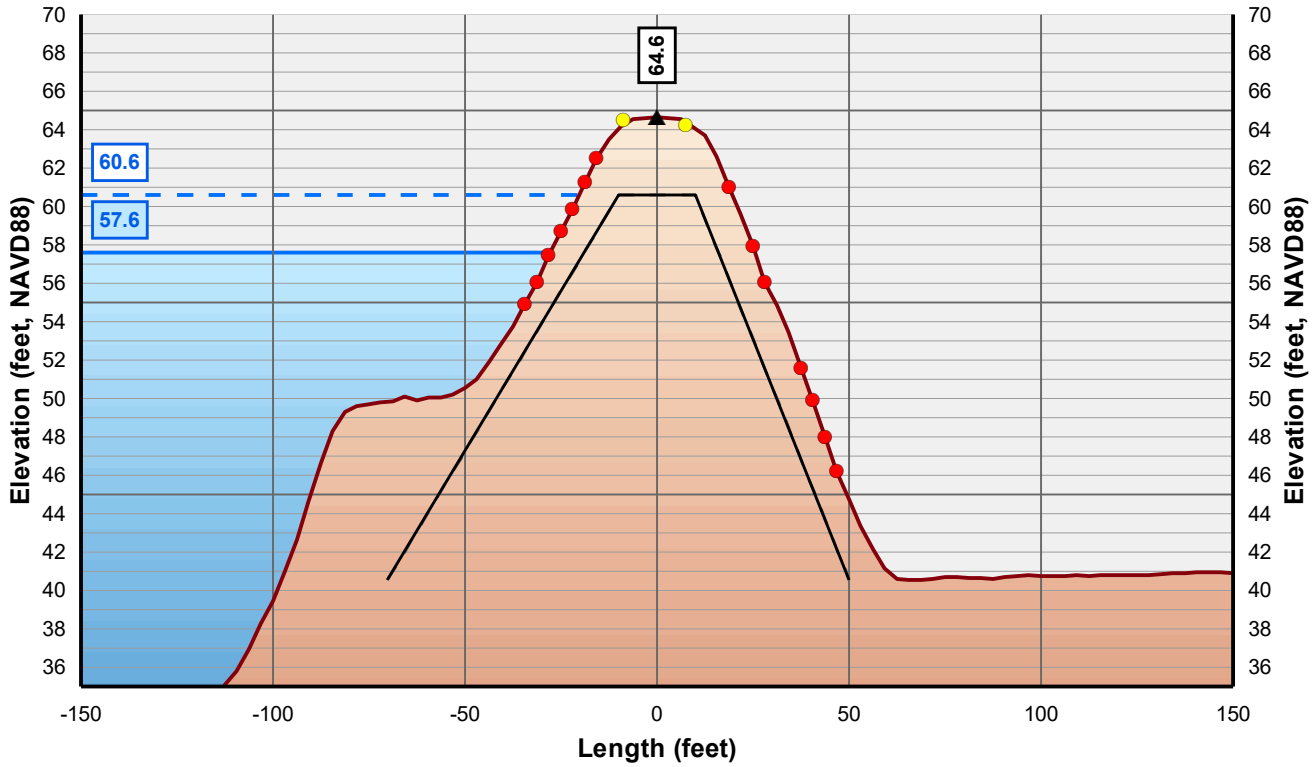
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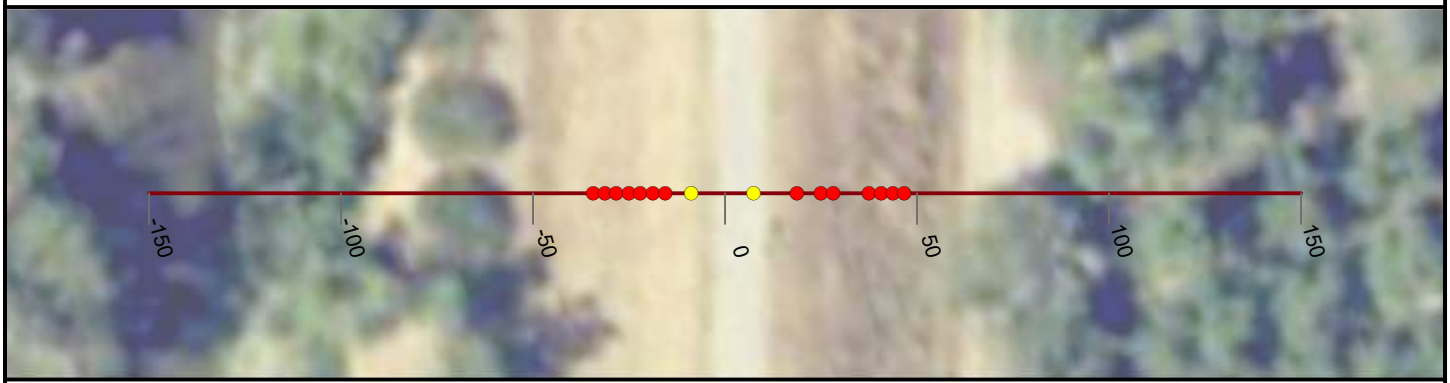
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Cross Section: Bear River 94+00



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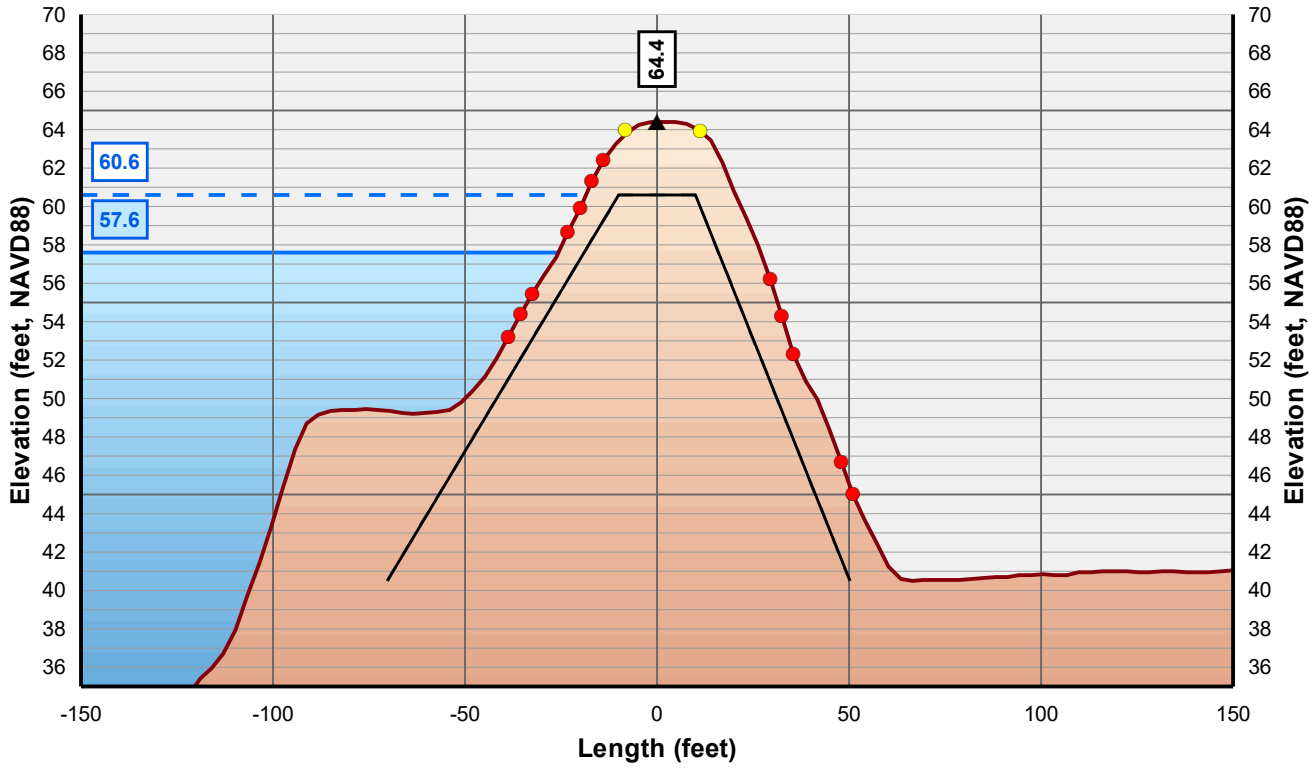
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Cross Section: Bear River 95+00



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BEAR RIVER LEVEE

CALIFORNIA

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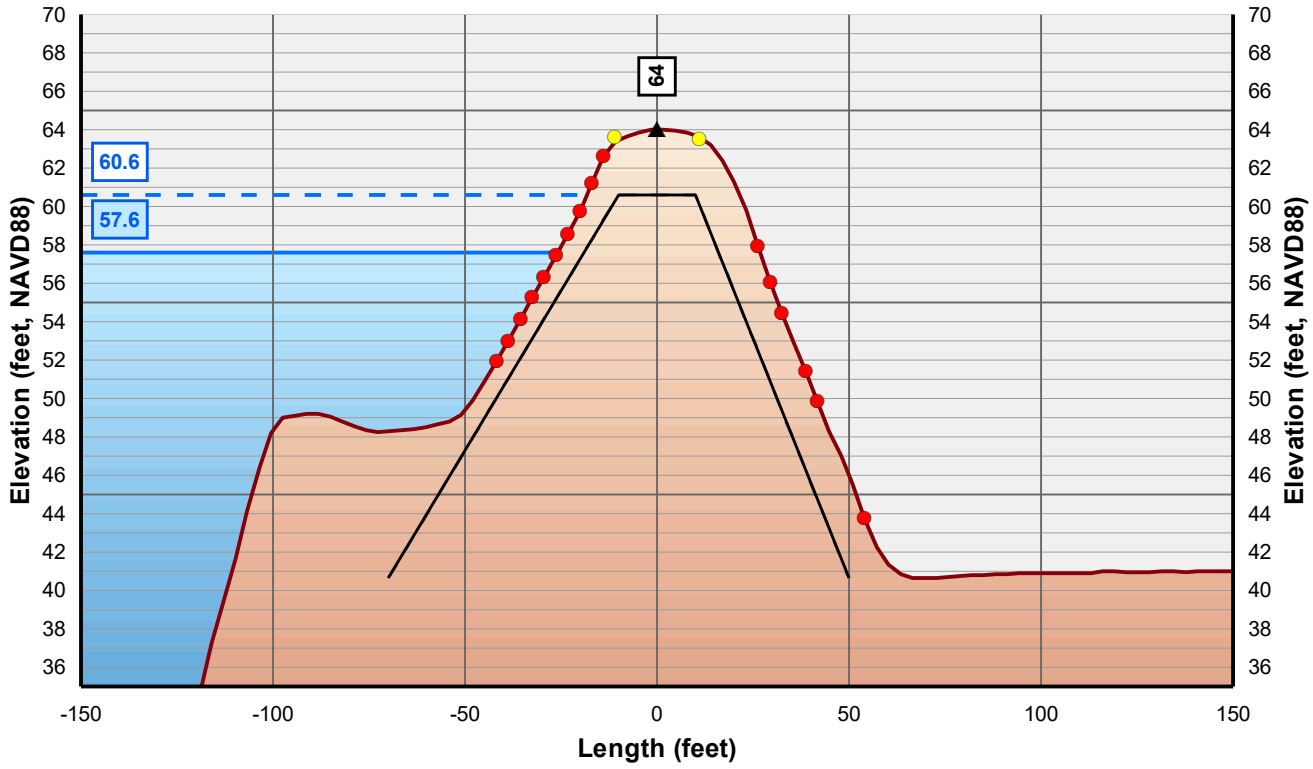
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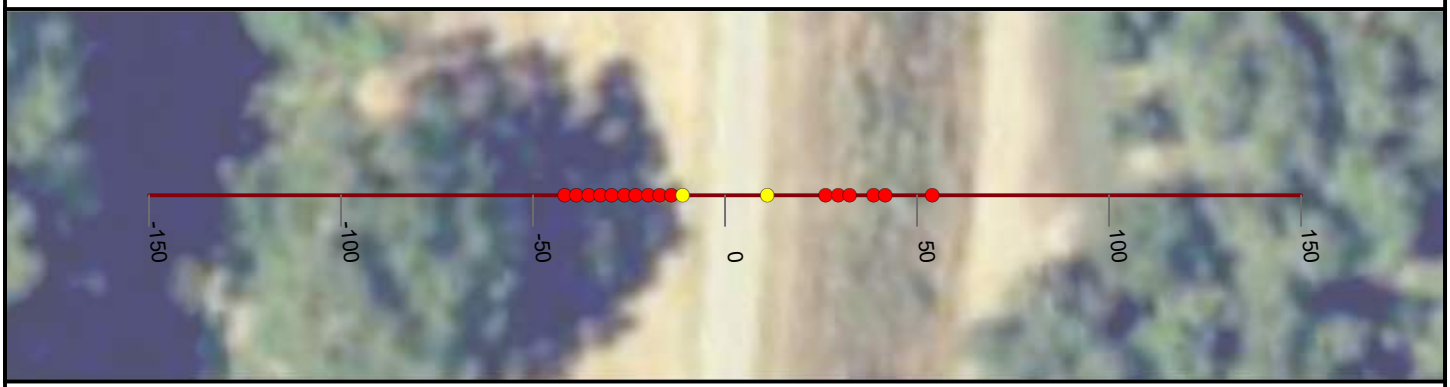
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Cross Section: Bear River 96+00



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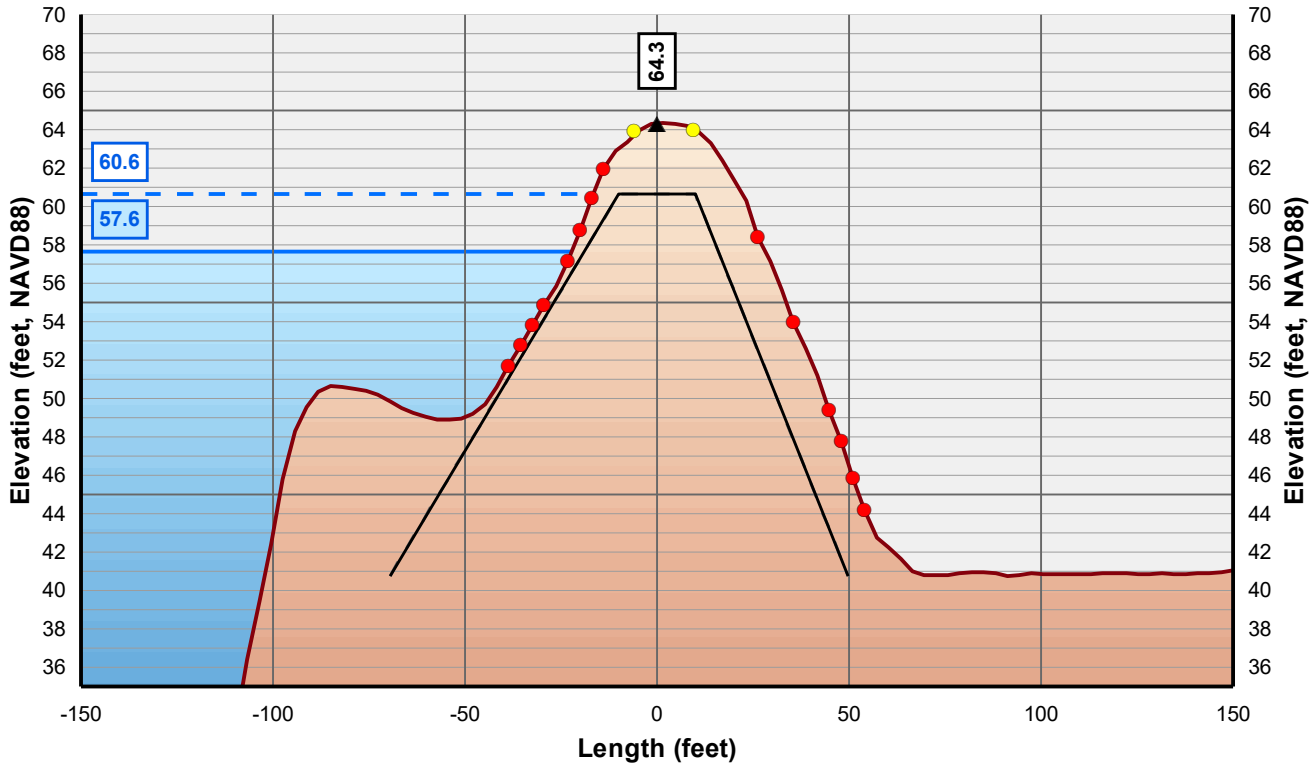
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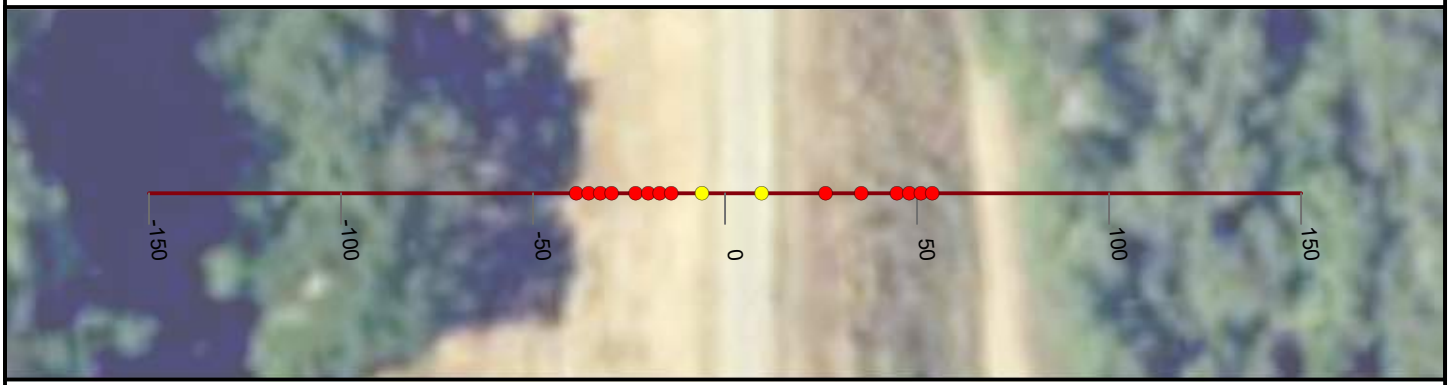
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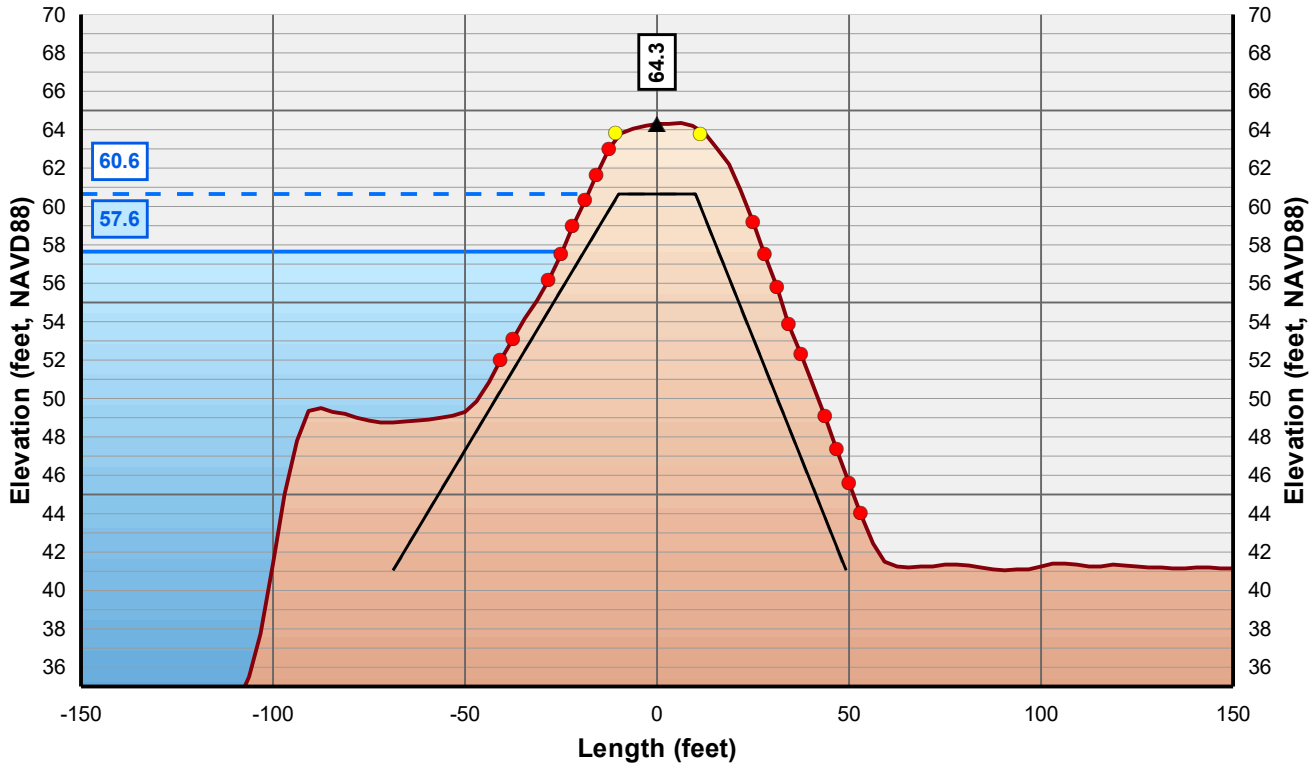
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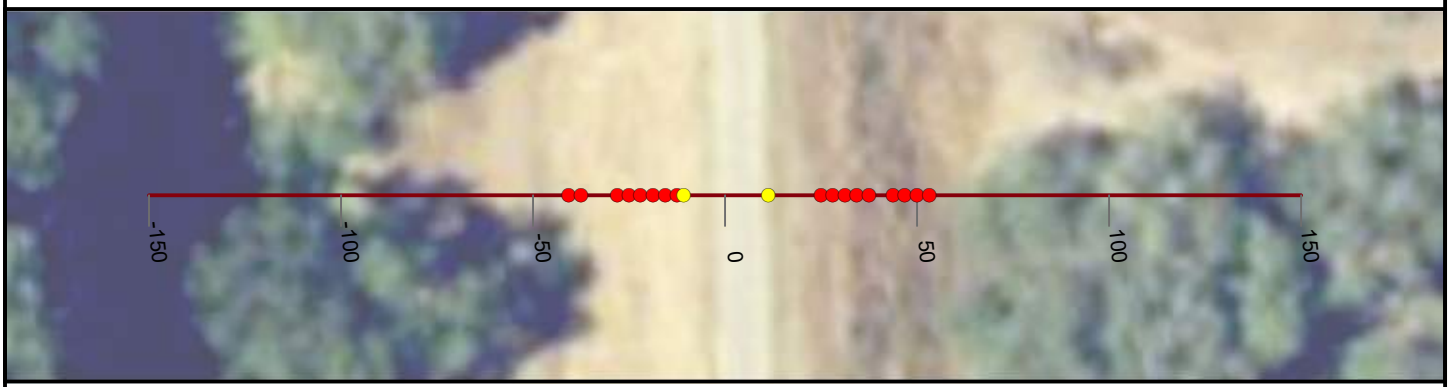
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Cross Section: Bear River 98+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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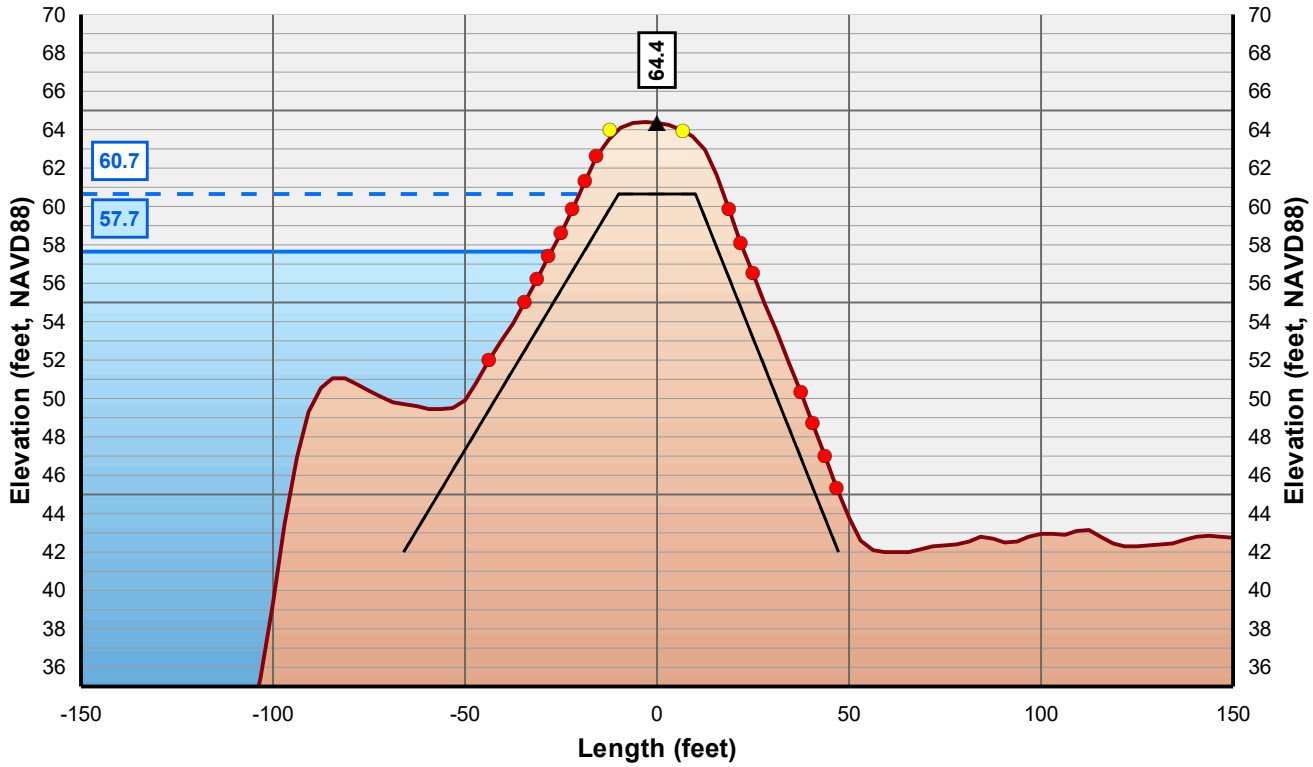
FEET

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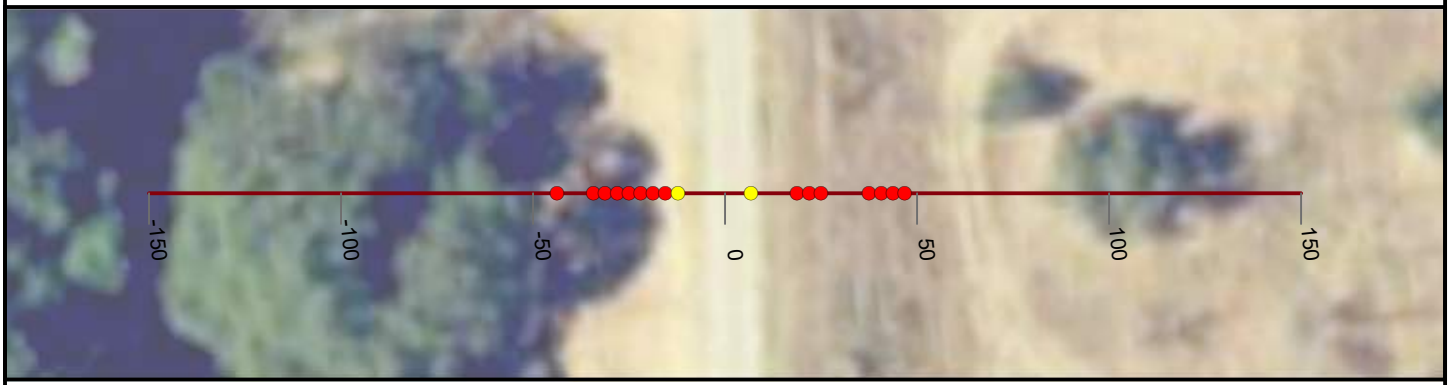
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Cross Section: Bear River 99+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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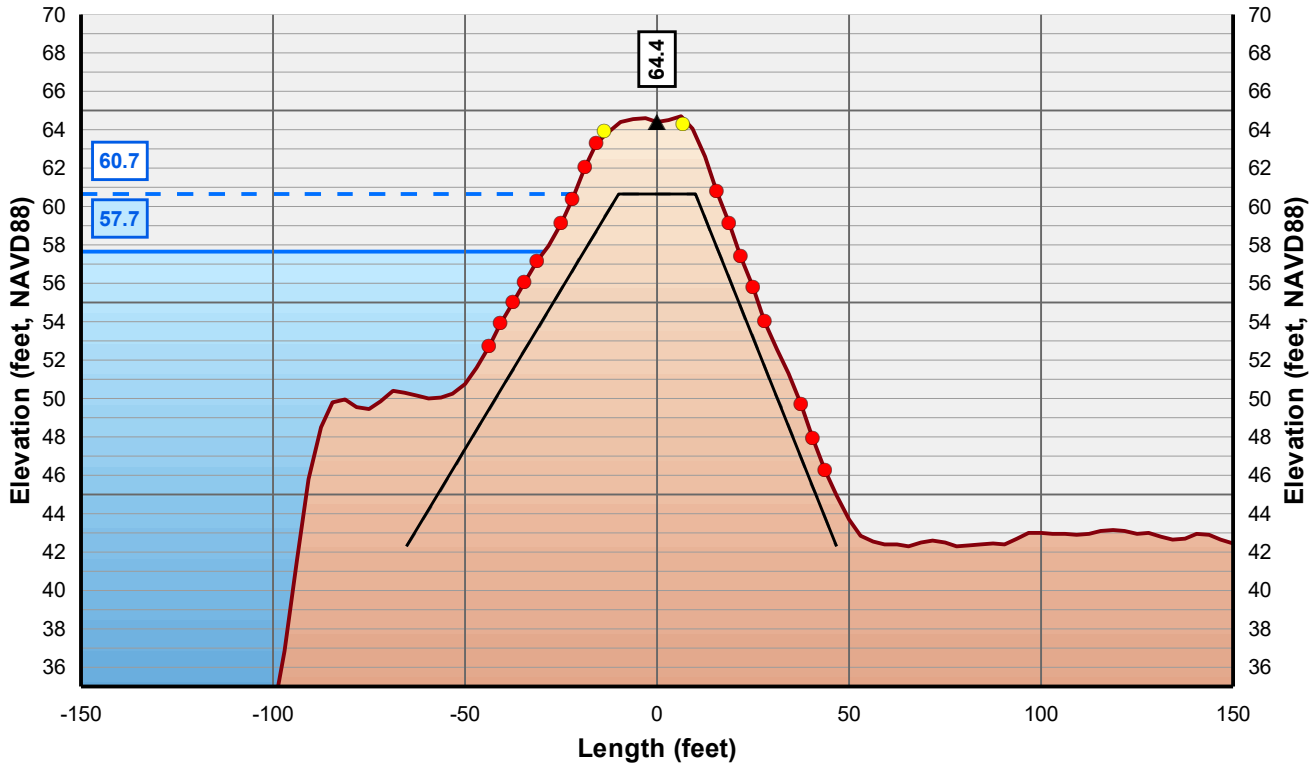
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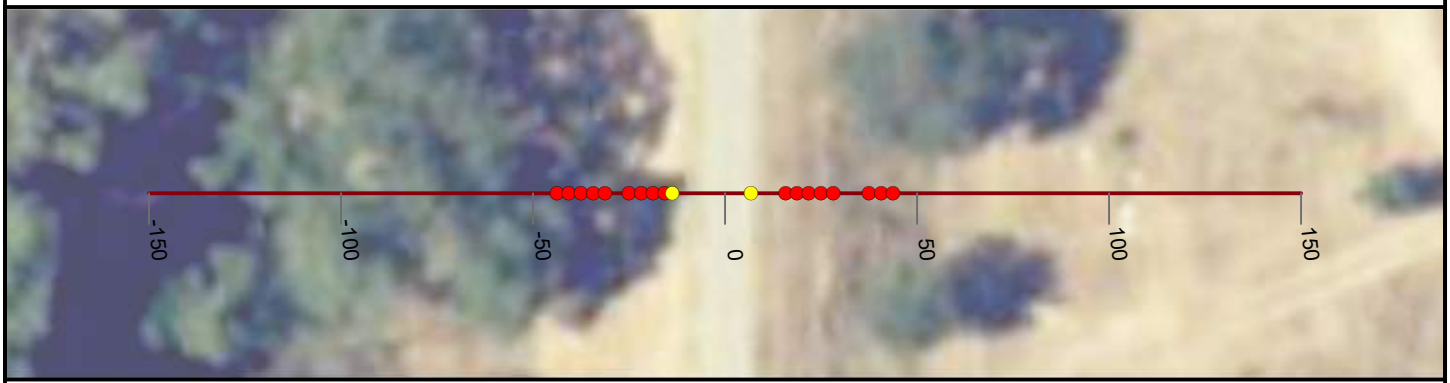
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Cross Section: Bear River 100+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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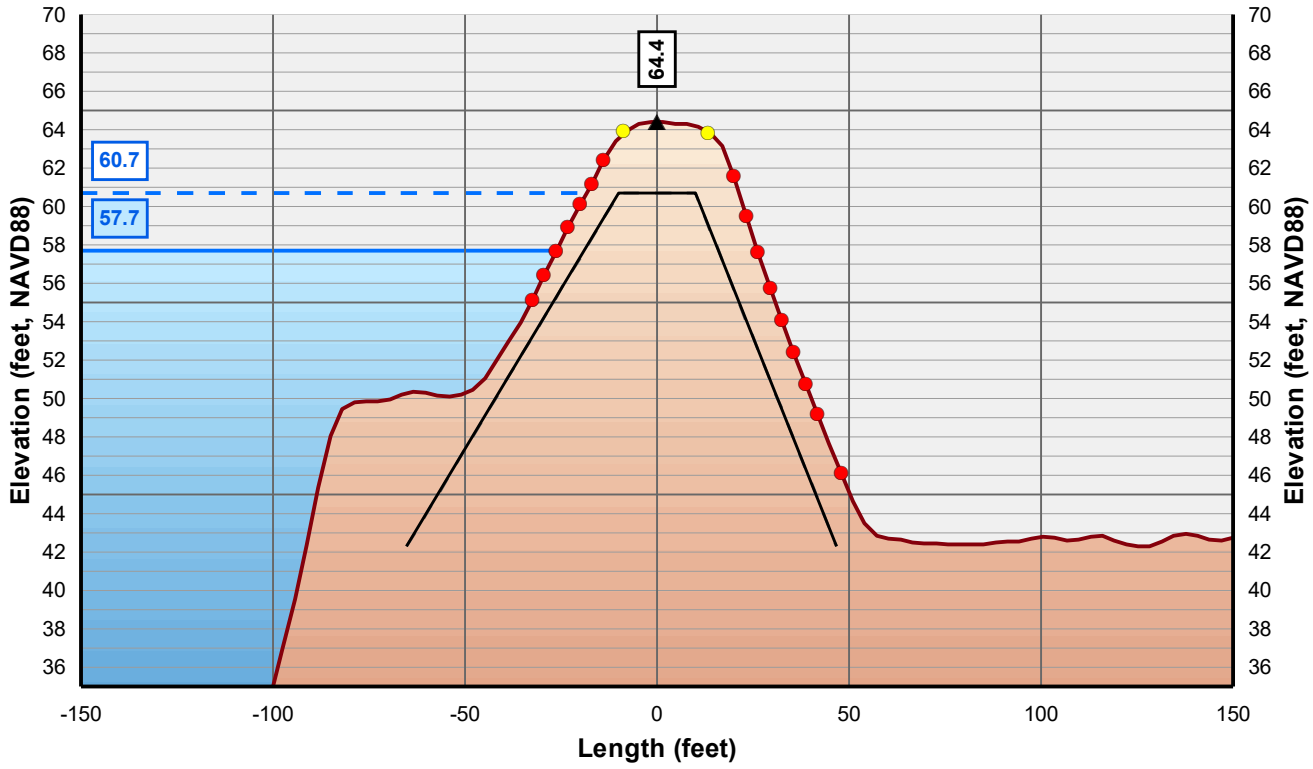
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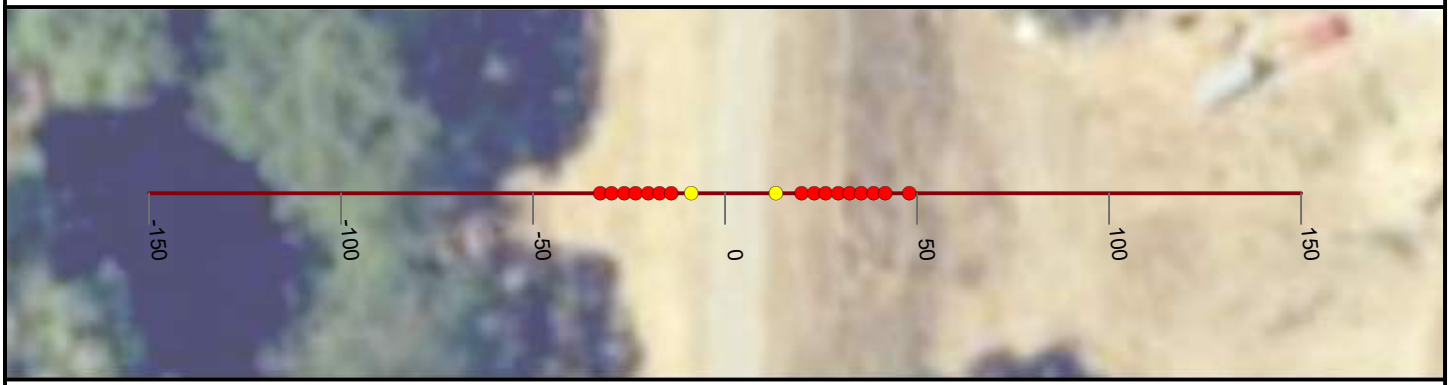
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Cross Section: Bear River 101+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
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- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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NORTH

