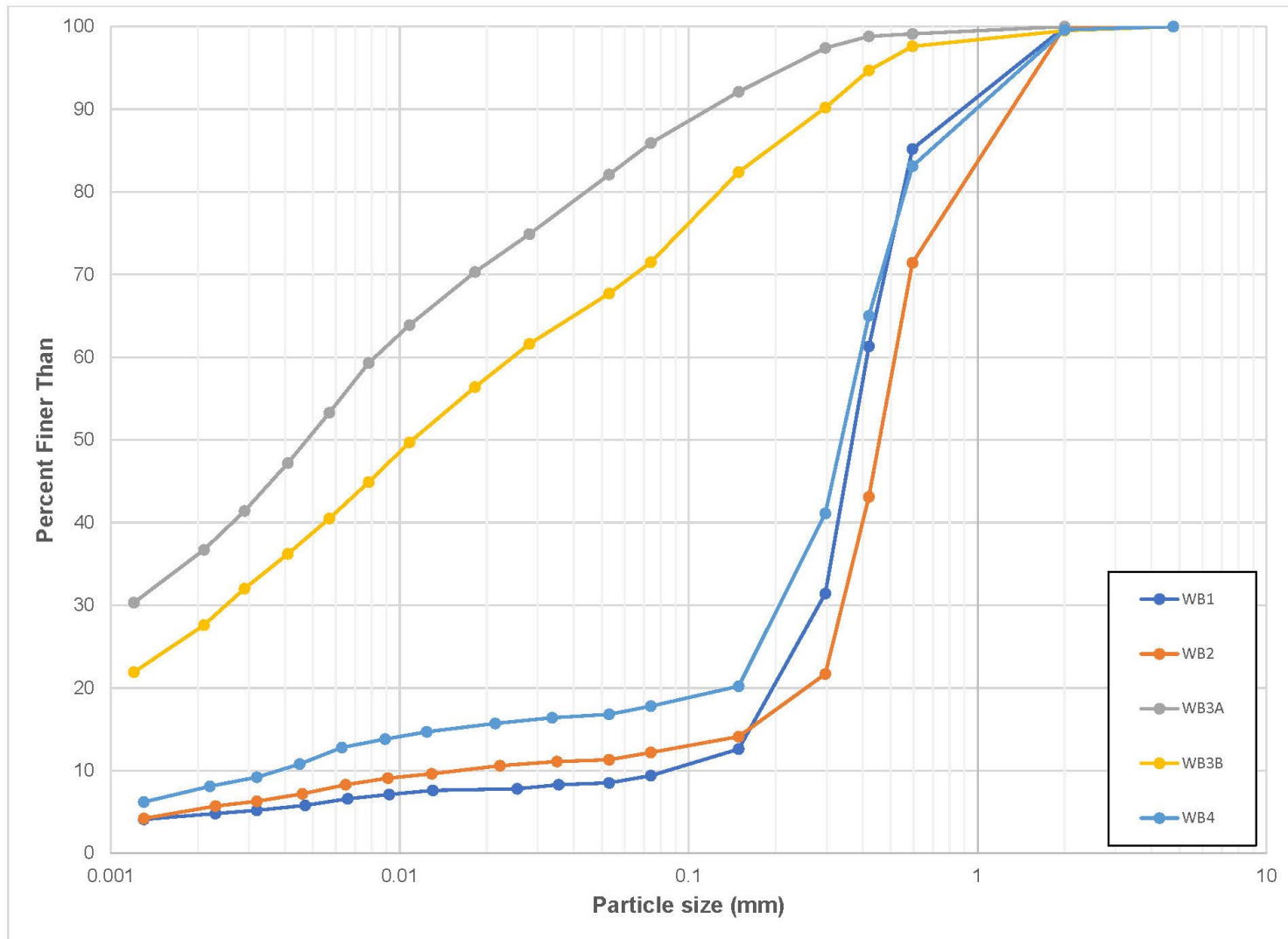


SOURCE: Levees (DWR 2012)

Butte Creek - Sutter Bypass Weir 1  
Feasibility Study and Alternatives Analysis



**Figure A-11**  
(A) Sediment Sample Locations, (B) Petite Ponar Sediment Sampler, and (C) Sediment Samples



**Figure A-12**  
Sediment Gradations for WBC Sampling Locations

## 5. MODEL RESULTS

### 5.1 Fish Passage Assessment

#### Fish Passage Criteria

**Table A-4** summarizes the hydraulic criteria used to assess fish passage of each alternative. These criteria were derived from the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (DWR, 2017; USBR, 2017) and the Tisdale Weir Rehabilitation and Fish Passage Project (ESA, 2020).

**TABLE A-4**  
**SUMMARY OF FISH PASSAGE CRITERIA**

Species	Adult migration time	Minimum flow depth (short distance, <60 ft)	Minimum flow depth (long distance, 60-200 ft)	Minimum channel width	Maximum flow velocity (short distance, <60 ft)	Maximum flow velocity (long distance, 60-200 ft)
Adult sturgeon	Jan-May	3	5	10	6	4
Adult salmon	Nov-May	1	3	4		

SOURCE: DWR, 2017; USBR, 2017

Passage conditions were assessed for alternatives 0, A, B, and C using the 2D HEC-RAS model. Alternatives B and C each have roughened structures with a length greater than 60 ft. The following figures (**Figures A-13 through A-15**) depict the depth and velocity predicted by the model for existing conditions and alternatives A, B and C for each passage flow listed in Table A-4.

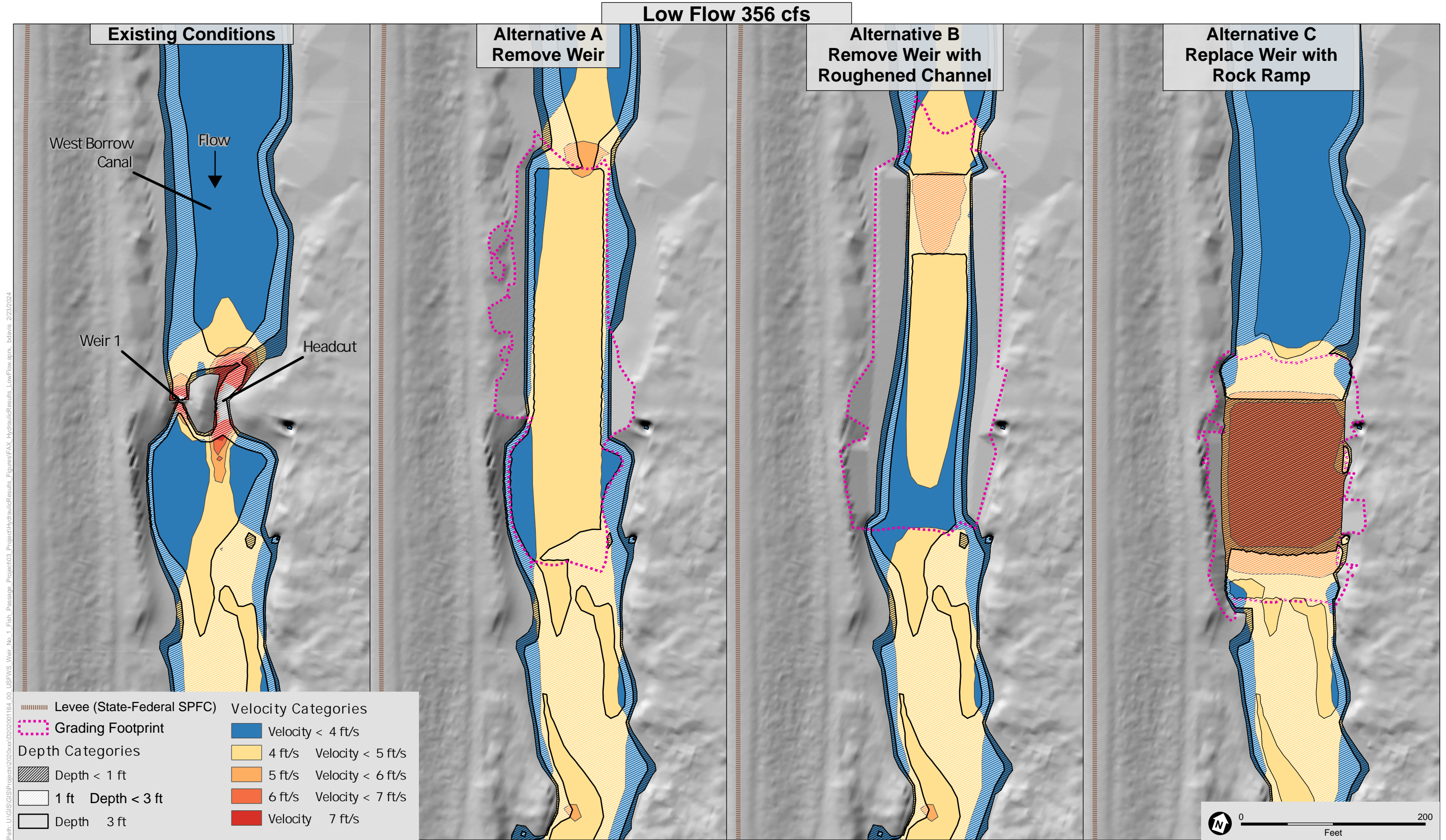
With design refinement each alternative is expected to provide passage for adult spring run Chinook salmon. Under high passage flow conditions, alternatives A & B provide unrestricted passage for fish as the hydraulic results meet all of the passage criteria. Under the high passage flow conditions, alternative C nearly meets all passage criteria, and the results suggest that with design refinement can be passable by adult Chinook salmon. The hydraulic results have a minimum of one-foot depth at the ramp crest but spans a distance greater than 60 feet and does not pass the passage criteria as designed and modeled. However, with improvement in the ramp design, and subsequent model refinement, alternative C is expected to provide more favorable passage conditions. The rock ramp was modeled using a continuous roughness, and improvements to the design could include iterating the size and placement of boulders, creating variable roughness along the ramp to increase hydraulic complexity and create a low flow channel with a depth-varying flow path along the ramp and between the boulder crests. An example of boulder crests arrangement is included in Appendix C, though for purposes of this comparative analysis was not included in the HEC-RAS modeling.

Similar to the results of Alternative C for the high passage flow, alternative B for the medium and low passage flows did not meet the passage criteria due to the lack of minimum flow depth. At the upstream end of the roughened channel, the minimum modeled depth is approximately 2.4 ft for the low passage flow for a distance greater than 60 feet. Though this doesn't meet the passage criteria, the alternative is expected to meet the criteria upon model and design refinement.

## 5.2 Wetland Activation

There are several wetlands adjacent to the West Borrow Canal in the Sutter National Wildlife Refuge, as depicted in Figure A-4. These wetlands are activated by the West Borrow Canal during instances of overbank (bankfull) flow. Utilizing the 2D HEC-RAS model, the minimum flow rate required to activate the wetlands was estimated for existing conditions and each alternative (**Table A-5**). **Figure A-16** depicts the WSE profiles for the median and high passage flows as well as surveyed wetland inverts surveyed by ESA in 2023. It should be noted that the surveyed wetland inverts are generally one-half to two feet lower than the HEC-RAS existing conditions model surface. The survey conducted by ESA in 2023 captured the invert location along the bank of the WBC. For wetland activation the invert on the WBC bank and wetland itself would need to be inundated, requiring additional flow. The 2D HEC-RAS terrains use LiDAR elevations for the overbank areas including the wetlands which contain thick vegetation which may be classified as ground. Because of this, the minimum required flows for wetland inundation may be lower than what is stated below. More detailed survey data (i.e. wetland boundary and transects) would need to be taken and incorporated in the terrains to provide a more accurate assessment. That said, the flows reported below serve as a comparative tool to assess the various alternatives and their effect on wetland activation.

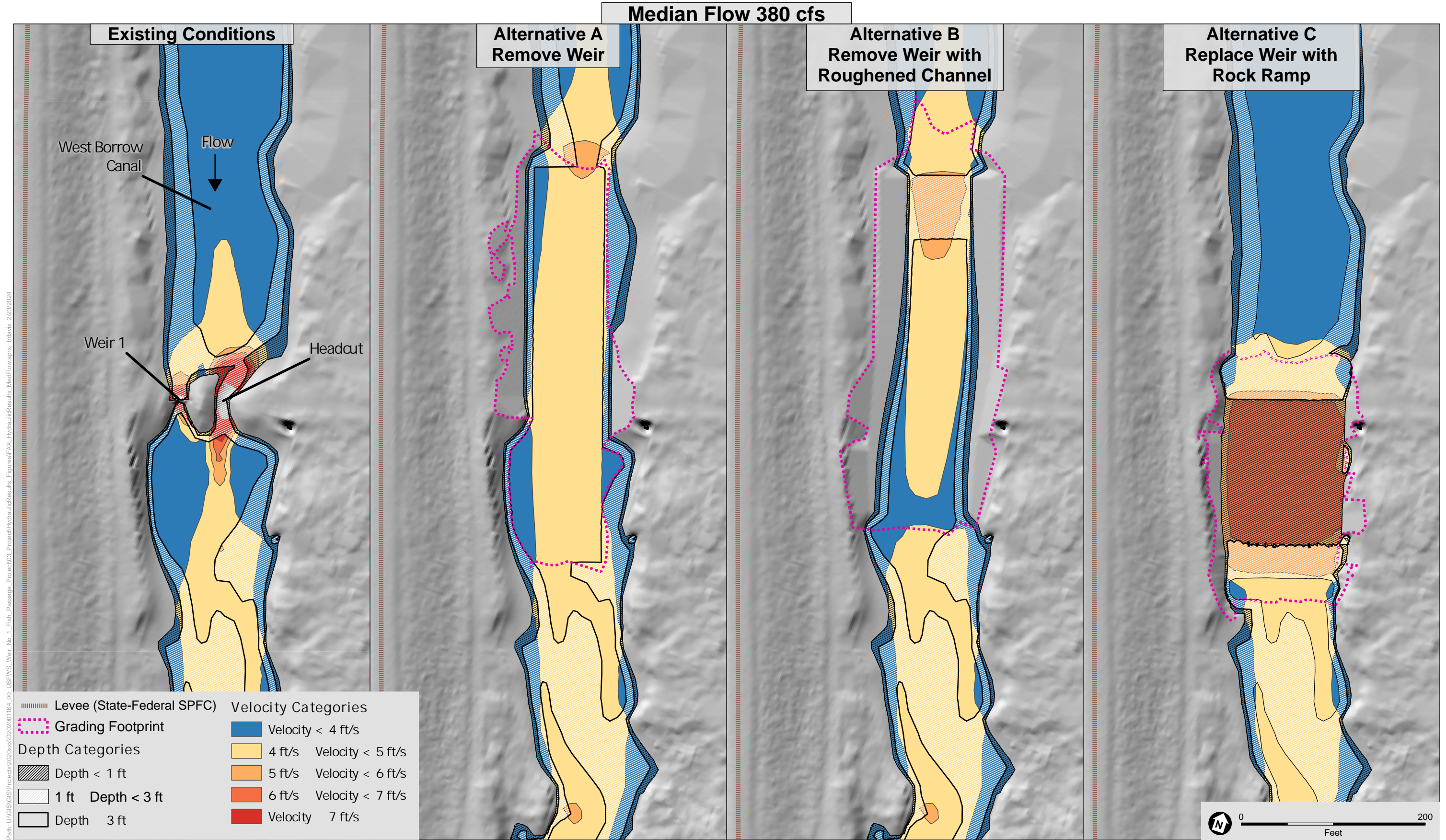
Using the 2D HEC-RAS model, under existing conditions a discharge of 650 to 750 is required to inundate the various wetlands. Due to broader wetland activation, a discharge of 750 cfs was used to represent the bankfull flow under existing conditions. More discharge (~1000 cfs) is required to activate the wetlands for Alternatives A and B due to removal of the weir, an inline hydraulic control within the WBC. Although Alternative C maintains the existing sill elevation of Weir 1, additional roughness elements (boulders and large cobble on the ramp) downstream of the weir raises the upstream water surfaces profile. Approximately 550 cfs is required to inundate the wetlands under Alternative C. Although not explicitly modeled, it is expected that Alternative D would result in a similar or slightly higher upstream water surface profile as Alternative C. The water surface profile under Alternative D may be higher due to the slight constriction from the fish ladder and embankment structures.



SOURCE: Levees (DWR 2012)

Butte Creek - Sutter Bypass Weir 1  
Feasibility Study and Alternatives Analysis

**Figure A-13**  
Two-dimensional HEC-RAS Model Hydraulic Results  
Low Passage Flow (356 cfs)

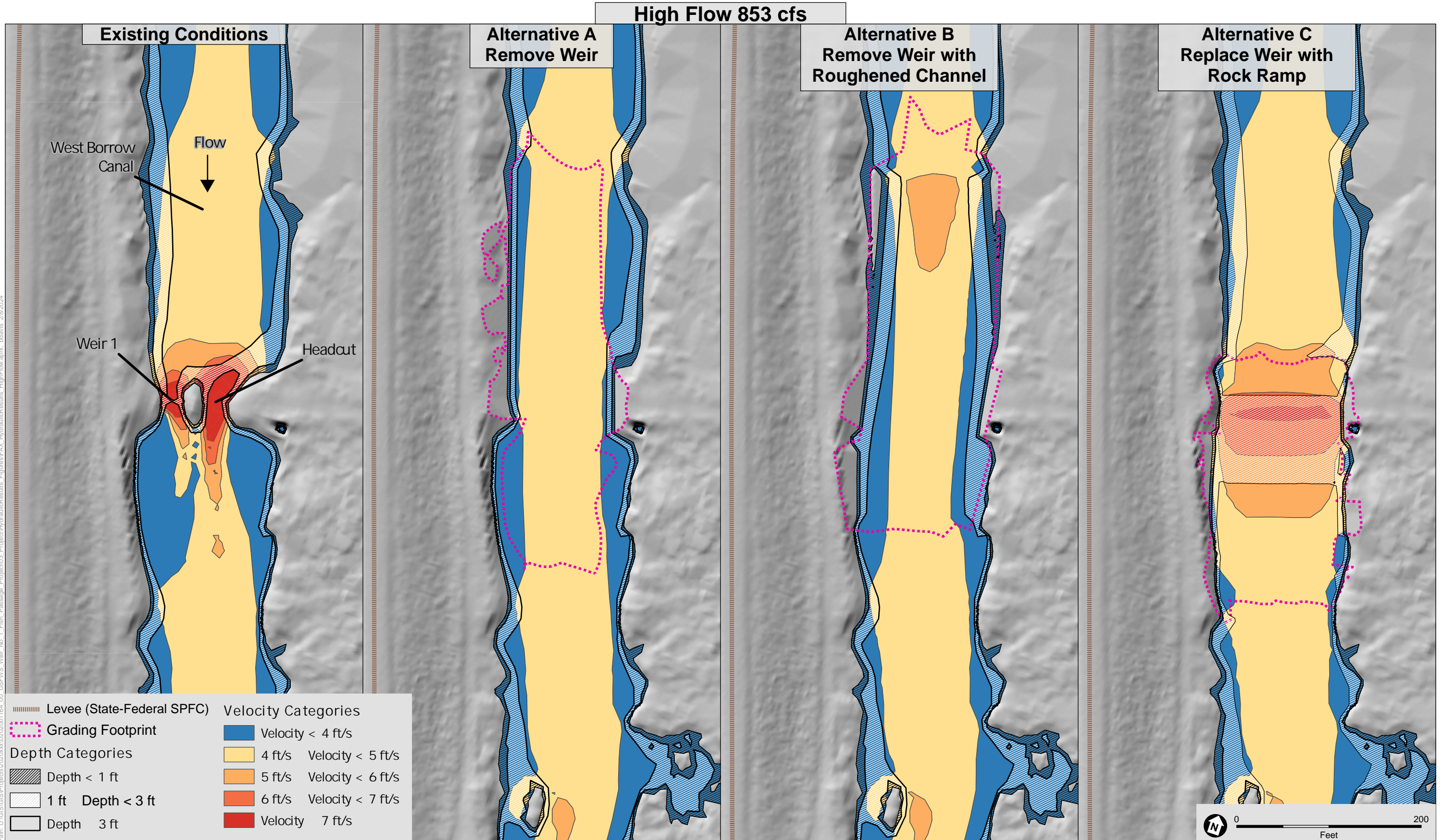


SOURCE: Levees (DWR 2012)

Butte Creek - Sutter Bypass Weir 1  
Feasibility Study and Alternatives Analysis

**Figure A-14**  
Two-dimensional HEC-RAS Model Hydraulic Results  
Median Passage Flow (380 cfs)

Path: U:\GIS\GISProjects\2020\00\02\001164\_00\_USFWS\_Weir\_No\_1\_Fish\_Passage\_Project\HydraulicResults\_Figures\FAX\_HydraulicResults\_HighFlow.aprx\_bdris\_2/8/2024



SOURCE: Levees (DWR 2012)

Butte Creek - Sutter Bypass Weir 1  
Feasibility Study and Alternatives Analysis



**Figure A-15**  
Two-dimensional HEC-RAS Model Hydraulic Results  
High Passage Flow (953 cfs)

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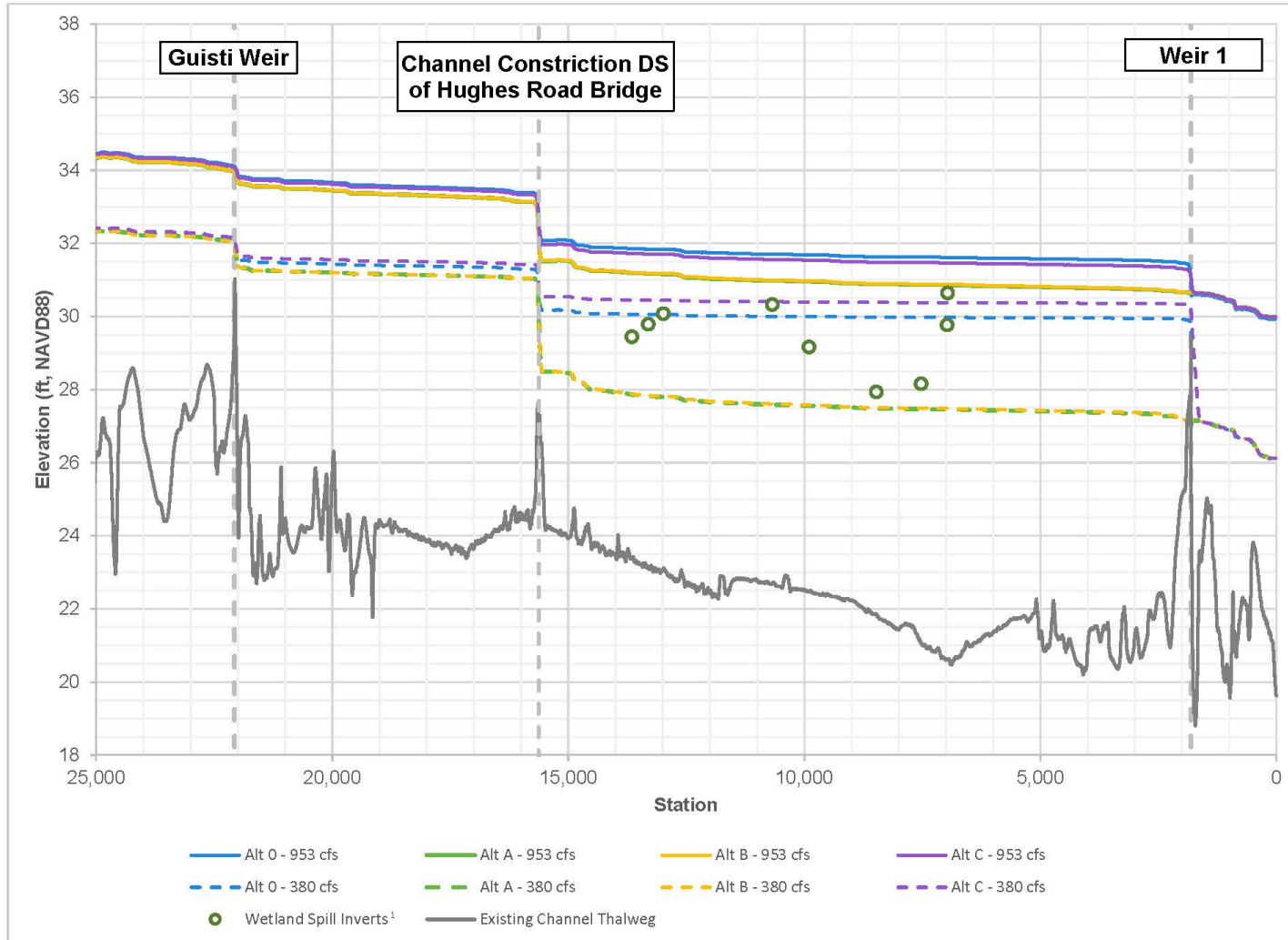
**TABLE A-5**  
**ESTIMATED BANKFULL FLOWS AND PERCENT EXCEEDANCES FOR WETLAND INUNDATION**

Scenario	Estimated Bankfull Discharge (cfs)	Percent Exceedance in WY 2014 (October through July) <sup>a</sup>
Existing Conditions	750	6
Alternative A	1,000	2
Alternative B	1,000	2
Alternative C	550	10

## NOTES:

<sup>a</sup> Estimated from the TUFLOW model results within the West Borrow Canal. The TUFLOW model simulation period extends from October through July.

In the context of percent exceedance, the flow rates in Table A-5 signify the percentage of time or frequency with which the actual flow exceeds the specified values, informing the estimated inundation in the wetlands during a critical water year. Assessing the TUFLOW model results for water year 2014 shows that the minimum flow to provide wetland inundation occurred approximately 6% of the time under existing conditions, 2% under alternatives A and B, and 10% of the time under Alternative C.



Notes: <sup>1</sup> Wetland spill inverts are from an ESA survey conducted in 2023. The 2D HEC-RAS existing conditions terrain is generally 0.5 to 2 feet higher at the surveyed locations due to interpolation with CVFED LIDAR data (DWR 2010).