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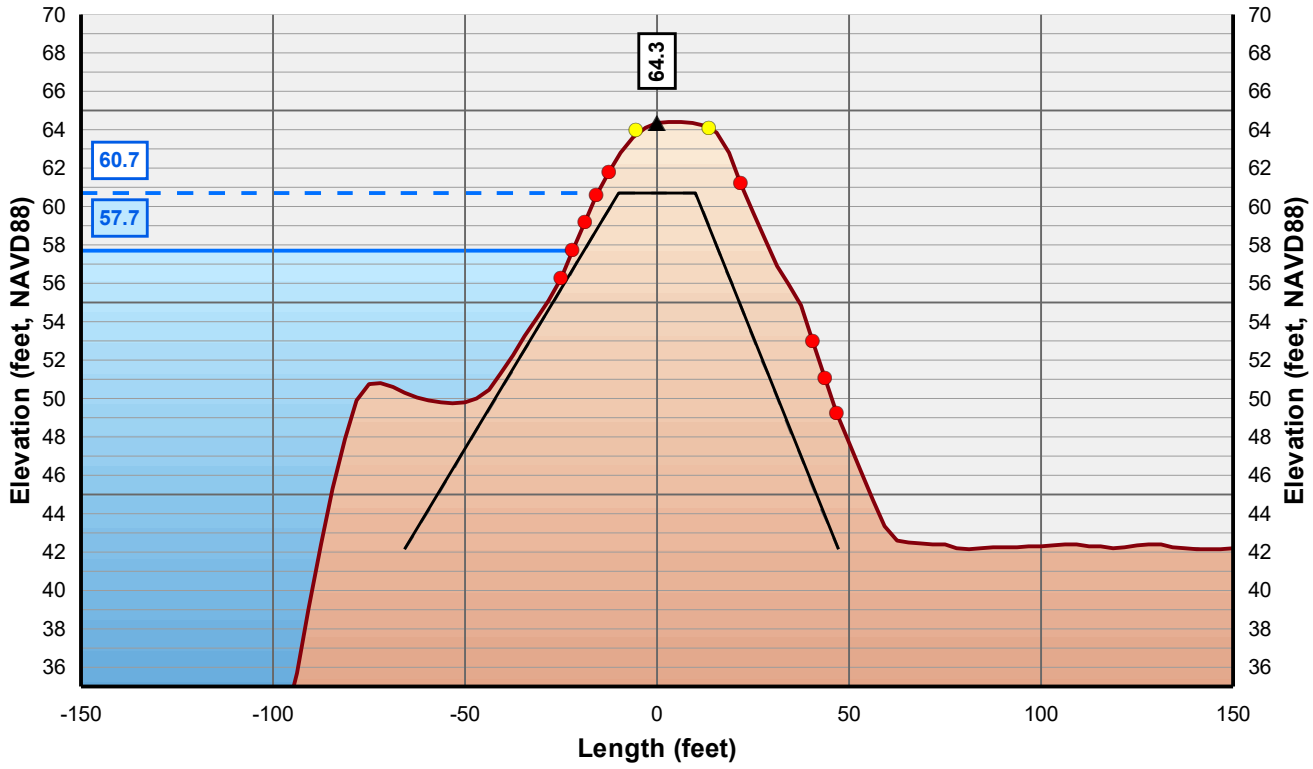
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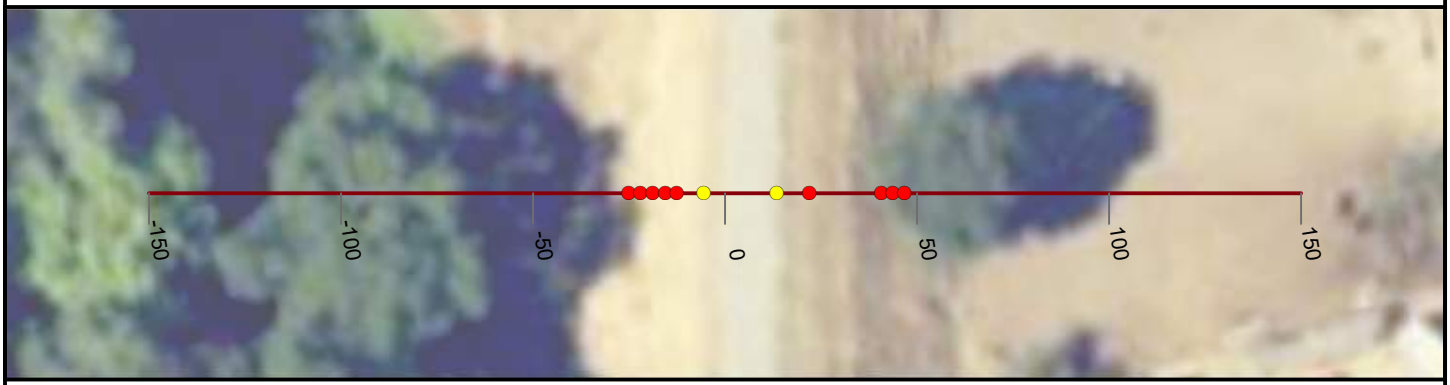
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Cross Section: Bear River 102+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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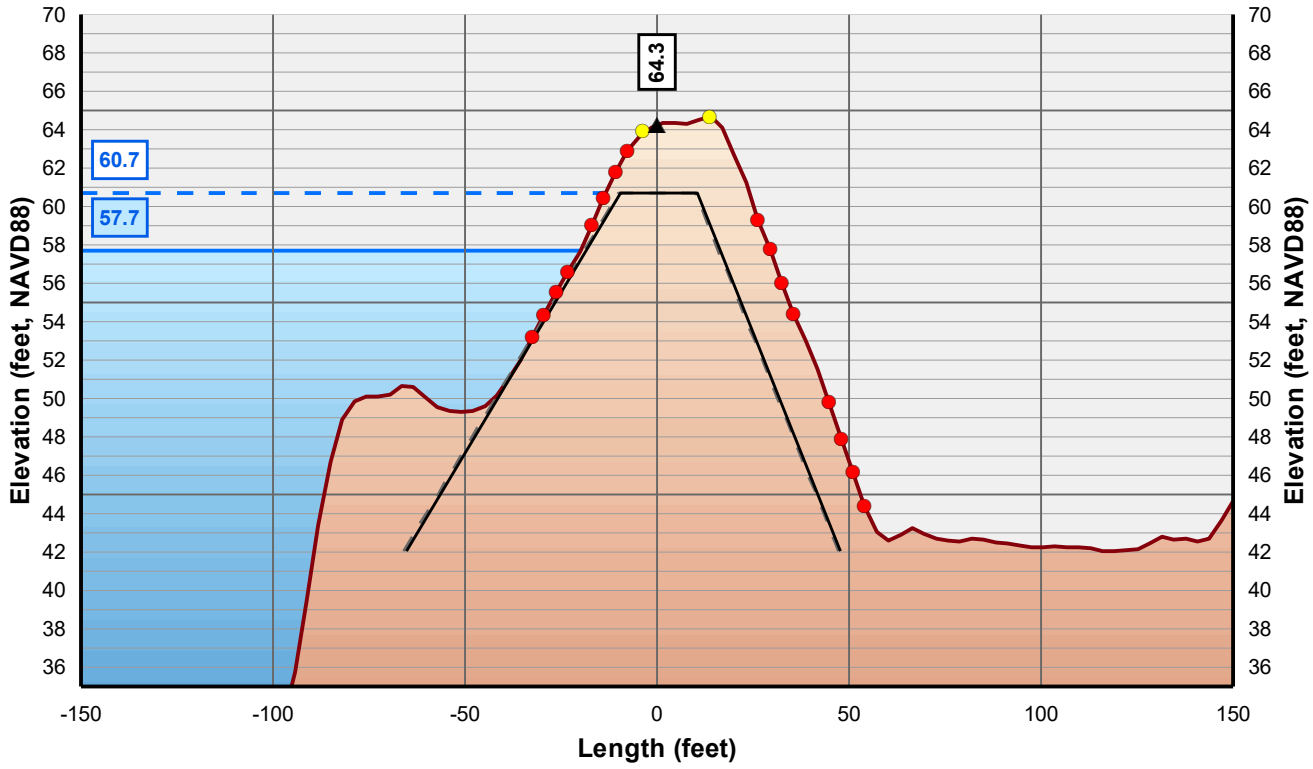
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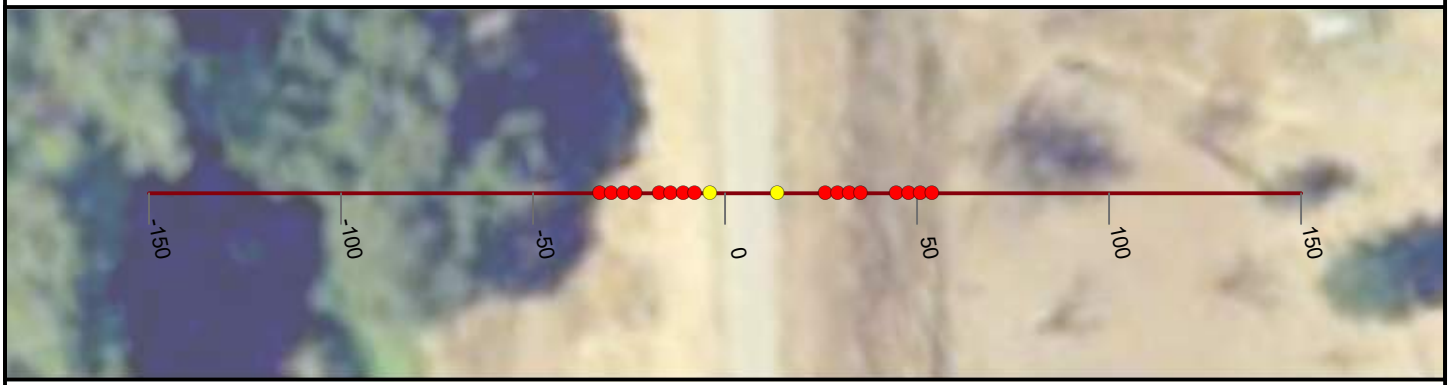
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Cross Section: Bear River 103+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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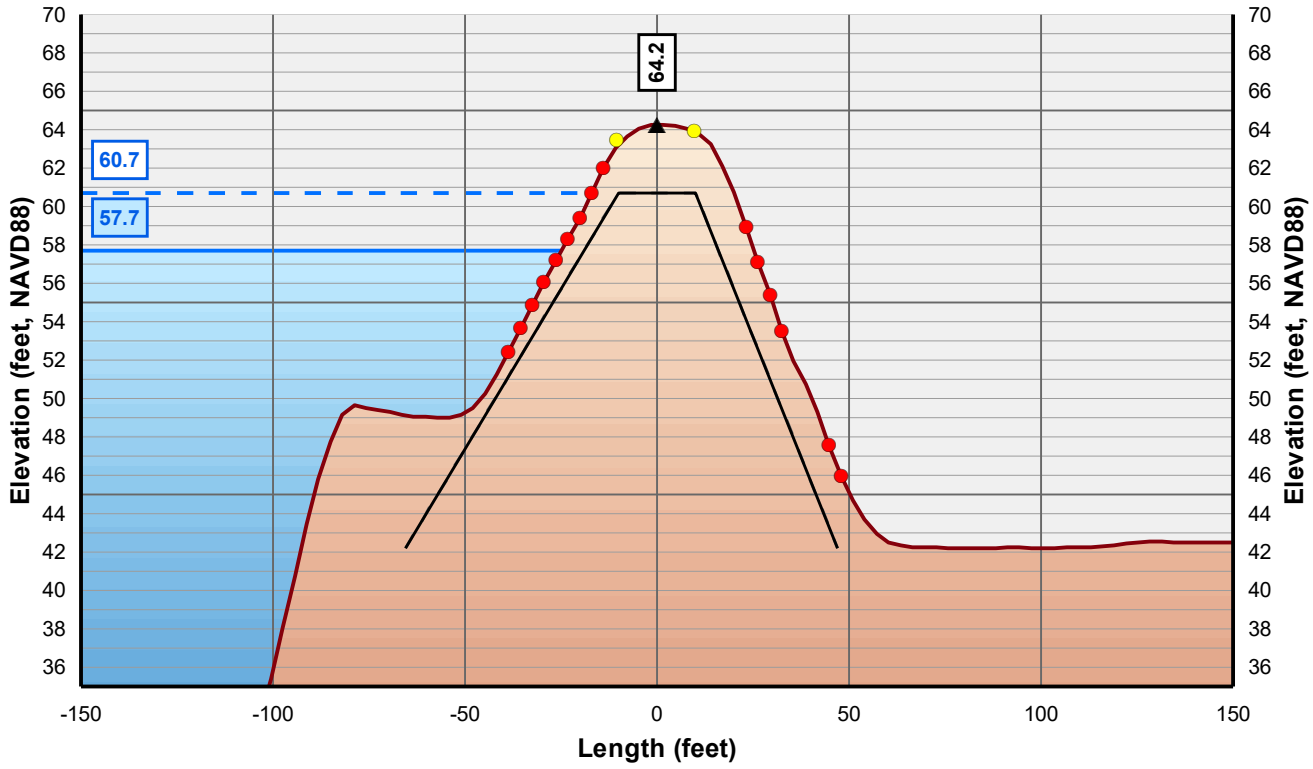
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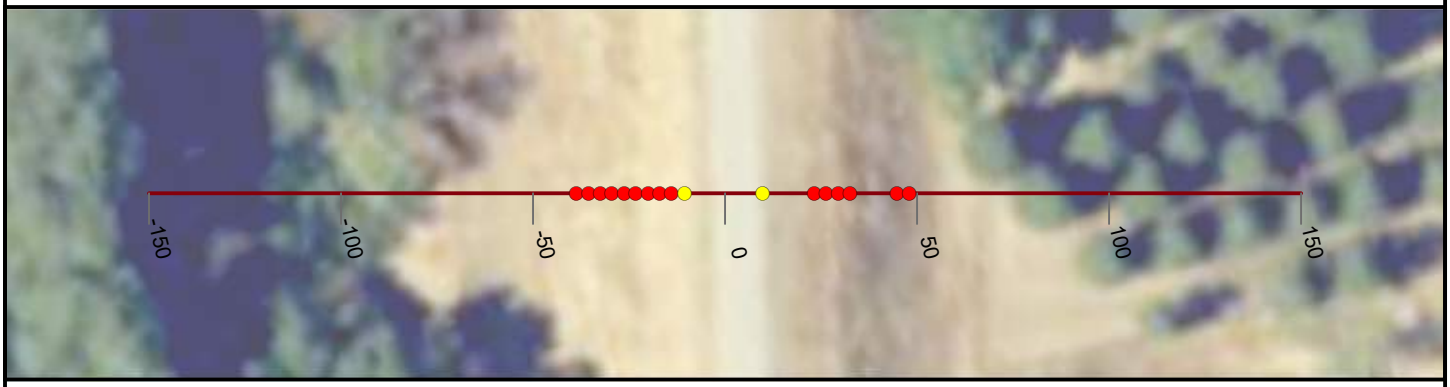
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Cross Section: Bear River 104+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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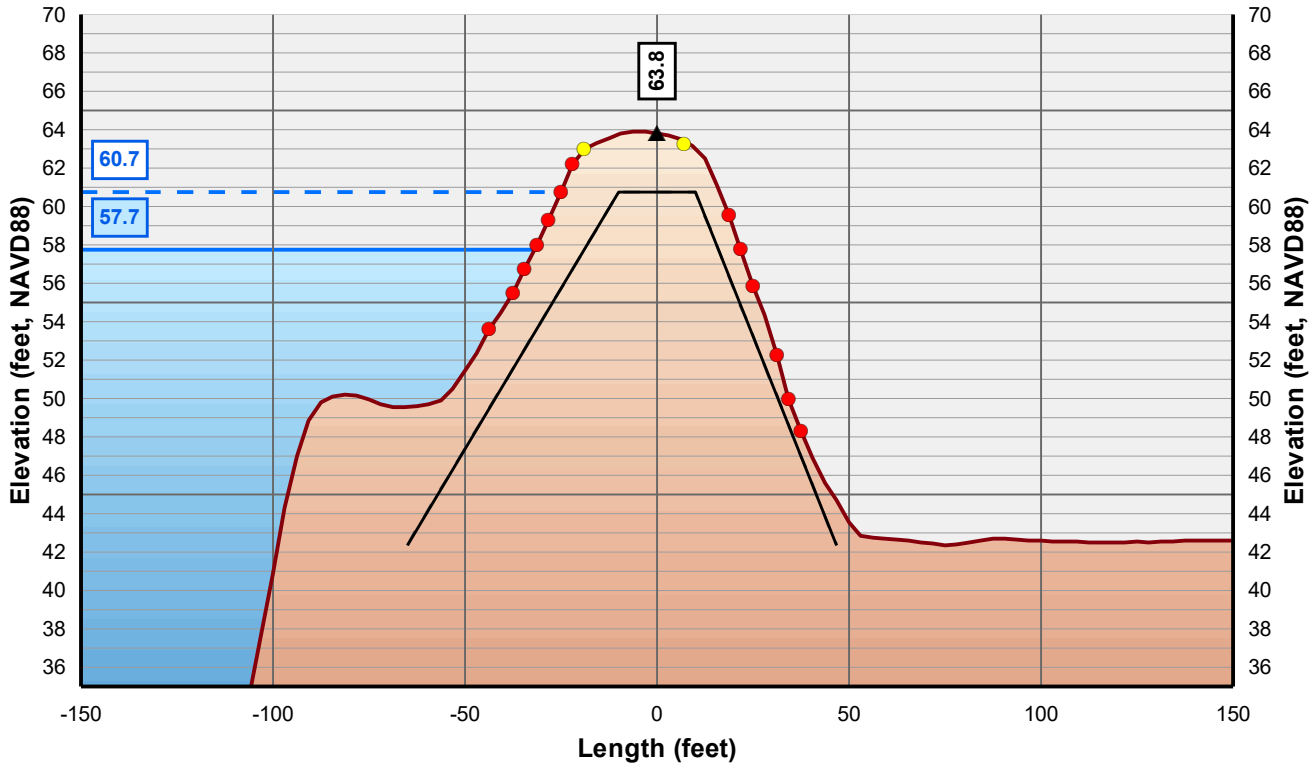
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Cross Section: Bear River 105+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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NORTH

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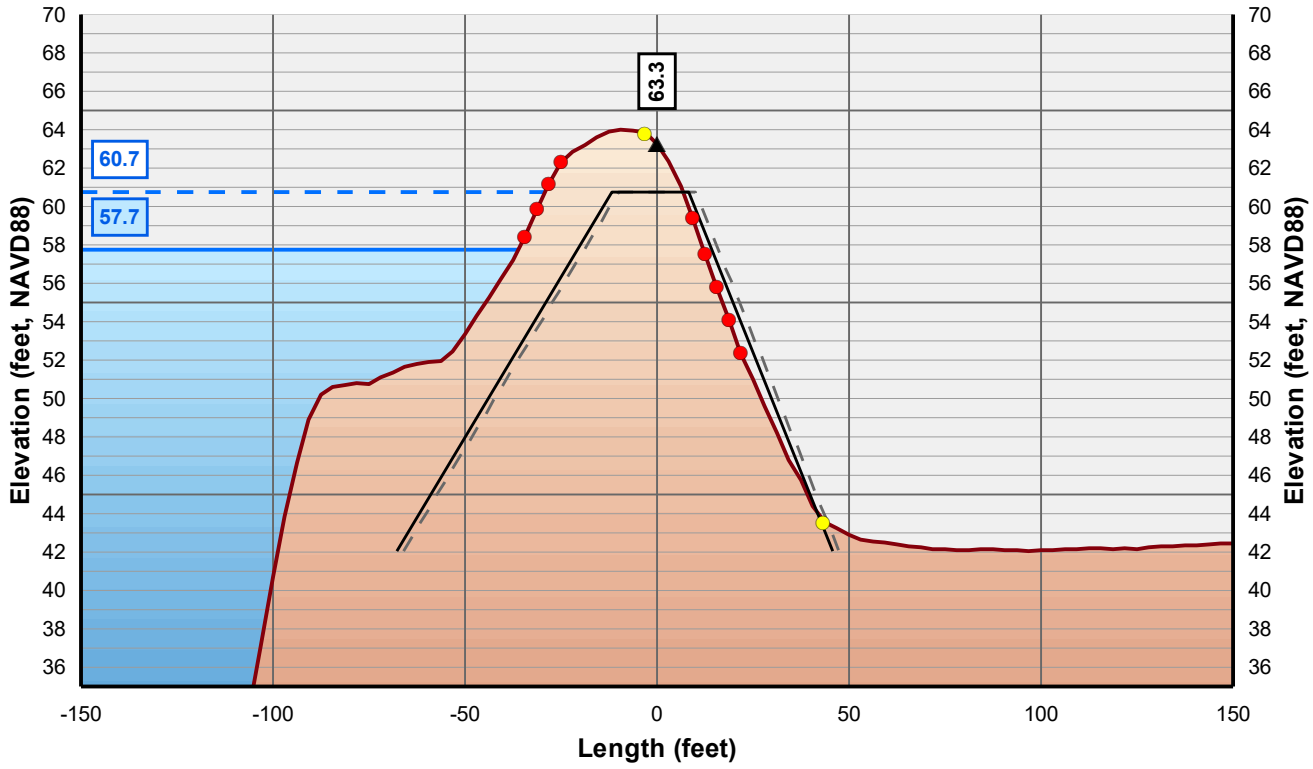
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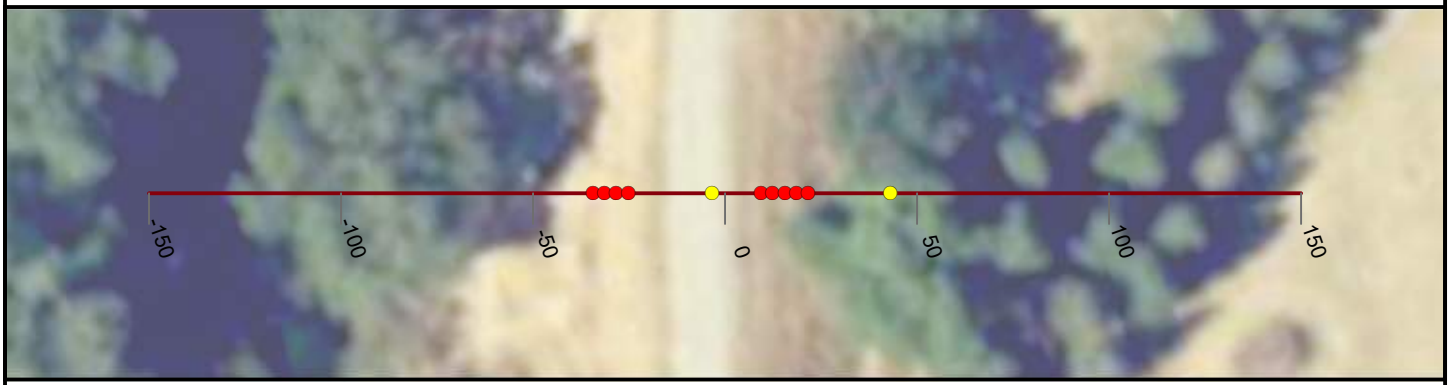
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Cross Section: Bear River 106+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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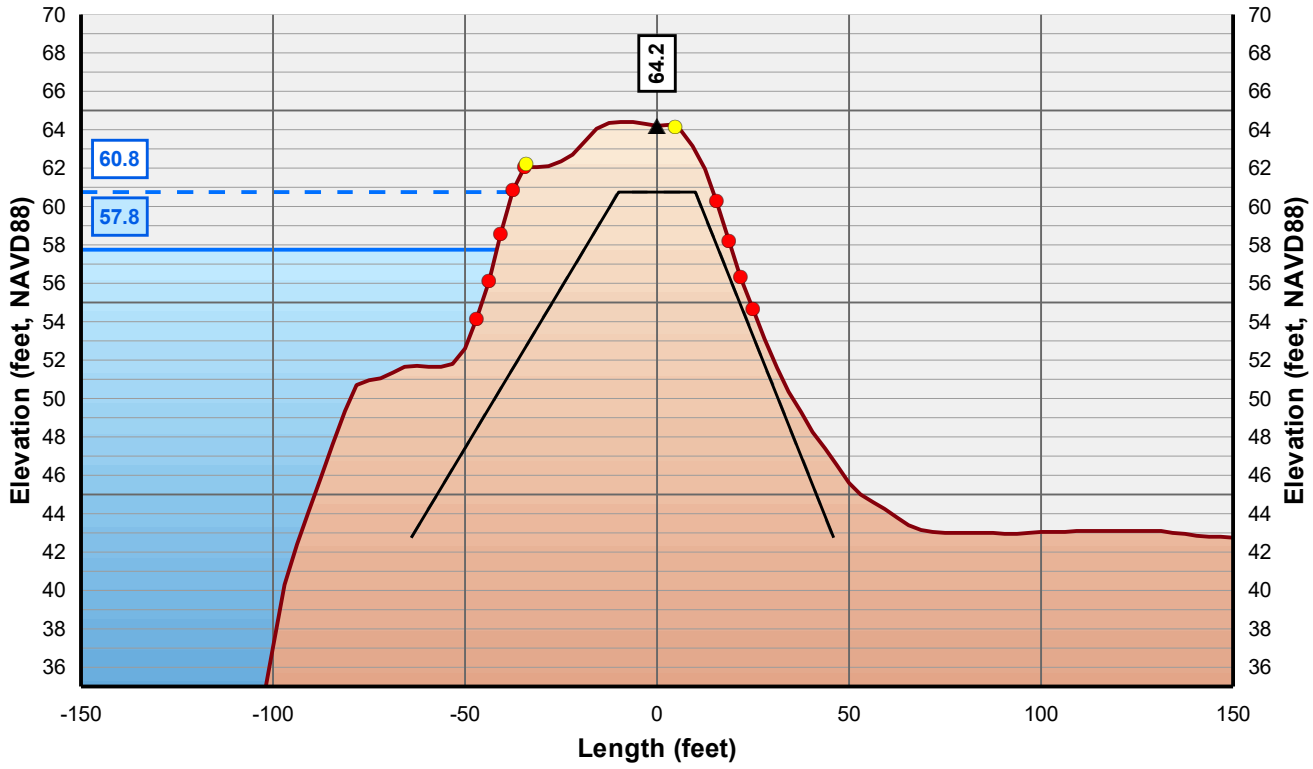
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Cross Section: Bear River 107+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
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- Theoretical Levee Prism Preliminary
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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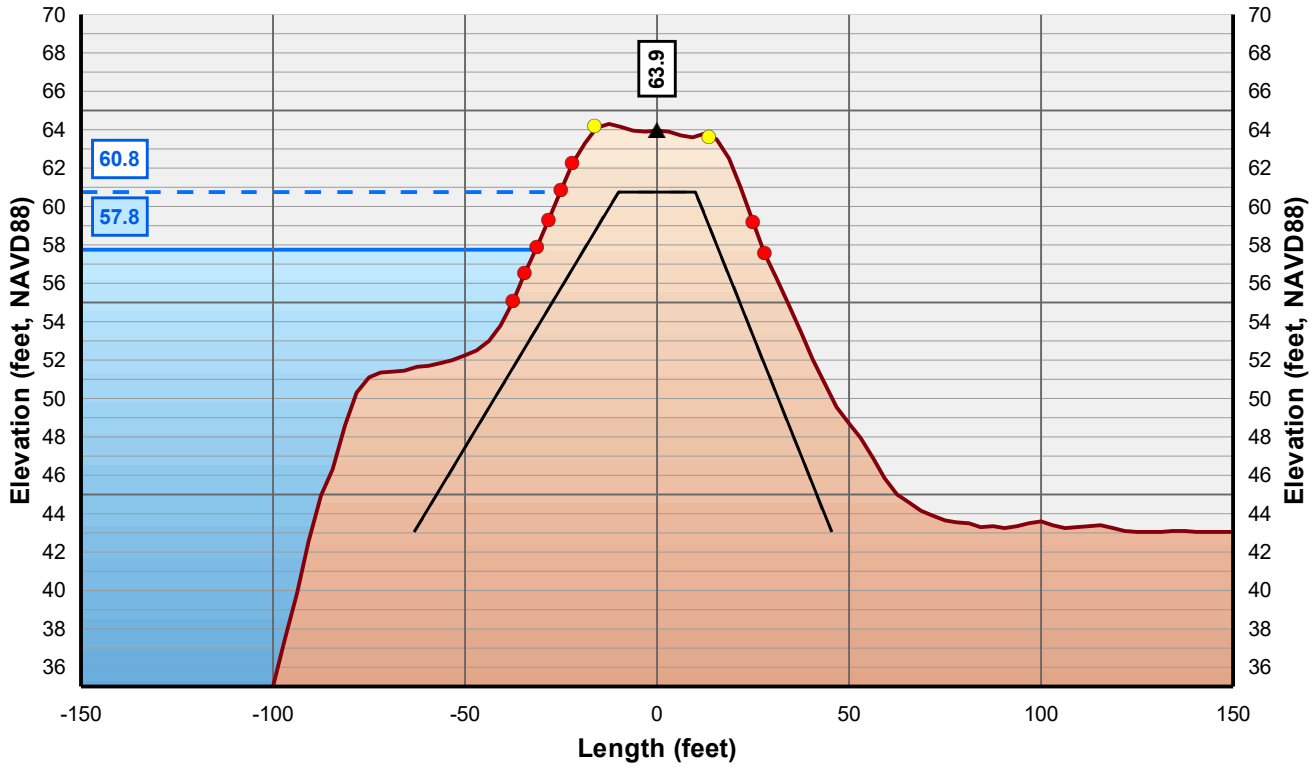
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Cross Section: Bear River 108+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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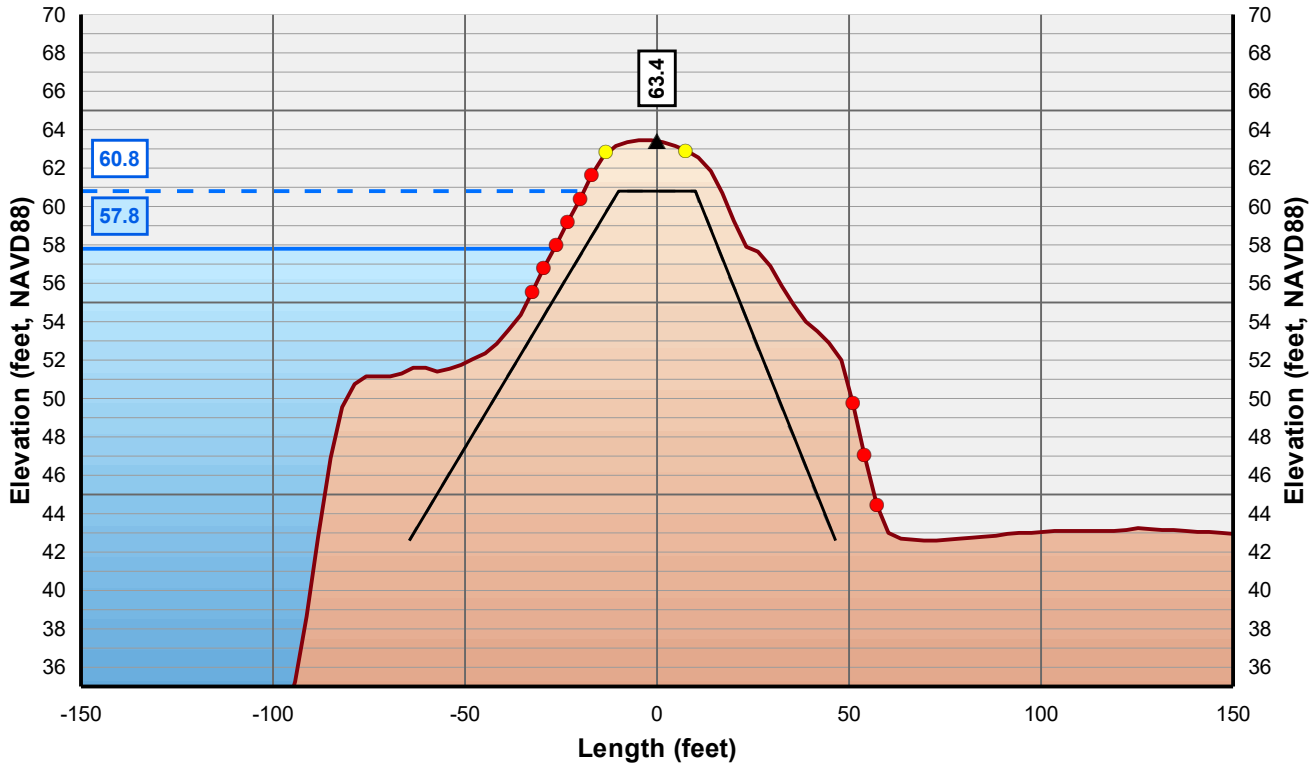
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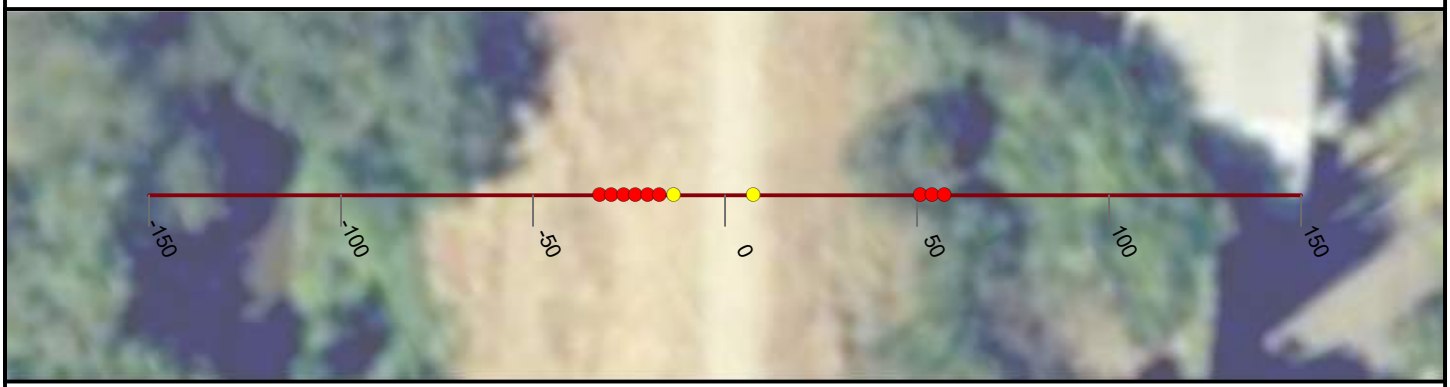
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Cross Section: Bear River 109+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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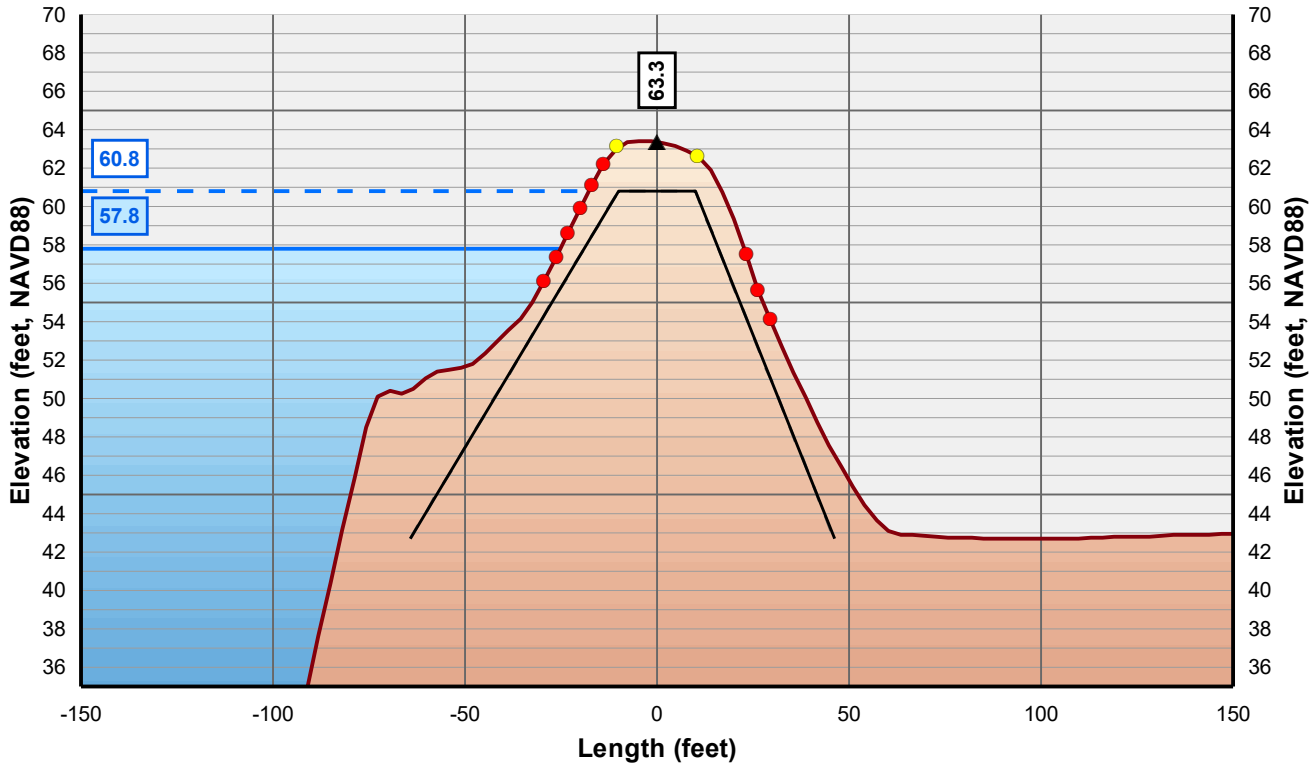
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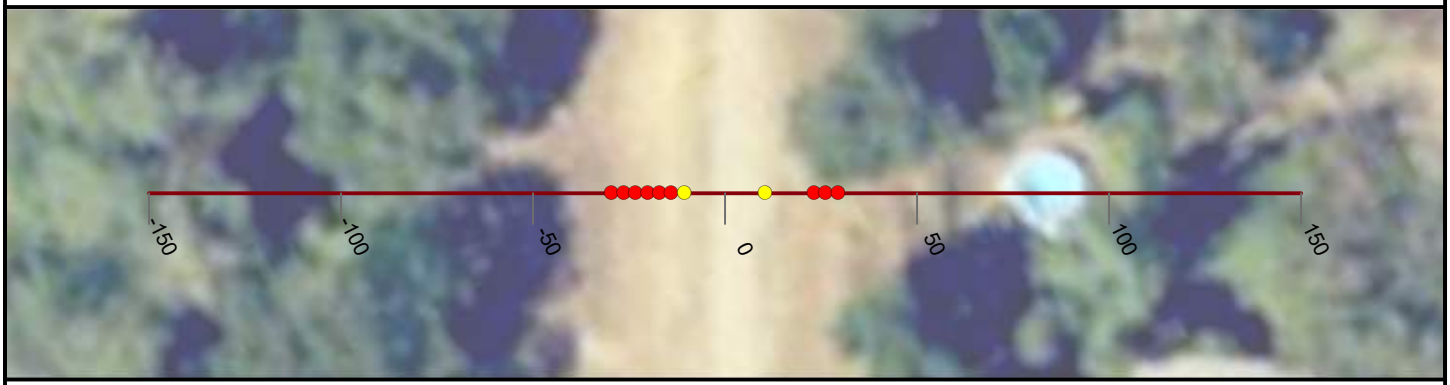
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Cross Section: Bear River 110+00



Horizontal Scale: 1 inch = 50 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

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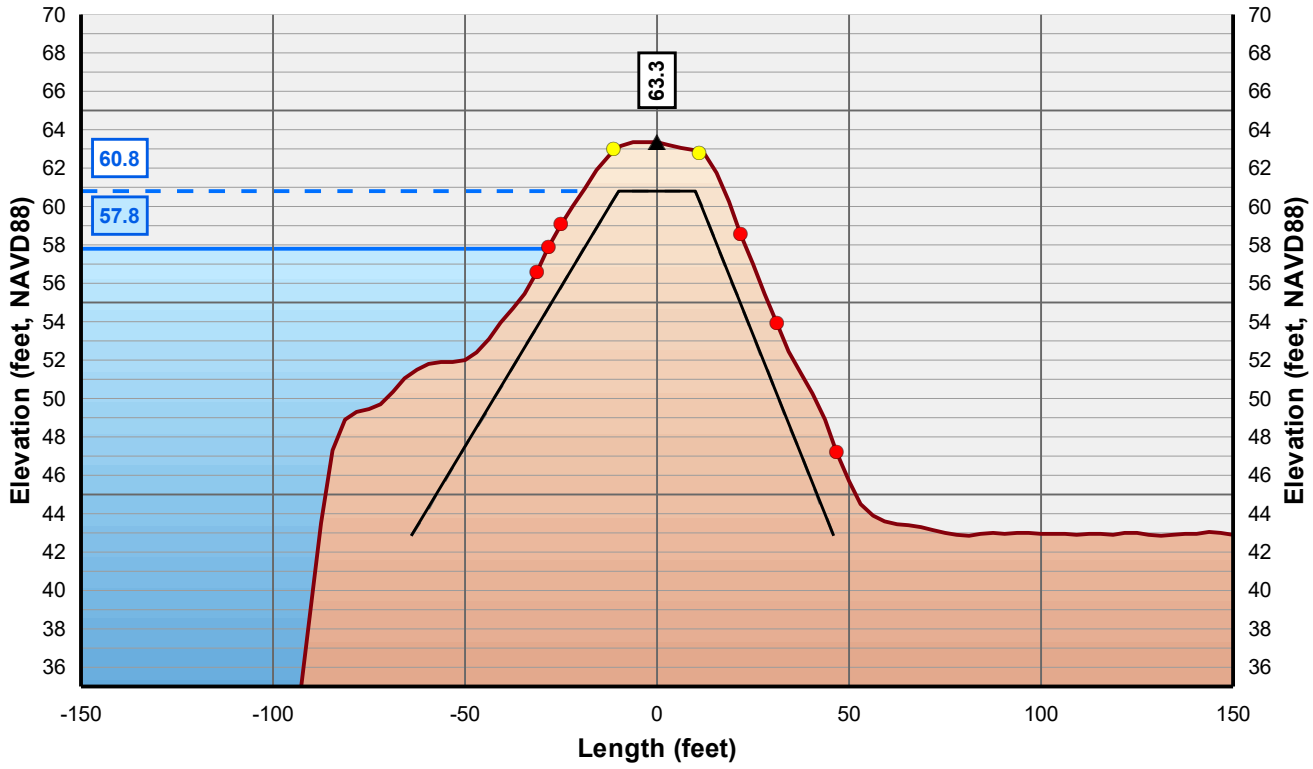
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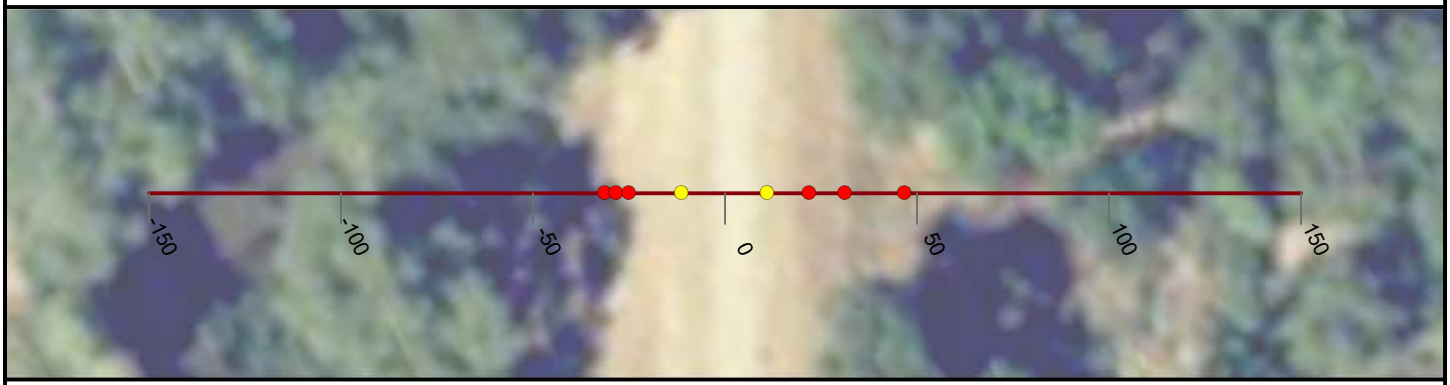
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Cross Section: Bear River 111+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
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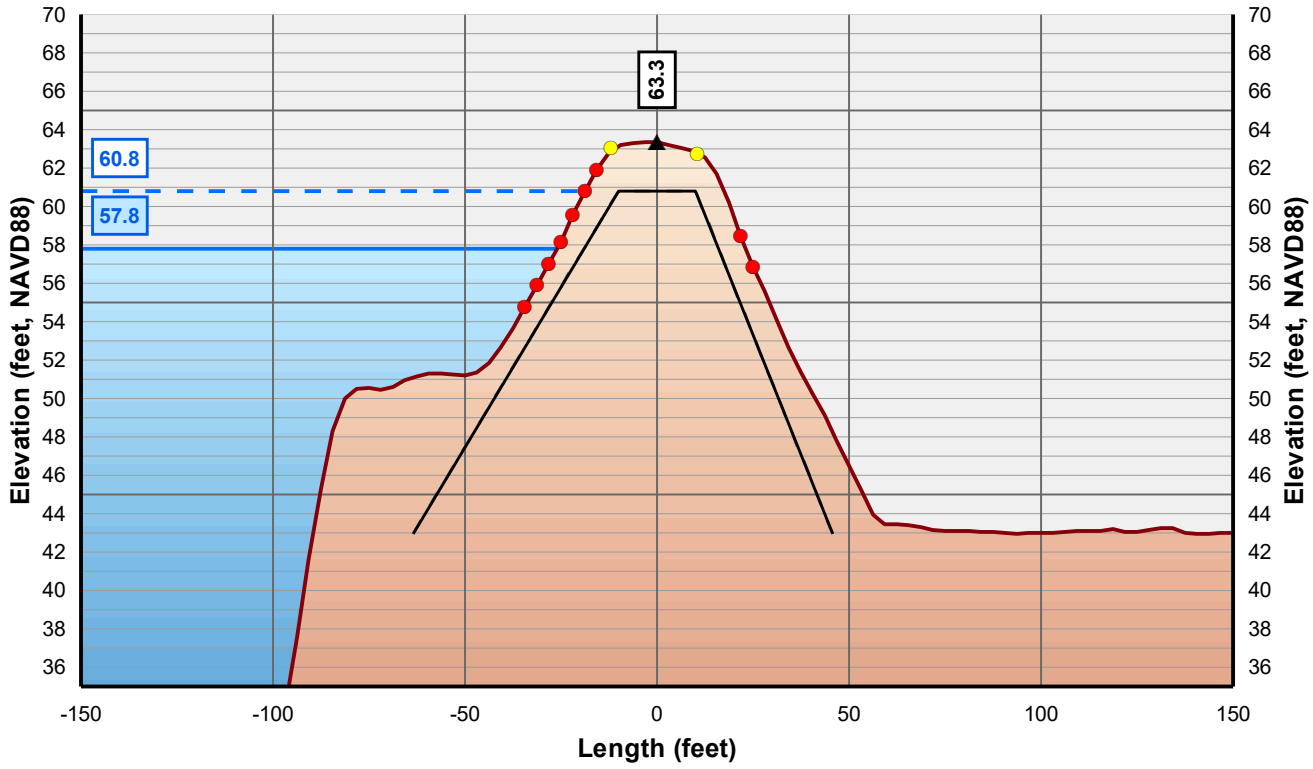
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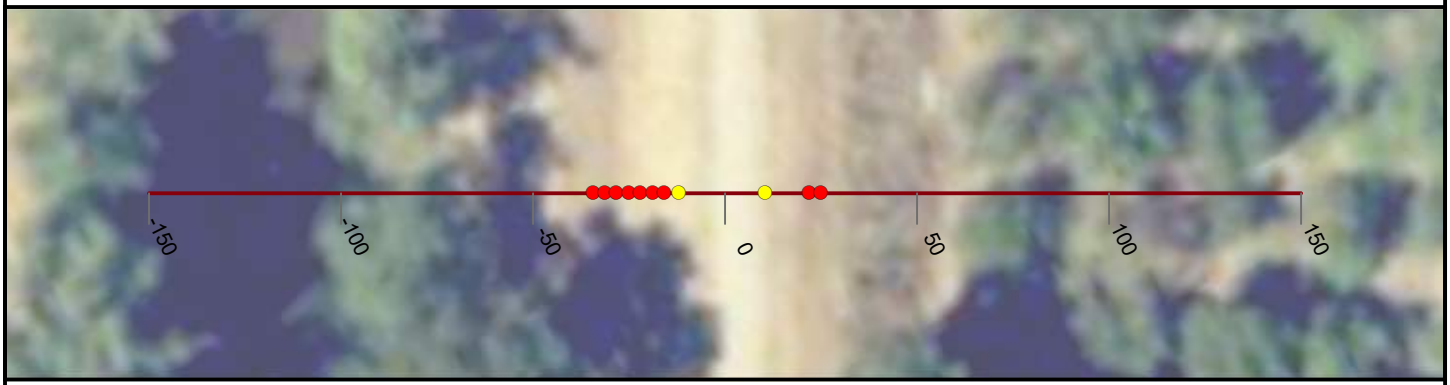
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Cross Section: Bear River 112+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
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- Issue Point
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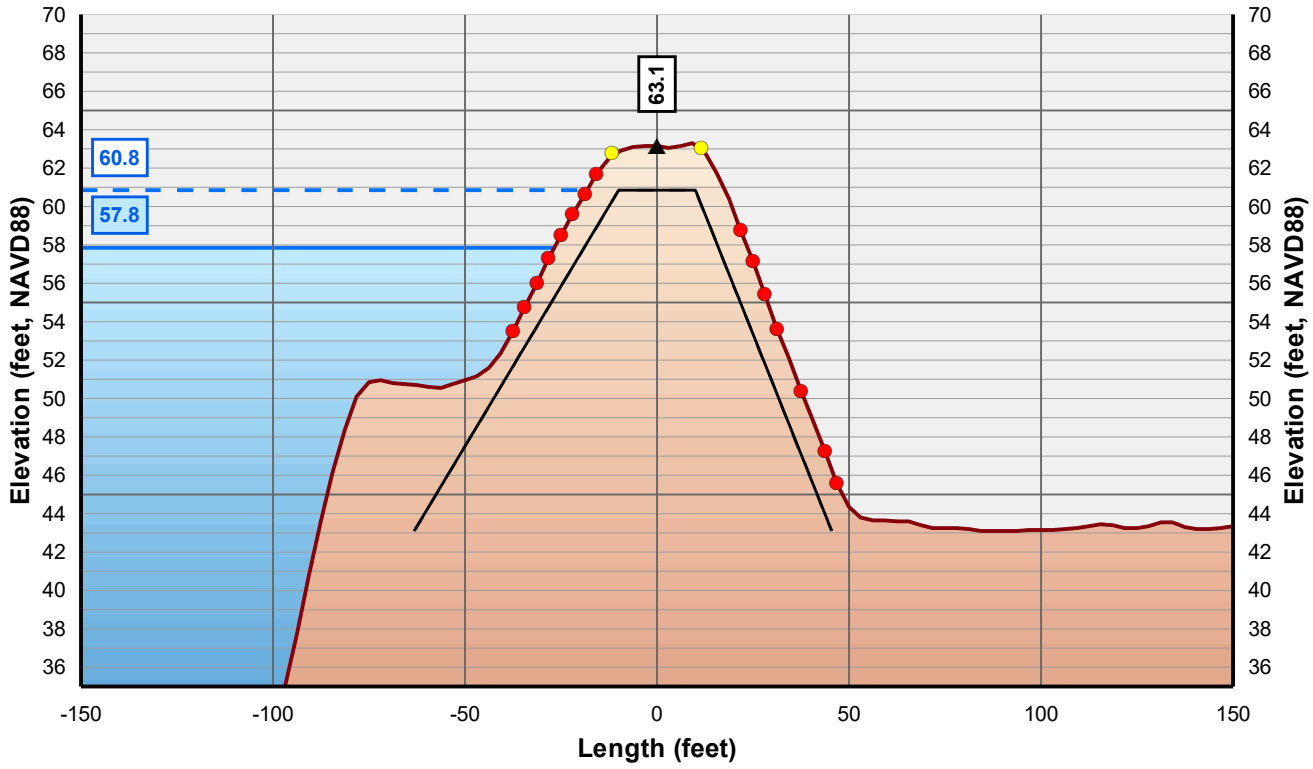
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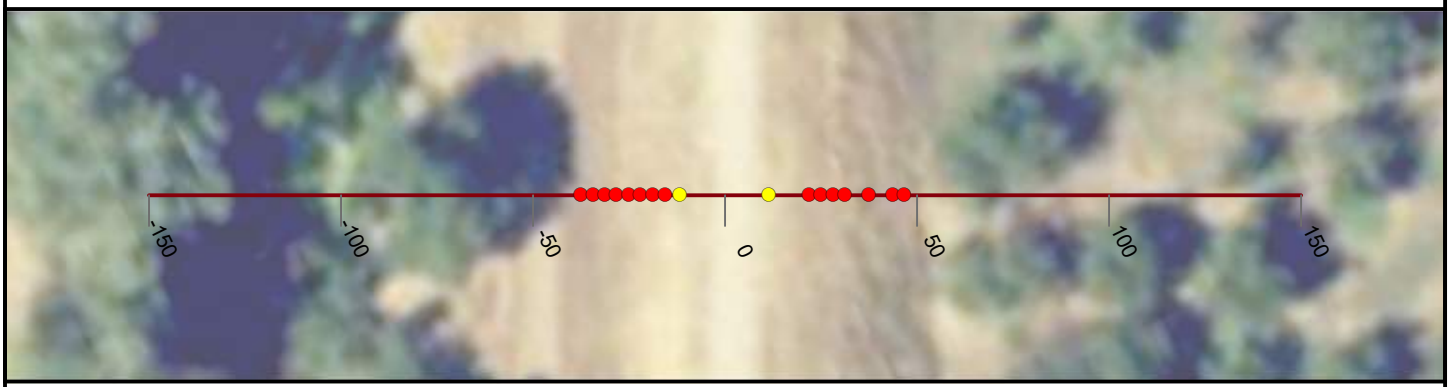
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Cross Section: Bear River 113+00



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BEAR RIVER LEVEE

CALIFORNIA

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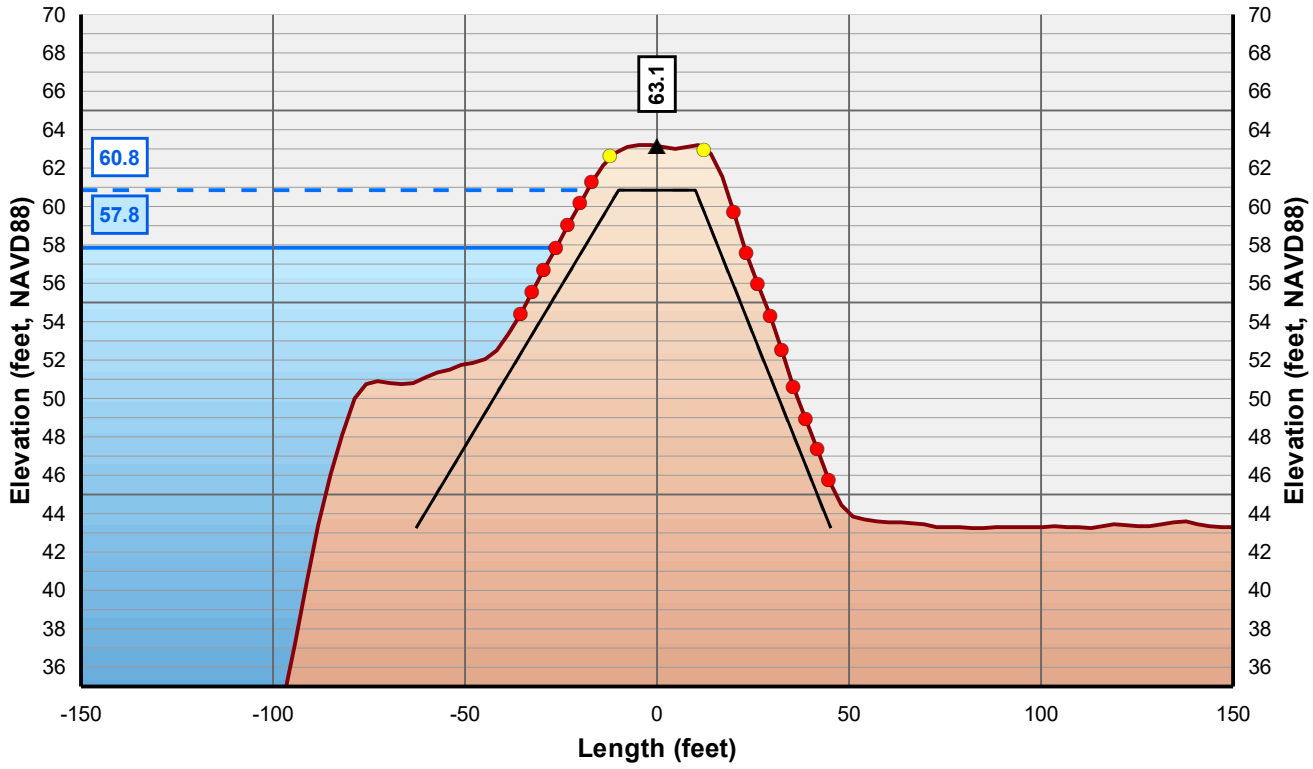
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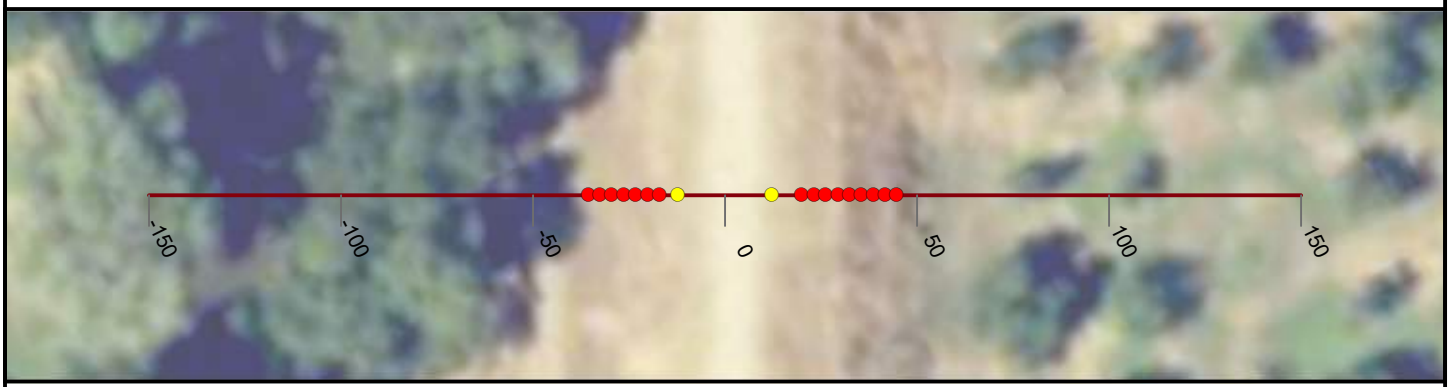
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Cross Section: Bear River 114+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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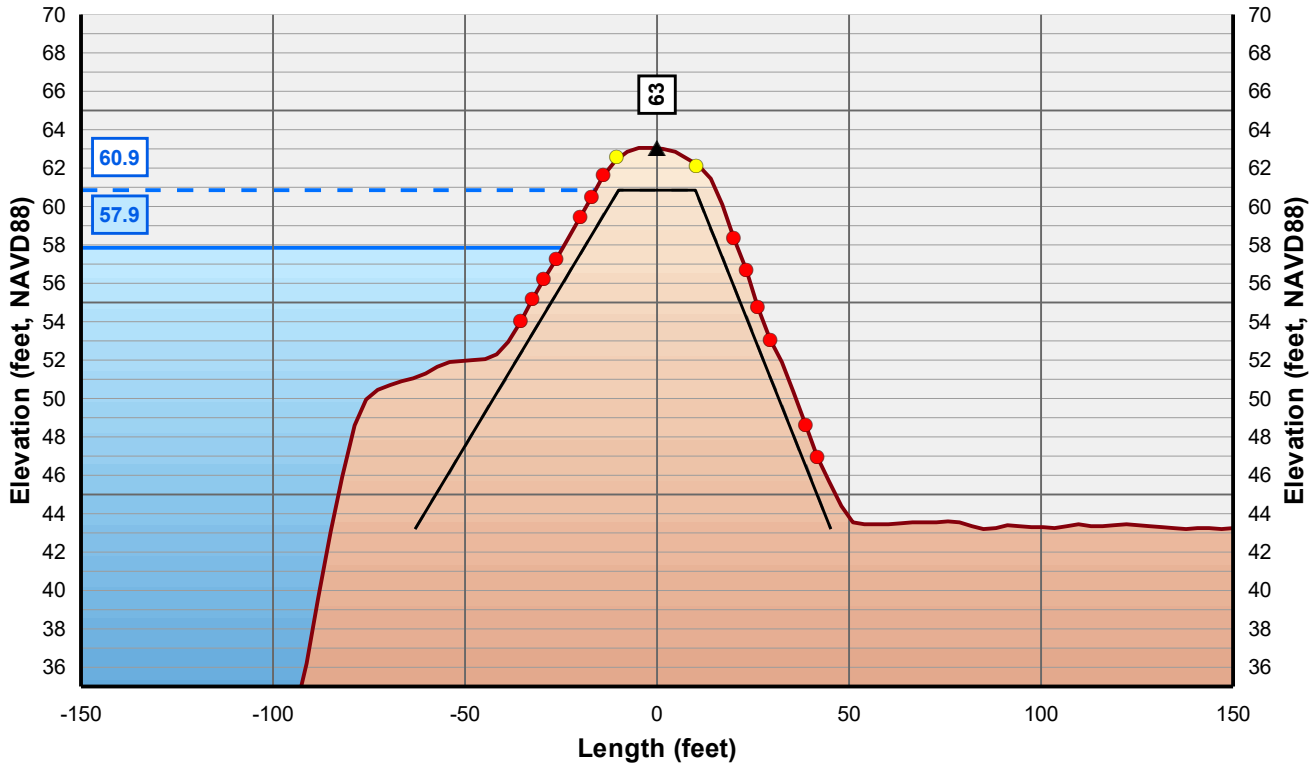
FEET

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3301 C Street, Bldg 100-B
Sacramento, CA 95816
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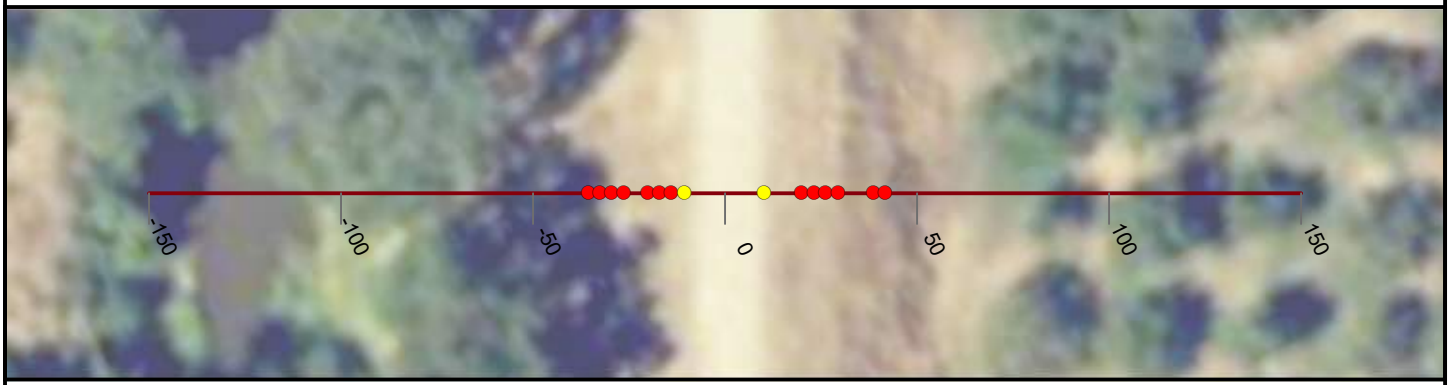
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Cross Section: Bear River 115+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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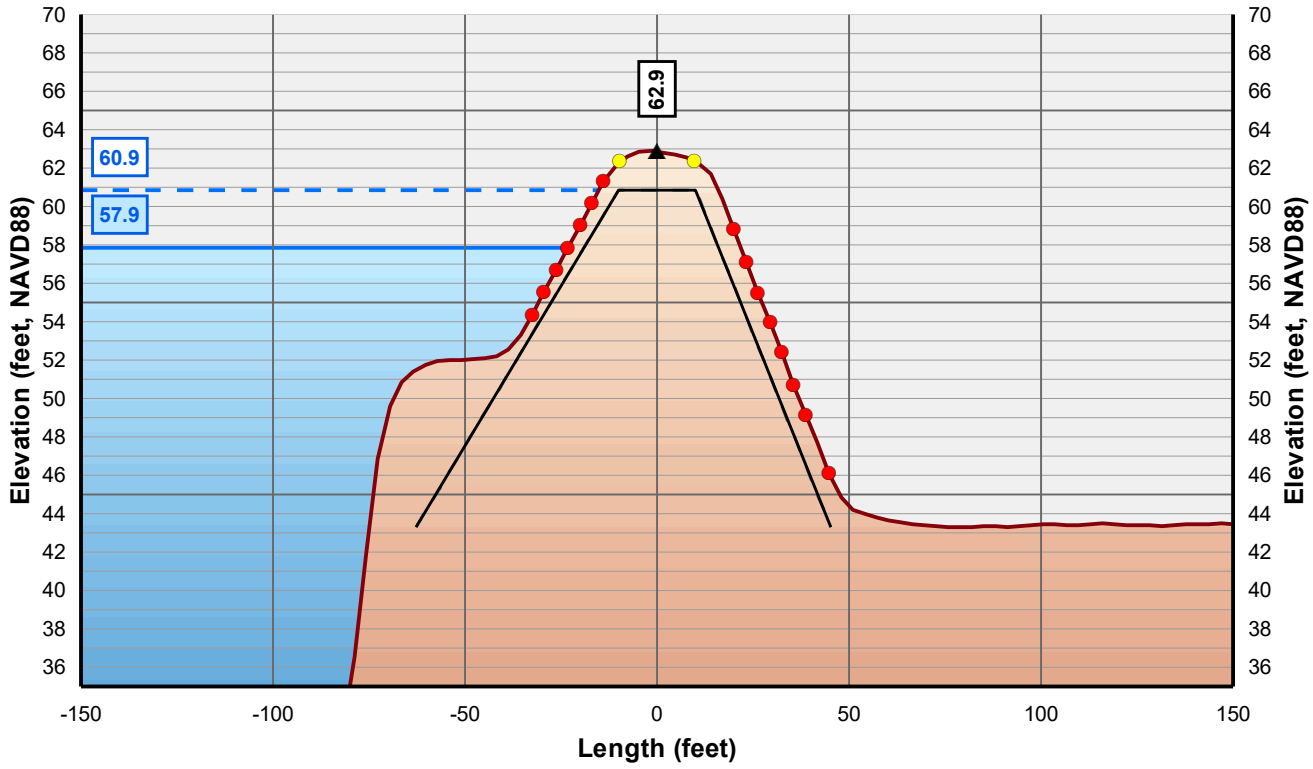
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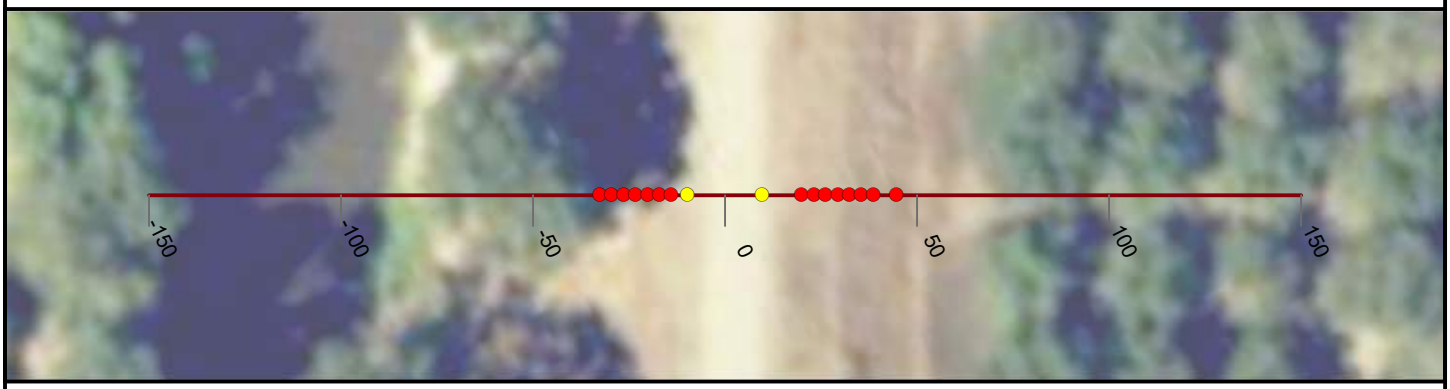
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Cross Section: Bear River 116+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