**Figure A-16**  
Two Dimensional HEC-RAS Model Longitudinal Profiles for the Median and High Passage Flow

### 5.3 Channel Stability

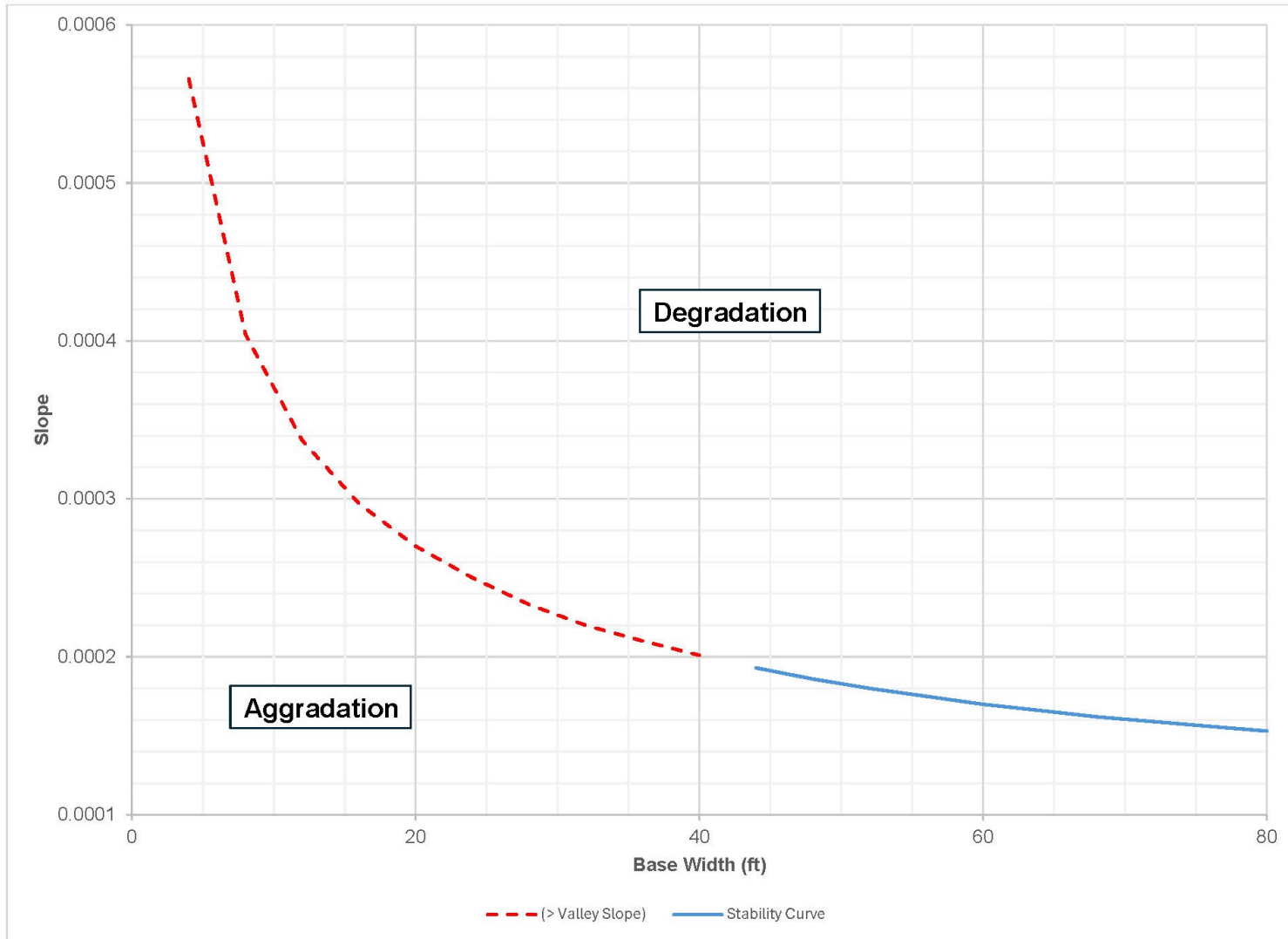
The “Copeland Method” of stable channel design (Copeland, 1994) was selected to assess the relative stability of the WBC at the Weir 1 location under a full weir removal and natural channel configuration as described in Alternative A. The Copeland Method is applicable to stability investigations for the WBC due to its foundation in the Brownlie sediment transport function, which was calibrated for labile, sand-bed channels (Brownlie, 1981). The Copeland Method uses the Brownlie depth prediction equation and other empirically derived hydraulic geometry relationships to determine stable channel dimensions given an incoming sediment concentration and gradation.

Because no sediment load data is available for this segment of the Butte Creek drainage, incoming sediment concentration was calculated using typical channel dimensions upstream of the weir (supply reach), where:

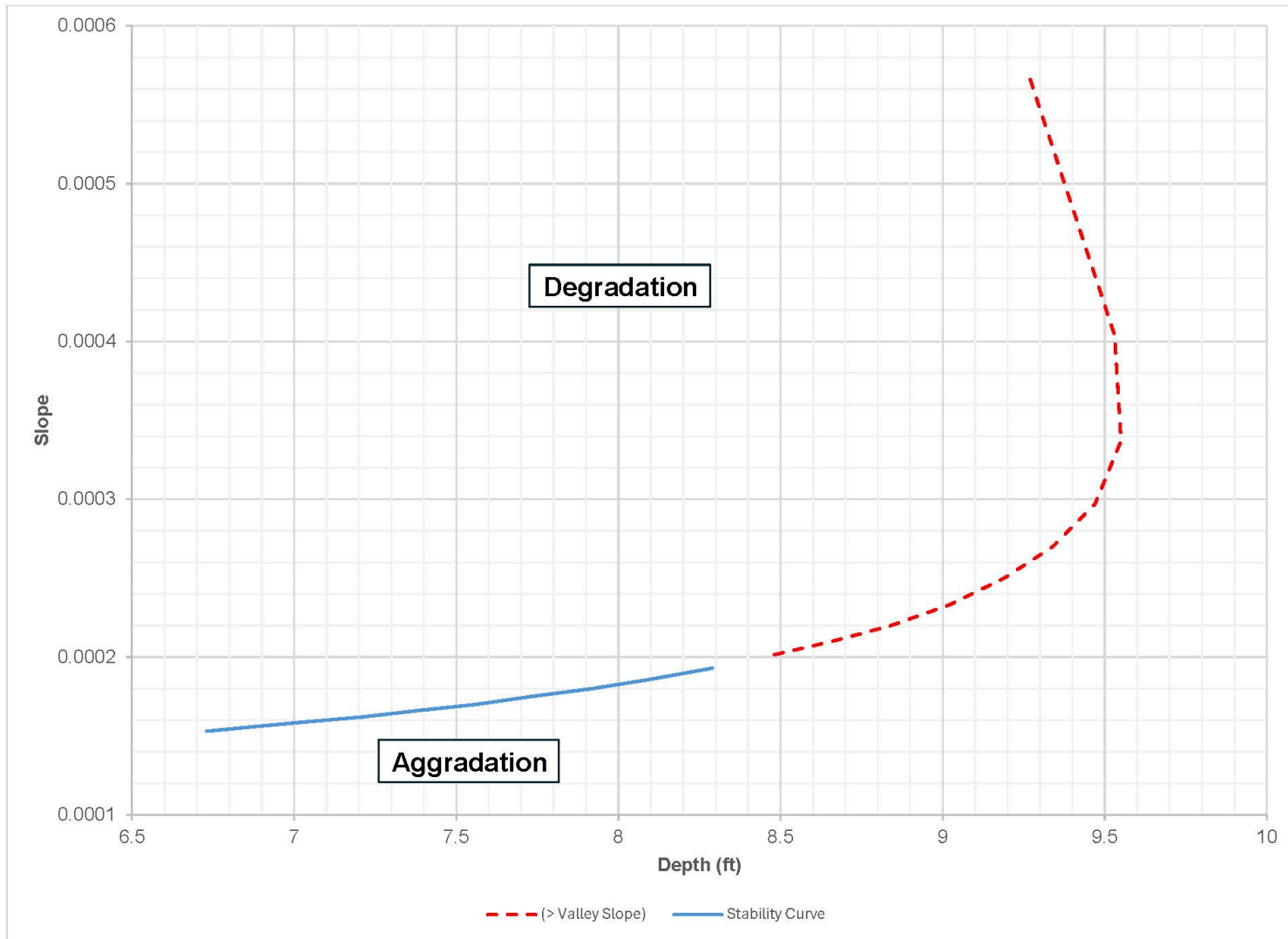
- Bottom width = 40 feet
- Bank height = 10 feet
- Energy slope = 0.0002 feet/feet
- Left side slope = 4H:1V
- Right side slope = 9H:1V
- Bank roughness (n) = 0.06

A discharge of 1000 cfs was used since the associated water surface profile in the WBC resulted in the initial inundation of most wetlands between the canal and refuge. This discharge represents our preliminary estimate of bankfull or effective discharge under the Alternative A scenario. Because most of the sediments sampled in the WBC could be characterized as “silty sand”, the average of Group 1 sediment gradations were used to define the incoming sediment load, where  $d_{84} = 0.68\text{mm}$ ,  $d_{50} = 0.39\text{mm}$ , and  $d_{16} = 0.13\text{mm}$ .

Results of the stability analysis indicate that Alternative A, as currently designed, would not result in aggradation or degradation of the channel. If the channel bottom is gradually transitioned from upstream to downstream, a bed slope equivalent to the average valley and channel slope of 0.0002 feet/feet is achievable. Maintaining the valley slope and average bottom width of 40 feet results in a stable channel design (**Figure A-17**). This configuration of slope and depth supports channel depths in the ballpark of those observed under existing conditions (**Figure A-18**). As anticipated, the stability charts indicate that a bed slope steeper than the valley slope may result in degradation (incision) of the channel bed. It is unlikely that the bed slope would flatten below 0.0002 feet/feet if the average channel geometry is maintained throughout the upstream to downstream transition of the channel bed as currently designed.



**Figure A-17**  
Stability Curve for Width and Slope



**Figure A-18**  
Stability Curve for Depth and Slope

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## 6. MODEL LIMITATIONS

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The model, validated against the TUFLOW flood flow model, lacks calibration due to insufficient gage data. While this limitation is acceptable for the current feasibility study focused on alternative scenario comparisons, it is crucial to note that calibration, supported by flow and stage gage data, is vital for refining the model's precision, accuracy, and future design development.

In subsequent stages of design, there are several actions that could significantly improve the hydraulic evaluation of Weir 1. The first action includes refining the input hydrology of the WBC, ideally from the collection of flow and stage data which could also be used to calibrate the hydraulic model and refine passage scenario flows. Subsequent model refinement should include the incorporation of gaged hydrology data for passage flows and model calibration, and the incorporation of flow-varied roughness values and spatially varied roughness values throughout any roughened channel features where applicable. If alternative A is selected additional sediment data should be collected to conduct additional stability analyses within the reach. If Alt C is selected, model refinement with gaged data and design iterations of boulder placement and associated roughness will be needed to improve passage hydraulics.

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## 7. CONCLUSION

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For the purposes of alternative comparisons, the modeling analysis suggests that with refinement Alternatives A, B, and C can all be designed to improve fish passage. Alternatives A and B (full weir removal) may adversely affect adjacent wetlands due to lower water surface in the WCB resulting from removal of the inline hydraulic control at Weir 1. Alternative C however, would maintain a similar water level within the WBC, resulting in no expected effects to the adjacent wetlands.

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## 8. REFERENCES

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Appendix B  
**Preliminary Geotechnical  
Assessment**



# Preliminary Geotechnical Assessment

Butte Creek - Sutter Bypass Weir 1 Feasibility  
Study and Alternative Analyses

Butte County, CA

November 6, 2023



Prepared under the responsible charge of



Mark H. Stanley  
GE 2397

## Introduction

As part of the project team, led by Environmental Science Associates (ESA), HDR is providing this preliminary Geotechnical Assessment that evaluates geologic and geotechnical conditions in the immediate area of Weir 1 located along the west edge of the Sutter Bypass in Butte County, California. The weir is located near the southern boundary of the Sutter National Wildlife Refuge approximately 2,500 feet upstream of the confluence with the Tisdale Weir (Figure 1). This assessment summarizes information gathered and presented in a team presentation on September 22, 2023, which consisted of a site visit and a limited desktop review of available information regarding performance of the Sutter Bypass and geotechnical and geological information in the site vicinity specifically to provide input into the alternative analysis process. Geotechnical exploration or analysis for any of the proposed alternatives was not included as part of this effort.

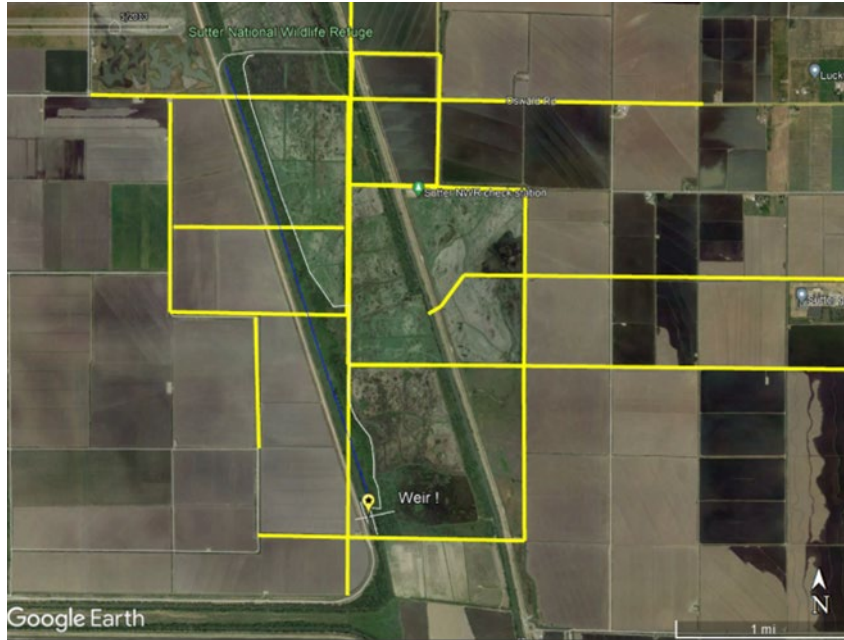
## Background

The Sutter Bypass is a constructed water conveyance that transmits excess flows from the Sacramento River to the Feather River. The Sutter Bypass begins west of the town of Sutter and extends in a southeast direction to the Feather River, east of the Town of Nicholas. The Sutter National Wildlife Refuge was established in 1968 by the California Fish and Game Commission and is located in the northern portion of the bypass, between the Tisdale Weir on the south and McClatchy Road on the north, approximately 5 miles in length. Tisdale Weir is located to the south of the site, a west-east flowing conveyance that also transmits flow from the Sacramento River to the Sutter Bypass. The Sutter Bypass West Levee, adjacent to the wildlife refuge, is maintained by Reclamation District 1660.