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NORTH

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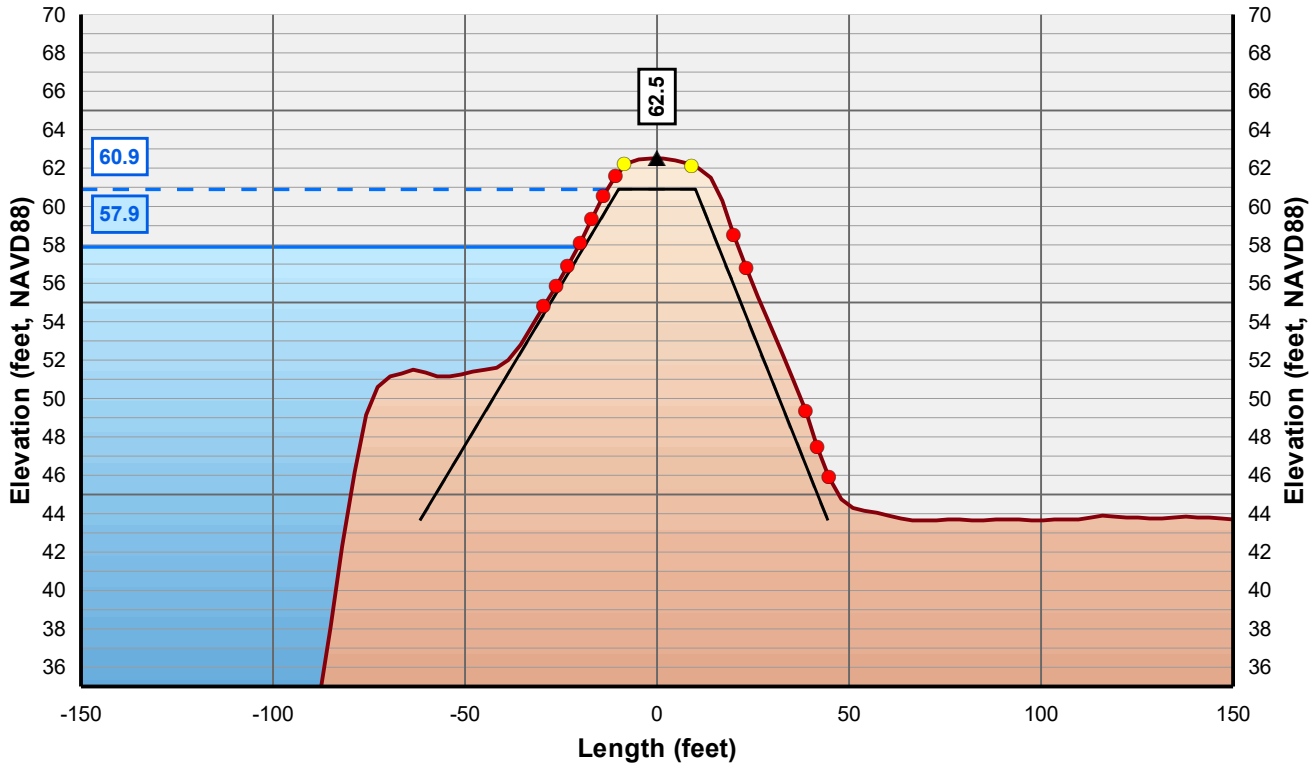
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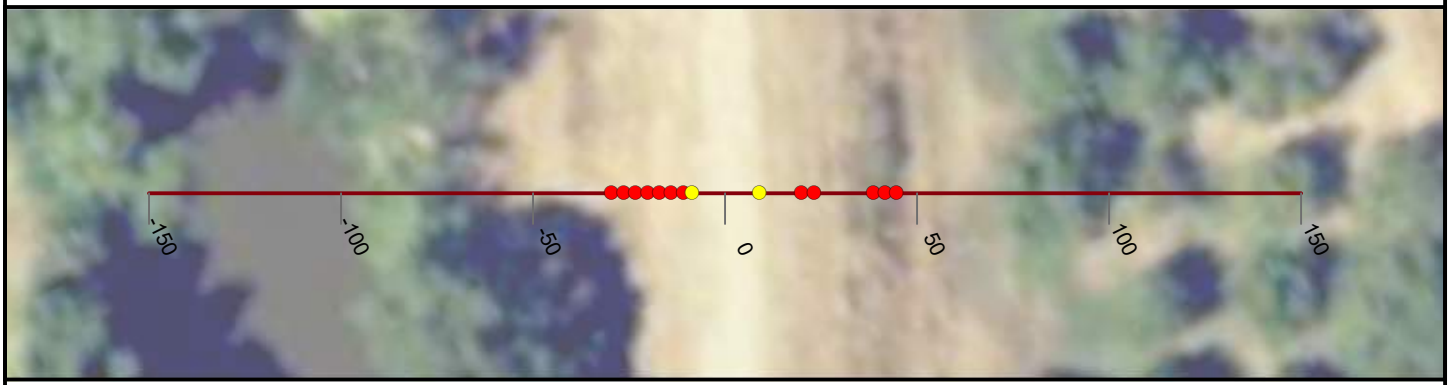
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Cross Section: Bear River 117+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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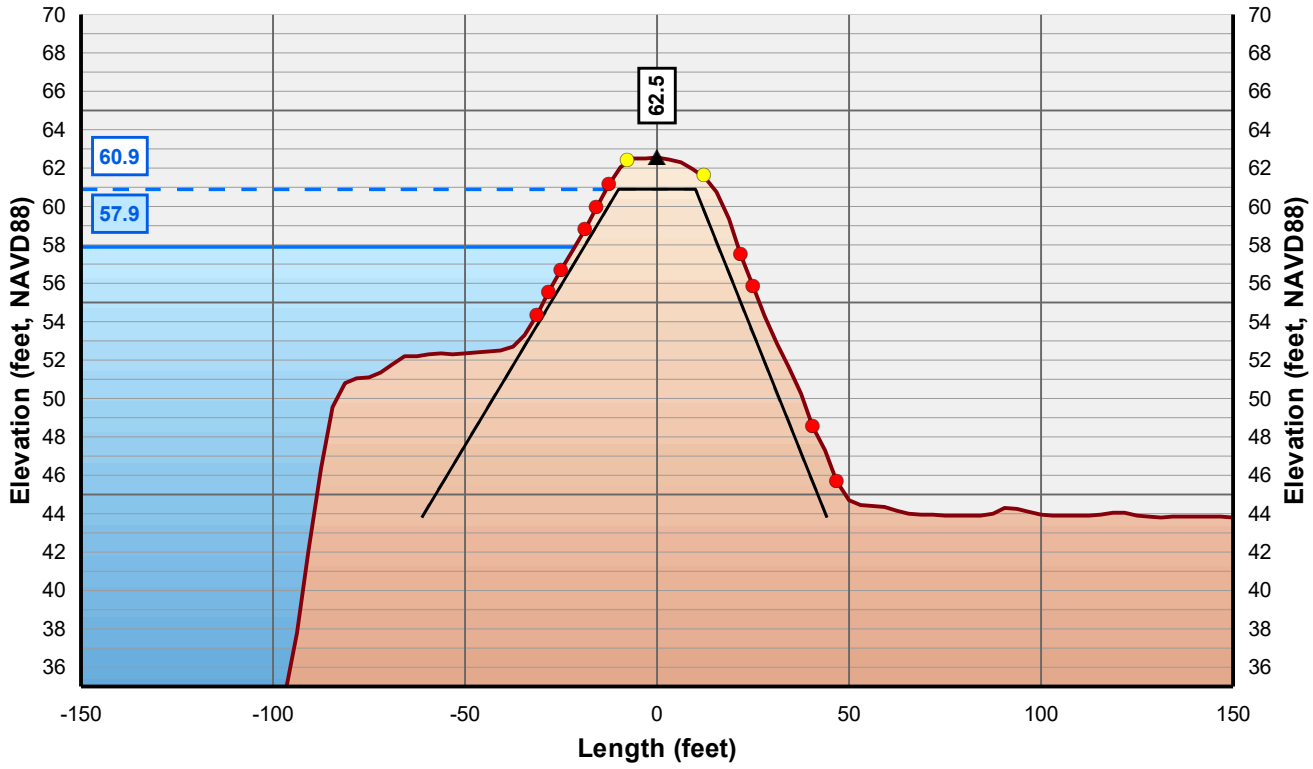
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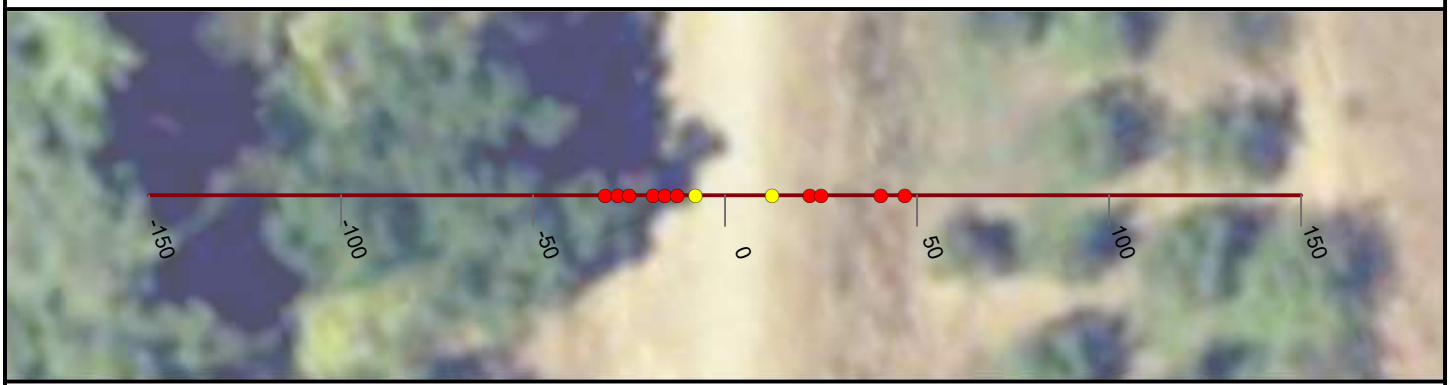
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Cross Section: Bear River 118+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
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- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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CALIFORNIA

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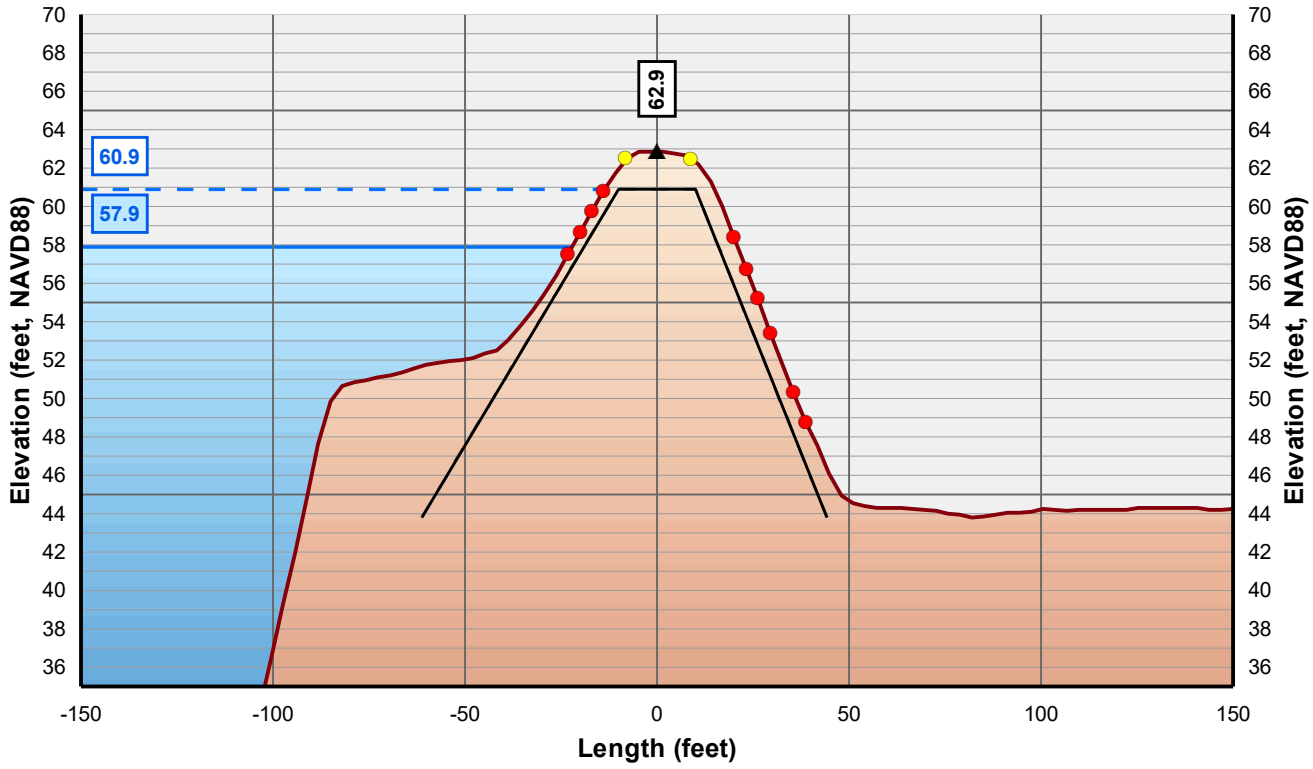
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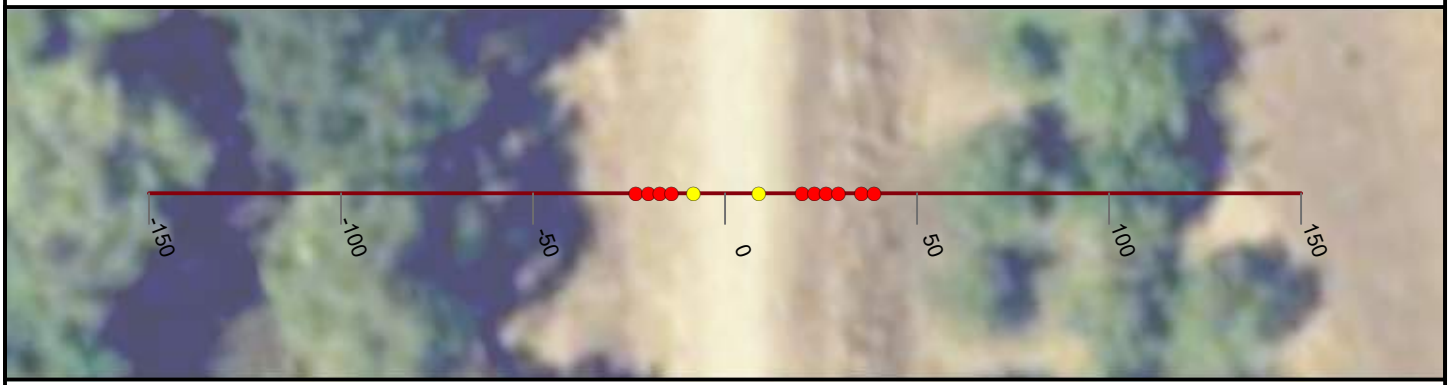
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Cross Section: Bear River 119+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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BEAR RIVER LEVEE

CALIFORNIA

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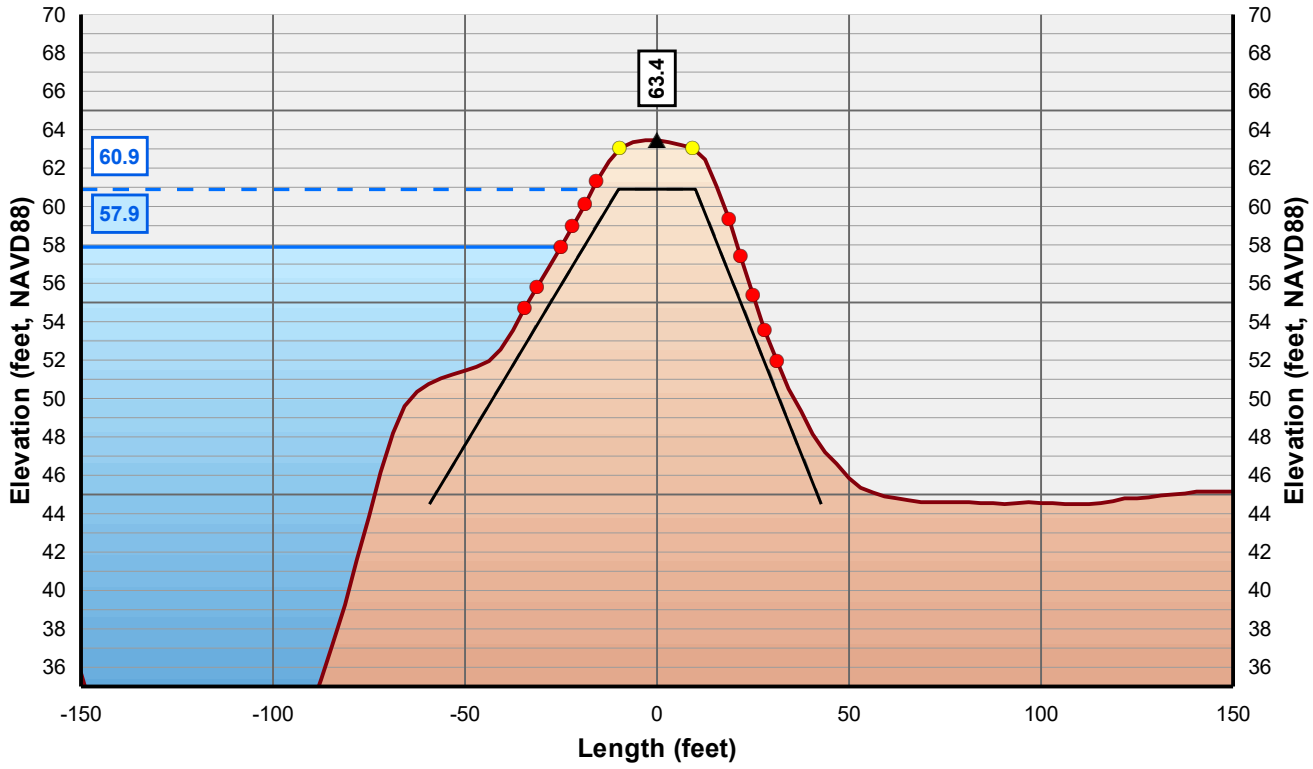
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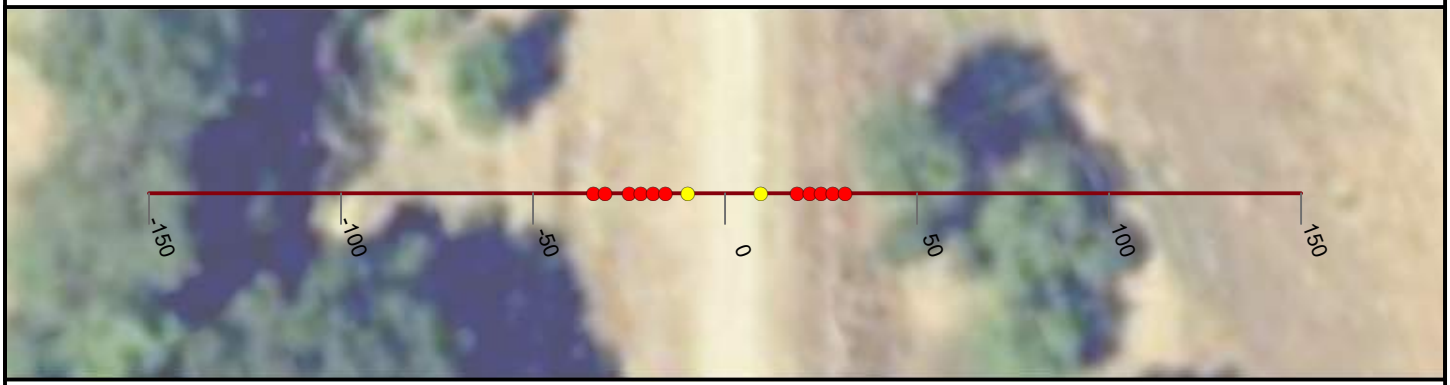
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Cross Section: Bear River 120+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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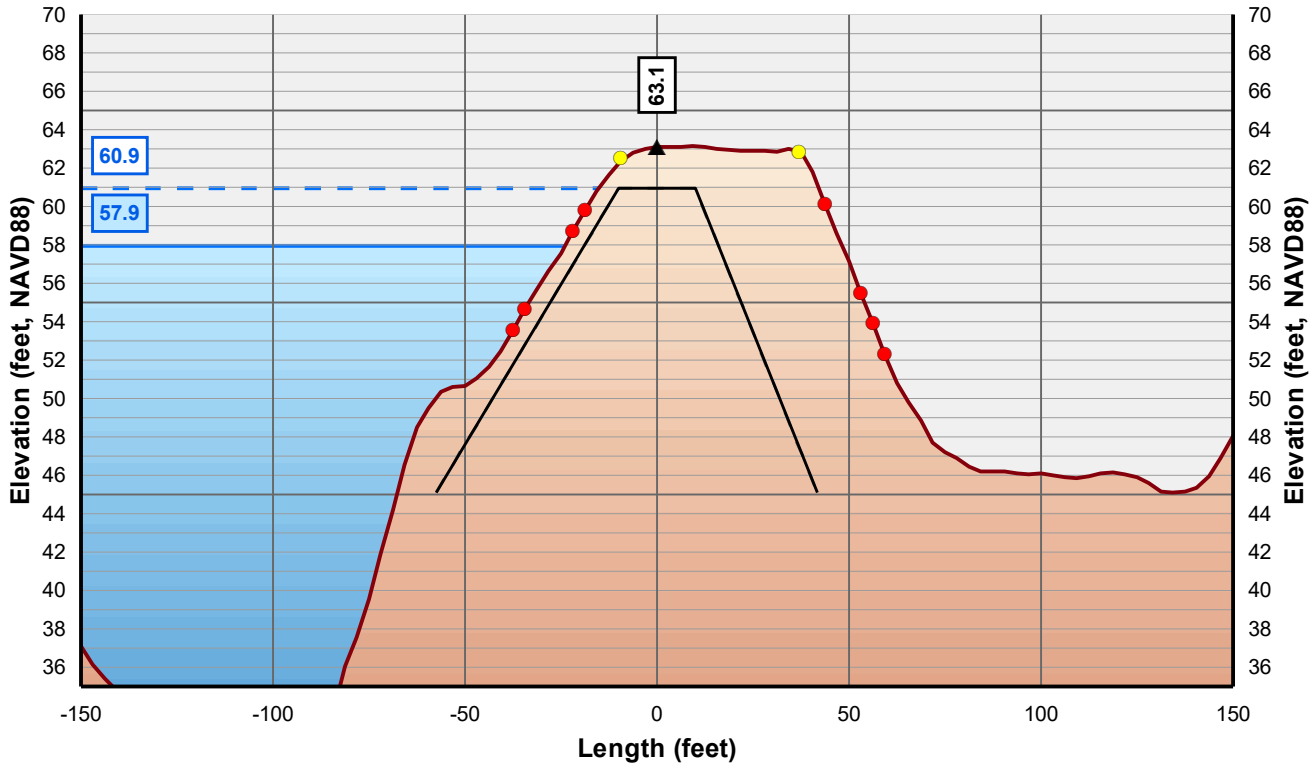
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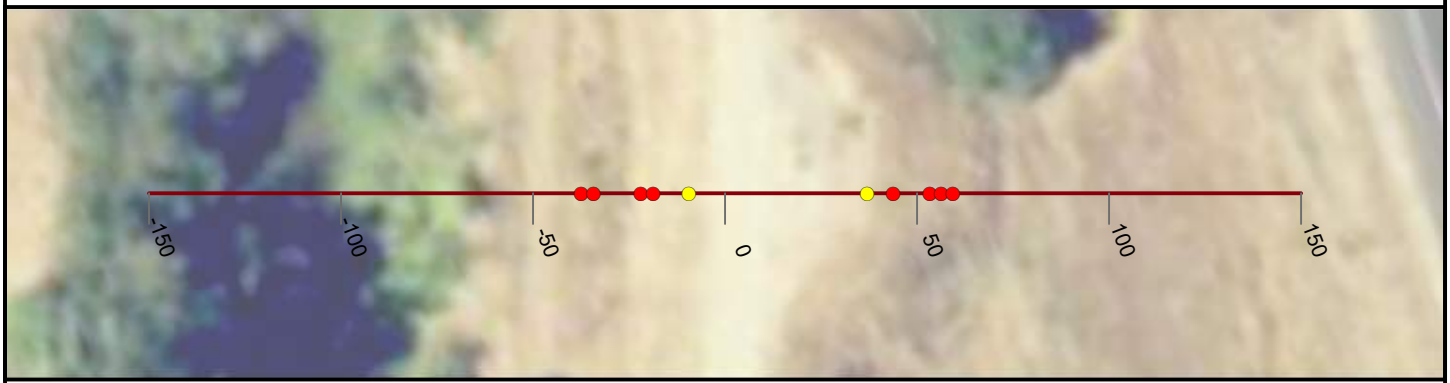
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Cross Section: Bear River 121+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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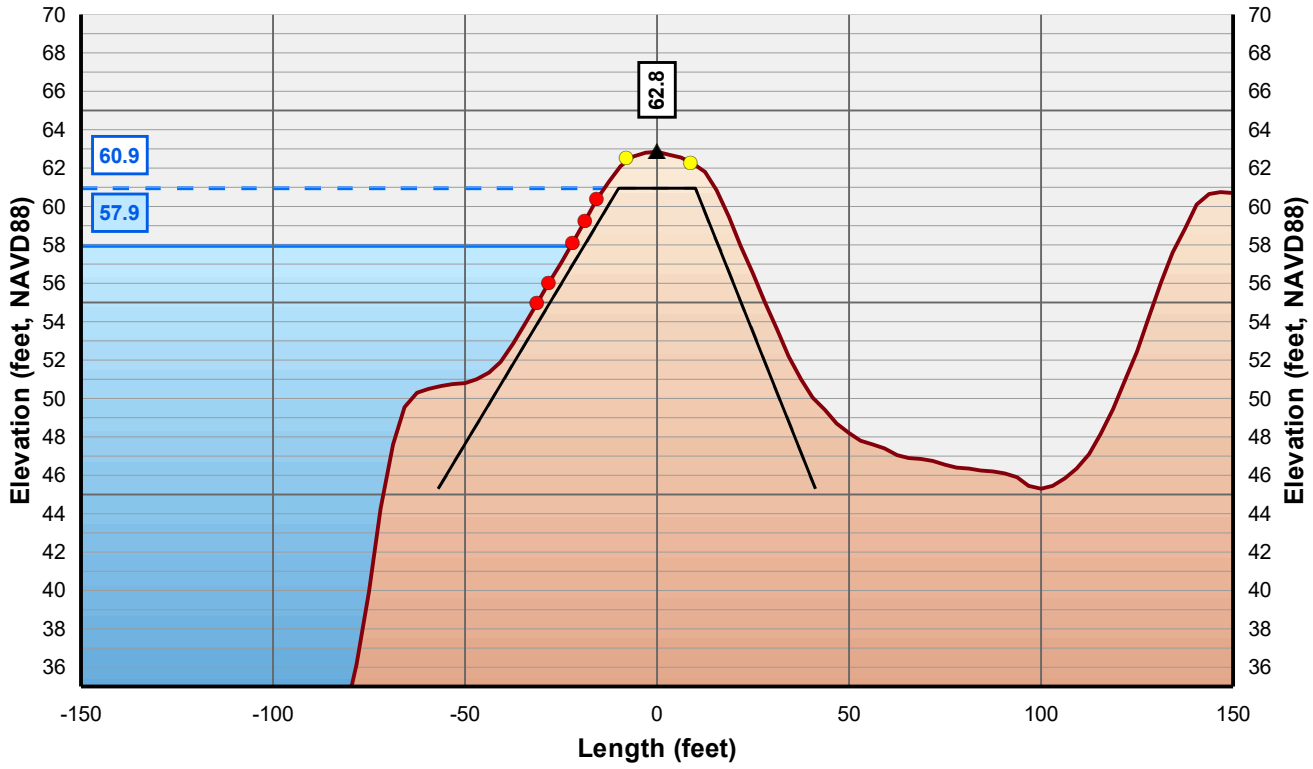
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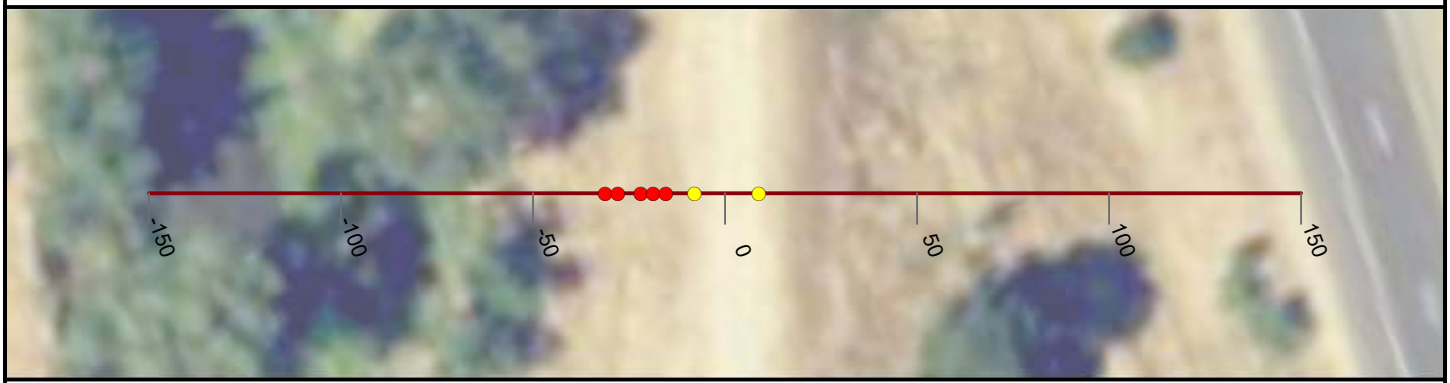
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Cross Section: Bear River 122+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

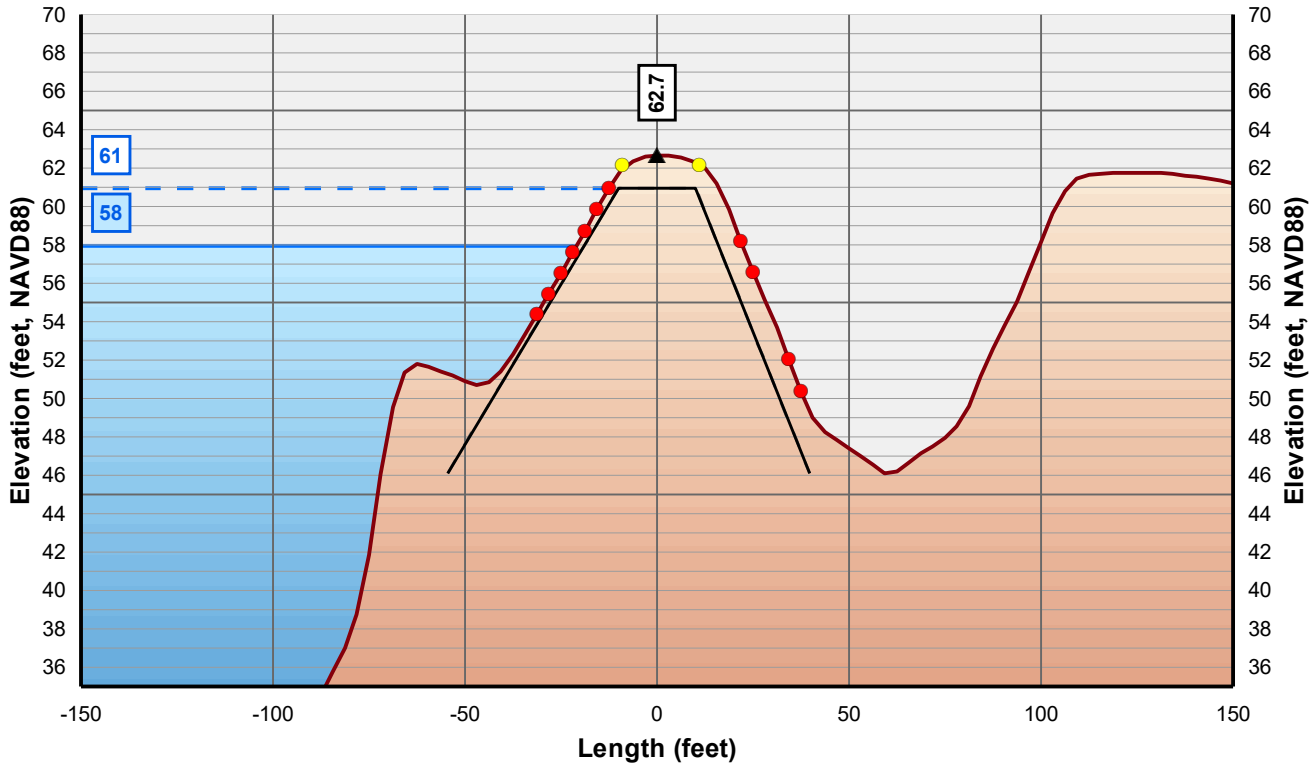
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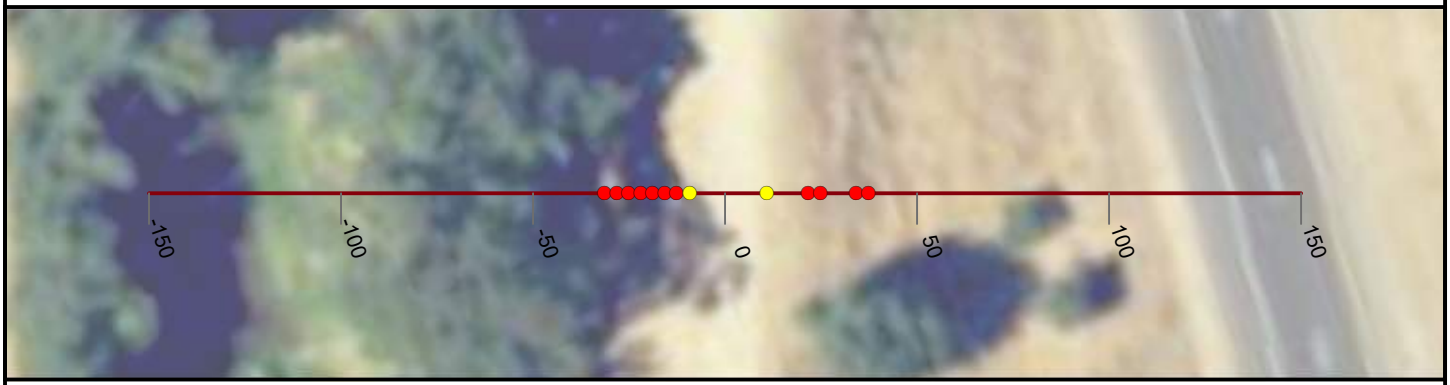
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Cross Section: Bear River 123+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

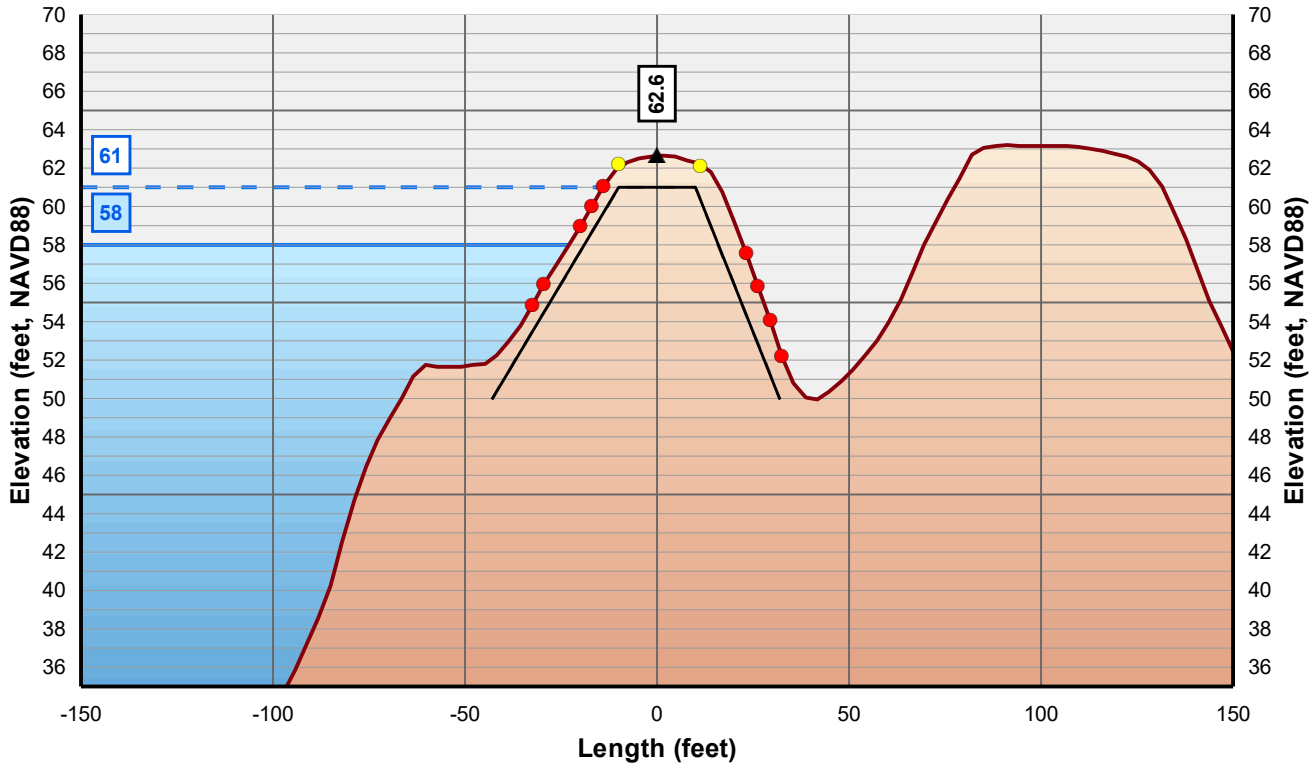
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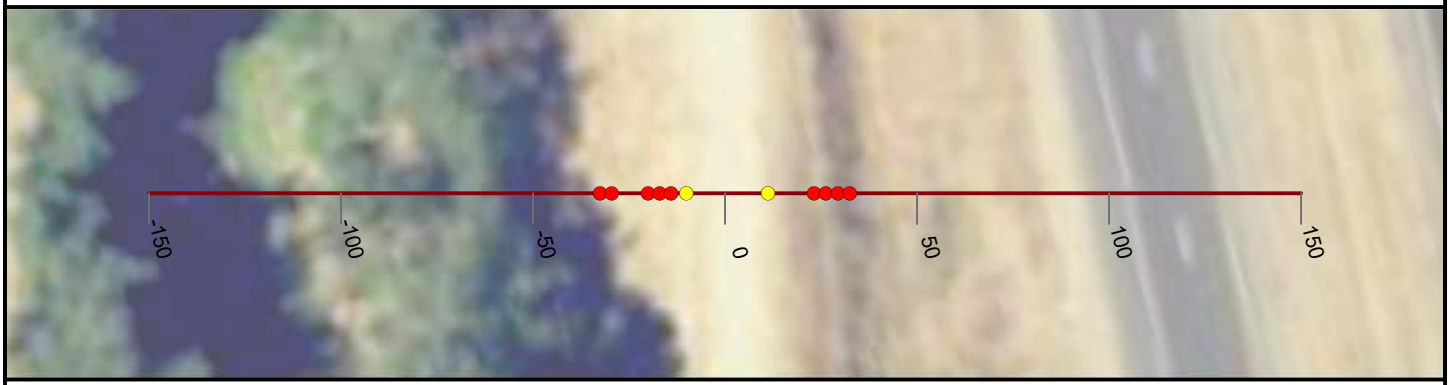
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Cross Section: Bear River 124+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