## Site Condition

The bypass is approximately 4,000 feet wide. It was constructed by United States Army Corps of Engineers in the early 1930s across existing farmlands and is contained by earthen levees. The levees were constructed by borrowing soil in long excavations that parallel the toe of the levees. Weir 1 is located at the southern end of one of these long borrow excavations. A review of Google Earth imagery and other available online aerial imagery shows the delineation of the remnant and current field boundaries inside and outside of the bypass, depicted in Figure 1. Farms in this region have been active for several generations and likely follow surveyed section lines dividing each township into 36 sections that are each 1-mile square, with farms broken into full, half or quarter sections. Therefore, other than excavation of the levee borrow area, the area within the bypass is relatively unchanged.

The available aerial photographs and review of historical topographic maps indicate that the levee west borrow area is approximately 150 feet wide and started (or stopped) at the location of Weir 1, leaving a narrow width (estimated to have once been 50 to 60 feet wide) of native material, likely maintained as farm access from the east to west side of the bypass. The borrow excavation then continued south of this crossing. The borrow cuts were likely made by drag line excavation methods. Aerial photographs from 2014/2015 show drought low water levels exposing shallow borrow excavation along the east side of the west borrow cut; therefore, the deeper excavation is limited to the western portion of the borrow cut.



**Figure 1 – Current and former agricultural field boundaries**

The west side of the west-east access was later abandoned, and a bridge is located where it crosses the east borrow excavation. The current weir and fish ladder was constructed through the embankment located towards the bypass west bank and an overflow cut weir section (cut weir) excavated to the east of the weir. A small portion of the former remnant embankment is located between the cut weir and the eastern edge of the borrow area. The cut weir appears to have progressed upstream over the years due to backward erosion.

## Levee Past Performance and Evaluation

A review of available documentation provided little information about the west levee performance. In 1997, the west levee breached north of the wildlife refuge and the levee at the intersection of the bypass and Tisdale Weir was cut to allow flood water to drain out of the Meridian Basin (within RD 1660). Prior historical floods in the region also occurred in 1940, 1955 and 1986. The 1955 flood affected levees located south of the Tisdale Weir but not the west levee adjacent to Weir 1.

The State of California Department of Water Resources (DWR) included an assessment of the bypass levees as part of the Non-Urban Levee Evaluation (NULE) program, documented in a report entitled, “Geotechnical Assessment Report, North NULE Study Area” (URS, 2011). DWR also assessed the east bypass levee as part of the Urban Levee Evaluation (ULE) documented in separate report (URS 2014). For the NULE study no explorations were performed though they likely relied on the exploration program of the east bypass levee and assessed the hazard level for the west levees based on projected performance from the east levee evaluations. The study ranked the flood hazard for each levee using a four-letter Hazard Classification as follows:

- Hazard Level A. When water reaches the assessment WSE, there is a low likelihood of either levee failure or the need to flood-fight to prevent levee failure.
- Hazard Level B. When water reaches the assessment WSE, there is a moderate likelihood of either levee failure or the need to flood-fight to prevent levee failure.

- Hazard Level C. When water reaches the assessment WSE, there is a high likelihood of either levee failure or the need to flood-fight to prevent levee failure.
- Lacking Sufficient Data (Category LD). The segment is currently lacking sufficient data regarding levee past performance or hazard indicators to be able to assign a hazard level, or there is poor correlation between past performance and hazard indicators.

Weir 1 will be inundated during large flood flows in the bypass. However, the assigned hazard level from the NULE study provides insight into the subsurface conditions. Also, the hazard levels look at the entire levee reach as a whole and not any specific location and, therefore, may not be representative of all portions of the levee. The west levee is classified as a Hazard Level C by DWR due to under seepage (ranked the highest hazard risk), stability (ranked the second highest hazard) and erosion (ranked the lowest hazard risk). The overall rank is based on the highest hazard level found for the levee reach. It should be noted that the west levee reach includes the 1997 breach that occurred due to under and through seepage. No other areas of the west levee within the wildlife refuge were noted as having past distress in the available records reviewed in this study.

## Surface Geology and Near Surface Conditions

DWR performed a detail mapping of the surface geology for each levee area assessed. The mapping is based on a review of aerial photography from 1937. A portion of this map is reproduced as Figure 2. The approximate weir location can be determined based on the agricultural field boundaries shown in in Figure 1.

The near surface geology in the Sutter Bypass area is generally characterized as follows:

- Fine-grained Holocene basin and/alluvium deposits overlie coarser late Pleistocene deposits of the Modesto and Riverbank formations.
- Typically, a well-developed soil with impervious horizons (hardpan) is found at the top of the late Pleistocene deposits, the basin and/or alluvium deposits from the underlying coarser deposits.
- Fine-grained basin and/or alluvium deposits and the hardpan generally have much lower hydraulic conductivity than the underlying late Pleistocene deposits.

More recent Holocene aged and historical channel deposits (map units Hch and Rch) are incised into the basin deposits. These southwest-trending alluvial channel deposits locally underlie the bypass levee and result in local differences in material textures beneath the levee. The mapped channels are about 250 feet wide. In this area, the channels are estimated to be about 6 to 8 feet deep, and are typically filled with sand, silt, and clay in a fining-upward sequence, i.e., coarser-grained and overlain by about 1 to 2 feet of silt and clay. This sedimentary sequence may be conducive to seepage where relatively more-permeable channel sands are overlain by a relatively thin, fine-grained blanket layer (Source URS 2014).

A review of Figure 2 suggests that the incised channel deposits were not mapped beneath the west levee and may be a factor in the lack of notable levee performance issues in this immediate area.



# Proposed Weir Alternatives

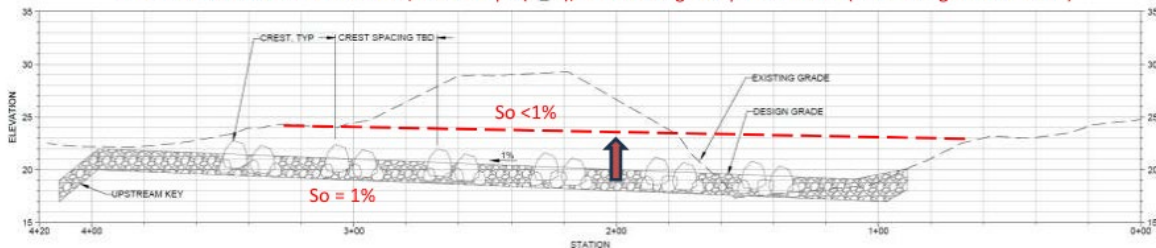
The project has evaluated several weir replacement alternatives consisting of:

- Alternative A - Weir Removal
- Alternative B - Roughened Channel
- Alternative C - Partial Weir Removal with Rock Ramp
- Alternative D - Operable Weir and Fish Ladder

For this assessment, only two alternatives were considered (Alternatives B and C) as presented in Figure 3.

## Alternative (B,C) Profiles

- 300-foot-long roughened channel with upstream key and downstream apron
- Engineered streambed material with riffle crests at a **1% bed slope** (more gradual than rock ramp)
- **Potential to raise bed elevation, lower slope (<1%), and hold higher upstream WSE (than configuration below)**



- 190-foot-long roughened ramp with upstream (behind weir) and downstream keys (at riffle)
- Requires considerable fill below ramp (volume TBD)
- Engineered streambed material with riffle crests at a **2% bed slope** (steeper than roughened channel)

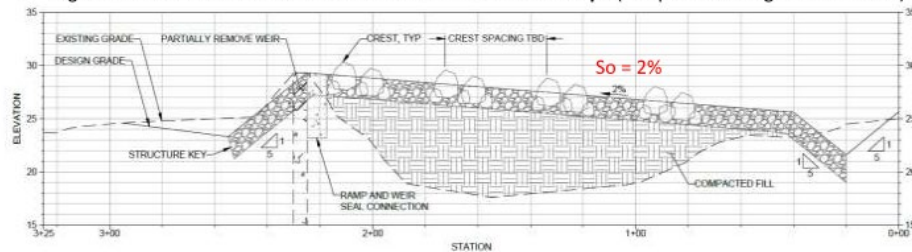


Figure 3 – Alternatives B and C (Source ESA, 2023)

## Preliminary Geotechnical Assessment

HDR developed the following geotechnical conclusions considering the above information.

### Alternative B: Roughened Channel

#### Pro

- Removes remnant barrier and weir.
- Provides continuity for flow.

- Does not impact west side of borrow cut along toe of levee with placement of erosion protection.
- Uniform surface elevation will not create a potentially adverse seepage condition along the channel.
- Fill thickness is limited.
- Foundation primarily in cut limiting requirements for surface preparation.

#### **Con**

- More excavation and material disposal required including completely removing weir.
- Site access will need to be created to access bottom of newly deepened channel.
- May result in lower water surface in dry years allowing flow from fields behind levee towards and into the channel.
- Will require cofferdams to divert water to unwater channel.
- Deep excavation can be more challenging from top of existing bank.
- May need to be checked for design flood event flows for levee scour impacts from change in channel flow characteristics.

### *Alternative C: Rock Ramp*

#### **Pro**

- Encapsulated the existing weir – limited removal.
- Provides a more similar to existing flow conditions.
- Provides for continuity of flow.
- Less impact to western borrow area slope.
- Construction access can be incorporated in the fill areas.
- Construction could be sequenced from west to east from top of bank.

#### **Con**

- Need to divert water to construct.
- Dewatering will be required to place fill.
- Fill downstream of weir will need to be designed to prevent internal erosion from hyporheic flows.
- Import fill required.
- Foundation conditions are unknown for placement of fill.

## Limitations

This study was performed reviewing limited geotechnical and site performance data to support the alternative analysis phase of the Butte Creek – Sutter Bypass Weir 1 Feasibility Study and Alternative Analysis project to support ESA by providing geotechnical input for consideration for two

of the proposed alternatives to modify Weir 1. An assessment has not been provided regarding the future performance of Weir 1 due to either low or high flows within the bypass. Subsurface conditions are inferred from past documentation of performance, nearby geotechnical investigations and assessment by the State of California using professional engineering judgment. A subsurface investigation has not been performed as part of this study and conditions may vary from those discussed in the memorandum.

This study has not been performed to appropriate detail to support design of any of the alternatives and site-specific geotechnical investigation would need to be performed to support further design of any of the alternatives, and consultation with appropriate federal, state, and local interests will be required to develop and execute the investigation program. This study should not be relied upon for determination of levee performance as it relies on the level of study performed by the State of California for its assessment. Future studies on weir modification could be required to address impacts to levee stability following established processes and procedures for levee evaluation established by state and federal agencies.

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# Appendix C

## **Engineering Drawings**





STAMP

PRELIMINARY  
-  
NOT FOR  
CONSTRUCTION

CONSULTANT

PROJECT NAME  
**USFWS WEIR 1  
FISH PASSAGE  
RESTORATION PROJECT**

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	XXX
DRAWN	XXX
CHECKED	XXX
IN CHARGE	XXX
	### ###

PROJECT NUMBER D202001164.00

ISSUE DATE MM/DD/YY

SCALE IS AS SHOWN WHEN  
PLOTTED TO FULL SIZE (22"x34")