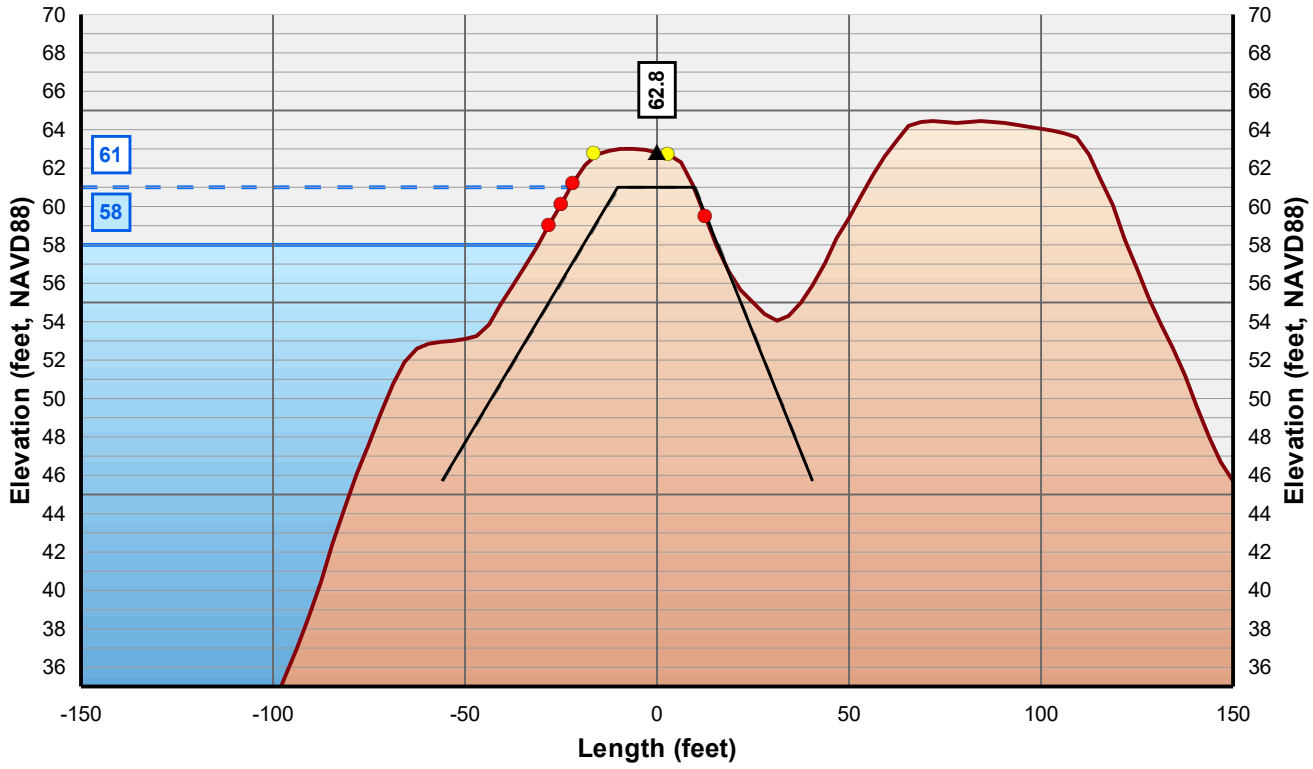
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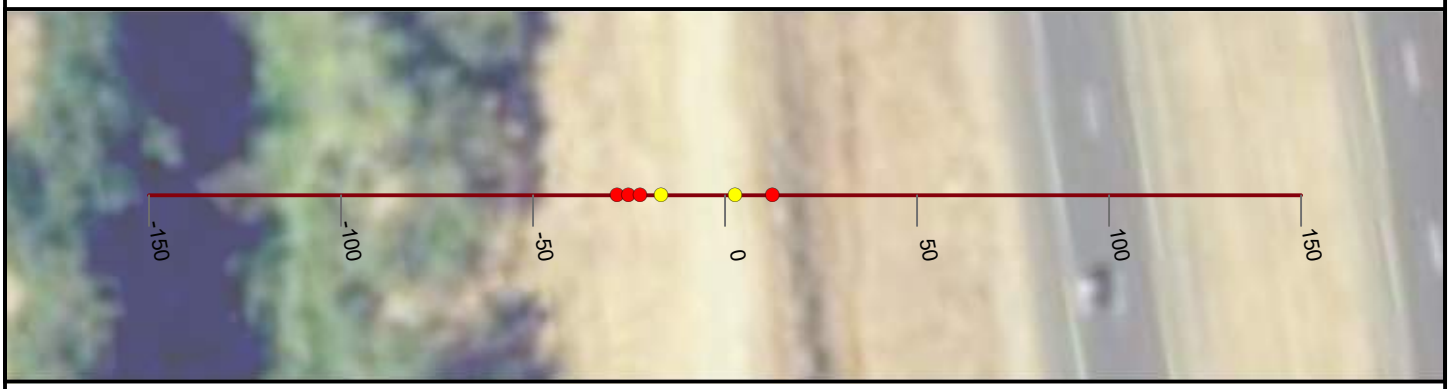
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Cross Section: Bear River 125+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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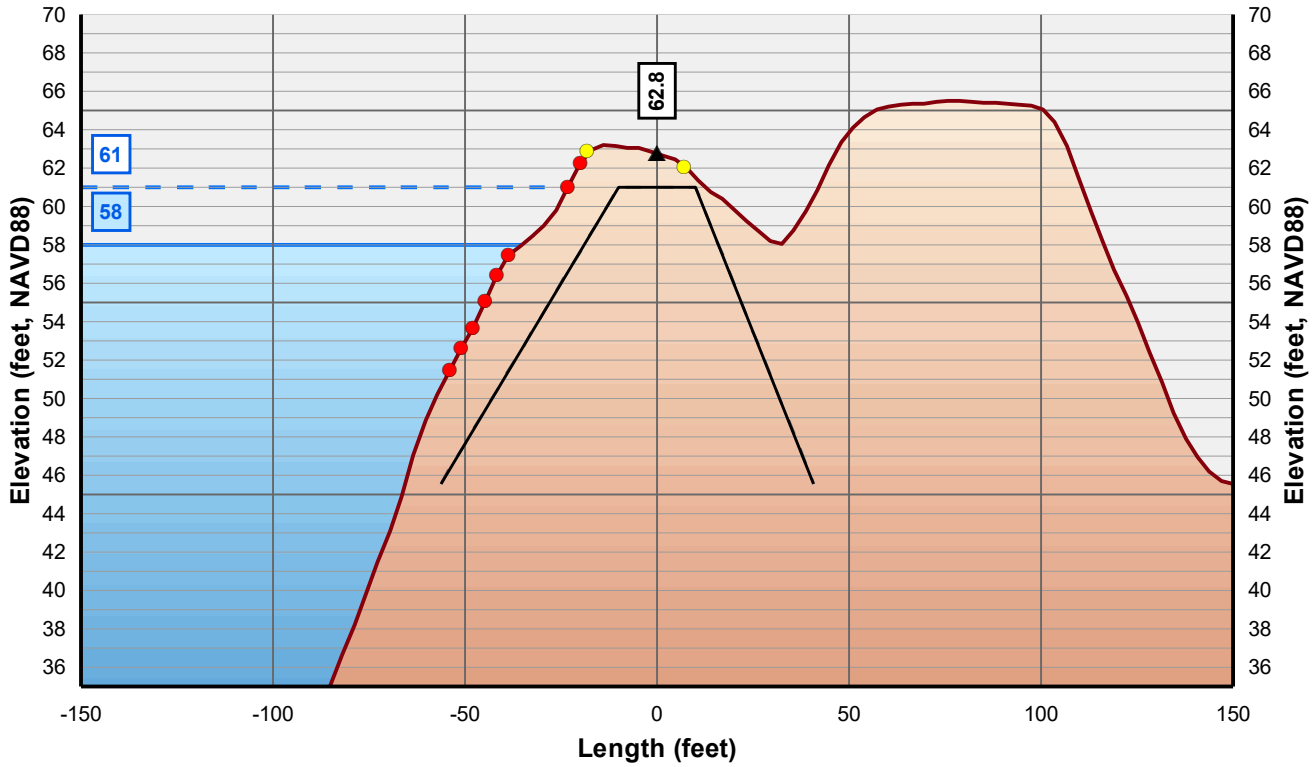
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Cross Section: Bear River 126+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



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FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

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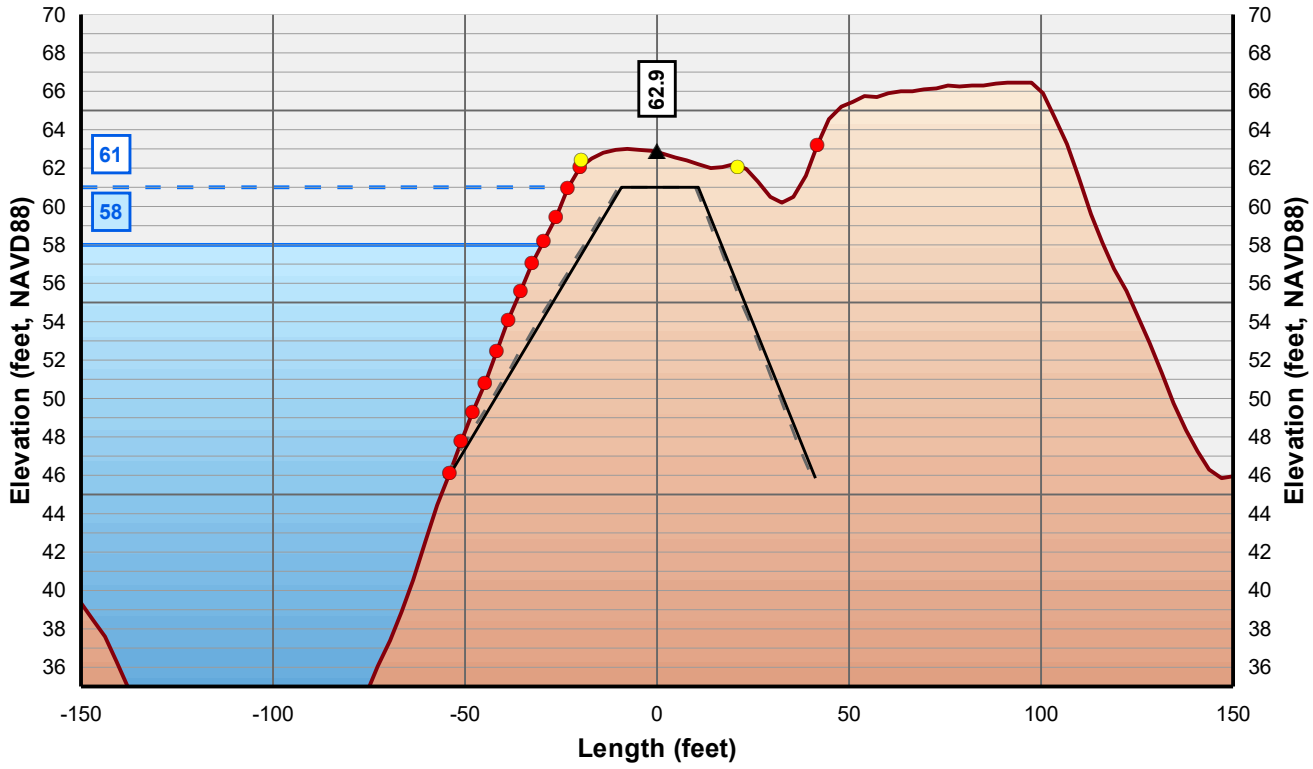
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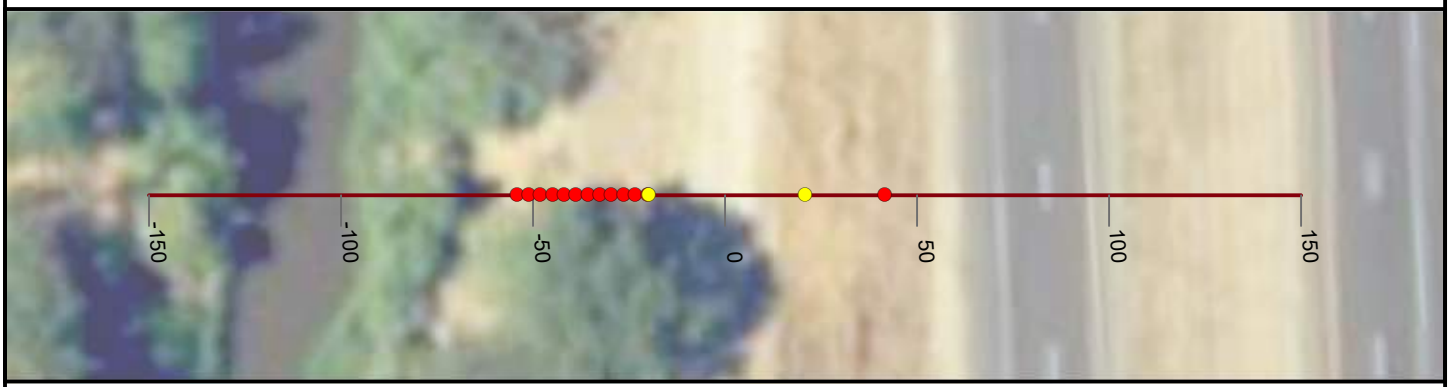
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Cross Section: Bear River 127+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
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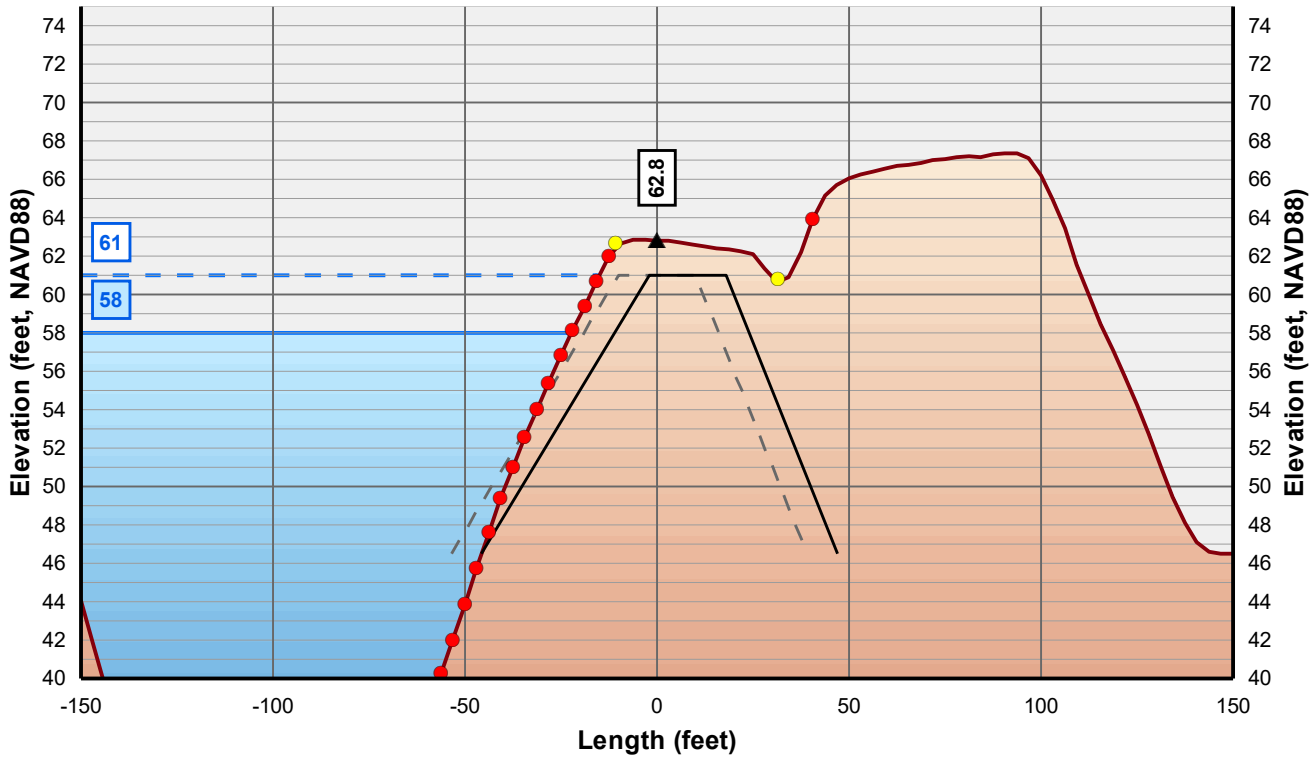
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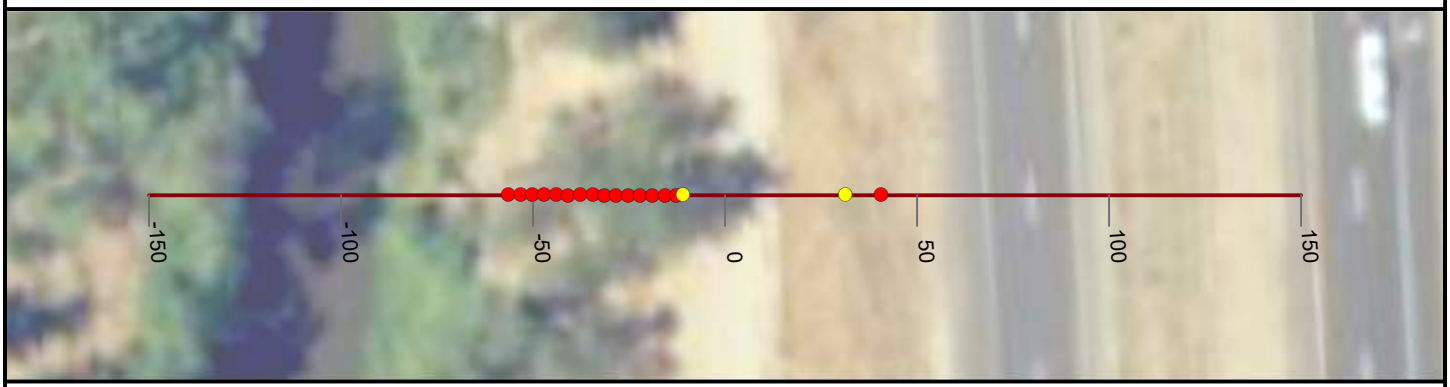
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Cross Section: Bear River 128+00



Horizontal Scale: 1 inch = 50 Feet
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- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
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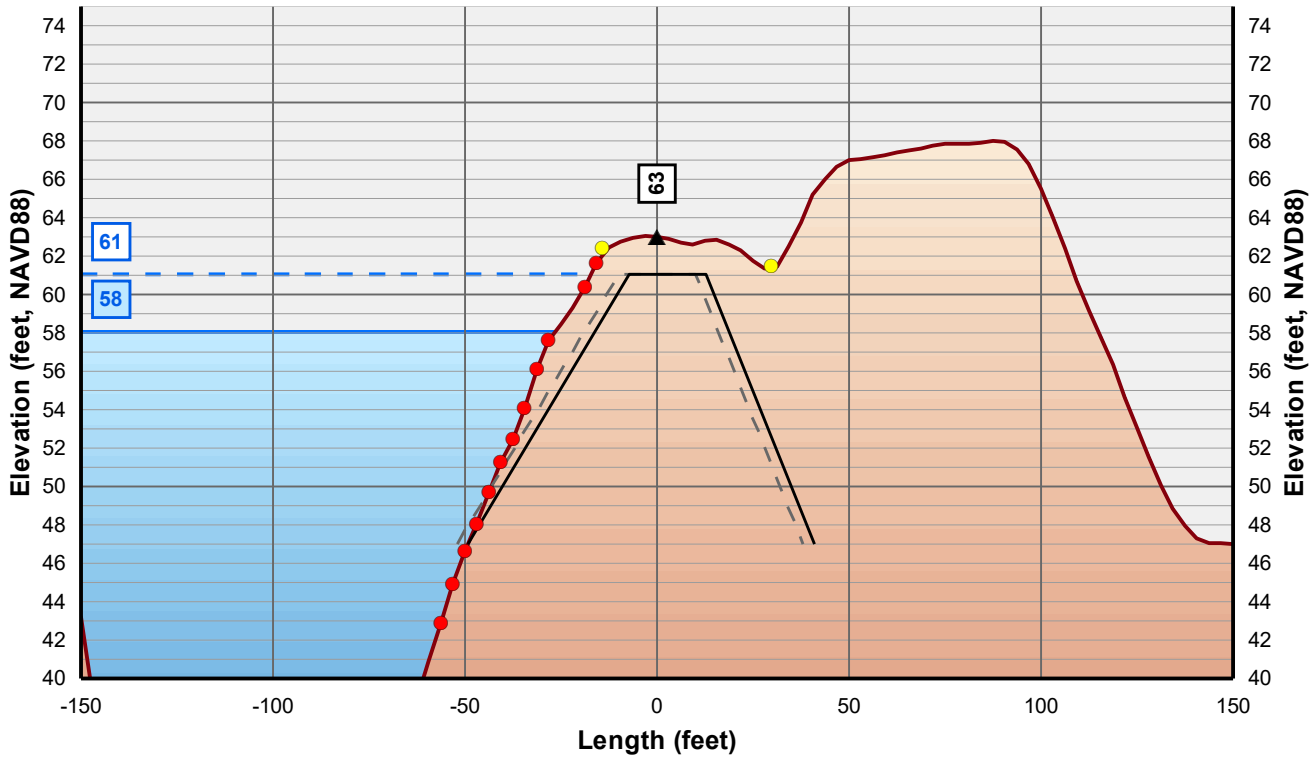
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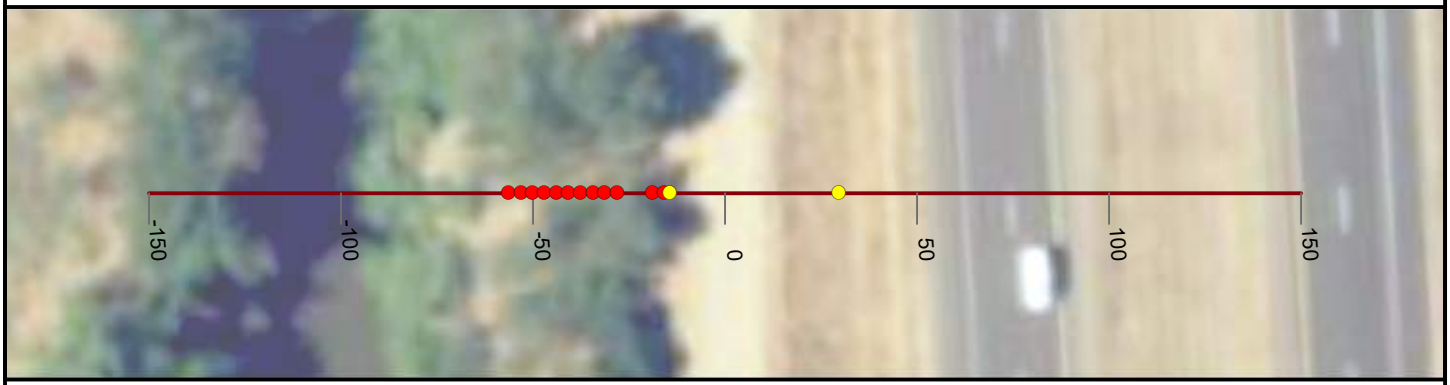
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Cross Section: Bear River 129+00



Horizontal Scale: 1 inch = 50 Feet
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- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

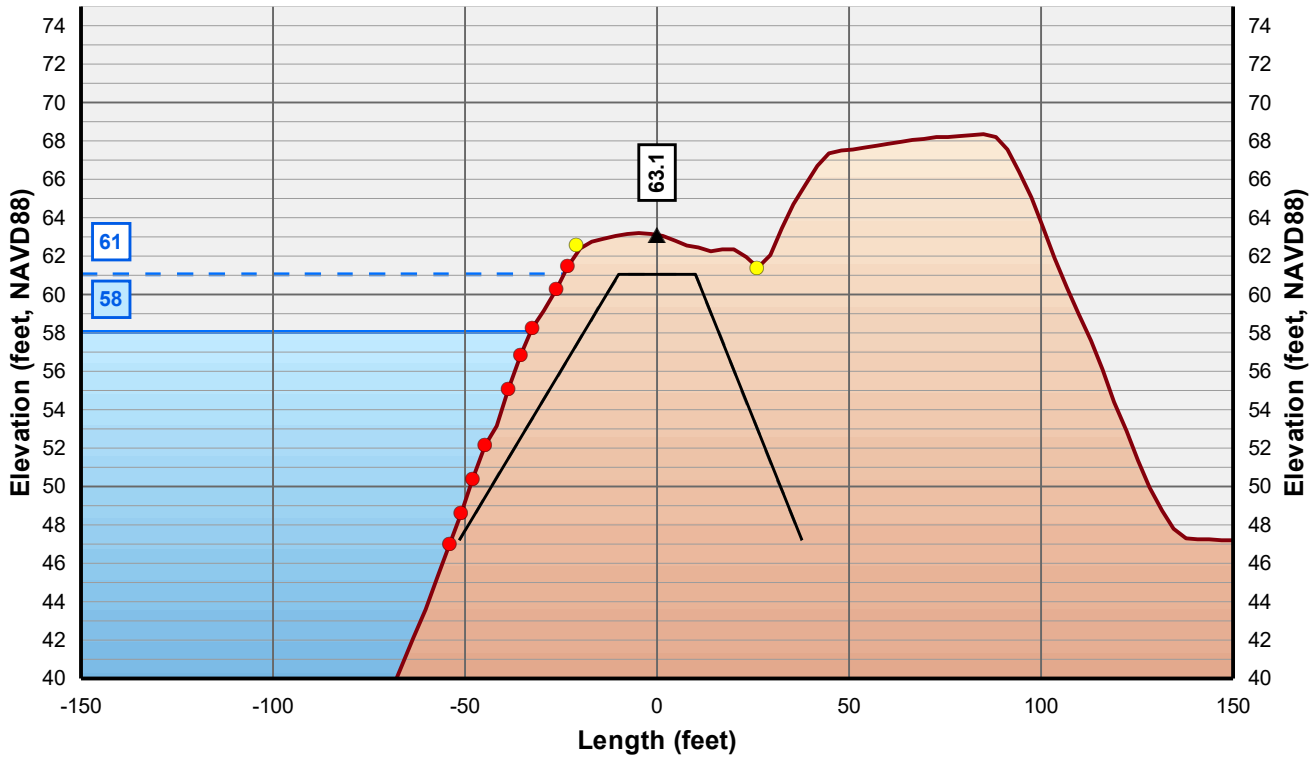
FEET

PRELIMINARY

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME
3301 C Street, Bldg 100-B
Sacramento, CA 95816
Tel: 916.341.7760
Fax: 916.341.7767

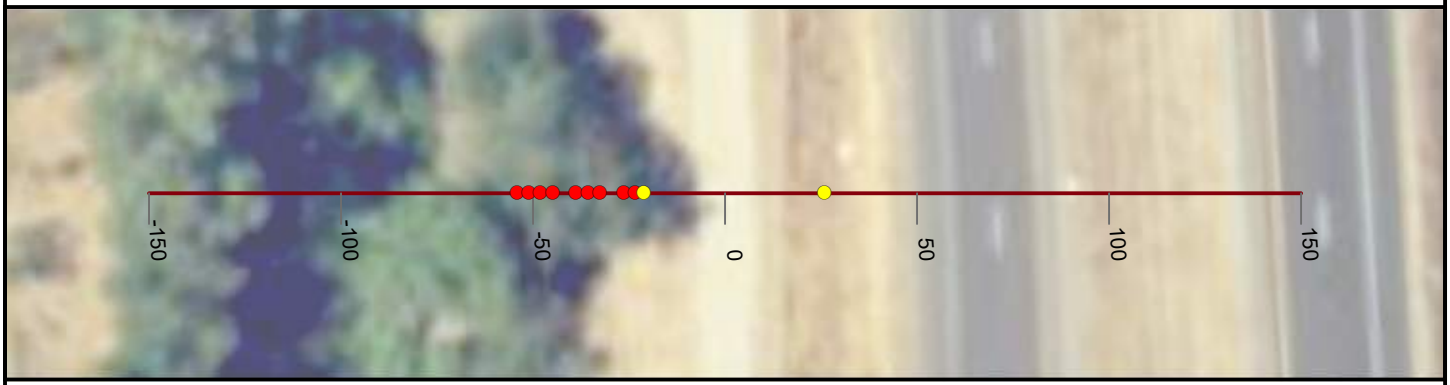
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Cross Section: Bear River 130+00



Horizontal Scale: 1 inch = 50 Feet
Vertical Scale: 1 inch = 10 Feet

- Control Line
- Crown Point
- Issue Point
- Existing Levee
- Theoretical Levee Prism Preliminary
- Theoretical Levee Prism Final
- Water Surface Elevation + 3 Feet
- Water Surface Elevation



RIO OSO

FEASIBILITY STUDY

BEAR RIVER LEVEE

CALIFORNIA

AUGUST, 2019

NORTH

0 25 50

FEET

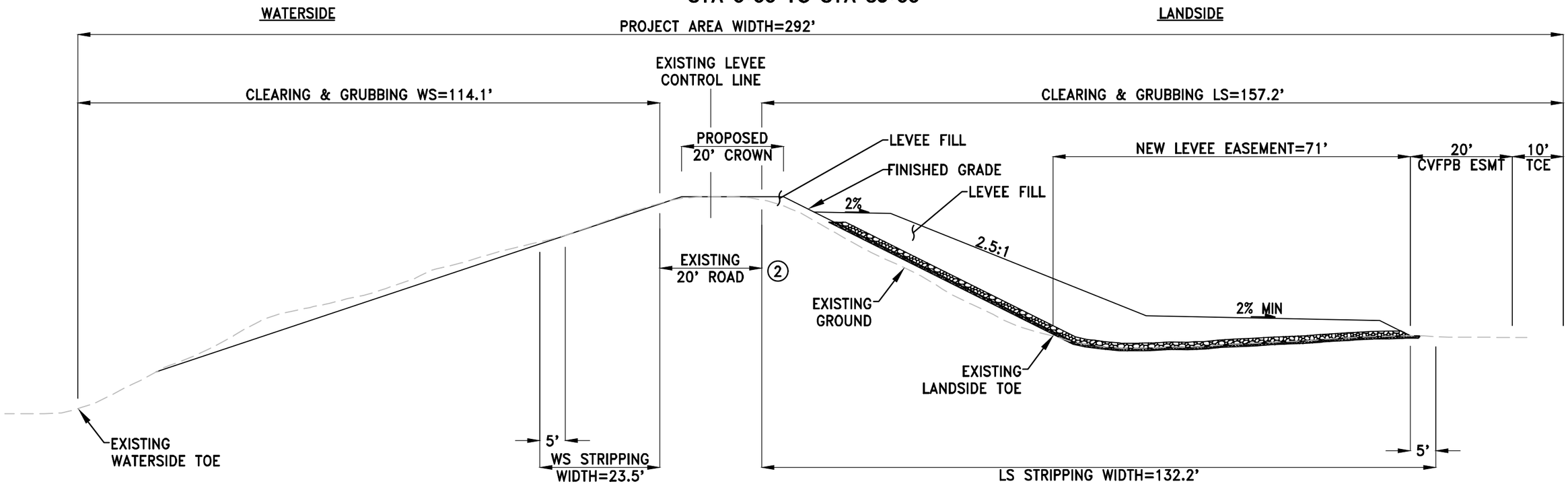
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ATTACHMENT J
Cost Estimate Cross Sections

BEAR RIVER EAST LEVEE REACH C
STA 0+00 TO STA 85+00



LEVEE FILL AREA = 874 SF

DRAIN ROCK AREA = 117 SF

FILTER SAND AREA = 61 SF

60' WIDE COMBINATION SEEPAGE/STABILITY BERM W/ GEOMETRY FIX

SCALE: 1"=20'

NOTES

1. EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)
2. EXISTING 20' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY
3. SEE FIGURE 4 FOR COMBINATION SEEPAGE/STABILITY BERM TYPICAL SECTION.
4. WATERSIDE ROCK SLOPE PROTECTION WAS RECOMMENDED FOR EROSION PROTECTION; HOWEVER, IT IS ASSUMED THAT EROSION WILL BE MITIGATED PER OTHER PROJECTS.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- DRAIN ROCK
- FILTER SAND

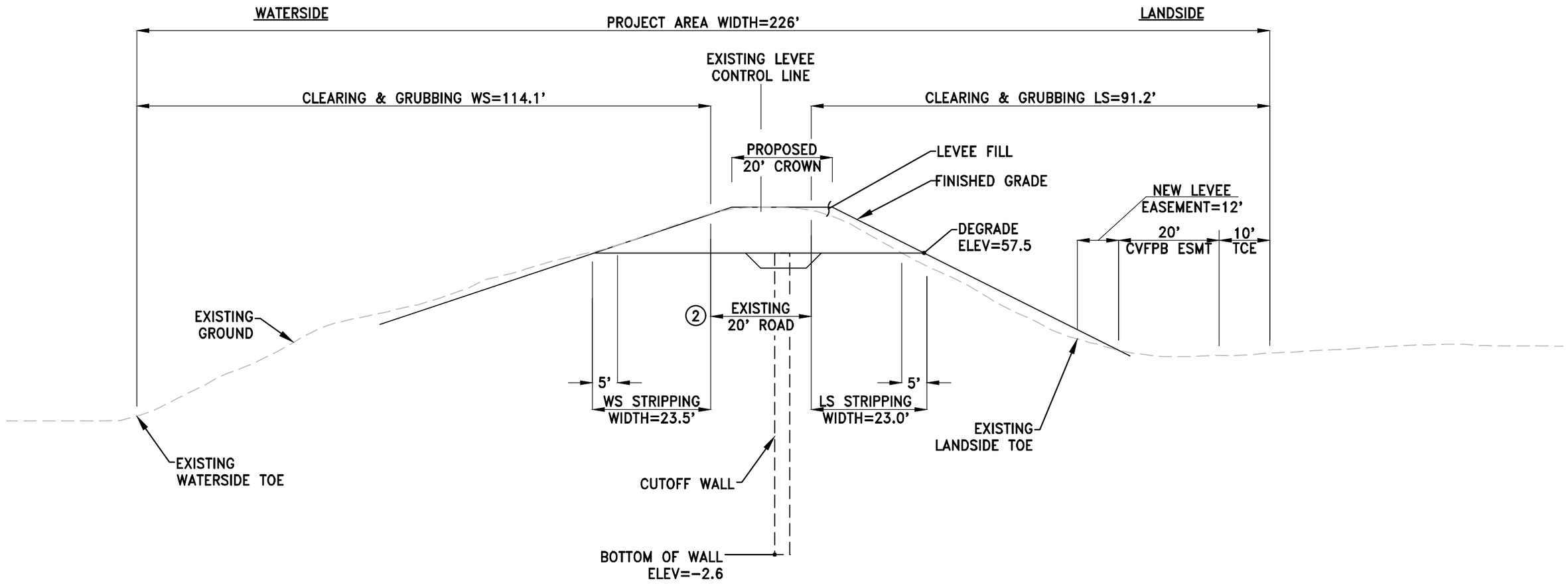
WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS
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Sacramento, CA 95816 Fax 916.341.7767

RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

BEAR RIVER EAST LEVEE REACH C
60' WIDE COMBINATION SEEPAGE/STABILITY BERM
QUANTITY ESTIMATE CROSS SECTION

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BEAR RIVER EAST LEVEE REACH C
STA 0+00 TO STA 85+00



1/3 LEVEE DEGRADE AREA = 356 SF
CUTOFF TRENCH AREA = 24 SF
LEVEE FILL AREA = 595 SF

60' DEEP SEEPAGE CUTOFF WALL W/ GEOMETRY FIX

SCALE: 1"=20'

NOTES

① EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)

② EXISTING 20' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY.