PHASE  
**10% DESIGN  
DOCUMENTATION**

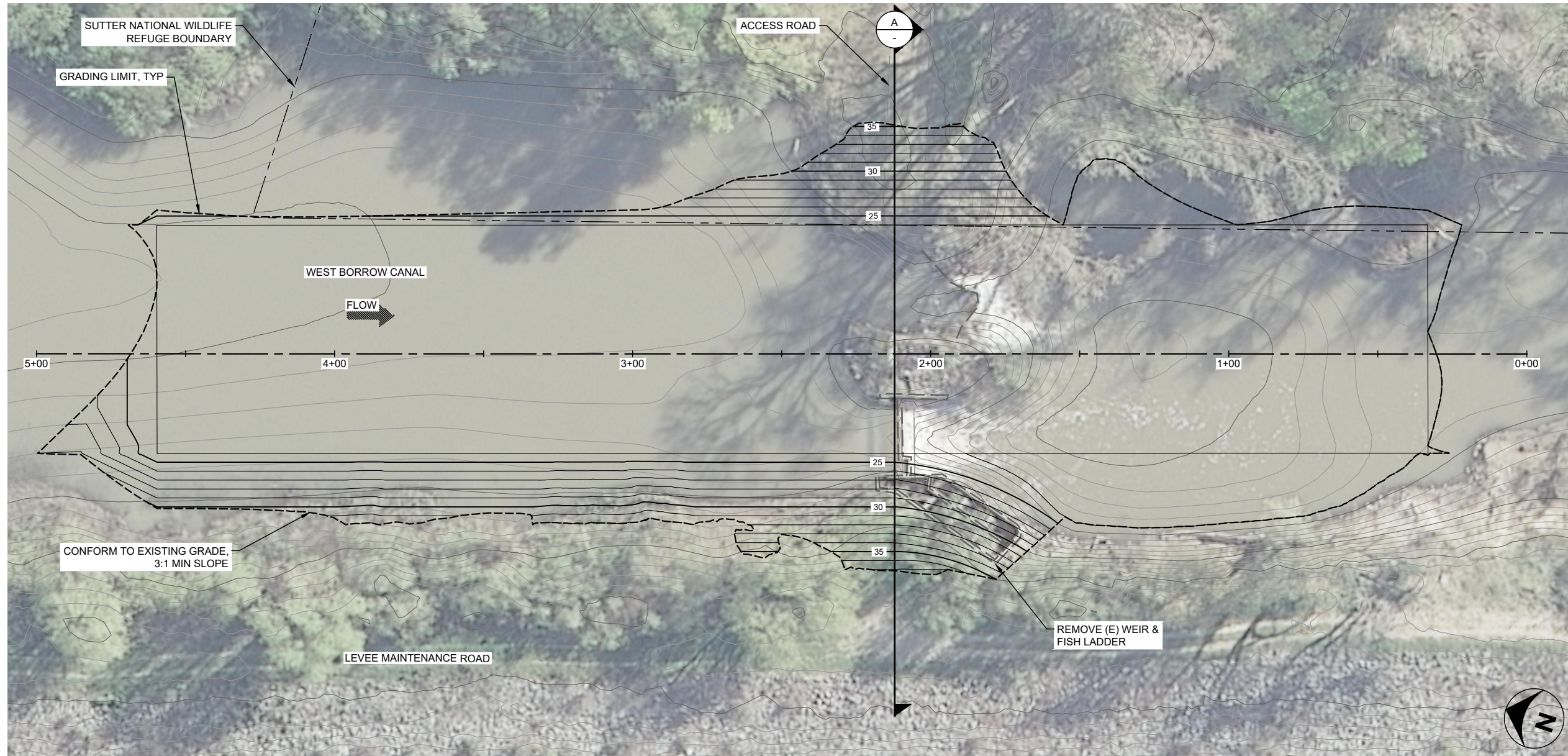
SHEET TITLE

**ALTERNATIVE A -  
WEIR REMOVAL**

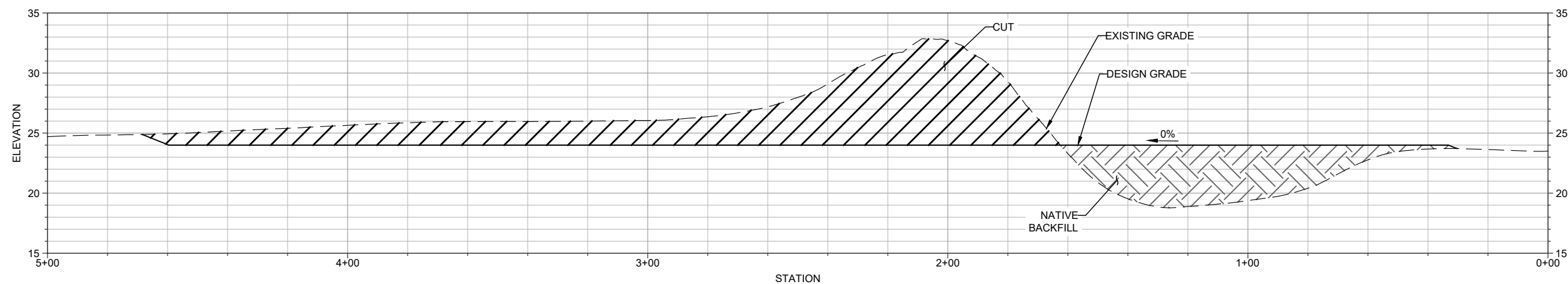
SHEET NUMBER

**2**

SHEET --- OF ###



ALTERNATIVE A - WEIR REMOVAL  
PLAN 1" = 40'



ALTERNATIVE A - WEIR REMOVAL  
PROFILE NOT TO SCALE

**NOTES**

- EXISTING ELEVATIONS ARE BASED ON TOPOGRAPHIC AND BATHYMETRIC SURVEYS (ESA 2023; USFWS 2020) AND LIDAR SURVEYS (QUANTUM SPATIAL 2021; DWR CVFED 2010).

STAMP  
PRELIMINARY  
NOT FOR  
CONSTRUCTION

CONSULTANT

PROJECT NAME  
**USFWS WEIR 1  
FISH PASSAGE  
RESTORATION PROJECT**

REVISIONS  
# DATE DESCRIPTION

DESIGNED XXX  
DRAWN XXX  
CHECKED XXX  
IN CHARGE XXX  
### ##

PROJECT NUMBER D202001164.00

ISSUE DATE MM/DD/YY

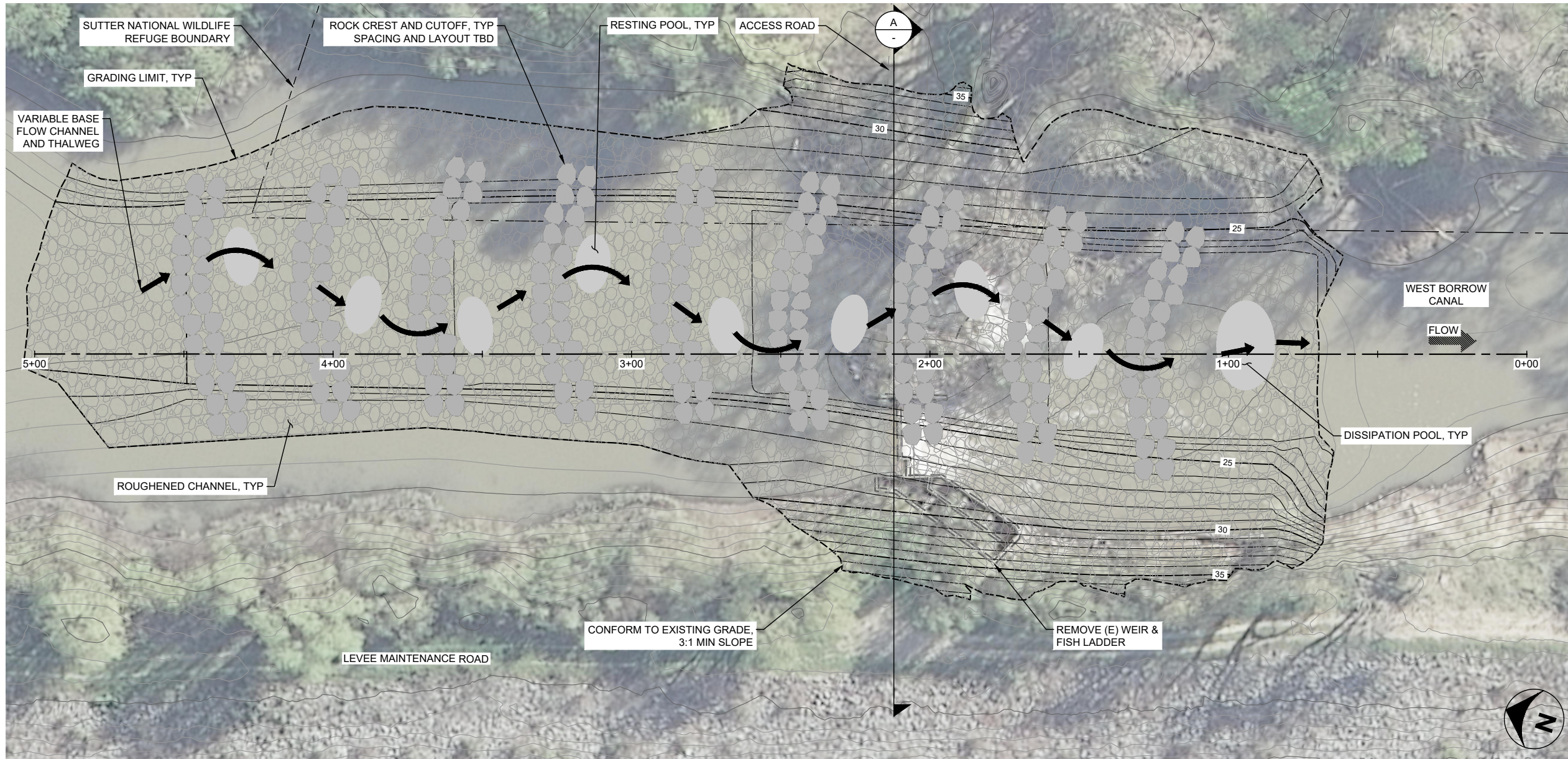
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PLOTTED TO FULL SIZE (22"x34")

PHASE  
10% DESIGN  
DOCUMENTATION

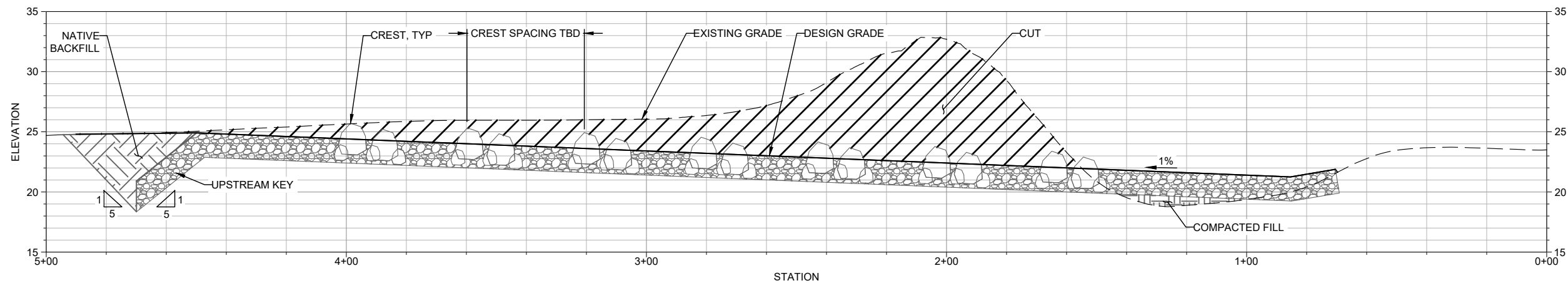
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**ALTERNATIVE B -  
ROUGHENED  
CHANNEL**

SHEET NUMBER  
**3**

SHEET --- OF ###



ALTERNATIVE B - ROUGHENED CHANNEL  
PLAN 1" = 40'



ALTERNATIVE B - ROUGHENED CHANNEL  
PROFILE NOT TO SCALE

**NOTES**  
1. EXISTING ELEVATIONS ARE BASED ON TOPOGRAPHIC AND BATHYMETRIC SURVEYS (ESA 2023; USFWS 2020) AND LIDAR SURVEYS (QUANTUM SPATIAL 2021; DWR CVFED 2010).

FILE: P:\01 CAD\2020\20xxxx\202001164.00 USFWS Weir-1 Fish Passage Project\DWG\3 ALTERNATIVE B - ROUGHENED CHANNEL.dwg PLOT DATE: 2/23/2024 2:57:42 PM PLOTTED BY: BRENT DAVIS

STAMP  
PRELIMINARY  
-  
NOT FOR  
CONSTRUCTION

CONSULTANT

PROJECT NAME  
**USFWS WEIR 1  
FISH PASSAGE  
RESTORATION PROJECT**

REVISIONS  
# DATE DESCRIPTION

DESIGNED XXX  
DRAWN XXX  
CHECKED XXX  
IN CHARGE XXX  
### ##

PROJECT NUMBER D202001164.00

ISSUE DATE MM/DD/YY

SCALE IS AS SHOWN WHEN  
PLOTTED TO FULL SIZE (22"x34")

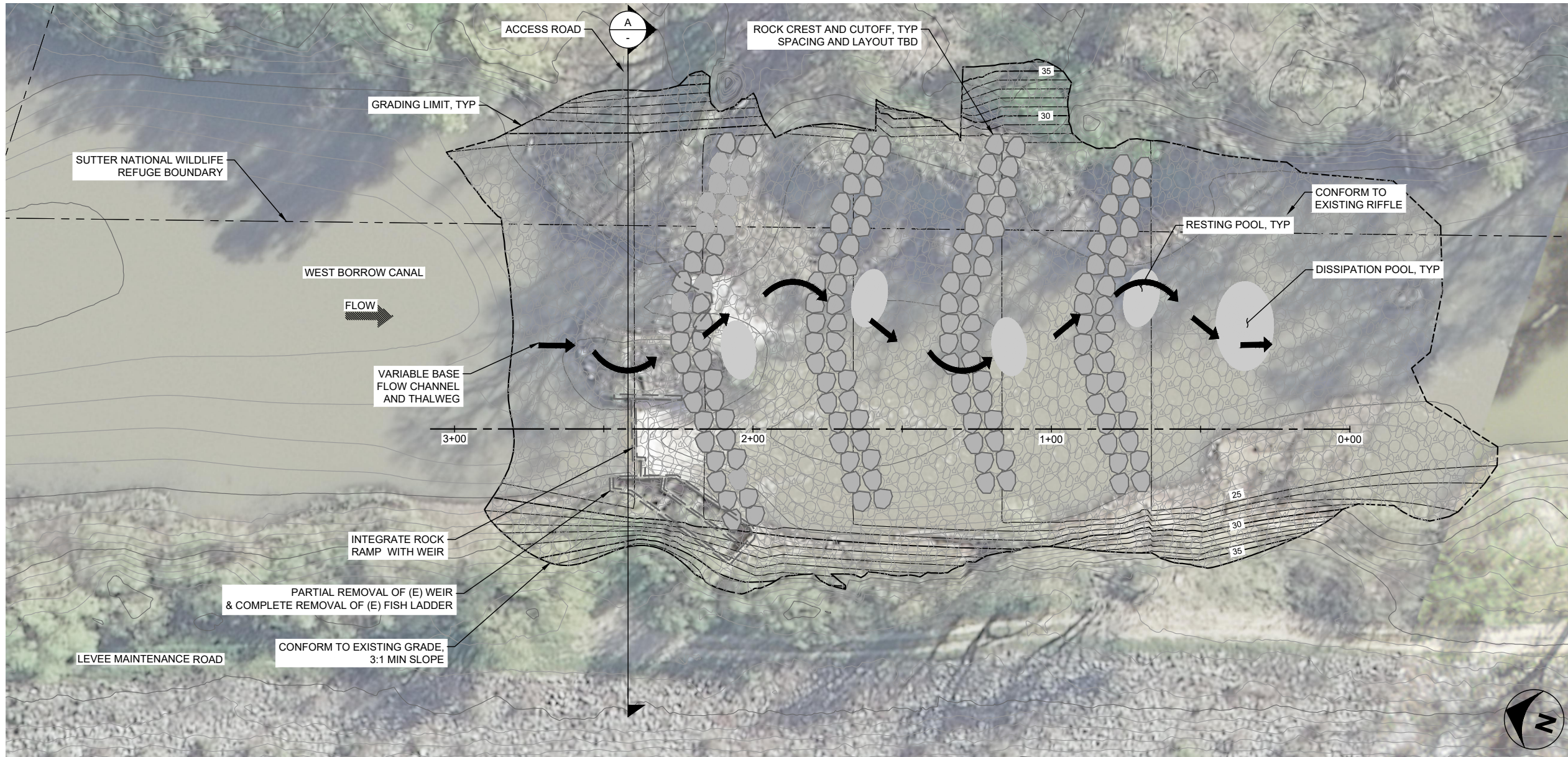
PHASE  
10% DESIGN  
DOCUMENTATION

SHEET TITLE  
**4 ALTERNATIVE C -  
PARTIAL WEIR  
REMOVAL - ROCK  
RAMP**

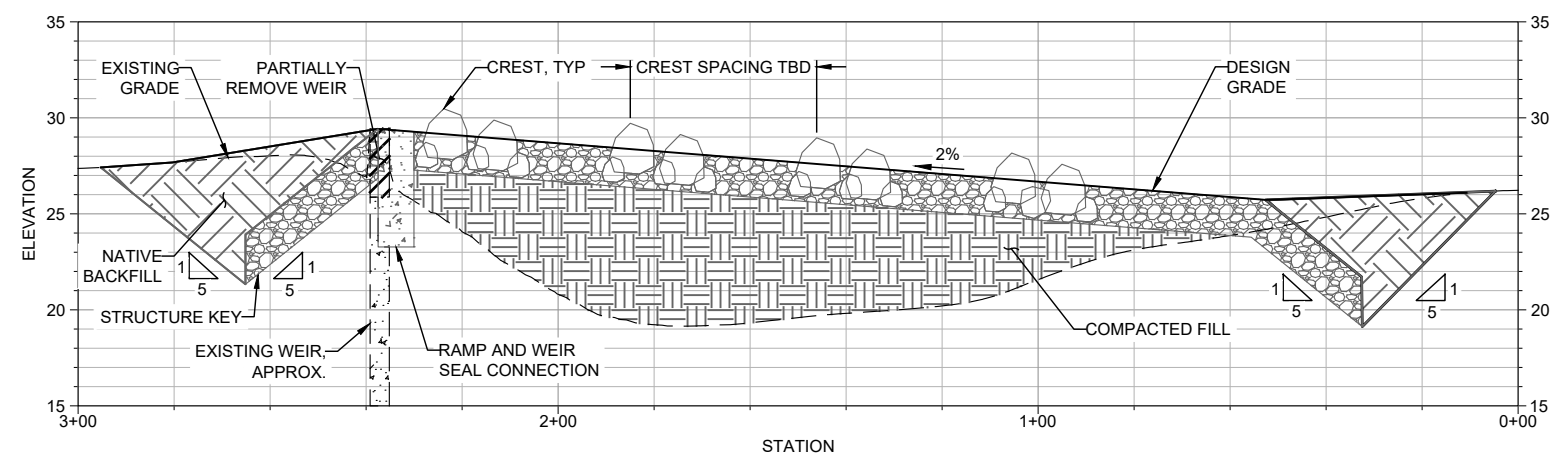
SHEET NUMBER

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SHEET --- OF ###



○ ALTERNATIVE C - PARTIAL WEIR REMOVAL WITH ROCK RAMP  
PLAN 1" = 40'

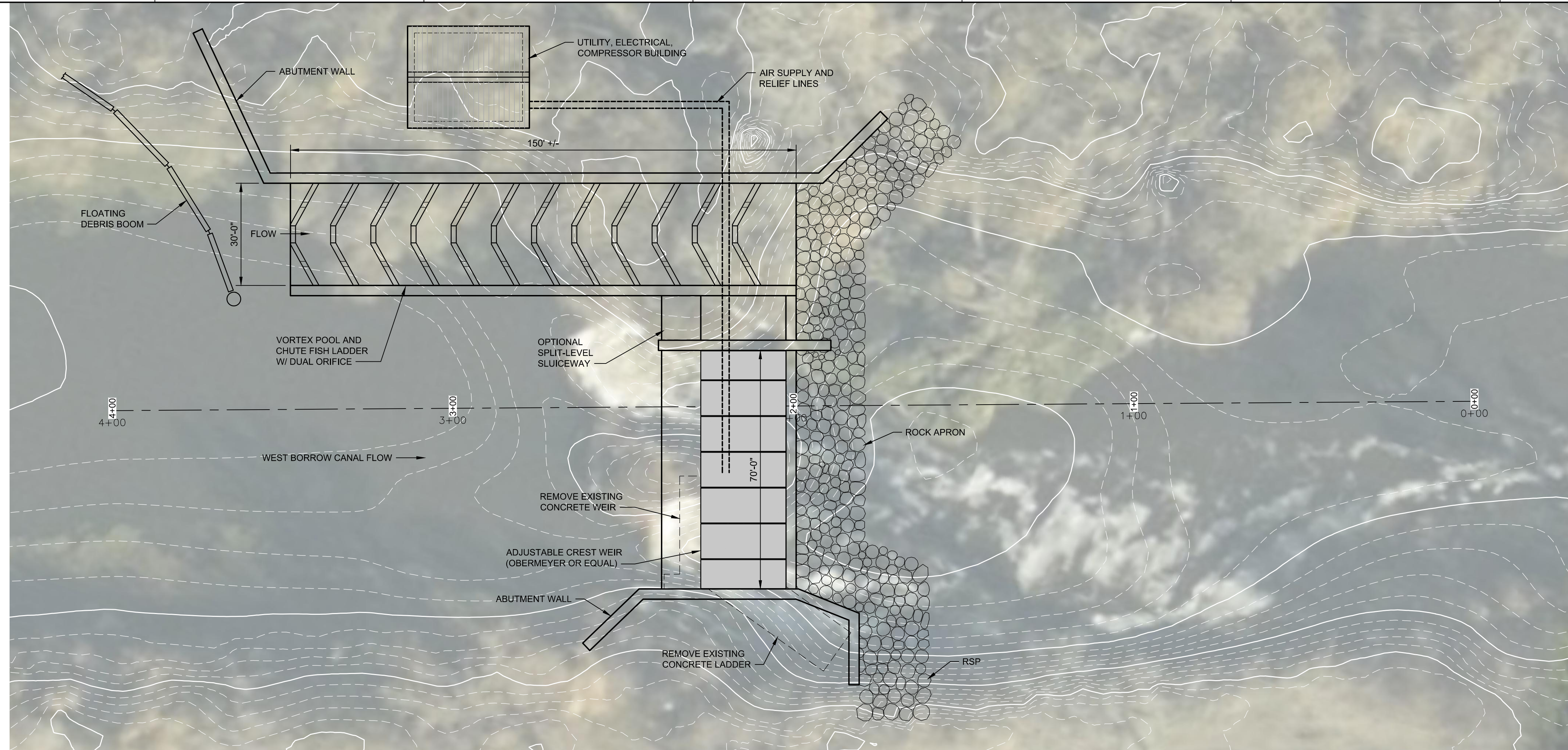


○ ALTERNATIVE C - PARTIAL WEIR REMOVAL WITH ROCK RAMP  
PROFILE NOT TO SCALE

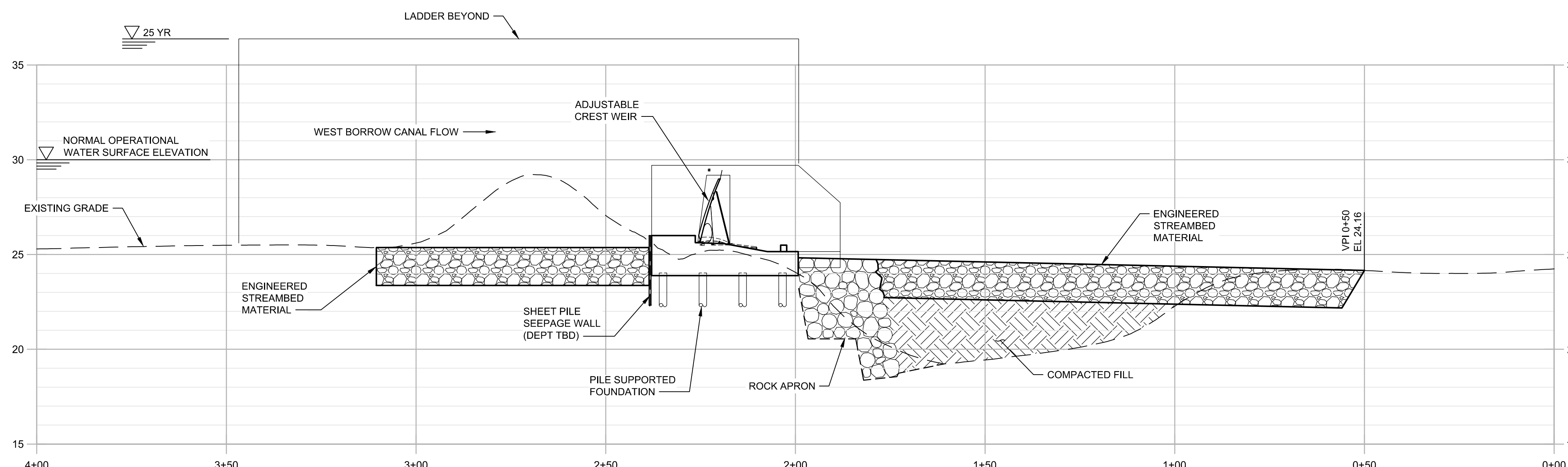
**NOTES**

- EXISTING ELEVATIONS ARE BASED ON TOPOGRAPHIC AND BATHYMETRIC SURVEYS (ESA 2023; USFWS 2020) AND LIDAR SURVEYS (QUANTUM SPATIAL 2021; DWR CVFED 2010).

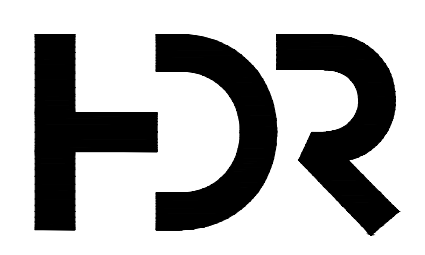
FILE: P:\01 CAD\2020\20xxxx\202001164.00 USFWS Weir-1 Fish Passage Project\DWG4 ALTERNATIVE C - PARTIAL WEIR REMOVAL - ROCK RAMP.v2.dwg PLOT DATE: 2/23/2024 2:59:21 PM PLOTTED BY: BRENT DAVIS



**PLAN**  
SCALE: 1" = 20'



**PROFILE**  
HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 4'

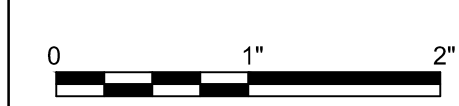


ISSUE	DATE	DESCRIPTION

DESIGN BY	T. MALONE
CHECKED BY	M. GARELLO
DRAWN BY	A. BLAKE
PLOT DATE	November 8, 2023

**BUTTE CREEK  
SUTTER BYPASS WEIR 1**

**ALTERNATIVE D  
PLAN AND PROFILE**



FILENAME | 4.01  
SCALE | AS NOTED

SHEET  
**4.1**

STAMP  
PRELIMINARY  
NOT FOR  
CONSTRUCTION

CONSULTANT

PROJECT NAME  
**USFWS WEIR 1  
FISH PASSAGE  
RESTORATION PROJECT**

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	XXX
DRAWN	XXX
CHECKED	XXX
IN CHARGE	XXX
	### ###

PROJECT NUMBER D202001164.00

ISSUE DATE MM/DD/YY

SCALE IS AS SHOWN WHEN  
PLOTTED TO FULL SIZE (22"x34")