③ SEE FIGURE 5 FOR SEEPAGE CUTOFF WALL TYPICAL SECTION.

④ WATERSIDE ROCK SLOPE PROTECTION WAS RECOMMENDED FOR EROSION PROTECTION; HOWEVER, IT IS ASSUMED THAT EROSION WILL BE MITIGATED PER OTHER PROJECTS.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- CUTOFF WALL EXCAVATION
- CUTOFF WALL

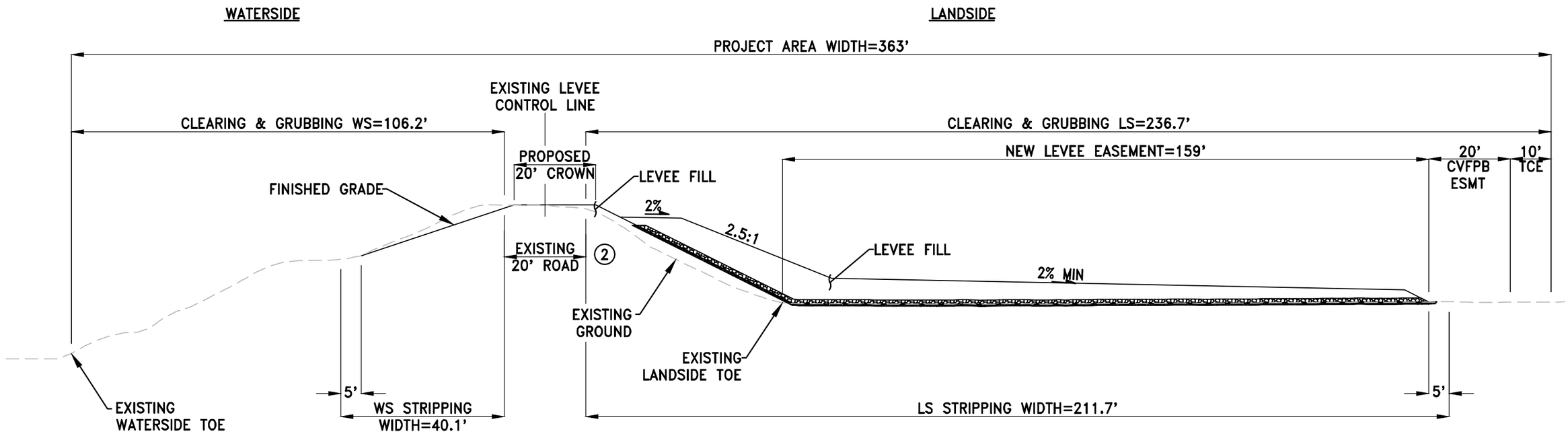
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Sacramento, CA 95816 Fax 916.341.7767

NICOLAUS FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

BEAR RIVER EAST LEVEE REACH C
60' DEEP SEEPAGE CUTOFF WALL
QUANTITY ESTIMATE CROSS SECTION

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BEAR RIVER REACH B
BEAR RIVER EAST LEVEE STA 85+00 TO STA 130+72
YANKEE SLOUGH SOUTH LEVEE STA 0+00 TO STA 4+64



LEVEE FILL AREA = 1058 SF

DRAIN ROCK AREA = 197 SF

FILTER SAND AREA = 101 SF

150' WIDE COMBINATION SEEPAGE/STABILITY BERM W/ GEOMETRY FIX

SCALE: 1"=25'

NOTES

1. EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)
2. EXISTING 20' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY.
3. SEE FIGURE 4 FOR COMBINATION SEEPAGE/STABILITY BERM TYPICAL SECTION.
4. WATERSIDE ROCK SLOPE PROTECTION WAS RECOMMENDED FOR EROSION PROTECTION; HOWEVER, IT IS ASSUMED THAT EROSION WILL BE MITIGATED PER OTHER PROJECTS.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- DRAIN ROCK
- FILTER SAND

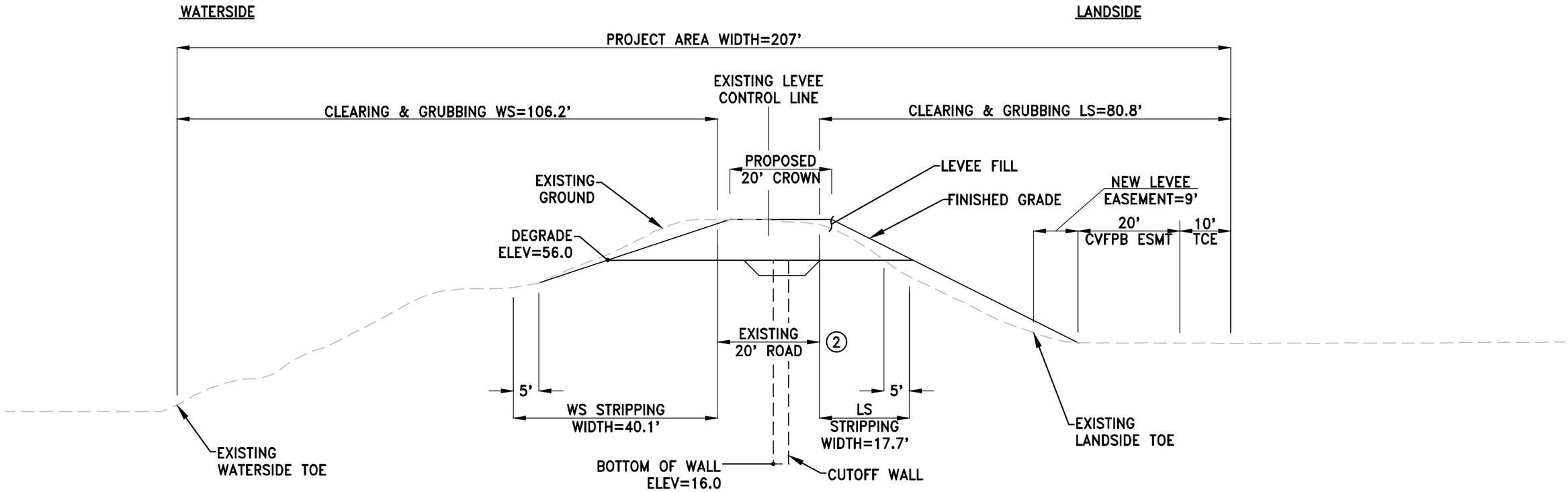
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3301 C St, Bldg. 100-B Tel 916.341.7760
Sacramento, CA 95816 Fax 916.341.7767

RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

BEAR RIVER EAST LEVEE REACH B
150' WIDE COMBINATION SEEPAGE/STABILITY BERM
QUANTITY ESTIMATE CROSS SECTION

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BEAR RIVER REACH B
BEAR RIVER EAST LEVEE STA 85+00 TO STA 130+72
YANKEE SLOUGH SOUTH LEVEE STA 0+00 TO STA 4+64



1/3 LEVEE DEGRADE AREA = 329 SF
CUTOFF TRENCH AREA = 24 SF
LEVEE FILL AREA = 495 SF

40' DEEP SEEPAGE CUTOFF WALL W/ GEOMETRY FIX

SCALE: 1"=20'

NOTES

1. EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)
2. EXISTING 20' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY.
3. SEE FIGURE 5 FOR SEEPAGE CUTOFF WALL TYPICAL SECTION.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- CUTOFF WALL EXCAVATION
- CUTOFF WALL

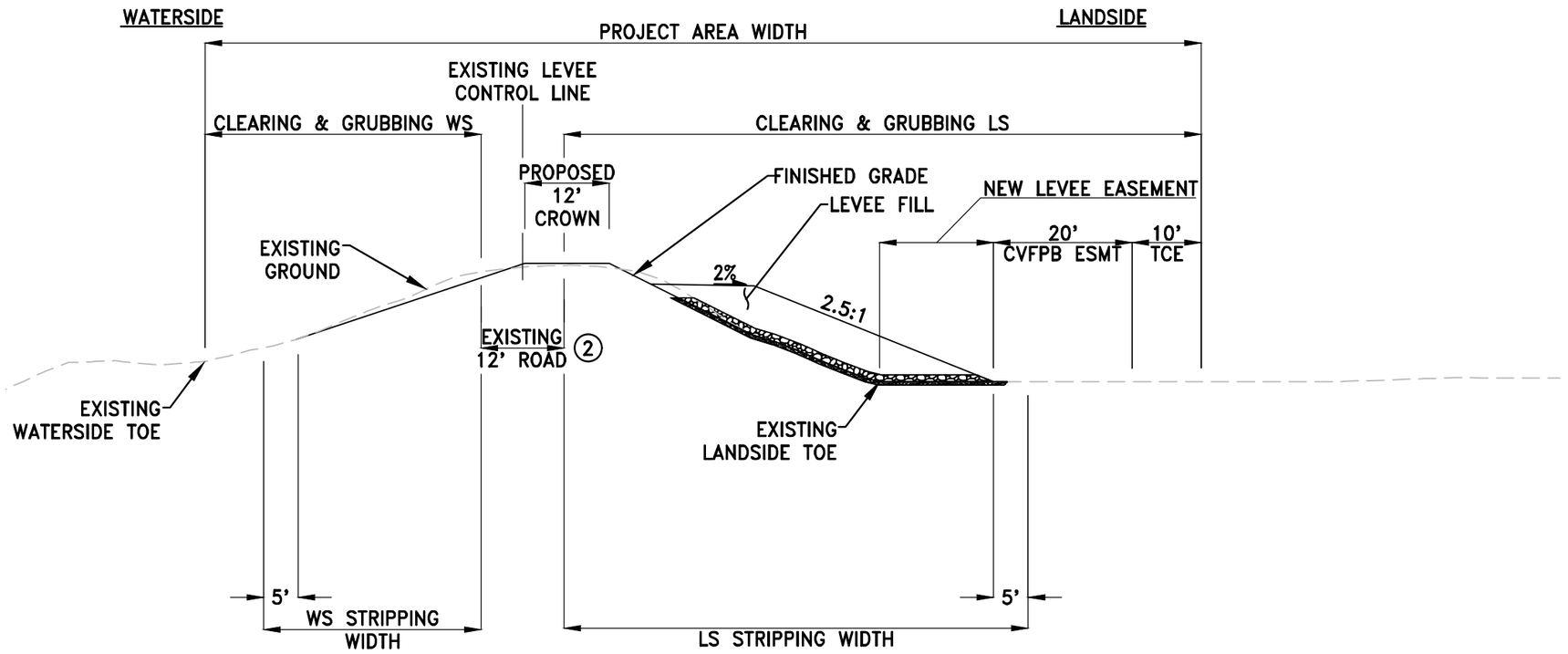
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Sacramento, CA 95816 Fax 916.341.7767

NICOLAUS FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

BEAR RIVER EAST LEVEE REACH B
40' DEEP SEEPAGE CUTOFF WALL
QUANTITY ESTIMATE CROSS SECTION

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YANKEE SLOUGH SOUTH LEVEE
REACH A.1: STA 4+64 TO STA 38+30
REACH A.2: STA 38+30 TO STA 231+17



YANKEE SLOUGH REACH A.1

NEW LEVEE EASEMENT	= 18 FT
LS STRIPPING WIDTH	= 95.1 FT
WS STRIPPING WIDTH	= 51.7 FT
CLEARING & GRUBBING LS	= 120.1 FT
CLEARING & GRUBBING WS	= 46.7 FT
PROJECT AREA WIDTH AREA	= 179 FT
LEVEE FILL AREA	= 353 SF
DRAIN ROCK AREA	= 46 SF
FILTER SAND AREA	= 26 SF

YANKEE SLOUGH REACH A.2

NEW LEVEE EASEMENT	= 17 FT
LS STRIPPING WIDTH	= 31.5 FT
WS STRIPPING WIDTH	= 67.1 FT
CLEARING & GRUBBING LS	= 39.9 FT
CLEARING & GRUBBING WS	= 92.1 FT
PROJECT AREA WIDTH AREA	= 145 FT
LEVEE FILL AREA	= 344 SF
DRAIN ROCK AREA	= 46 SF
FILTER SAND AREA	= 26 SF

15' WIDE DRAINED STABILITY BERM W/ GEOMETRY FIX

SCALE: N.T.S.

NOTES

1. EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)
2. EXISTING 12' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY
3. SEE FIGURE 6 FOR DRAINED STABILITY BERM TYPICAL SECTION.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- DRAIN ROCK
- FILTER SAND

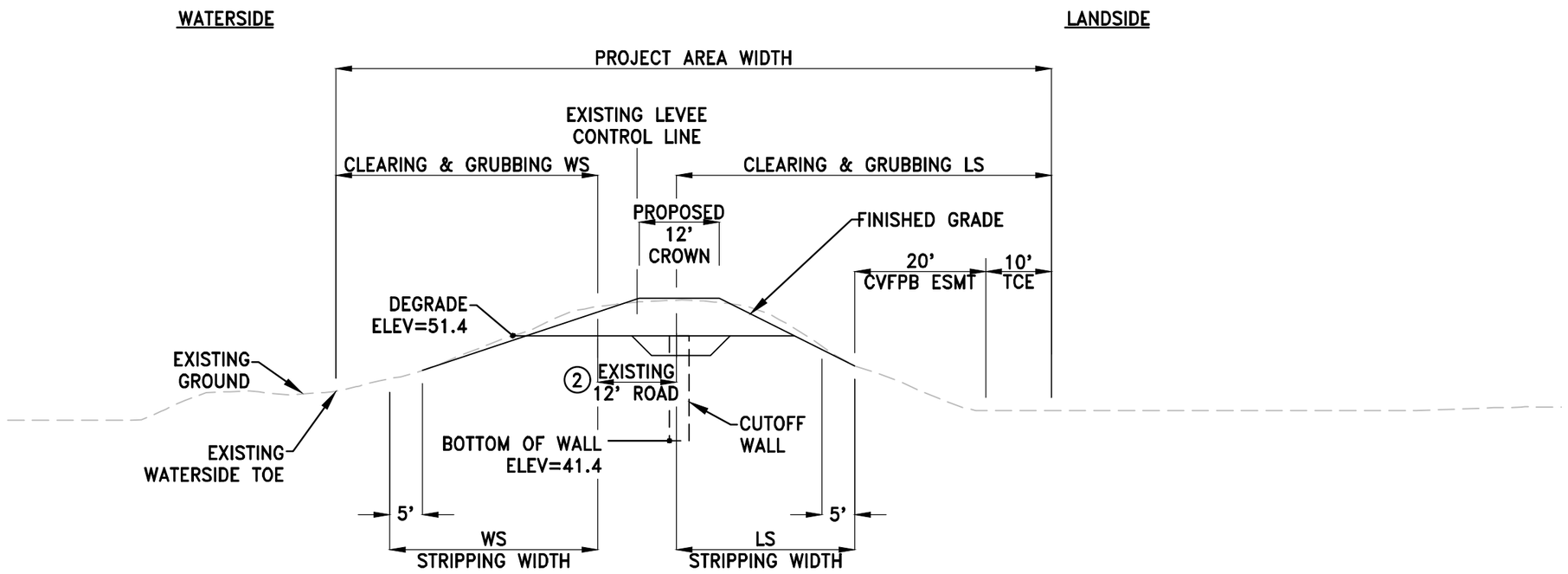
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RIO OSO FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

YANKEE SLOUGH S LEVEE REACHES A.1 & A.2
15' WIDE DRAINED STABILITY BERM
QUANTITY ESTIMATE CROSS SECTION

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YANKEE SLOUGH SOUTH LEVEE
REACH A.1: STA 4+64 TO STA 38+30
REACH A.2: STA 38+30 TO STA 231+17



YANKEE SLOUGH REACH A.1

LS STRIPPING WIDTH	= 55.7 FT
WS STRIPPING WIDTH	= 51.7 FT
CLEARING & GRUBBING LS	= 95.2 FT
CLEARING & GRUBBING WS	= 46.7 FT
PROJECT AREA WIDTH	= 154 FT
DEGRADE ELEV	= 57.6
BOTTOM OF WALL ELEV	= 41.6
1/3 LEVEE DEGRADE AREA	= 326 SF
CUTOFF TRENCH AREA	= 24 SF
LEVEE FILL AREA	= 399 SF

YANKEE SLOUGH REACH A.2

LS STRIPPING WIDTH	= 24.8 FT
WS STRIPPING WIDTH	= 31.7 FT
CLEARING & GRUBBING LS	= 57.2 FT
CLEARING & GRUBBING WS	= 39.9 FT
PROJECT AREA WIDTH	= 110 FT
DEGRADE ELEV	= 57.4
BOTTOM OF WALL ELEV	= 41.4
1/3 LEVEE DEGRADE AREA	= 171 SF
CUTOFF TRENCH AREA	= 24 SF
LEVEE FILL AREA	= 283 SF

16' DEEP SEEPAGE CUTOFF WALL W/ GEOMETRY FIX

SCALE: 1"=20'

NOTES

1. EXISTING GROUND SURFACE USES CVFED LiDAR DATA (2008)
2. EXISTING 20' PATROL ROAD NOT INCLUDED IN STRIPPING AND CLEARING & GRUBBING WIDTHS. PATROL ROAD WIDTH IS ESTIMATED PER AVAILABLE AS-BUILT INFORMATION. ACTUAL PATROL ROAD WIDTH MAY VARY.
3. SEE FIGURE 5 FOR SEEPAGE CUTOFF WALL TYPICAL SECTION.

LEGEND

- EXISTING GROUND
- FINISHED GRADE
- CUTOFF WALL EXCAVATION
- CUTOFF WALL

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS
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Sacramento, CA 95816 Fax 916.341.7767

NICOLAUS FLOOD RISK REDUCTION PROGRAM FEASIBILITY STUDY

YANKEE SLOUGH S LEVEE REACH REACH A.1–A.2
16' DEEP SEEPAGE CUTOFF WALL
QUANTITY ESTIMATE CROSS SECTION

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ATTACHMENT K
Cost Estimate - Summary

Reclamation District 1001
Rio Oso Feasibility Study
Summary of 100-YR Remedial Alternative Costs

WOOD RODGERS

Alternative	Estimated Cost							
	Land and Damages	Environmental Mitigation	Relocations	Levees	Sub-Total	Planning, Engineering, & Design (8%)	Construction Management (6%)	Total
Bear River Reach C - STA 0+00 - 85+00 (8,500 ft)								
(Waterside) Rock Slope Protection & (Landside) 60' wide Combination Berm	$2,744,300	$2,807,300	$273,000	$39,830,700	$45,655,300	$2,809,600	$2,107,200	$50,572,100
(Waterside) Rock Slope Protection & 60' deep Cutoff Wal	$1,221,400	$2,584,100	$232,100	$36,682,800	$40,720,400	$2,505,900	$1,879,500	$45,105,800
Bear River Reach B - STA 85+00 - 130+72 (BR) & STA 0+00 - 4+64 (YS) (5,036 ft)								
150' wide Combination Berm	$2,565,600	$1,038,600	$178,500	$14,658,000	$18,440,700	$1,134,900	$851,200	$20,426,800
40' deep Cutoff Wall	$1,153,100	$493,400	$137,500	$6,910,100	$8,694,100	$535,100	$401,300	$9,630,500
Yankee Slough Reach A.1 - STA 4+64 - 38+30 (3,366 ft)								
15' wide Drained Stability Berm	$393,900	$283,300	$542,400	$3,503,600	$4,723,200	$290,700	$218,000	$5,231,900
16' deep Cutoff Wall	$335,400	$286,200	$542,400	$3,545,700	$4,709,700	$289,900	$217,400	$5,217,000
Yankee Slough Reach A.2 - STA 38+30 - 231+17 (19,287 ft)								
15' wide Drained Stability Berm	$4,254,300	$1,762,400	$6,299,200	$18,876,900	$31,192,800	$1,919,600	$1,439,700	$34,552,100
16' deep Cutoff Wall	$2,614,300	$1,212,800	$2,122,300	$15,202,800	$21,152,200	$1,301,700	$976,300	$23,430,200
Total of Preferred Alternatives								**$83,383,500**

Recommended Alternative

NICOLAUS SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
PROJECT UNIT COSTS (PRELIMINARY)

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
PROJECT UNIT COSTS (PRELIMINARY)

Item #	Description	Unit	Unit Price	Comments
	General			
	Alternatives (100-YR or 200-YR)		100-YEAR (20' CROWN)	
	Escalation @ 3.3% for 3-years	%	9.9%	
	Land Acquisition Contingency	%	30%	
	Environmental Mitigation Contingency	%	30%	
	Relocations Contingency	%	30%	
	Roads Contingency	%	30%	
	Levee Contingency	%	30%	
	Planning, Engineering, & Design Contingency	%	8%	
	Construction Management Contingency	%	6%	
	Mobilization and Demobilization	LS	5%	
	Traffic Control (Rural)	LS	1%	
	Traffic Control (Urban)	LS	3%	
	Storm Water Pollution Control	LS	3%	
	Wheatland Outfall Contingency	%	50%	
1	**Lands**			
1.1	Land Acquisition (Flood Control Feature)	AC	$45,000.00	From OPC
	Land Acquisition (O&M Easement)	AC	$45,000.00	Added by CH
	Borrow Site Royalties	AC	$20,000.00	
	Residential Building	EA	$400,000.00	From Sutter County Assessor/Zillow Estimates
2	**Mitigation - Environmental**			
2.1	Environmental Mitigation	LS	7%	
3	**Relocations**			
3.1	Utility Pole Relocation	EA	$30,000.00	FRWL Project C/B/D, 2014, From Pete B
3.2	Private Irrigation Allowance	LF	$20.00	
3.3	Canal Relocation	LF	$110.00	from M&H, NLIP
3.4	Irrigation Pump Relocation	EA	$20,000.00	From SCWA Rio Vista (8246.007)
3.5	Utility Pole w/ meter Relocation	EA	$17,500.00	From SCWA Rio Vista (8246.007)
3.6	Remove & Replace Fiber Optic Cable	LF	$300.00	Based on Caltrans Contract Cost Data
3.7	Remove & Replace RD 1001 Main Pump Station (650 CFS Capacity)	EA	$60,000,000.00	Pricing of pumps and structures. Comparison with similar, but smaller, projects
3.8	PG&E Substation Relocation	EA	$2,000,000.00	Based on Caltrans Contract Cost Data
3.9	Remove & Replace Distribution Tower	EA	$3,000,000.00	
4	**Roads**			
4.1	Road Relocation	LF	$0.00	
4.2	Remove Ex. Agg. Surfacing	LF	$10.00	FRWL Project 1 B/D, 2014
4.3	Remove Existing Roadway	SY	$6.00	Removal of AC and AB
4.4	Class 2 Aggregate Base	TON	$35.00	FRWL Project 1 B/D, 2014
4.5	Asphalt Concrete (3.5")	TON	$120.00	FRWL Project 1 B/D, 2014
4.6	Class 2 Aggregate Surfacing	TON	$35.00	FRWL Project 1 B/D, 2014
5	**Levees**			
5.1	Project Fencing	LF	$3.50	FRWL Project C/B/D, 2014
5.2	Clearing and Grubbing	AC	$3,000.00	FRWL Project C/B/D, 2014
5.3	Levee Stripping	AC	$4,000.00	FRWL Project C/B/D, 2014
5.4	Levee Degrading/ Excavation	CY	$5.00	FRWL Project C/B/D, 2014
5.5	Levee Fill (Embankment)	CY	$4.00	FRWL Project C/B/D, 2014
5.6	Levee Fill (Clay Cap)	CY	$4.50	FRWL Project C/B/D, 2014
5.7	Levee Erosion Control Seeding	AC	$3,500.00	FRWL Project C/B/D, 2014
5.8	Cutoff Wall - Soil Bentonite	SF	$6.50	Wall depth < 75-ft, FRWL Project C/B/D, 2014
5.9	Drain Rock	TON	$45.00	HDR input
5.10	Sand Filter Layer	TON	$45.00	HDR input
5.11	Filter Fabric	SY	$5.00	FRWL Project C/B/D, 2014
5.12	Rock Slope Protection	TON	$80.00	MHC Cost Estimate
5.13	Borrow Site Clearing and Grubbing	AC	$3,000.00	FRWL Project C/B/D, 2014
5.14	Borrow Site Stripping	AC	$3,500.00	FRWL Project C/B/D, 2014
5.15	Borrow Site Excavation and Hauling	CY	$15.00	FRWL Project C/B/D, 2014
5.16	Borrow Site Erosion Control Seeding	AC	$3,500.00	FRWL Project C/B/D, 2014
5.17	Haul and Dispose of Unsuitable Material	CY	$10.00	FRWL Project C/B/D, 2014
5.18	Haul and Dispose of Unsuitable Debris	CY	$7.50	FRWL Project C/B/D, 2014

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN & 20' CROWN)
STABILITY/SEEPAGE BERM (150-FOOT WIDE)
BEAR RIVER REACH B - STA 85+00 TO STA 130+72 (BR) & STA 0+00 TO 4+64 (YS)

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	20.7	AC	$45,000	$931,500	30%	$279,450	$1,210,950
1.2	Land Acquisition (O&M Easement)	1.2	AC	$45,000	$54,000	30%	$16,200	$70,200
1.3	Borrow Site Royalties	29.4	AC	$20,000	$588,000	30%	$176,400	$764,400
1.4	Residential Building	1.0	EA	$400,000	$400,000	30%	$120,000	$520,000
	Subtotal - Land and Damages				***$1,973,500***		***$592,100***	***$2,565,600***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$798,889	30%	$239,667	$1,038,556
	Subtotal - Mitigation				***$798,900***		***$239,700***	***$1,038,600***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$6,536.00	30%	$1,961	$8,497
3.2	Utility Pole Relocation	1	EA	$30,000	$30,000	30%	$9,000	$39,000
3.3	Private Irrigation Allowance	5,036	LF	$20	$100,720	30%	$30,216	$130,936
	Subtotal - Relocations				***$137,300***		***$41,200***	***$178,500***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$536,920	30%	$161,076	$697,996
4.2	Traffic Control (Rural)	1	LS	1%	$106,321	30%	$31,896	$138,217
4.3	Storm Water Pollution Control	1	LS	3%	$309,672	30%	$92,902	$402,574
4.4	Project Fencing	10,072	LF	$4	$35,252	30%	$10,576	$45,828
4.5	Clearing and Grubbing	40	AC	$3,000	$120,000	30%	$36,000	$156,000
4.6	Remove Ex. Agg. Surfacing	5,036	LF	$10	$50,360	30%	$15,108	$65,468
4.7	Levee Stripping	30	AC	$4,000	$120,000	30%	$36,000	$156,000
4.8	Levee Degrading/ Excavation	1,213	CY	$5	$6,065	30%	$1,820	$7,885
4.9	Levee Fill (Embankment)	197,337	CY	$4	$789,348	30%	$236,804	$1,026,152
4.10	Cutoff Wall - Soil Bentonite	0	SF	$7	$0	30%	$0	$0
4.11	Drain Rock	74,407	TON	$45	$3,348,315	30%	$1,004,495	$4,352,810
4.12	Sand Filter Layer	38,148	TON	$45	$1,716,660	30%	$514,998	$2,231,658
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	3,777	TON	$35	$132,195	30%	$39,659	$171,854
4.15	Levee Erosion Control Seeding	40	AC	$3,500	$140,000	30%	$42,000	$182,000
4.16	Haul and Dispose of Unsuitable Material	1,213	CY	$10	$12,130	30%	$3,639	$15,769
4.17	Borrow Site Clearing and Grubbing	30	AC	$3,000	$90,000	30%	$27,000	$117,000
4.18	Borrow Site Stripping	30	AC	$3,500	$105,000	30%	$31,500	$136,500
4.19	Borrow Site Excavation and Hauling	236,805	CY	$15	$3,552,075	30%	$1,065,623	$4,617,698
4.20	Borrow Site Erosion Control Seeding	30	AC	$3,500	$105,000	30%	$31,500	$136,500
	Subtotal - Levees				***$11,275,400***		***$3,382,600***	***$14,658,000***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN & 20' CROWN))				**$14,185,100**		**$4,255,600**	**$18,440,700**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$1,134,808	0%	$0	$1,134,900
6	**Construction Management**							
6.1	Construction Management (6%)				$851,106	0%	$0	$851,200
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN & 20' CROWN))				**$16,171,014**		**$4,255,600**	**$20,426,800**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$17,771,944.39**		**$4,676,904.40**	**$22,449,100**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN & 20' CROWN)
CUTOFF WALL (40-FOOT DEEP)
BEAR RIVER REACH B - STA 85+00 TO STA 130+72 (BR) & STA 0+00 TO 4+64 (YS)

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	3.4	AC	$45,000	$153,000	30%	$45,900	$198,900
1.2	Land Acquisition (O&M Easement)	1.2	AC	$45,000	$54,000	30%	$16,200	$70,200
1.3	Borrow Site Royalties	14.0	AC	$20,000	$280,000	30%	$84,000	$364,000
1.4	Residential Building	1.0	EA	$400,000	$400,000	30%	$120,000	$520,000
	Subtotal - Land and Damages				***$887,000***		***$266,100***	***$1,153,100***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$379,491	30%	$113,847	$493,338
	Subtotal - Mitigation				***$379,500***		***$113,900***	***$493,400***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$5,036.00	30%	$1,511	$6,547
3.2	Utility Pole Relocation	0	EA	$30,000	$0	30%	$0	$0
3.3	Private Irrigation Allowance	5,036	LF	$20	$100,720	30%	$30,216	$130,936
	Subtotal - Relocations				***$105,800***		***$31,800***	***$137,500***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$253,117	30%	$75,935	$329,052
4.2	Traffic Control (Rural)	1	LS	1%	$50,122	30%	$15,037	$65,159
4.3	Storm Water Pollution Control	1	LS	3%	$145,987	30%	$43,796	$189,783
4.4	Project Fencing	10,072	LF	$4	$35,252	30%	$10,576	$45,828
4.5	Clearing and Grubbing	22	AC	$3,000	$66,000	30%	$19,800	$85,800
4.6	Remove Ex. Agg. Surfacing	5,036	LF	$10	$50,360	30%	$15,108	$65,468
4.7	Levee Stripping	7	AC	$4,000	$28,000	30%	$8,400	$36,400
4.8	Levee Degrading/ Excavation	64,070	CY	$5	$320,350	30%	$96,105	$416,455
4.9	Levee Fill (Embankment)	93,446	CY	$4	$373,784	30%	$112,135	$485,919
4.10	Cutoff Wall - Soil Bentonite	201,440	SF	$7	$1,309,360	30%	$392,808	$1,702,168
4.11	Drain Rock	0	TON	$45	$0	30%	$0	$0
4.12	Sand Filter Layer	0	TON	$45	$0	30%	$0	$0
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	3,777	TON	$35	$132,195	30%	$39,659	$171,854
4.15	Levee Erosion Control Seeding	22	AC	$3,500	$77,000	30%	$23,100	$100,100
4.16	Haul and Dispose of Unsuitable Material	65,189	CY	$10	$651,890	30%	$195,567	$847,457
4.17	Borrow Site Clearing and Grubbing	14	AC	$3,000	$42,000	30%	$12,600	$54,600
4.18	Borrow Site Stripping	14	AC	$3,500	$49,000	30%	$14,700	$63,700
4.19	Borrow Site Excavation and Hauling	112,136	CY	$15	$1,682,040	30%	$504,612	$2,186,652
4.20	Borrow Site Erosion Control Seeding	14	AC	$3,500	$49,000	30%	$14,700	$63,700
	Subtotal - Levees				***$5,315,500***		***$1,594,700***	***$6,910,100***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN & 20' CROWN))				**$6,687,800**		**$2,006,500**	**$8,694,100**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$535,024	0%	$0	$535,100
6	**Construction Management**							
6.1	Construction Management (6%)				$401,268	0%	$0	$401,300
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN & 20' CROWN))				**$7,624,092**		**$2,006,500**	**$9,630,500**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$8,378,877.11**		**$2,205,143.50**	**$10,584,000**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN)
DRAINED STABILITY BERM (15-FOOT WIDE)
YANKEE SLOUGH REACH A.1 - STA 4+64 TO STA 38+30

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	3.0	AC	$45,000	$135,000	30%	$40,500	$175,500
1.2	Land Acquisition (O&M Easement)	0.8	AC	$45,000	$36,000	30%	$10,800	$46,800
1.3	Borrow Site Royalties	6.6	AC	$20,000	$132,000	30%	$39,600	$171,600
	Subtotal - Land and Damages				***$303,000***		***$90,900***	***$393,900***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$217,861	30%	$65,358	$283,219
	Subtotal - Mitigation				***$217,900***		***$65,400***	***$283,300***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$19,866.00	30%	$5,960	$25,826
3.2	Utility Pole Relocation	0	EA	$30,000	$0	30%	$0	$0
3.3	Canal Relocation	3,000	LF	$110	$330,000	30%	$99,000	$429,000
3.4	Private Irrigation Allowance	3,366	LF	$20	$67,320	30%	$20,196	$87,516
	Subtotal - Relocations				***$417,200***		***$125,200***	***$542,400***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$128,336	30%	$38,501	$166,837
4.2	Traffic Control (Rural)	1	LS	1%	$25,413	30%	$7,624	$33,037
4.3	Storm Water Pollution Control	1	LS	3%	$74,019	30%	$22,206	$96,224
4.4	Project Fencing	6,732	LF	$4	$23,562	30%	$7,069	$30,631
4.5	Clearing and Grubbing	13	AC	$3,000	$39,000	30%	$11,700	$50,700
4.6	Remove Ex. Agg. Surfacing	3,366	LF	$10	$33,660	30%	$10,098	$43,758
4.7	Levee Stripping	12	AC	$4,000	$48,000	30%	$14,400	$62,400
4.8	Levee Degrading/ Excavation	24,560	CY	$5	$122,800	30%	$36,840	$159,640
4.9	Levee Fill (Embankment)	44,008	CY	$4	$176,032	30%	$52,810	$228,842
4.10	Cutoff Wall - Soil Bentonite	0	SF	$7	$0	30%	$0	$0
4.11	Drain Rock	11,613	TON	$45	$522,585	30%	$156,776	$679,361
4.12	Sand Filter Layer	6,564	TON	$45	$295,380	30%	$88,614	$383,994
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	1,515	TON	$35	$53,025	30%	$15,908	$68,933
4.15	Levee Erosion Control Seeding	13	AC	$3,500	$45,500	30%	$13,650	$59,150
4.16	Haul and Dispose of Unsuitable Material	24,560	CY	$10	$245,600	30%	$73,680	$319,280
4.17	Borrow Site Clearing and Grubbing	7	AC	$3,000	$21,000	30%	$6,300	$27,300
4.18	Borrow Site Stripping	7	AC	$3,500	$24,500	30%	$7,350	$31,850
4.19	Borrow Site Excavation and Hauling	52,810	CY	$15	$792,150	30%	$237,645	$1,029,795
4.20	Borrow Site Erosion Control Seeding	7	AC	$3,500	$24,500	30%	$7,350	$31,850
	Subtotal - Levees				***$2,695,100***		***$808,600***	***$3,503,600***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN))				**$3,633,200**		**$1,090,100**	**$4,723,200**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$290,656	0%	$0	$290,700
6	**Construction Management**							
6.1	Construction Management (6%)				$217,992	0%	$0	$218,000
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN))				**$4,141,848**		**$1,090,100**	**$5,231,900**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$4,551,890.95**		**$1,198,019.90**	**$5,749,900**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN)
CUTOFF WALL (16-FOOT DEEP)
YANKEE SLOUGH REACH A.1 - STA 4+64 TO STA 38+30