PHASE  
**10% DESIGN  
DOCUMENTATION**

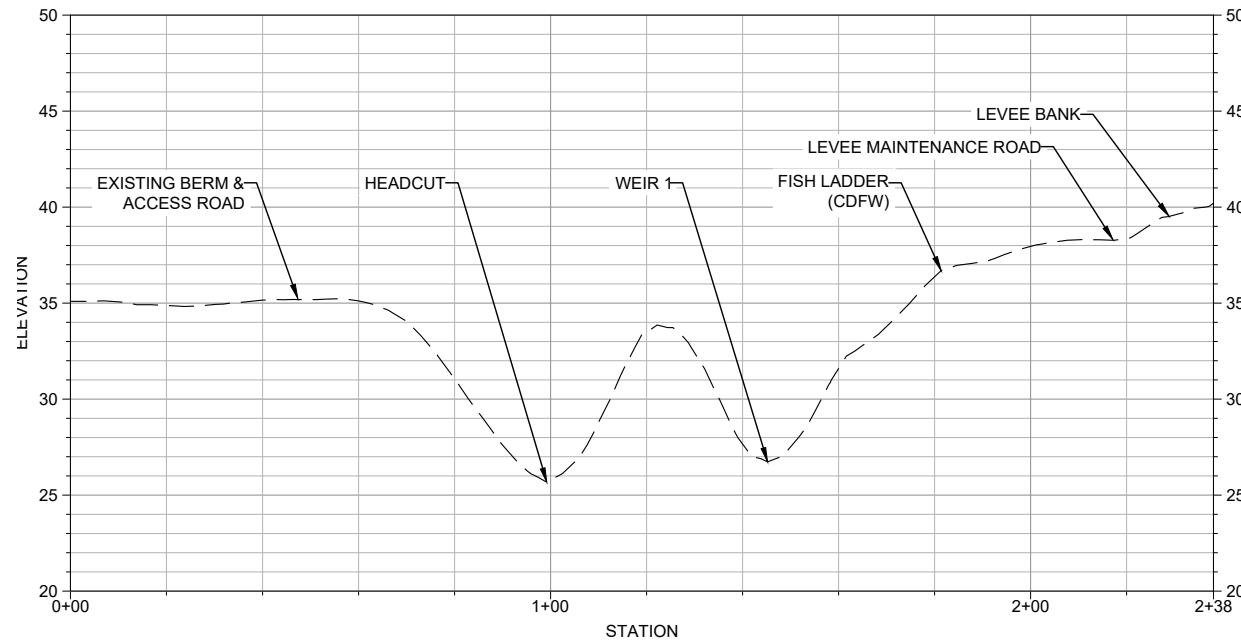
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**SECTIONS**

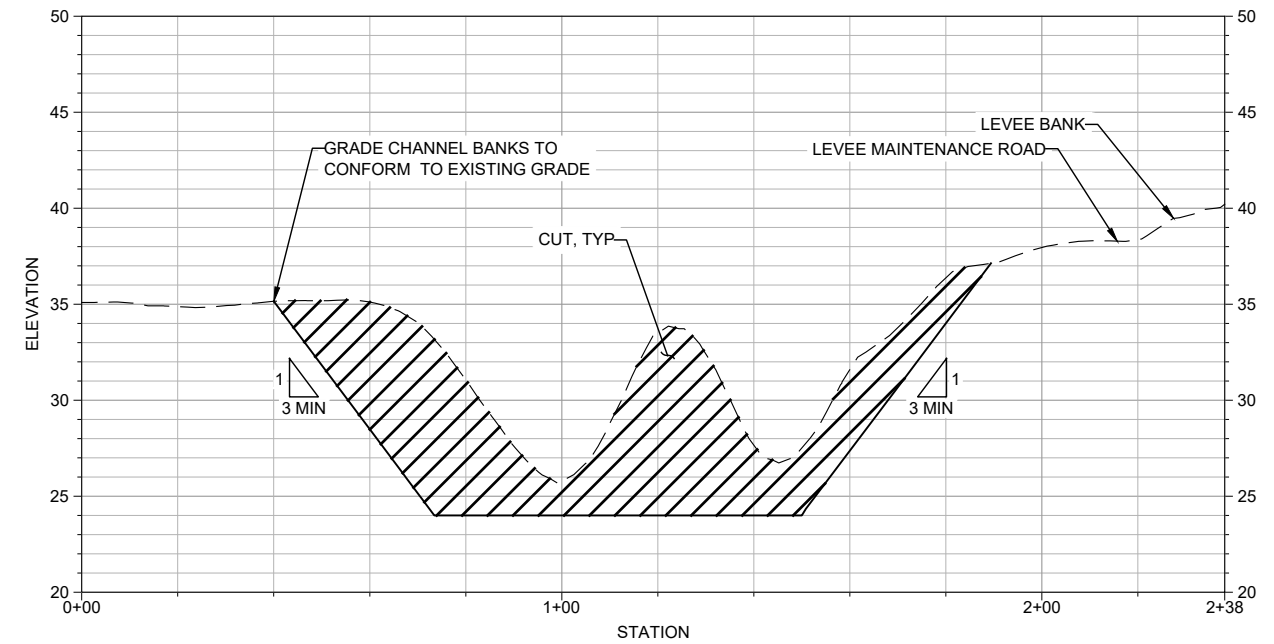
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**6**

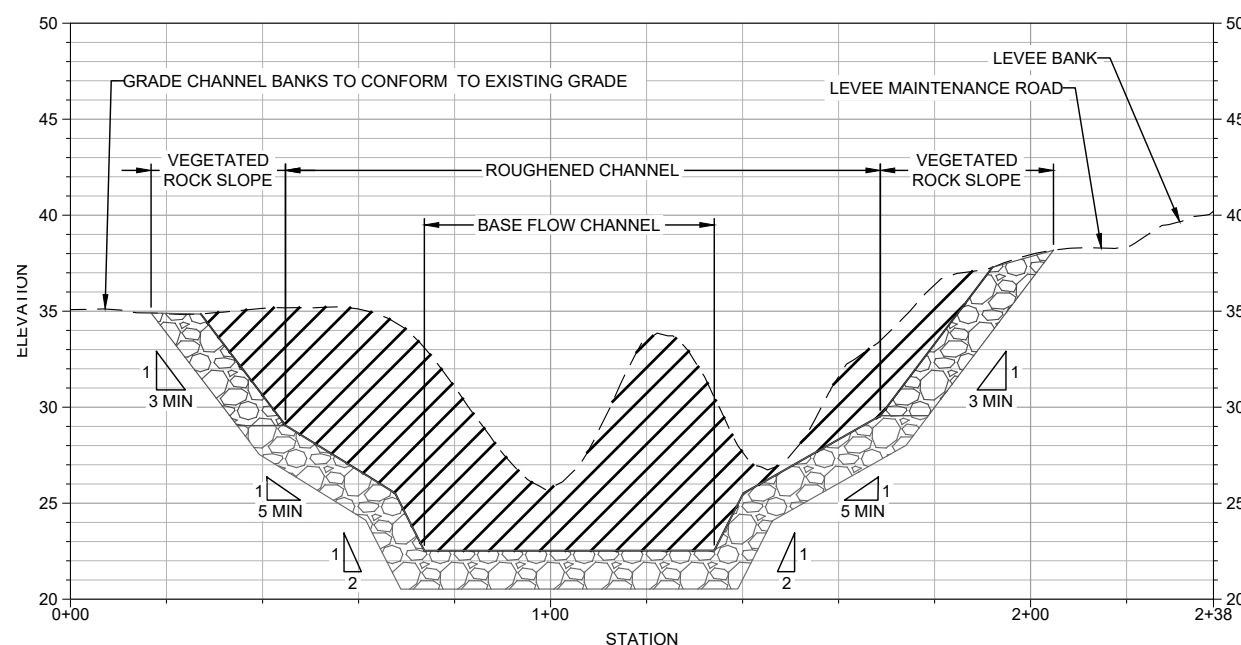
SHEET --- OF ###



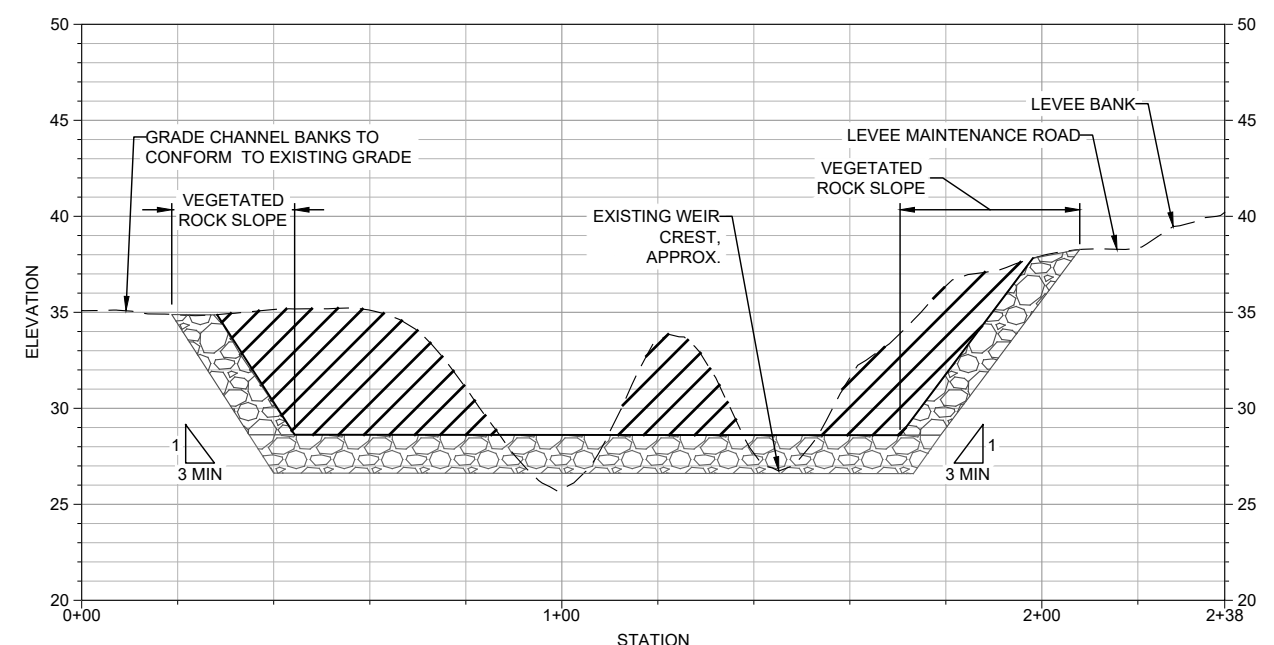
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SECTION  
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**A**  
SECTION  
**ALTERNATIVE A - WEIR REMOVAL**  
NOT TO SCALE



**A**  
SECTION  
**ALTERNATIVE B - ROUGHENED CHANNEL**  
NOT TO SCALE



**A**  
SECTION  
**ALTERNATIVE C - PARTIAL WEIR REMOVAL WITH RAMP**  
NOT TO SCALE

**NOTES**

- EXISTING ELEVATIONS ARE BASED ON TOPOGRAPHIC AND BATHYMETRIC SURVEYS (ESA 2023; USFWS 2020) AND LIDAR SURVEYS (QUANTUM SPATIAL 2021; DWR CVFED 2010).

Appendix D  
**Preliminary Opinions of  
Probable Construction Costs**



# ALTERNATIVE A

## USFWS WEIR 1 FISH PASSAGE RESTORATION PROJECT PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

BID ITEM	DESCRIPTION	QUANTITY	UNIT	COST	AMOUNT	TOTAL
	<b>SITE WORK AND DEMO</b>					<b>\$245,720.00</b>
1	SITE SURVEYING	1	LS	\$ 40,000.00	\$ 40,000.00	
2	TESC MEASURES	1	LS	\$ 20,000.00	\$ 20,000.00	
3	ACCESS AND STAGING AREA	1	LS	\$ 10,000.00	\$ 10,000.00	
4	STREAM DIVERSION AND CONSTRUCTION ISOLATION	1	LS	\$ 30,000.00	\$ 30,000.00	
5	EXISTING FISH LADDER AND WEIR DEMO	1	LS	\$ 100,000.00	\$ 100,000.00	
6	CONCRETE DISPOSAL	106	CY	\$ 120.00	\$ 12,720.00	
7	FINISH GRADING	1	LS	\$ 5,000.00	\$ 5,000.00	
8	SITE CLEAN-UP	1	LS	\$ 8,000.00	\$ 8,000.00	
9	PLANTING	1	ACRE	\$ 20,000.00	\$ 20,000.00	
	<b>IN-CHANNEL WORK</b>					<b>\$365,010.00</b>
10	EXCAVATION INCL. HAUL	2,329	CY	\$ 30.00	\$ 69,870.00	
11	ENGINEERED STREAMBED GRADING	1,495	CY	\$ 180.00	\$ 269,100.00	
12	INFILL SEDIMENT	186	CY	\$ 140.00	\$ 26,040.00	
					<b>SUBTOTAL</b>	<b>\$ 611,000</b>
	<b>MOBILIZATION (5%)</b>					<b>\$ 30,550</b>
	<b>GENERAL CONDITIONS (10%)</b>					<b>\$ 61,100</b>
	<b>BOND (2%)</b>					<b>\$ 12,220</b>
	<b>GENERAL CONTRACTORS OH AND PROFIT (15%)</b>					<b>\$ 91,650</b>
					<b>SUBTOTAL</b>	<b>\$ 806,520</b>
	<b>TAXES (9%)</b>					<b>\$ 73,000</b>
					<b>TOTAL BASE CONSTRUCTION COSTS</b>	<b>\$ 879,520</b>
						<i>UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)</i> \$ 440,000
					<b>TOTAL WITH CONTINGENCY</b>	<b>\$ 1,320,000</b>
						<i>MARKET VOLATILITY ADJUSTMENT FACTOR (3%)</i> \$ 40,000
					<b>TOTAL DIRECT COSTS</b>	<b>\$ 1,360,000</b>
						<i>DESIGN SERVICES (12%)</i> \$ 163,000
						<i>TESTING, MATERIAL AND GENERAL (1%)</i> \$ 14,000
						<i>CONSTRUCTION MANAGEMENT SERVICES (4%)</i> \$ 54,000
						<i>CONSTRUCTION INSPECTION SERVICES (5%)</i> \$ 68,000
						<i>ENGINEERING SERVICES DURING CONSTRUCTION (4%)</i> \$ 54,000
					<b>TOTAL DIRECT AND INDIRECT COSTS</b>	<b>\$ 1,713,000</b>