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	1.6	AC	$45,000	$72,000	30%	$21,600	$93,600
1.2	Land Acquisition (O&M Easement)	0.8	AC	$45,000	$36,000	30%	$10,800	$46,800
1.3	Borrow Site Royalties	7.5	AC	$20,000	$150,000	30%	$45,000	$195,000
	Subtotal - Land and Damages				***$258,000***		***$77,400***	***$335,400***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$220,129	30%	$66,039	$286,168
	Subtotal - Mitigation				***$220,200***		***$66,100***	***$286,200***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$19,866.00	30%	$5,960	$25,826
3.2	Utility Pole Relocation	0	EA	$30,000	$0	30%	$0	$0
3.3	Canal Relocation	3,000	LF	$110	$330,000	30%	$99,000	$429,000
3.4	Private Irrigation Allowance	3,366	LF	$20	$67,320	30%	$20,196	$87,516
	Subtotal - Relocations				***$417,200***		***$125,200***	***$542,400***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$129,878	30%	$38,963	$168,841
4.2	Traffic Control (Rural)	1	LS	1%	$25,718	30%	$7,716	$33,434
4.3	Storm Water Pollution Control	1	LS	3%	$74,908	30%	$22,472	$97,380
4.4	Project Fencing	6,732	LF	$4	$23,562	30%	$7,069	$30,631
4.5	Clearing and Grubbing	11	AC	$3,000	$33,000	30%	$9,900	$42,900
4.6	Remove Ex. Agg. Surfacing	3,366	LF	$10	$33,660	30%	$10,098	$43,758
4.7	Levee Stripping	9	AC	$4,000	$36,000	30%	$10,800	$46,800
4.8	Levee Degrading/ Excavation	49,680	CY	$5	$248,400	30%	$74,520	$322,920
4.9	Levee Fill (Embankment)	50,042	CY	$4	$200,168	30%	$60,050	$260,218
4.10	Cutoff Wall - Soil Bentonite	53,856	SF	$7	$350,064	30%	$105,019	$455,083
4.11	Drain Rock	0	TON	$45	$0	30%	$0	$0
4.12	Sand Filter Layer	0	TON	$45	$0	30%	$0	$0
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	1,515	TON	$35	$53,025	30%	$15,908	$68,933
4.15	Levee Erosion Control Seeding	11	AC	$3,500	$38,500	30%	$11,550	$50,050
4.16	Haul and Dispose of Unsuitable Material	49,979	CY	$10	$499,790	30%	$149,937	$649,727
4.17	Borrow Site Clearing and Grubbing	8	AC	$3,000	$24,000	30%	$7,200	$31,200
4.18	Borrow Site Stripping	8	AC	$3,500	$28,000	30%	$8,400	$36,400
4.19	Borrow Site Excavation and Hauling	60,051	CY	$15	$900,765	30%	$270,230	$1,170,995
4.20	Borrow Site Erosion Control Seeding	8	AC	$3,500	$28,000	30%	$8,400	$36,400
	Subtotal - Levees				***$2,727,500***		***$818,300***	***$3,545,700***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN))				**$3,622,900**		**$1,087,000**	**$4,709,700**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$289,832	0%	$0	$289,900
6	**Construction Management**							
6.1	Construction Management (6%)				$217,374	0%	$0	$217,400
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN))				**$4,130,106**		**$1,087,000**	**$5,217,000**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$4,538,986.49**		**$1,194,613.00**	**$5,733,500**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN)
DRAINED STABILITY BERM (15-FOOT WIDE)
YANKEE SLOUGH REACH A.2 - STA 38+30 TO STA 231+17

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	16.4	AC	$45,000	$738,000	30%	$221,400	$959,400
1.2	Land Acquisition (O&M Easement)	4.5	AC	$45,000	$202,500	30%	$60,750	$263,250
1.3	Borrow Site Royalties	36.6	AC	$20,000	$732,000	30%	$219,600	$951,600
1.4	Residential Building	4.0	EA	$400,000	$1,600,000	30%	$480,000	$2,080,000
	Subtotal - Land and Damages				***$3,272,500***		***$981,800***	***$4,254,300***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$1,355,634	30%	$406,690	$1,762,324
	Subtotal - Mitigation				***$1,355,700***		***$406,700***	***$1,762,400***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$230,737.00	30%	$69,221	$299,958
3.2	Utility Pole Relocation	16	EA	$30,000	$480,000	30%	$144,000	$624,000
3.3	Canal Relocation	5,900	LF	$110	$649,000	30%	$194,700	$843,700
3.4	Irrigation Pump Relocation	5	EA	$20,000	$100,000	30%	$30,000	$130,000
3.5	Remove & Replace Distribution Tower	1	EA	$3,000,000	$3,000,000	30%	$900,000	$3,900,000
3.6	Private Irrigation Allowance	19,287	LF	$20	$385,740	30%	$115,722	$501,462
	Subtotal - Relocations				***$4,845,500***		***$1,453,700***	***$6,299,200***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$691,459	30%	$207,438	$898,897
4.2	Traffic Control (Rural)	1	LS	1%	$136,923	30%	$41,077	$177,999
4.3	Storm Water Pollution Control	1	LS	3%	$398,804	30%	$119,641	$518,445
4.4	Project Fencing	38,574	LF	$4	$135,009	30%	$40,503	$175,512
4.5	Clearing and Grubbing	59	AC	$3,000	$177,000	30%	$53,100	$230,100
4.6	Remove Ex. Agg. Surfacing	19,287	LF	$10	$192,870	30%	$57,861	$250,731
4.7	Levee Stripping	44	AC	$4,000	$176,000	30%	$52,800	$228,800
4.8	Levee Degrading/ Excavation	109,293	CY	$5	$546,465	30%	$163,940	$710,405
4.9	Levee Fill (Embankment)	245,731	CY	$4	$982,924	30%	$294,877	$1,277,801
4.10	Cutoff Wall - Soil Bentonite	0	SF	$7	$0	30%	$0	$0
4.11	Drain Rock	66,541	TON	$45	$2,994,345	30%	$898,304	$3,892,649
4.12	Sand Filter Layer	37,610	TON	$45	$1,692,450	30%	$507,735	$2,200,185
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	8,680	TON	$35	$303,800	30%	$91,140	$394,940
4.15	Levee Erosion Control Seeding	59	AC	$3,500	$206,500	30%	$61,950	$268,450
4.16	Haul and Dispose of Unsuitable Material	109,293	CY	$10	$1,092,930	30%	$327,879	$1,420,809
4.17	Borrow Site Clearing and Grubbing	37	AC	$3,000	$111,000	30%	$33,300	$144,300
4.18	Borrow Site Stripping	37	AC	$3,500	$129,500	30%	$38,850	$168,350
4.19	Borrow Site Excavation and Hauling	294,878	CY	$15	$4,423,170	30%	$1,326,951	$5,750,121
4.20	Borrow Site Erosion Control Seeding	37	AC	$3,500	$129,500	30%	$38,850	$168,350
	Subtotal - Levees				***$14,520,700***		***$4,356,200***	***$18,876,900***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN))				**$23,994,400**		**$7,198,400**	**$31,192,800**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$1,919,552	0%	$0	$1,919,600
6	**Construction Management**							
6.1	Construction Management (6%)				$1,439,664	0%	$0	$1,439,700
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN))				**$27,353,616**		**$7,198,400**	**$34,552,100**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$30,061,623.98**		**$7,911,041.60**	**$37,972,800**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (12' CROWN)
CUTOFF WALL (16-FOOT DEEP)
YANKEE SLOUGH REACH A.2 - STA 38+30 TO STA 231+17

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	8.9	AC	$45,000	$400,500	30%	$120,150	$520,650
1.2	Land Acquisition (O&M Easement)	4.5	AC	$45,000	$202,500	30%	$60,750	$263,250
1.3	Borrow Site Royalties	30.4	AC	$20,000	$608,000	30%	$182,400	$790,400
1.4	Residential Building	2.0	EA	$400,000	$800,000	30%	$240,000	$1,040,000
	Subtotal - Land and Damages				***$2,011,000***		***$603,300***	***$2,614,300***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$932,890	30%	$279,867	$1,212,757
	Subtotal - Mitigation				***$932,900***		***$279,900***	***$1,212,800***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$77,737.00	30%	$23,321	$101,058
3.2	Utility Pole Relocation	14	EA	$30,000	$420,000	30%	$126,000	$546,000
3.3	Canal Relocation	5,900	LF	$110	$649,000	30%	$194,700	$843,700
3.4	Irrigation Pump Relocation	5	EA	$20,000	$100,000	30%	$30,000	$130,000
3.5	Remove & Replace Distribution Tower	0	EA	$3,000,000	$0	30%	$0	$0
3.6	Private Irrigation Allowance	19,287	LF	$20	$385,740	30%	$115,722	$501,462
	Subtotal - Relocations				***$1,632,500***		***$489,800***	***$2,122,300***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$556,879	30%	$167,064	$723,942
4.2	Traffic Control (Rural)	1	LS	1%	$110,273	30%	$33,082	$143,355
4.3	Storm Water Pollution Control	1	LS	3%	$321,183	30%	$96,355	$417,539
4.4	Project Fencing	38,574	LF	$4	$135,009	30%	$40,503	$175,512
4.5	Clearing and Grubbing	44	AC	$3,000	$132,000	30%	$39,600	$171,600
4.6	Remove Ex. Agg. Surfacing	19,287	LF	$10	$192,870	30%	$57,861	$250,731
4.7	Levee Stripping	26	AC	$4,000	$104,000	30%	$31,200	$135,200
4.8	Levee Degrading/ Excavation	191,085	CY	$5	$955,425	30%	$286,628	$1,242,053
4.9	Levee Fill (Embankment)	203,871	CY	$4	$815,484	30%	$244,645	$1,060,129
4.10	Cutoff Wall - Soil Bentonite	308,592	SF	$7	$2,005,848	30%	$601,754	$2,607,602
4.11	Drain Rock	0	TON	$45	$0	30%	$0	$0
4.12	Sand Filter Layer	0	TON	$45	$0	30%	$0	$0
4.13	Rock Slope Protection	0	TON	$80	$0	30%	$0	$0
4.14	Class 2 Aggregate Surfacing	8,680	TON	$35	$303,800	30%	$91,140	$394,940
4.15	Levee Erosion Control Seeding	44	AC	$3,500	$154,000	30%	$46,200	$200,200
4.16	Haul and Dispose of Unsuitable Material	192,799	CY	$10	$1,927,990	30%	$578,397	$2,506,387
4.17	Borrow Site Clearing and Grubbing	31	AC	$3,000	$93,000	30%	$27,900	$120,900
4.18	Borrow Site Stripping	31	AC	$3,500	$108,500	30%	$32,550	$141,050
4.19	Borrow Site Excavation and Hauling	244,646	CY	$15	$3,669,690	30%	$1,100,907	$4,770,597
4.20	Borrow Site Erosion Control Seeding	31	AC	$3,500	$108,500	30%	$32,550	$141,050
	Subtotal - Levees				***$11,694,500***		***$3,508,400***	***$15,202,800***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (12' CROWN))				**$16,270,900**		**$4,881,400**	**$21,152,200**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$1,301,672	0%	$0	$1,301,700
6	**Construction Management**							
6.1	Construction Management (6%)				$976,254	0%	$0	$976,300
	ESTIMATED REACH TOTAL (100-YEAR (12' CROWN))				**$18,548,826**		**$4,881,400**	**$23,430,200**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$20,385,159.77**		**$5,364,658.60**	**$25,749,800**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (20' CROWN)
WATERSIDE ROCK SLOPE PROTECTION & LANDSIDE SEEPAGE/STABILITY BERM (60-FOOT WIDE)
BEAR RIVER REACH C - STA 0+00 TO STA 85+00

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	17.8	AC	$45,000	$801,000	30%	$240,300	$1,041,300
1.2	Land Acquisition (O&M Easement)	2.0	AC	$45,000	$90,000	30%	$27,000	$117,000
1.3	Borrow Site Royalties	41.0	AC	$20,000	$820,000	30%	$246,000	$1,066,000
1.4	Residential Building	1.0	EA	$400,000	$400,000	30%	$120,000	$520,000
	Subtotal - Land and Damages				***$2,111,000***		***$633,300***	***$2,744,300***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$2,159,430	30%	$647,829	$2,807,259
	Subtotal - Mitigation				***$2,159,500***		***$647,900***	***$2,807,300***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$10,000.00	30%	$3,000	$13,000
3.2	Utility Pole Relocation	1	EA	$30,000	$30,000	30%	$9,000	$39,000
3.3	Private Irrigation Allowance	8,500	LF	$20	$170,000	30%	$51,000	$221,000
	Subtotal - Relocations				***$210,000***		***$63,000***	***$273,000***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$1,459,000	30%	$437,700	$1,896,700
4.2	Traffic Control (Rural)	1	LS	1%	$288,911	30%	$86,673	$375,584
4.3	Storm Water Pollution Control	1	LS	3%	$841,488	30%	$252,446	$1,093,934
4.4	Project Fencing	17,000	LF	$4	$59,500	30%	$17,850	$77,350
4.5	Clearing and Grubbing	54	AC	$3,000	$162,000	30%	$48,600	$210,600
4.6	Remove Ex. Agg. Surfacing	8,500	LF	$10	$85,000	30%	$25,500	$110,500
4.7	Levee Stripping	31	AC	$4,000	$124,000	30%	$37,200	$161,200
4.8	Levee Degrading/ Excavation	58,399	CY	$5	$291,995	30%	$87,599	$379,594
4.9	Levee Fill (Embankment)	275,149	CY	$4	$1,100,596	30%	$330,179	$1,430,775
4.10	Cutoff Wall - Soil Bentonite	0	SF	$7	$0	30%	$0	$0
4.11	Drain Rock	74,588	TON	$45	$3,356,460	30%	$1,006,938	$4,363,398
4.12	Sand Filter Layer	79,050	TON	$45	$3,557,250	30%	$1,067,175	$4,624,425
4.13	Rock Slope Protection	161,925	TON	$80	$12,954,000	30%	$3,886,200	$16,840,200
4.14	Class 2 Aggregate Surfacing	6,375	TON	$35	$223,125	30%	$66,938	$290,063
4.15	Levee Erosion Control Seeding	54	AC	$3,500	$189,000	30%	$56,700	$245,700
4.16	Haul and Dispose of Unsuitable Material	58,399	CY	$10	$583,990	30%	$175,197	$759,187
4.17	Borrow Site Clearing and Grubbing	41	AC	$3,000	$123,000	30%	$36,900	$159,900
4.18	Borrow Site Stripping	41	AC	$3,500	$143,500	30%	$43,050	$186,550
4.19	Borrow Site Excavation and Hauling	330,179	CY	$15	$4,952,685	30%	$1,485,806	$6,438,491
4.20	Borrow Site Erosion Control Seeding	41	AC	$3,500	$143,500	30%	$43,050	$186,550
	Subtotal - Levees				***$30,639,000***		***$9,191,700***	***$39,830,700***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (20' CROWN))				**$35,119,500**		**$10,535,900**	**$45,655,300**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$2,809,560	0%	$0	$2,809,600
6	**Construction Management**							
6.1	Construction Management (6%)				$2,107,170	0%	$0	$2,107,200
	ESTIMATED REACH TOTAL (100-YEAR (20' CROWN))				**$40,036,230**		**$10,535,900**	**$50,572,100**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$43,999,816.77**		**$11,578,954.10**	**$55,578,800**

RIO OSO SMALL COMMUNITIES FLOOD RISK REDUCTION PROGRAM
FLOOD RISK REDUCTION FEASIBILITY STUDY
OPINION OF PROBABLE PROJECT COSTS - 100-YEAR (20' CROWN)
WATERSIDE ROCK SLOPE PROTECTION & CUTOFF WALL (60-FOOT DEEP)
BEAR RIVER REACH C - STA 0+00 TO STA 85+00

WOOD RODGERS

Item No.	Item	Quantity	Unit	Unit Price	Cost	Contingency (%)	Contingency ($)	Cost w/Contingency
1	**Lands**							
1.1	Land Acquisition (Flood Control Feature)	6.3	AC	$45,000	$283,500	30%	$85,050	$368,550
1.2	Land Acquisition (O&M Easement)	2.0	AC	$45,000	$90,000	30%	$27,000	$117,000
1.3	Borrow Site Royalties	28.3	AC	$20,000	$566,000	30%	$169,800	$735,800
1.4	Residential Building	0.0	EA	$400,000	$0	30%	$0	$0
	Subtotal - Land and Damages				***$939,500***		***$281,900***	***$1,221,400***
2	**Mitigation - Environmental**							
2.1	Environmental Mitigation	1	LS	7%	$1,987,727	30%	$596,318	$2,584,045
	Subtotal - Mitigation				***$1,987,800***		***$596,400***	***$2,584,100***
3	**Relocations**							
3.1	Mobilization and Demobilization	1	LS	5%	$8,500.00	30%	$2,550	$11,050
3.2	Utility Pole Relocation	0	EA	$30,000	$0	30%	$0	$0
3.3	Private Irrigation Allowance	8,500	LF	$20	$170,000	30%	$51,000	$221,000
	Subtotal - Relocations				***$178,500***		***$53,600***	***$232,100***
4	**Levees**							
4.1	Mobilization and Demobilization	1	LS	5%	$1,343,692	30%	$403,108	$1,746,799
4.2	Traffic Control (Rural)	1	LS	1%	$266,078	30%	$79,823	$345,901
4.3	Storm Water Pollution Control	1	LS	3%	$774,983	30%	$232,495	$1,007,478
4.4	Project Fencing	17,000	LF	$4	$59,500	30%	$17,850	$77,350
4.5	Clearing and Grubbing	41	AC	$3,000	$123,000	30%	$36,900	$159,900
4.6	Remove Ex. Agg. Surfacing	8,500	LF	$10	$85,000	30%	$25,500	$110,500
4.7	Levee Stripping	10	AC	$4,000	$40,000	30%	$12,000	$52,000
4.8	Levee Degrading/ Excavation	172,047	CY	$5	$860,235	30%	$258,071	$1,118,306
4.9	Levee Fill (Embankment)	190,149	CY	$4	$760,596	30%	$228,179	$988,775
4.10	Cutoff Wall - Soil Bentonite	510,000	SF	$7	$3,315,000	30%	$994,500	$4,309,500
4.11	Drain Rock	0	TON	$45	$0	30%	$0	$0
4.12	Sand Filter Layer	40,163	TON	$45	$1,807,335	30%	$542,201	$2,349,536
4.13	Rock Slope Protection	161,925	TON	$80	$12,954,000	30%	$3,886,200	$16,840,200
4.14	Class 2 Aggregate Surfacing	6,375	TON	$35	$223,125	30%	$66,938	$290,063
4.15	Levee Erosion Control Seeding	41	AC	$3,500	$143,500	30%	$43,050	$186,550
4.16	Haul and Dispose of Unsuitable Material	174,880	CY	$10	$1,748,800	30%	$524,640	$2,273,440
4.17	Borrow Site Clearing and Grubbing	29	AC	$3,000	$87,000	30%	$26,100	$113,100
4.18	Borrow Site Stripping	29	AC	$3,500	$101,500	30%	$30,450	$131,950
4.19	Borrow Site Excavation and Hauling	228,179	CY	$15	$3,422,685	30%	$1,026,806	$4,449,491
4.20	Borrow Site Erosion Control Seeding	29	AC	$3,500	$101,500	30%	$30,450	$131,950
	Subtotal - Levees				***$28,217,600***		***$8,465,300***	***$36,682,800***
	ESTIMATED REACH SUB-TOTAL (100-YEAR (20' CROWN))				**$31,323,400**		**$9,397,200**	**$40,720,400**
5	**Planning, Engineering and Design**							
5.1	Planning, Engineering and Design (8%)				$2,505,872	0%	$0	$2,505,900
6	**Construction Management**							
6.1	Construction Management (6%)				$1,879,404	0%	$0	$1,879,500
	ESTIMATED REACH TOTAL (100-YEAR (20' CROWN))				**$35,708,676**		**$9,397,200**	**$45,105,800**
	ESTIMATED REACH TOTAL (w/Escalation @ 3.3% for 3-years)				**$39,243,834.92**		**$10,327,522.80**	**$49,571,300**

ATTACHMENT L

Levee Encroachment Table

Rio Oso SCFRR Feasibility Study
RD 1001 LEVEES ENCROACHMENT LIST

Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
10.16 - 10.08	1001	Yankee Slough	0+00 - 4+00	Barbed wire fence, running along landside of levee from levee toe to hinge.	Fence			2/22/2012		USACE - PI Report
10.15	1001	Yankee Slough	0+50	Landside vehicle access ramp with pipe gate to levee crown from Highway 70.	Access					USACE - PI Report
10.08	1001	Yankee Slough	4+00	Vehicle access ramp at bridge crossing.	Access			2/22/2012		USACE - PI Report
10.08 - 10.05	1001	Yankee Slough	4+00 - 5+50	Highway 70 bridge crossing levee.	Bridge	3209	1959	2/22/2012	Department of Public Works - Division of Highways	USACE - EGIS System / USACE - PI Report
10.05	1001	Yankee Slough	5+63	Barbed wire fence running up landside slope and along landside shoulder, east side of Highway 70. Fence continues along east side of Highway 70.	Fence			2/22/2012		USACE - PI Report
10.04	1001	Yankee Slough	6+30	Waterside access ramp at Highway 70.	Access	9659	1974	2/22/2012	Charles C. Watts	USACE - PI Report
10.03	1001	Yankee Slough	6+70	Overhead power lines crossing over levee.	Overhead Utility			2/22/2012		USACE - PI Report
9.78	1001	Yankee Slough	16+50	Landside vehicle access ramp from levee toe to crown.	Access			2/22/2012		USACE - PI Report
9.73	1001	Yankee Slough	19+00	Waterside vehicle access ramp from levee toe to crown.	Access			2/22/2012		USACE - PI Report
9.69	1001	Yankee Slough	21+00	Landside vehicle access ramp from levee toe to crown.	Access			2/22/2012		USACE - PI Report
9.41	1001	Yankee Slough	35+88	10-inch HDPE conduit containing fiber-optic cables running through levee.	Fiber Optic Line	16996	1999		Level 3 Communications	USACE - EGIS System
9.39	1001	Yankee Slough	37+00	Waterside vehicle access ramp from levee toe to crown.	Access			2/20/2012		USACE - PI Report
9.38	1001	Yankee Slough	37+50	Overhead power lines crossing over levee.	Overhead Utility			2/20/2012		USACE - PI Report
9.38	1001	Yankee Slough	37+67	Coated steel telephone conduit of an unknown size running through levee, 3 feet below the crown.	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
3.69	1001	Yankee Slough	38+00	50-foot long landside buildout that doubles crown width.	Other					USACE - PI Report
3.67	1001	Yankee Slough	39+00	Railroad crossing levee. Pipe gates on both sides of railroad.	Railroad	14706	1987	2/20/2012	Union Pacific Railroad	USACE - EGIS System / USACE - PI Report
3.66	1001	Yankee Slough	39+71	Overhead power lines crossing over levee. Power pole located on landside shoulder.	Overhead Utility			2/20/2012		USACE - PI Report
3.60	1001	Yankee Slough	40+44	1-inch PVC fiber optic conduit running through levee, 2.5 feet below the crown.	Communications	14039	1986	4/2/2019	United Telecom Communications, Inc.	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report

Rio Oso SCFRR Feasibility Study
RD 1001 LEVEES ENCROACHMENT LIST

Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
3.63	1001	Yankee Slough	42+00	Overbuilt section of levee that doubles with of crown, 50 feet long.	Other			2/20/2012		USACE - PI Report
3.14 - 2.82	1001	Yankee Slough	66+47 - 83+45	10-foot wide and 6-foot deep ditch located 13 to 15 feet from landside toe.	Other			2/20/2012		USACE - PI Report
2.87	1001	Yankee Slough	80+47	24-inch corrugated metal gravity drainage pipe running through levee. Invert elevation 49 feet (USED Datum). Flap gate at outfall on waterside end. (Not field verified).	Drainage		1955	4/2/2019		DWR - Utility Crossing Inventory Program
2.86	1001	Yankee Slough	81+00	Waterside vehicle access ramp from levee toe to crown.	Access			2/20/2012		USACE - PI Report
2.54	1001	Yankee Slough	96+64	Pipe gate across levee crown.	Access			2/20/2012		USACE - PI Report
2.53	1001	Yankee Slough	96+99	Coated steel telephone conduit of unknown size running through levee, 3 feet below the crown. Conduit attached to downstream side of Swanson Road bridge.	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
2.53	1001	Yankee Slough	97+20	Swanson Road crossing and bridge abutment.	Bridge	2809	1958	2/17/2012	County of Sutter	USACE - EGIS System / USACE - PI Report
2.53	1001	Yankee Slough	97+31	4-inch coated galvanized steel telephone conduit running through levee, 2 feet below the crown. Conduit attached to the upstream side of Swanson Road bridge.	Telephone	9166	1974	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
2.52 - 2.32	1001	Yankee Slough	97+50-109+93	Landside ditch at levee toe, up to 12 feet wide and 5 feet deep.	Drainage			2/17/2012		USACE - PI Report
2.52	1001	Yankee Slough	97+60	Overhead power lines crossing over levee.	Overhead Utility			2/17/2012		USACE - PI Report
2.52	1001	Yankee Slough	97+75	12-inch coated steel drainage discharge pipe running through levee, 2.2 feet below the crown. Vertical pump on a metal structure in a drainage ditch on the landside. Steps and walkway on the landside to the pump. Pipe discharges into Yankee Slough on the waterside. Flap gate and metal apron on the waterside end. Service pole and meter box on the landside shoulder.	Drainage	3109	1959	4/2/2019	RD 1001	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
2.52	1001	Yankee Slough	98+10	Pipe gate across levee crown.	Access			2/17/2012		USACE - PI Report
2.28	1001	Yankee Slough	110+20	Landside access ramp from levee toe to crown, with pipe gate at levee toe.	Access			2/17/2012		USACE - PI Report
2.28	1001	Yankee Slough	110+23	36-inch corrugated metal gravity drainage pipe running through levee, 15 feet below the crown. Flap gate and concrete U-shaped headwall at outfall on the waterside end. Slide gate at inlet on the landside end.	Drainage		1955	4/2/2019	RD 1001	DWR - Utility Crossing Inventory Program / USACE - PI Report
2.30 - 2.05	1001	Yankee Slough	111+02 - 123+96	Irrigation sprinkler heads spaced 20 to 40 feet apart along the landside toe.	Irrigation			2/17/2012		USACE - PI Report
2.06	1001	Yankee Slough	123+79	6-inch broken concrete standpipe on landside hinge.	Other			2/17/2012		USACE - PI Report
2.05	1001	Yankee Slough	124+35	Guy wire in landside slope.	Other			2/17/2012		USACE - PI Report

Rio Oso SCFRR Feasibility Study
RD 1001 LEVEES ENCROACHMENT LIST

Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
2.05	1001	Yankee Slough	124+35	Landside vehicle access ramp from levee toe to crown with access gate.	Access			2/17/2012		USACE - PI Report
1.78	1001	Yankee Slough	138+72	Power pole and guy wire located in landside slope, barn at landside toe, and landscaping and irrigation located on landside slope.	Other			2/17/2012		USACE - PI Report
1.73	1001	Yankee Slough	139+39	8 5/8-inch gas line of an unknown material running through levee, at an unknown depth.	Gas	4399, 4399-A, 4399-B	1964	4/2/2019	PG&E	DWR - Utility Crossing Inventory Program / USACE - EGIS System
1.73	1001	Yankee Slough	139+39	Coated steel telephone conduit of an unknown size along the center of the crown, 2.6 feet below the crown. (Not field verified)	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
1.73	1001	Yankee Slough	139+50	Landside vehicle access ramp from levee toe to crown.	Access			2/17/2012		USACE - PI Report
1.71	1001	Yankee Slough	140+70	8-inch coated steel irrigation pipe running through levee, 3 feet below the crown. Pump station with platform on bank of Yankee Slough. Air vent on landside shoulder.	Irrigation	13645	1983	4/2/2019	Richard Nelson	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
1.70	1001	Yankee Slough	141+60	Waterside vehicle access ramp from levee toe to crown. Ramp provides access to pump.	Access			2/17/2012		USACE - PI Report
1.68	1001	Yankee Slough	143+70	Overhead power line crossing over levee. Power pole and guy wire on landside slope.	Overhead Utility			2/17/2012		USACE - PI Report
1.50			152+50	Landside access ramp from levee toe to crown.	Access			2/17/2012		USACE - PI Report
1.48	1001	Yankee Slough	153+40	Landside access ramp from levee toe to crown.	Access			2/17/2012		USACE - PI Report
1.30	1001	Yankee Slough	162+03	6-inch irrigation pipe of an unknown material running through levee, 3 feet below the crown. 15-horsepower submersible pump and platform on the waterside. Standpipe on landside slope.	Irrigation	13646	1983	4/2/2019	Conant Orchards	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
1.30	1001	Yankee Slough	163+00	Waterside vehicle access ramp from levee toe to crown.	Access			2/17/2012		USACE - PI Report
1.29	10001	Yankee Slough	164+40	Landside vehicle access ramp from levee toe to crown	Access			2/17/2012		USACE - PI Report
1.14 - 1.17	1001	Yankee Slough	170+38 - 172+20	Valves located at landside toe for irrigation lines and sprinkler pipe that parallel the levee.	Irrigation			2/17/2012		USACE - PI Report
1.10	1001	Yankee Slough	172+70	8-inch irrigation pipe of an unknown material running through levee, 2.6 feet below the crown. 6-inch steel riser pipe with siphon breaker on the landside shoulder.	Irrigation	14219	1985	4/2/2019	Frank B. Foster	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
0.89	1001	Yankee Slough	183+91	Access pipe gate across levee crown.	Access			2/17/2012		USACE - PI Report

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Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
0.88	1001	Yankee Slough	184+21	4.5-inch coated galvanized steel telephone conduit running through levee, 3 feet below the crown.	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
0.88	1001	Yankee Slough	184+30	Pleasant Grove Road bridge crossing levee. Abutment on waterside.	Bridge			2/17/2012		USACE - PI Report
0.88	1001	Yankee Slough	184+50	4-inch coated steel telephone conduit running through levee, 4 feet below the crown. Conduit attached to east side of Pleasant Grove Road bridge.	Telephone	13927	1984	4/2/2019	Pacific Bell	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report
0.88 - 0.62	1001	Yankee Slough	184+52 - 200+00	Power poles spaces at 200 to 250 feet apart along the landside toe.	Overhead Utility			2/17/2012		USACE - PI Report
0.88	1001	Yankee Slough	184+70	Overhead power line crossing over levee.	Overhead Utility			2/17/2012		USACE - PI Report
0.75	1001	Yankee Slough	191+50	Chain link fence running along landside toe. House and propane tank located within 15 feet of landside toe.	Other			2/17/2012		USACE - PI Report
0.75	1001	Yankee Slough	191+78	Discharge pipe running through levee. Low lift pump located in Yankee Slough channel.	Irrigation	14218	1985		Frank B. Foster	USACE - EGIS System
0.73	1001	Yankee Slough	192+40	Landside vehicle access ramp from levee toe to crown.	Access			2/17/2012		USACE - PI Report
0.70	1001	Yankee Slough	194+15	Overhead power line crossing over levee	Overhead Utility			2/17/2012		USACE - PI Report
0.67	1001	Yankee Slough	195+73	Landside vehicle access ramp from levee toe to crown.	Access	7446	1971	40956	George Darby	USACE - EGIS System / USACE - PI Report
0.65	1001	Yankee Slough	198+13	Shed within 15 feet of landside toe.	Other			2/17/2012		USACE - PI Report
0.56	1001	Yankee Slough	202+93	Two power poles, fence, and large tank on landside slope or within 15 feet of landside toe.	Other			2/17/2012		USACE - PI Report
0.53	1001	Yankee Slough	203+18	Landside access ramp and pipe gate crossing levee crown.	Access			2/17/2012		USACE - PI Report
0.51	1001	Yankee Slough	203+99	Coated steel telephone conduit of an unknown size along the center of the crown, 2.6 feet below the crown. (Not field verified)	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
0.47	1001	Yankee Slough	206+95	Removed 7-inch steel irrigation pipe running through levee, 1.9 feet below the crown. Portable pump mounted on the bank during summer months. Control valve on waterside. Steel plate bolted on the waterside end during the winter months. Pipe discharges into a 30-inch concrete standpipe at the landside toe. (Not field verified)	Irrigation	2281	1956	4/2/2019	Willard R. Brown	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE PI Report
0.34	1001	Yankee Slough	214+03	Landside access ramp that cuts into embankment.	Access			2/17/2012		USACE - PI Report

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RD 1001 LEVEES ENCROACHMENT LIST

Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
0.30	1001	Yankee Slough	214+99	Coated steel telephone conduit of an unknown size along the landside toe, 2.5 feet deep. (Not field verified)	Telephone	1580	1951	4/2/2019	Pacific Telephone and Telegraph Company	DWR - Utility Crossing Inventory Program / USACE - EGIS System
0.24	1001	Yankee Slough	218+31	6-inch coated steel irrigation pipe running through levee, 3.5 feet below the crown. Metal cutoff collar placed on the pipe at the center of the levee crown. Pump was removed. Pump base on the waterside berm. Shutoff valve on the discharge side of the pump. Foot valve below water on the intake side of pump. Siphon breaker on landside shoulder. Pipe discharges into underground irrigation system on the landside. Power pole and meter box, 10 feet from the landward toe. 1.5-inch flexible conduit through levee, 3.5 feet below the crown.	Irrigation	5562	1967	4/2/2019	Samual B. Single	DWR - Utility Crossing Inventory Program / USACE - EGIS System / USACE - PI Report /
0.21	1001	Yankee Slough	220+00	Overhead power lines crossing over levee.	Overhead Utility	2769		2/17/2012	PG&E	USACE - EGIS System / USACE - PI Report
0.07	1001	Yankee Slough	228+88	Farming activity along landside toe.	Other			2/17/2012		USACE - PI Report
0.07	1001	Yankee Slough	230+95	Fencing across the levee crown.	Access			2/17/2012		USACE - PI Report
12.60	1001	Bear River	2+00	Landside access ramp from levee toe to crown with pipe gate.	Access	3470	1960	2/22/2012	RD 1001	USACE - EGIS System / USACE - PI Report
12.59	1001	Bear River	2+50	Waterside vehicle access ramp from levee toe to crown.	Access	5947	1968	2/22/2012	Frank P. LaSalle	USACE - EGIS System / USACE - PI Report
12.57 - 12.28	1001	Bear River	3+64 - 18+55	10-foot wide, 4-foot deep ditch 10 feet from landside toe.	Other			2/22/2012		USACE - PI Report
12.31	1001	Bear River	17+58	15-foot portion of barbed wire fence within 15 feet of waterside toe.	Fence			2/22/2012		USACE - PI Report
11.90	1001	Bear River	39+00	Landside vehicle access ramp from levee toe to crown with access gate.	Access			2/22/2012		USACE - PI Report
11.89	1001	Bear River	39+59	3-inch pipe running through levee. Part of pipe is PVC slip lined. No positive closure observed. Located less than a foot below levee crown.	Pipeline			2/22/2012		USACE - PI Report
11.88	1001	Bear River	39+68	12-inch corrugated metal gravity irrigation pipe running through levee, 20.5 feet below the crown. Invert elevation 45.2 feet (USED Datum). Slide gate on the waterside. (Not field verified)	Irrigation		1955	4/2/2019		DWR - Utility Crossing Inventory Program
11.69	1001	Bear River	48+00	40-foot long waterside building that doubles crown width.						
11.65	1001	Bear River	50+00	40-foot long waterside building that doubles crown width.	Other			2/22/2012		USACE - PI Report
11.65	1001	Bear River	52+25	Sprinklers and fence 2 to 3 feet below waterside hinge for re-vegetation site on waterside embankment.	Fence			2/22/2012		USACE - PI Report
11.42	1001	Bear River	64+50	Landside vehicle access ramp from levee toe to crown.	Access			2/22/2012		USACE - PI Report
11.39 - 11.21	1001	Bear River	66+16 - 75+48	3- to 6-foot wide, 2-foot deep ditch located within 10 feet of landside toe.	Other			2/22/2012		USACE - PI Report
11.26	1001	Bear River	72+80	50-foot long waterside buildout that doubles crown width.	Other			2/22/2012		USACE - PI Report
10.61	1001	Bear River	107+00	Waterside vehicle access ramp from levee toe to crown.	Access	1667	1952	2/22/2012	Sutter County	USACE - EGIS System / USACE - PI Report
10.60	1001	Bear River	107+46	Wire fence at landside toe.	Fence			2/22/2012		USACE - PI Report

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Levee Mile	Reclamation District	Project Reach	Project STA	Encroachment	Type	Permit No.	Year	Inspection Date	Owner Name	Data Source
10.60	1001	Bear River	107+70	Landside vehicle access ramp from levee toe to crown.	Access			2/22/2012		USACE - PI Report
10.60	1001	Bear River	107+90	Overhead power lines crossing over levee. Utility pole at waterside shoulder.	Overhead Utility			2/22/2012		USACE - PI Report
10.57	1001	Bear River	109+17	Two sheds and fence located at landside toe.	Other			2/22/2012		USACE - PI Report
10.36 - 10.16	1001	Bear River	120+00 - 130+71	Barbed wire fence, running along landside of levee from levee toe to hinge.	Fence			2/22/2012		USACE - PI Report
10.36	1001	Bear River	120+28	Abandoned 38-inch diameter concrete tank, 8 feet from landside toe.	Other			2/22/2012		USACE - PI Report
10.34	1001	Bear River	121+00	Landside buildout, 30 feet long and 30 feet wide.	Other			2/22/2012		USACE - PI Report

ATTACHMENT M

Draft Nonstructural Measures, Rio Oso Flood Risk Reduction Feasibility Project

Nonstructural Measures

Rio Oso Flood Risk Reduction Feasibility Project

Sutter County
April 2020

1

2 Nonstructural Measures

The nonstructural measures evaluated to reduce residual risk in Rio Oso are presented in this attachment. Residual risk is defined as the product of (1) the chance of damage or other adverse consequence and (2) the amount of that damage or other adverse consequence, after flood management actions have been taken. Therefore, even after implementing the recommended alternative, Rio Oso would still face residual risk from flooding. Although it is not possible to completely eliminate residual risk, it can be mitigated with the implementation of nonstructural measures that improve flood system performance of existing facilities and/or reduce exposure, vulnerability, and consequences of flooding by adapting to the natural floodplain or inherent features of the floodplain. These nonstructural measures include: changes to the National Flood Insurance Program (NFIP), levee relief cuts, emergency flood fight plan, flood emergency evacuation plan, flood evacuation warning system, voluntary structure elevation, and agricultural conservation easements.

2.1 Changes to National Flood Insurance Program

2.1.1 2012 Central Valley Flood Protection Plan (CVFPP) & 2017 Update of the CVFPP

As proposed in the 2012 CVFPP and the 2017 update of the CVFPP, the State will work with FEMA's NFIP to determine opportunities to provide affordable flood insurance for low risk agricultural and farming structures within the floodplain and to promote a sustainable rural-agricultural economy. The State supports efforts to reform the NFIP under the condition that they result in more equitable implementation while reflecting corresponding flood risks. Consequently, the California Department of Water Resources (DWR) funded and participated in the Agricultural Floodplain Ordinance Task Force (Task Force that convened throughout 2016 to develop recommendations to FEMA for administrative refinements to the NFIP to help sustain agriculture in leveed Special Flood Hazard Areas (SFHA).

The 2017 CVFPP proposes evaluating implementation of a state-led flood insurance program to improve or replace the NFIP. A state-led flood insurance program could also serve as a new mechanism for funding projects such as levee improvements, land acquisitions, and easements in the long term. An assessment still needs to be performed to evaluate the feasibility and potential cost effectiveness of a state-led flood insurance program in comparison to the NFIP, especially in regards to mitigating losses to those affected by flooding and flood insurance (DWR, 2017).

2.1.2 Regional Flood Management Plan

The 2014 Feather River Regional Flood Management Plan (RFMP) presented possible nonstructural measures to be considered in the rural areas, including the small community of Rio Oso. The RFMP also considered similar nonstructural measures such as the modification of the area's status within the NFIP's administrative structure, elevating and flood-proofing structures, relocating structures, agricultural easements, and hazard mitigation.

2.1.3 Agricultural Floodplain Ordinance Task Force – Zone D with floodplain management ordinance and flood insurance instrument

The Task Force prepared a technical memorandum which presents recommendations for modifying FEMA's rules and practices under the NFIP to improve sustainability of agriculture in leveed SFHAs.

One of those recommendations included the implementation of a Zone D designation. It may be possible for Rio Oso to qualify for FEMA Zone D designation rather than Zone AE. Zone D designation is used in areas where there are undetermined, but possible, flood hazards and definitive analysis has yet to be conducted. Zone D designated areas are:

- Undeveloped and sparsely populated
- There are no federal restrictions on building new structures
- Flood insurance is not required but can be purchased through the NFIP at relatively high premiums.

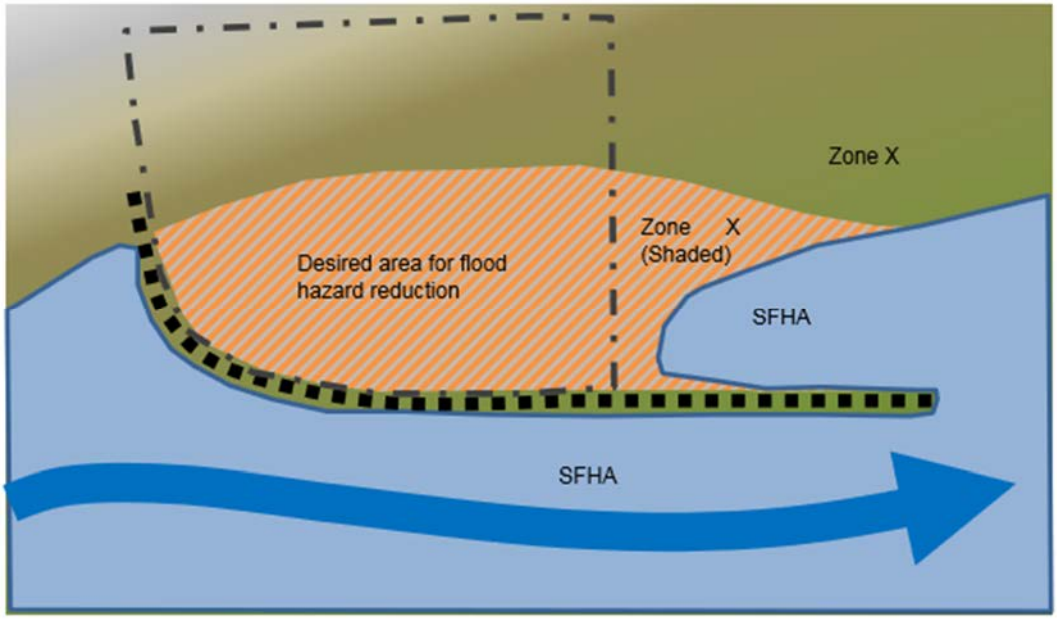
Past performance events on the levees protecting Rio Oso have included include levee breaks, underseepage, through seepage, erosion, overtopping, and slope instability. The levee systems affected may meet NFIP freeboard requirements but may fail to meet levee seepage, stability, and erosion standards. Changing designation is not recommended because it could lead to residents having a false sense security, even though the flood risk in the community would still remain.

While application of Zone D for rural areas was recommended by the Task Force, FEMA has not formally responded to the Task Force recommendations. Based on informal discussions with FEMA, it appears unlikely that FEMA would change the designation of an area already mapped as a SFHA, such as the Rio Oso area, to Zone D.

2.1.4 Agricultural Floodplain Ordinance Task Force – Zone X (Shaded) for certified levee reaches

The Agricultural Floodplain Ordinance Task Force recommended FEMA to revise Operating Guidance 12-13 to designate areas behind a certified reach of levee as Zone X (Shaded) instead of Zone D

FEMA's Operating Guidance 12-13 does not allow accreditation of a reach of levee unless the entire levee system is certified and accredited. Due to this, unshaded Zone X designation is used on the FIRM behind reaches of levees that meet all requirements for accreditation. In February 2018, FEMA issued updated guidance (Guidance Document 95) that states Zone X (Shaded) certification may be allowed behind an accredited reach of levee if it connects to a non-accredited reach of levee and would not unravel if a breach occurred where they connect (Figure 1).



Source: FEMA Guidance Document 95 (February 2018)

Figure 1. Levee System Designed to End in the Absence of High Ground

Initial outreach to FEMA on this issue has not confirmed whether this new approach can be used for Zone X (Shaded) designation behind a certified reach of levee. According to FEMA Title 44 Code of Federal Regulations Part 65.10 (Mapping of areas protected by levee systems), FEMA is required to apply the regulatory certification criteria to a levee system, not a levee reach. In informal discussions with FEMA, FEMA has suggested a change to CFR 65.10 may be required to implement this recommendation. However, this recommendation by the Agricultural Floodplain Ordinance Task Force does not actually appear to violate the requirements of 44CFR 65.10 since FEMA defines a levee system as “a flood protection system that consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.”

In the case of Rio Oso, even if these changes are made, this option only appears feasible if:

(1) the recommended alternative is implemented;
(2) additional levee evaluations/improvements dictated by additional hydraulic studies are implemented; and
(3) the levee reaches required for identifying a Zone X (Shaded), are certified by an engineer and accredited by FEMA.

The community may choose to pursue levee certification after the recommended alternative is implemented, and because the levee design water surface elevation is greater than the FEMA base flood elevation (BFE), the levee may be robust enough so as to not require much additional construction or geotechnical work. For Rio Oso, more analysis needs to be done before pursuing this measure.

2.1.5 Agricultural Floodplain Ordinance Task Force – Insurance rates for non-accredited levees

The Task Force also recommended setting insurance rates for structures protected by non-accredited levees with respect to the level of risk. The non-accredited levees of Rio Oso provide substantial risk reduction but not enough for accreditation. Insurance rates for structures protected by non-accredited levees are currently set as if the levees do not exist. FEMA would need to develop a methodology for rating a levee's level of flood protection.

The Task Force report (HDR, 2016) provided a methodology for FEMA to consider. A civil engineer would need to certify the level of flood protection. Justification for higher levels of flood protection would require more data and analysis than justification for lower levels of flood protection. Land use requirements, such as elevation requirements for new structures, would not be affected.

2.1.6 NFIP premiums increases

FEMA recently made changes to the NFIP that apply to new businesses and renewals, effective April 1, 2019. These changes include premium increases, changes to primary residence determination, introduction of a Severe Repetitive Loss (SRL) Premium, and clear communication of these changes to policy holders. Premium increases comply with all the requirements of Biggert-Waters Flood Insurance Reform Act of 2012 and the Homeowners Flood Insurance Affordability Act (HFIAA) of 2014. Premiums will increase an average of 8.2%, the Federal Policy Fee or the HFIAA surcharge are not included (FEMA 2018). Including the HFIAA and Federal Policy Fee, the total amount billed will increase an average of 7.3% (FEMA 2018). No changes were made to the Deductible Factor, Federal Policy Fee, Reserve Fund Assessment, HFIAA Surcharge, or Probation Surcharge. ICC Fee will increase 3% for all policies except Preferred Risk and Newly Mapped rated policies (FEMA 2018).

FEMA is updating the Primary Residence Determination Guidance to allow a 2-4 family building to be a primary residence for the purpose of assessing the HFIAA Surcharge for policies effective on or after April 1, 2019. FEMA will introduce a SRL Premium of 5% for all policies covering properties with an SRL designation. FEMA is requiring that the Policy Declaration page display the following message; "Refer to www.fema.gov/cost-of-flood for more information about flood risk and policy rating." This page provides information regarding flood risk and policy rating to NFIP stakeholders.

2.1.7 Community Rating System

The NFIP Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. The completion of the Local Hazard Mitigation Plan (LHMP) for Sutter County earns credits for the NFIP's CRS which provides for lower flood insurance premiums in CRS communities. The "benefit of mitigation planning is that it can help lessen the cost of flood insurance in Sutter County and the Cities of Live Oak and Yuba City" through NFIP CRS.

Flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the goals of the CRS program. The reduction in premium rates is provided according to a community's CRS classification. Sutter County joined the CRS in 2008 and is currently a CRS Class 6, with a 20 percent discount on flood insurance for those located within the SFHA and a 10 percent discount for those located in non-SFHA areas. More information on the NFIP CRS is located in the Sutter County LHMP.

Sutter County developed the LHMP update so that the County would be eligible for the FEMA Pre-Disaster Mitigation and Hazard Mitigation Grant Programs. More information on the Flood Mitigation Assistance Grant Program is located in section 1.6.3 of this attachment.

2.2 Levee Relief Cuts

A technical memorandum (TM) for evaluating potential flood risk for the communities of Rio Oso and Nicolaus analyzing the benefits of a potential levee relief cut in the RD 1001 basin was developed by MBK. Hydraulic analysis were performed as part of this feasibility study to evaluate the stage reduction benefits of the proposed relief cuts based on a breach on the Feather River levees at Highway 99. Based on the evaluation done by MBK, in the case of a breach on the Feather River levees at Highway 99, the relief cut is not a feasible flood contingency option for Rio Oso because the flood stage reduction is constrained by outflow as the inflow from the breach at Highway 99 exceeds outflow capacity at the site of the relief cut.

The proposed site of the relief cut is on the Feather River near Verona, as shown in Figure 5 of the *Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus TM*. The depth of the relief cut proposed is 10 feet because in the Highway 99 breach analysis the stage reached approximately 40 feet on the water side of the relief cut location and the top-of-levee elevation at this location is approximately 50 feet. Three potential relief cuts were explored in the hydraulic analysis with varying widths. The three different widths of the potential relief cuts are 100 feet, 500 feet, and 1,000 feet. The final crest elevation for all the relief cuts is 40 feet (NAVD 88). The approximate time available to construct the relief cut after breach occurs is 24 hours for all the potential relief cuts.

The breach parameters of a breach on the Feather River levees at Highway 99 are the following:

- The levee breach was assumed to occur once the water surface elevation (WSE) exceeds the Federal/State project levee design criteria of 45 feet (NAVD 88).
- The levee structure is assumed to completely wash out the levee towards the dry-side toe elevation of 33 feet (NAVD 88).
- The assumed width of the breach is 600 feet.
- Assumed formation time is 2 hours.

The results of the hydraulic analysis indicate the maximum flood stage reduction due to a relief cut is about 0.1 feet to 0.6 feet. While relief cuts in the lower portions of the RD 1001 basin are constrained by outflow, there are potential reductions in up to 2,779 acres that are inundated during a breach on the Feather River levees at Highway 99. As seen in Figure 5 of the *Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus TM (Appendix B)*, Rio Oso would experience the majority of the reduction in inundated land.

2.3 Emergency Flood Fight Plan

Sutter County developed a LHMP update to make the County and its residents less vulnerable to future hazard events. The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards. According to the Sutter County LHMP update in 2013, one of the mitigation actions for RD 1001 includes a flood emergency response project. This project includes developing a training video, coordinate SIMS/NIMS/ICS training, establish a flood safe location for the Yuba Sutter Coalition, and purchase emergency equipment and supplies. In 2018 Sutter County

received a grant from DWR to update the Emergency Operations Plan. The Sutter County Board of Supervisors approved a resolution to begin the update process in the summer of 2019. Sutter County is planning futures updates to Evacuation Annex, South Area Flood Plan, Sutter County Flood Annex, and a plan specific to Rio Oso.

2.4 Flood Emergency Evacuation Plan

2.4.1 Sutter County

The *Sutter County Emergency Operations Plan – Annex 9 Evacuation and Mass Care/Shelter* details the flood emergency evacuation plan throughout the County. The Emergency Operations Plan for Sutter County was most recently updated in January of 2015. In the event of an emergency this plan will be implemented by the County Administrative Officer, Sheriff, County Fire Chief, or Incident Commander as appropriate. Many factors need to be considered during evacuations such as magnitude of the hazard, intensity, and duration. These factors are essential for determining the scope and timeframe for evacuation needed to ensure the safety of all the residents.

According to the Sutter County evacuation plan, the Operational Area Emergency Operations Center (OA EOC) will monitor hazardous situations as they develop. The OA EOC will determine the area's most likely to be impacted and notify the Regional Emergency Operations Center (REOC). The OA EOC will monitor the progress of the evacuation and exchange information with the REOC. The State and OA EOC will coordinate the deployment of resources as needed, available evacuee shelter capacity, and address modifications to evacuation routes if necessary.

The OA EOC may issue two types of evacuations; advisory and mandatory evacuations.

Advisory Evacuation: When conditions exist which indicate a mandatory evacuation order may be given in the near future. An advisory evacuation indicates:

- No imminent threat to lives.
- The public is advised to prepare for the issue of a Mandatory Evacuation order.
- Residents are advised to leave the area.
- Businesses are advised to take whatever precautions they deem necessary for protecting equipment and/or inventory.
- Access to the area under an Advisory Evacuation is unrestricted.
- May also be issued when a Mandatory Evacuation order has been lifted in an area but the conditions in the area remain subject to rapid change and could again become serious.

Mandatory Evacuation: When conditions exist that seriously endanger the lives of those in a defined area. A mandatory evacuation indicates:

- The danger is imminent.
- All non-essential persons are ordered to immediately leave the area via the described evacuation routes.
- Once out of the area, people (including residents) will not be permitted to return until conditions permit.
- Any non-essential persons found by officials traveling through the area will be escorted out and not permitted to re-enter the area.

The anticipated primary evacuation mode will most likely be private vehicles. Evacuation movement efforts will be conducted by the law enforcement agencies involved. Evacuation instructions will be

part of the warning and public information releases. Two-way traffic will be maintained if possible on all evacuation routes to allow access for emergency vehicles. Public Works will provide traffic control devices such as signs and barricades.

The Emergency Operations Director/Incident Commander will make the re-entry order after the threat has passed and Fire, Law Enforcement, Public Works, and/or Building Division personnel have inspected the evacuated area.

2.5 Flood Evacuation Warning System

Flood evacuation warning system information is detailed in the *Sutter County Emergency Operations Plan – Annex 5 Floods and Dam Failure* and the *Sutter County Emergency Operations Plan – Annex 9 Evacuation and Mass Care/Shelter*. There are three types of flooding that may occur in the Sutter County Operational Area. The first type is localized flooding due to severe rainfall and flash flooding. The second is slow rise flooding due to rising river levels caused by continued and heavy precipitation. The last type is flooding caused by catastrophic dam failure.

The following information is provided as guidelines for the Emergency Operations Team to be used within the procedural structure of SEMS and ICS and not intended to be a substitute for the decisions of the Emergency Operations Director. The information presented here is based on information provided by Local, State, and Federal Agencies as well as experiences and lessons learned from previous events/emergencies.

2.5.1 Public Notification

Public notification recommendations are detailed in the *Sutter County Emergency Operations Plan – Annex 9 Evacuation and Mass Care/Shelter*. Persons to be evacuated should be given as much warning time as possible.

1. *Pre-evacuation Warning:* On slow-moving events, pre-evacuation notice should be given to affected residents if it appears that hazardous conditions may warrant such action. Residents should be advised that they might have to evacuate on thirty minutes notice or less.

2. *Evacuation Warning:* Warnings should be given on a direct basis as well as through the media. This includes the following:

- Use of law enforcement and fire emergency vehicles moving through the affected area with sirens.
- Door-to-door notification
- Cable channel 19 broadcast
- “Stream Level” link on the Sutter County home web page (www.suttercounty.org)
- Sutter County’s Facebook page
- Wireless Emergency Alerts (www.calalerts.org)
- Flood information broadcasted on radio stations KUBA (1600 AM & 100.7 FM), KMJE (101.5 FM), and KKCY (103.1 FM).

3. *Emergency Public Information:* The Public Information Officer (PIO) will ensure that evacuation information is issued to the media on a timely basis. This information includes evacuation routes, location of temporary reception centers, and updates as information becomes available.

2.5.2 Responsible Agencies and Duties

This section presents the various duties and responsible agencies during a flood event or emergency.

Operational Structure: The County of Sutter will activate the appropriate SEMS functions based upon the level of the flood event/emergency.

Coordination of Disciplines: Sutter County will use multi-agency, multi-discipline coordination in its response to a flooding disaster or emergency.

Inclusion of Non-Profit Agencies/Organizations: Non-profit organizations, such as the American Red Cross will be involved in flood response planning. Sutter County will contact the appropriate non-profit organizations in the event of a potential threat.

Public Information: The PIO will be activated when necessary during an emergency. The PIO will coordinate with media for news releases.

Safety and Security: During actual emergency operations, heightened safety and security procedures will be followed by county personnel. Security and safety procedures will also be implemented for all command posts and other operational sites. The Sheriff's Department will serve as lead for security functions.

Information Sharing and Dissemination: During an actual emergency or disaster the release of information raises significant issues regarding information sharing and dissemination. Notification of an event or an emergency and any subsequent updates will be made verbally through the most secure landline available. Written confirmations of notification and updates will also be used. It is recommended that sensitive information not be communicated by cell phone or radio. Sutter County will have scheduled briefings for EOC staff to coordinate briefing times, reporting approaches, and news releases.

Sheriff's Office: The Sheriff, or designee, will determine and establish SOPs required for the operation and deployment of law enforcement assets controlled by his Department and as authorized by Local, State, and Federal Statutes/Regulations. The Sheriff Office will be the lead for the following actions:

- perimeter security
- access control
- traffic/crowd control
- evacuations
- notifications
- coordinate coroner issues
- assist with damage assessment
- fatalities management

Fire Services: The County Fire Chief, or designee, will determine and establish SOPs required for the operation and deployment of OA Fire assets controlled by the Division and as authorized by Local, State, and Federal Statutes/Regulations. Fire Services will be the lead for fire response, hazardous materials events, and medical/rescue operations. Fire Services will also provide support

as necessary to the Sheriff's Office for evacuation activities. Fire Services will assist with the following actions:

- perimeter and access control
- evacuation operations
- notifications
- damage assessment
- fatalities management
- addressing environmental needs
- fire and rescue mutual aid
- support to hazardous materials operations
- coordination with EMS and hospitals
- personnel protection issues
- coordination with public works and utilities

Public Works: Public Works will serve as lead for damage assessment and will be the representative for utilities concerns. Potential Public Works activities include:

- reconnaissance of public infrastructure (roads, bridges, facilities, and utilities)
- alternate route identification
- building access
- utility access re-routing
- temporary repairs
- access and crowd control
- fatalities management

2.5.3 Slow Rise Flood Threat Summary of Emergency Activation Stages

River stages are intended to be guides for declaring the response stages, which are also influenced by weather forecasts, dam releases and levee conditions. Table 1 shows the various response stages based on the Feather River gage at Nicolaus, which would impact Rio Oso.

When the Feather River is measured, at Nicolaus to be 39.5 feet the Emergency Management Team will enter into the Planning and Preparation Phase, Stage 1. The Emergency Management Team will take all factors into consideration when deciding to implement the following actions. The following Stages are intended to be guidelines for the Emergency Management Team and not intended to be a substitute for the decisions of the Emergency Operations Director.

Table 1. Response stages based on the Feather River gage at Nicolaus (NIC).

Stage 1 Planning and Preparation Phase (< 42.6')*		**Stage 2 Ready for Action Phase (≥ 42.6')***		**Stage 3 Emergency Phase (> 46.4')***
39.5' and Forecast to Rise	40' and Forecast to Rise	42.6' and Forecast to Rise	44' and Forecast to Rise	46.4' and Forecast to Rise
Emergency Operations Manager notifies members of the Management Team. Identification of On-Call Duty Officer for Emergency Operations Level 1 activation of the EOC, at 1130 Civic Center Blvd. during working hours Emergency Operations staff closely monitors river forecasts and river levels Emergency Operations Manager notifies REOC of plan activation and status (Duty Officer and/or Level 1 Activation of the EOC)	Level 2 activation of the EOC, if deemed necessary, location determined by Emergency Operations Director Emergency Operations notifies REOC of plan activation and status (Duty Officer and/or Level 2 Activation of the EOC) Begin written log. Human Services Director initiates preliminary planning for mass care centers. Notification of key personnel involved in emergency organization. Management Team meets as soon as practical. Assess conditions for Advisory Evacuation and evacuation of medical facilities, rest homes, and other special needs populations. County Health Officer requests (U.S. Department of Health and Human Services) DHHS assistance with planning for persons with medical needs. Assess need to fully activate (Level 3) the EOC, and to request DWR and National Guard Liaison. Request Incident Management Team from California Office of Emergency Services (CalOES) if the developing situation is predicted to reach Stage 3. PIO begins to make regular press releases. Assess need for disaster declaration. Vital records identified and tagged. Essential vehicles moved to pre-designated staging areas. Non-emergency equipment and vehicles made ready for move out of danger area. All Levee Districts and Reclamation Districts contacted every 24 hours (or more often) for situation update. Consider evacuation of schools in threatened areas EOC facility in Sutter set up (not activated). Emergency personnel ensure safety of families and prepare to return to duty. Incident Action Plan developed. Alert Beale Air Force Base Command Post or Disaster Preparedness Office	Activate Level 3 EOC, and relocate personnel, if not done previously. County Administrative Officer (Emergency Operations Director), Emergency Operations Manager, and PIO coordinate notification of change of status to all agencies and emergency organizations. Incident Action Plan developed for each operational period. Management Team meets every 12 hours. Assessment of conditions for advisory or mandatory evacuation. Request Incident Management Team from CalOES if the developing situation is predicted to reach Stage 3.	Assessment of conditions for advisory or mandatory evacuation. If all local resources are anticipated to be exhausted, County Administrative Officer and/or Board of Supervisors Chair, in cooperation with the City Administrator and Mayor of Yuba City and/or Live Oak, may proclaim the existence of a disaster and request the Governor to declare the county a disaster area. Cal Fire Incident Management Team requested if not already done.	Management Team meets every 12 hours or more often as necessary. Assess need for mandatory evacuation. Request Sheriff to coordinate with Yuba City Police to secure evacuated areas from possible looting.

Notes: Refer to the Basic Emergency Operations Plan and Annex 2 for additional information regarding EOC operations, recovery and mitigation operations/procedures, and/or disaster assistance.

*Southeast County Basins – Feather River @ Nicolaus (NIC)

Information summarized from the Sutter County Emergency Operations Plan – Annex 5 Floods and Dam Failure.

2.5.4 Dam Failure Plan and Response

Another potential hazard in the Rio Oso area is a potential dam failure. The estimated flood arrival time for an Oroville Dam failure reported by DWR is 13.2 hours with a 34 hour total inundation time, a New Bullards Bar Dam failure reported by Yuba Water Agency would have a 2.5 hour arrival time with a 4 hour total inundation time, and a Camp Far West Dam failure reported by South Sutter Water District would have 2.17 hour arrival time with a 2.75 hour total inundation time. The *Sutter County Emergency Operations Plan – Annex 5 Floods and Dam Failure* includes detailed information if hazardous situation is developing at any of these locations and if the situations escalate and failure is imminent or has occurred.

2.6 Voluntary Structure Elevation & Floodproofing

2.6.1 2012 CVFPP

The 2012 CVFPP proposed elevation and floodproofing of structures in small communities that would not be protected through structural improvements such as improved levees and/or ring levees to achieve 100-year level flood protection.

According to the 2012 CVFPP, State investments in small community protection will be prioritized based on relative community flood threat levels, considering factors such as:

- Population
- Likelihood of flooding
- Proximity to flooding source
- Depth of flooding
- Financial feasibility
- Achievement of the CVFPP Goals with respect to integrating multiple benefits

In general, the State will consider the following nonstructural options for protecting small communities in the SPFC Planning Area from a 100-year flood:

- Raising/elevating structures
- Floodproofing
- Willing seller purchases
- Relocating structures

For planning purposes, DWR used a preliminary cost threshold of $100,000 per house protected for elevating or floodproofing a house. When estimated costs exceed the threshold, other nonstructural means for flood protection will be considered.

Based on planning level estimates:

- 15 small communities would receive 100-year flood protection from about 80 miles of levee improvements or new levee construction.
- Another five small communities would receive 100-year flood protection, at minimum, through implementation of urban and system improvements included in the State Systemwide Investment Approach (SSIA).
- Seven small communities would receive flood protection through floodplain management actions such as floodproofing or raising structures.

The Flood Risk Reduction Projects Program develops projects that support the CVFPP Goals. In addition to new projects and improvement of existing facilities, some existing flood protection facilities may be modified or removed if the facilities no longer support system performance. State investments in system improvements may be through grant programs or direct investments in improved or new facilities. System improvements may be implemented through a partnership program and cost-sharing among DWR, local agencies, the Board, and USACE. The implementation program for the Flood Risk Reduction Projects Program applicable to Rio Oso is the Small Community Flood Risk Reduction Program. This program aims to coordinate efforts to develop local flood damage reduction projects for small communities to assist them with achieving 100-year level flood protection through ring levees and improving existing levees. On top of feasible structural improvements, nonstructural improvements may be considered in flood risk reduction in small communities.

It is recommended that Rio Oso pursue these CVFPP programs in the future should funding ever become available.

2.6.2 2017 CVFPP

The 2017 CVFPP continued to target 100-yr flood protection to small communities. A near-term milestone was established to “seek resources to establish floodplain management programs to implement key activities such as expanded agricultural easements, environmental conservation, flood risk awareness campaigns, floodproofing, and similar activities that promote land uses compatible with periodic flooding” (DWR 2017). Near-term Milestones are brief statements of progress that might be achieved by the 2022 CVFPP update if sufficient resources are available.

Small communities are encouraged to consider a wide range of actions to reduce flood risk. Along with structural improvements, nonstructural alternatives, such as raising/elevating structures and floodproofing should be considered.

Currently, DWR has not developed a program for funding structure raising or floodproofing.

2.6.3 FEMA Programs

FEMA has grant programs to assist state, local, tribal, and territorial governments following emergency situations and provides preparedness grants to reduce risk for future hazards. Potential options for Rio Oso to pursue include the Pre-Disaster Mitigation (PDM) Grant Program, the Flood Mitigation Assistance (FMA) Program, and the Hazard Mitigation Grant Program.

The PDM Grant Program is designed to assist states in implementing a sustained pre-disaster natural hazard mitigation program. This grant programs aims to reduce overall risk to the population and structures from future hazard events, while reducing reliance of Federal funding in future disasters. PDM grants are funded annually by Congressional appropriations.

The purpose of the FMA program is to reduce or eliminate claims under the NFIP by providing funding for projects that reduce or eliminate long-term flood risk to structures insured under the NFIP. FEMA requires states and local governments develop and adopt hazard mitigation plans in order to receive certain non-emergency disaster assistance. Sutter County developed the Local Hazard Mitigation Plan (LHMP) update so that the County would be eligible for the FEMA Pre-Disaster Mitigation and Hazard Mitigation Grant Programs. With the Sutter County LHMP, the FMA Grant Program is a recommended avenue to pursue funding.

The purpose of the Hazard Mitigation Grant Program is to help communities implement hazard mitigation measures following a Presidential Major Disaster Declaration in the areas of the state requested by the Governor. This grant program aims to reduce the risk of loss of life and property from future disaster through mitigation measures and could become applicable to Rio Oso following a catastrophic flood.

2.6.4 Potential Floodproofing in Rio Oso

A GIS analysis was performed to assess structures that are potential candidates for floodproofing. The structure data was from the 2012 CVFPP structure inventory database from ParcelQuest. Structures may have changed in the years since the last update to the structure inventory but are applicable for this exercise. The data associated with these points includes structure category, ground elevation, and foundation height. The structure inventory data points were then compared to a composite of maximum water depths from a breaches on the Feather River levee at Highway 99 and Highway 70 from the *Small Communities Flood Risk Reduction Program – Hydraulic Analysis for the Communities of Rio Oso and Nicolaus TM*. The maximum flood depths for structures were then calculated while taking into account foundation height.

Table 2 below summarizes the maximum flood depths for Rio Oso. Table 3 summarizes the total numbers of structures in this analysis by category. Note that this information is based on the max flood depths of breaches on the Feather River levee at Highway 99 and at Highway 70, actual flood depths may vary based on the location of the levee breach. For a particular breach that might actually occur, the flood depth may be lower, increasing the number of structures exposed to only shallow flooding. The structures in this analysis are located in Rio Oso.

Table 2. Structure inventory and maximum flood depths for Rio Oso

	Max Flood Depths	
	< 3 feet	**> 3 feet**
Residential	47	8
Industrial	1	0
Commercial	0	1
Public	0	1
Total	**48**	**10**

Table 3. Total number of structures by category

Category	Number of Structures
Residential	55
Industrial	1
Commercial	1
Public	1
Total	**58**

Normally, dry floodproofing requires a structure-specific evaluation by a civil engineer specializing in hydraulic loading of structures. It may be advantages for the community to identify structures which meet the flood depth criteria for dry floodproofing. These structures should be tested to see if they meet structural criteria prior to dry floodproofing. Residential structures that experience flooding of less than three feet could potentially be considered for dry floodproofing and reduce their flood risk. Dry floodproofing is a more viable option for structures with slab foundations than with raised

foundations. Additionally, structures with more than three feet of flooding would benefit from structure elevation. Structure elevation is generally less costly for structures with raised foundations than structures on slab foundations.

2.6.5 Remodeling Benefits

Concerns were raised by local stakeholders that structure elevations and floodproofing may divert funds from levee improvements. If this is a concern, structure elevations may still be accomplished by interested residents. A secondary benefit of this option is that this may allow the interested resident to remodel their homes and while elevating the structure. This could potentially reduce flood risk without diverting funds for structure elevations. The County could assist residents in acquiring all the proper building permits to elevate their homes and obtain the flood risk reduction benefit.

2.6.6 Public Outreach

It could serve to benefit those in the community if they are made aware to their flood risk and make them aware of the possibility of elevating their residence assuming the proposed remodeling option were to become available to them. Structure elevations through remodeling would be on a volunteer basis. Additional more detailed analysis would need to be done to determine specific structures that fall within the criteria for dry floodproofing and structure elevation.

2.7 Agricultural Conservation Easements

2.7.1 2012 CVFPP

The 2012 CVFPP initially proposed DWR's interest in acquiring agricultural conservation easements to limit rural development in areas protected by the SPFC. The idea is to acquire easements that preclude development from farmers on a volunteer basis.

According to the 2012 CVFPP, the State supports "investing in "no-regrets" programs and actions that clearly enhance system resiliency, integrate programs and resources, and preserve flexibility for future generations." Acquisition of agricultural conservation easements falls into this plan.

The Flood Risk Reduction Projects Program System Improvements implementation program aims to provide resiliency during major flood events by lowering peak stages, diverting devastating flows from urban areas, creating open spaces, and ecosystem enhancements. Specific actions under this program include acquiring land and establishing easements. Participation and partnership in this program by USACE will be critical for implementing large-scale systemwide projects. The State and local project sponsors would be responsible for any lands, easements, rights-of-way, and relocations.

2.7.2 2017 CVFPP

The 2017 update of the CVFPP continues DWR's interest in acquiring agricultural conservation easements. A near term milestone was established to "seek resources to establish floodplain management programs to implement key activities such as expanded agricultural easements, environmental conservation, flood risk awareness campaigns, floodproofing, and similar activities that promote land uses compatible with periodic flooding."

2.7.3 Summary

Currently, DWR has not developed a program for acquiring agricultural easements. No model agreement has been developed and funding has not been acquired. If and when DWR acquires

funding and develops a program, the community of Rio Oso should carefully evaluate the pros and cons of the program as it would apply in the Rio Oso area. Although participation would likely be on a voluntary basis with only willing sellers, the community itself would have an interest in how the program is applied in the Rio Oso area. Considering that the Rio Oso area comprises only a small portion of the lands protected by the State Plan of Flood Control and it is currently mapped by FEMA as a SFHA, DWR's funding for agricultural conservation easements in the Rio Oso area may be very limited.

2.8 Nonstructural Measures Ranked

For this study, several nonstructural measures were considered and evaluated for future consideration by Rio Oso. The measures are presented in order of feasibility and potential benefit to Rio Oso:

- Flood Emergency Evacuation Plan
- Flood Evacuation Warning System
- Emergency Flood Fight Plan
- Levee Relief Cuts
- Voluntary Structure Elevation & Floodproofing
- Changes to National Flood Insurance Program (NFIP)
- Agricultural Conservation Easements

3 References

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