# ALTERNATIVE B

## USFWS WEIR 1 FISH PASSAGE RESTORATION PROJECT PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

BID ITEM	DESCRIPTION	QUANTITY	UNIT	COST	AMOUNT	TOTAL
	<b>SITE WORK AND DEMO</b>					<b>\$258,720.00</b>
1	SITE SURVEYING	1	LS	\$ 40,000.00	\$ 40,000.00	
2	TESC MEASURES	1	LS	\$ 20,000.00	\$ 20,000.00	
3	ACCESS AND STAGING AREA	1	LS	\$ 10,000.00	\$ 10,000.00	
4	STREAM DIVERSION AND CONSTRUCTION ISOLATION	1	LS	\$ 40,000.00	\$ 40,000.00	
5	EXISTING FISH LADDER AND WEIR DEMO	1	LS	\$ 100,000.00	\$ 100,000.00	
6	CONCRETE DISPOSAL	106	CY	\$ 120.00	\$ 12,720.00	
7	FINISH GRADING	1	LS	\$ 8,000.00	\$ 8,000.00	
8	SITE CLEAN-UP	1	LS	\$ 8,000.00	\$ 8,000.00	
9	PLANTING	1	ACRE	\$ 20,000.00	\$ 20,000.00	
	<b>IN-CHANNEL WORK</b>					<b>\$962,550.00</b>
10	EXCAVATION INCL. HAUL	6,376	CY	\$ 30.00	\$ 191,280.00	
11	12"-24" BOULDERS	523	CY	\$ 190.00	\$ 99,370.00	
12	24"-36" BOULDERS	523	CY	\$ 200.00	\$ 104,600.00	
13	ENGINEERED STREAMBED GRADING	2,176	CY	\$ 180.00	\$ 391,680.00	
14	ROCK FILTER LAYER	1,269	CY	\$ 100.00	\$ 126,900.00	
14	INFILL SEDIMENT	348	CY	\$ 140.00	\$ 48,720.00	
					<b>SUBTOTAL</b>	<b>\$ 1,221,000</b>
	<b>MOBILIZATION (5%)</b>					<b>\$ 61,050</b>
	<b>GENERAL CONDITIONS (10%)</b>					<b>\$ 122,100</b>
	<b>BOND (2%)</b>					<b>\$ 24,420</b>
	<b>GENERAL CONTRACTORS OH AND PROFIT (15%)</b>					<b>\$ 183,150</b>
					<b>SUBTOTAL</b>	<b>\$ 1,611,720</b>
	<b>TAXES (9%)</b>					<b>\$ 145,000</b>
					<b>TOTAL BASE CONSTRUCTION COSTS</b>	<b>\$ 1,756,720</b>
					<i>UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)</i>	<b>\$ 878,000</b>
					<b>TOTAL WITH CONTINGENCY</b>	<b>\$ 2,640,000</b>
					<i>MARKET VOLATILITY ADJUSTMENT FACTOR (3%)</i>	<b>\$ 79,000</b>
					<b>TOTAL DIRECT COSTS</b>	<b>\$ 2,719,000</b>
					<i>DESIGN SERVICES (12%)</i>	<b>\$ 326,000</b>
					<i>TESTING, MATERIAL AND GENERAL (1%)</i>	<b>\$ 27,000</b>
					<i>CONSTRUCTION MANAGEMENT SERVICES (4%)</i>	<b>\$ 109,000</b>
					<i>CONSTRUCTION INSPECTION SERVICES (5%)</i>	<b>\$ 136,000</b>
					<i>ENGINEERING SERVICES DURING CONSTRUCTION (4%)</i>	<b>\$ 109,000</b>
					<b>TOTAL DIRECT AND INDIRECT COSTS</b>	<b>\$ 3,426,000</b>

# ALTERNATIVE C

## USFWS WEIR 1 FISH PASSAGE RESTORATION PROJECT PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

BID ITEM	DESCRIPTION	QUANTITY	UNIT	COST	AMOUNT	TOTAL
	<b>SITE WORK AND DEMO</b>					<b>\$217,580.00</b>
1	SITE SURVEYING	1	LS	\$ 40,000.00	\$ 40,000.00	
2	TESC MEASURES	1	LS	\$ 20,000.00	\$ 20,000.00	
3	ACCESS AND STAGING AREA	1	LS	\$ 10,000.00	\$ 10,000.00	
4	STREAM DIVERSION AND CONSTRUCTION ISOLATION	1	LS	\$ 40,000.00	\$ 40,000.00	
5	EXISTING FISH LADDER AND PARTIAL WEIR DEMO	1	LS	\$ 60,000.00	\$ 60,000.00	
6	CONCRETE DISPOSAL	97	CY	\$ 120.00	\$ 11,580.00	
7	FINISH GRADING	1	LS	\$ 8,000.00	\$ 8,000.00	
8	SITE CLEAN-UP	1	LS	\$ 8,000.00	\$ 8,000.00	
9	PLANTING	1	ACRE	\$ 20,000.00	\$ 20,000.00	
	<b>IN-CHANNEL WORK</b>					<b>\$1,164,920.00</b>
10	RAMP AND WEIR SEAL CONNECTION	210	CY	\$ 500.00	\$ 105,000.00	
11	EXCAVATION	2,325	CY	\$ 20.00	\$ 46,500.00	
12	COMPACTED BACKFILL (IMPORT)	4,213	CY	\$ 60.00	\$ 252,780.00	
13	12"-24" BOULDERS	360	CY	\$ 190.00	\$ 68,400.00	
14	24"-36" BOULDERS	360	CY	\$ 200.00	\$ 72,000.00	
15	ENGINEERED STREAMBED GRADING	2,425	CY	\$ 180.00	\$ 436,500.00	
16	ROCK FILTER LAYER	1,339	CY	\$ 100.00	\$ 133,900.00	
17	INFILL SEDIMENT	356	CY	\$ 140.00	\$ 49,840.00	
					<b>SUBTOTAL</b>	<b>\$ 1,383,000</b>
	<b>MOBILIZATION (5%)</b>					\$ 69,150
	<b>GENERAL CONDITIONS (10%)</b>					\$ 138,300
	<b>BOND (2%)</b>					\$ 27,660
	<b>GENERAL CONTRACTORS OH AND PROFIT (15%)</b>					\$ 207,450
					<b>SUBTOTAL</b>	<b>\$ 1,825,560</b>
	<b>TAXES (9%)</b>					\$ 164,000
						<b>TOTAL BASE CONSTRUCTION COSTS \$ 1,989,560</b>
						<i>UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)</i> \$ 995,000
						<b>TOTAL WITH CONTINGENCY \$ 2,990,000</b>
						<i>MARKET VOLATILITY ADJUSTMENT FACTOR (3%)</i> \$ 90,000
						<b>TOTAL DIRECT COSTS \$ 3,080,000</b>
						<i>DESIGN SERVICES (12%)</i> \$ 370,000
						<i>TESTING, MATERIAL AND GENERAL (1%)</i> \$ 31,000
						<i>CONSTRUCTION MANAGEMENT SERVICES (4%)</i> \$ 123,000
						<i>CONSTRUCTION INSPECTION SERVICES (5%)</i> \$ 154,000
						<i>ENGINEERING SERVICES DURING CONSTRUCTION (4%)</i> \$ 123,000
						<b>TOTAL DIRECT AND INDIRECT COSTS \$ 3,881,000</b>

# ALTERNATIVE D

## USFWS WEIR 1 FISH PASSAGE RESTORATION PROJECT PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

BID ITEM	DESCRIPTION	QUANTITY	UNIT	COST	AMOUNT	TOTAL
	<b>SITE WORK AND DEMO</b>					<b>\$258,720.00</b>
1	SITE SURVEYING	1	LS	\$ 40,000.00	\$ 40,000.00	
2	ACCESS AND STAGING AREA	1	LS	\$ 10,000.00	\$ 10,000.00	
3	STREAM DIVERSION AND CONSTRUCTION ISOLATION	1	LS	\$ 60,000.00	\$ 60,000.00	
4	EXISTING FISH LADDER AND WEIR DEMO	1	LS	\$ 100,000.00	\$ 100,000.00	
5	CONCRETE DISPOSAL	106	CY	\$ 120.00	\$ 12,720.00	
6	FINISH GRADING	1	LS	\$ 8,000.00	\$ 8,000.00	
7	SITE CLEAN-UP	1	LS	\$ 8,000.00	\$ 8,000.00	
8	PLANTING	1	ACRE	\$ 20,000.00	\$ 20,000.00	
	<b>IN-CHANNEL WORK</b>					<b>\$1,061,260.00</b>
	FLOATING DEBRIS GUIDANCE BOOM AND ANCHORAGE	1	LS	\$ 250,000.00	\$ 250,000.00	
3	EXCAVATION INCL. HAUL	2,121	CY	\$ 30.00	\$ 63,630.00	
4	COMPACTED BACKFILL	1,297	CY	\$ 50.00	\$ 64,850.00	
5	24"-36" BOULDERS	771	CY	\$ 200.00	\$ 154,200.00	
6	ENGINEERED STREAMBED GRADING	2,333	CY	\$ 180.00	\$ 419,940.00	
7	INFILL SEDIMENT	776	CY	\$ 140.00	\$ 108,640.00	
	<b>WEIR AND FISHWAY</b>					<b>\$2,410,000.00</b>
8	OBERMEYER WEIR	1	LS	\$ 500,000.00	\$ 500,000.00	
9	CONCRETE WEIR FOUNDATION	450	CY	\$ 800.00	\$ 360,000.00	
	PILE FOUNDATION (LIQUIFACTION) DEPTH TBD	1	LS	\$ 200,000.00	\$ 200,000.00	
	SEEPAGE CUTOFF WALL (SHEET PILE) DEPTH TBD	153,000	LB	\$ 5.00	\$ 765,000.00	
10	VORTEX POOL AND CHUTE FISH LADDER W/ DUAL ORIFICE	700	CY	\$ 800.00	\$ 560,000.00	
11	SLUICeway GATE	1	LS	\$ 25,000.00	\$ 25,000.00	
	<b>BUILDING</b>					<b>\$30,000.00</b>
12	UTILITY ELECTRICAL COMPRESSOR BUILDING	1	LS	\$ 30,000.00	\$ 30,000.00	
	<b>ELECTRICAL SYSTEM</b>					<b>\$80,000.00</b>
13	ELECTRICAL UTILITY SERVICE DISTRIBUTION	600	LF	\$ 50.00	\$ 30,000.00	
14	ELECTRICAL UTILITY SERVICE	1	LS	\$ 50,000.00	\$ 50,000.00	
	<b>INSTRUMENTATION AND CONTROLS</b>					<b>\$130,000.00</b>
15	CONTROL SYSTEM EQUIPMENT PANELS AND RACKS	1	LS	\$ 30,000.00	\$ 30,000.00	
16	PLC AND SCADA PROGRAMMING	1	LS	\$ 70,000.00	\$ 70,000.00	
17	INSTRUMENTATION	1	LS	\$ 30,000.00	\$ 30,000.00	
						<b>SUBTOTAL \$ 3,970,000</b>
	<b>MOBILIZATION (5%)</b>					\$ 198,500
	<b>GENERAL CONDITIONS (10%)</b>					\$ 397,000
	<b>BOND (2%)</b>					\$ 79,400
	<b>GENERAL CONTRACTORS OH AND PROFIT (15%)</b>					\$ 595,500
						<b>SUBTOTAL \$ 5,240,400</b>
	<b>TAXES (9%)</b>					\$ 472,000
						<b>TOTAL BASE CONSTRUCTION COSTS \$ 5,712,400</b>
						<i>UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)</i> \$ 2,856,000
						<b>TOTAL WITH CONTINGENCY \$ 8,570,000</b>
						<i>MARKET VOLATILITY ADJUSTMENT FACTOR (3%)</i> \$ 257,000
						<b>TOTAL DIRECT COSTS \$ 8,827,000</b>
						<i>DESIGN SERVICES (12%)</i> \$ 1,059,000
						<i>TESTING, MATERIAL AND GENERAL (1%)</i> \$ 88,000
						<i>CONSTRUCTION MANAGEMENT SERVICES (4%)</i> \$ 353,000
						<i>CONSTRUCTION INSPECTION SERVICES (5%)</i> \$ 441,000
						<i>ENGINEERING SERVICES DURING CONSTRUCTION (4%)</i> \$ 353,000
						<b>TOTAL DIRECT AND INDIRECT COSTS \$ 11,121,000</b>