

**Draft Final Basis of Design Report**

Willow Creek Royes Dam Fish Passage Restoration  
Union County, Oregon

*for*

**Union Soil and Water Conservation District**

July 5, 2023



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**Willow Creek Royes Dam Fish Passage**  
**Restoration**  
**Union County, Oregon**

**File No. 19369-003-01**

**July 5, 2023**

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## **LIST OF ACRONYMS**

BPA – Bonneville Power Administration

cfs – cubic feet per second

ESA – Endangered Species Act

HIP – Habitat Improvement Program

NMFS – National Marine Fisheries Service

USWCD – Union Soil and Water Conservation District

ODFW – Oregon Department of Fish and Wildlife

OWRD – Oregon Water Resources Department

RRT – Restoration Review Team

RSI – Resource Specialists, Inc.

USACE – United States Army Corps of Engineers

USGS – United States Geological Society

DRAFT

## 1.0 INTRODUCTION

GeoEngineers, Inc. (GeoEngineers) has prepared this Draft Final Basis of Design report (report) for the Union Soil and Water Conservation District (USWCD). This report provides a summary of our findings pertaining to the existing conditions of the Willow Creek Royes Dam project site in Union County near Imbler, Oregon, and an explanation of the design process, analyses, and preliminary outcomes for the proposed enhancement design.

GeoEngineers organized the following sections of this report to describe the General Project and Data Summary Requirements required by the Bonneville Power Administration (BPA) for regulatory compliance coverage under the Habitat Improvement Program (HIP). This report is submitted to satisfy the 30 percent design step as part of the BPA Restoration Review Team (RRT) review process. BPA developed the requirements to effectively communicate that appropriate planning, analysis, design, and resulting construction documentation are met. The conditions of the project reach are described in terms of processes that shaped the stream and associated ecosystem within the context of various ecological disciplines. This includes discussions on hydrology, hydraulics, fish passage, irrigation facilities, and geomorphology. The evaluation and consideration of the site conditions provide the basis for the project design.

- Appendix A—Draft Final Design Drawings
- Appendix B—Site Photographs
- Appendix C—Hydrologic and Hydraulic Analysis
- Appendix D—Sediment Mobility Analysis
- Appendix E—Construction Quantities and Estimate of Anticipated Costs
- Appendix F—Monitoring and Adaptive Management Plan
- Appendix G—Bonneville Power Administration 30 Percent Submittal Comment Response
- Appendix H—Report Limitations and Guidelines for Use

### 1.1. Project Responsible Parties

- The project sponsor is the USWCD, and the project manager is Aaron Bliesner, 541.963.1313.
- The prime design consultant is GeoEngineers, Inc. and the engineer of record is Ryan S. Carnie, PE, 208.258.8326.

### 1.2. Site Location

Willow Creek is a tributary to the Grande Ronde River in Union County, Oregon. The project site includes Royes dam, located approximately 3.8 miles upstream of the confluence with the Grande Ronde River as shown in Figure 1. The overall project site and proposed grading areas are shown in Figure 2.

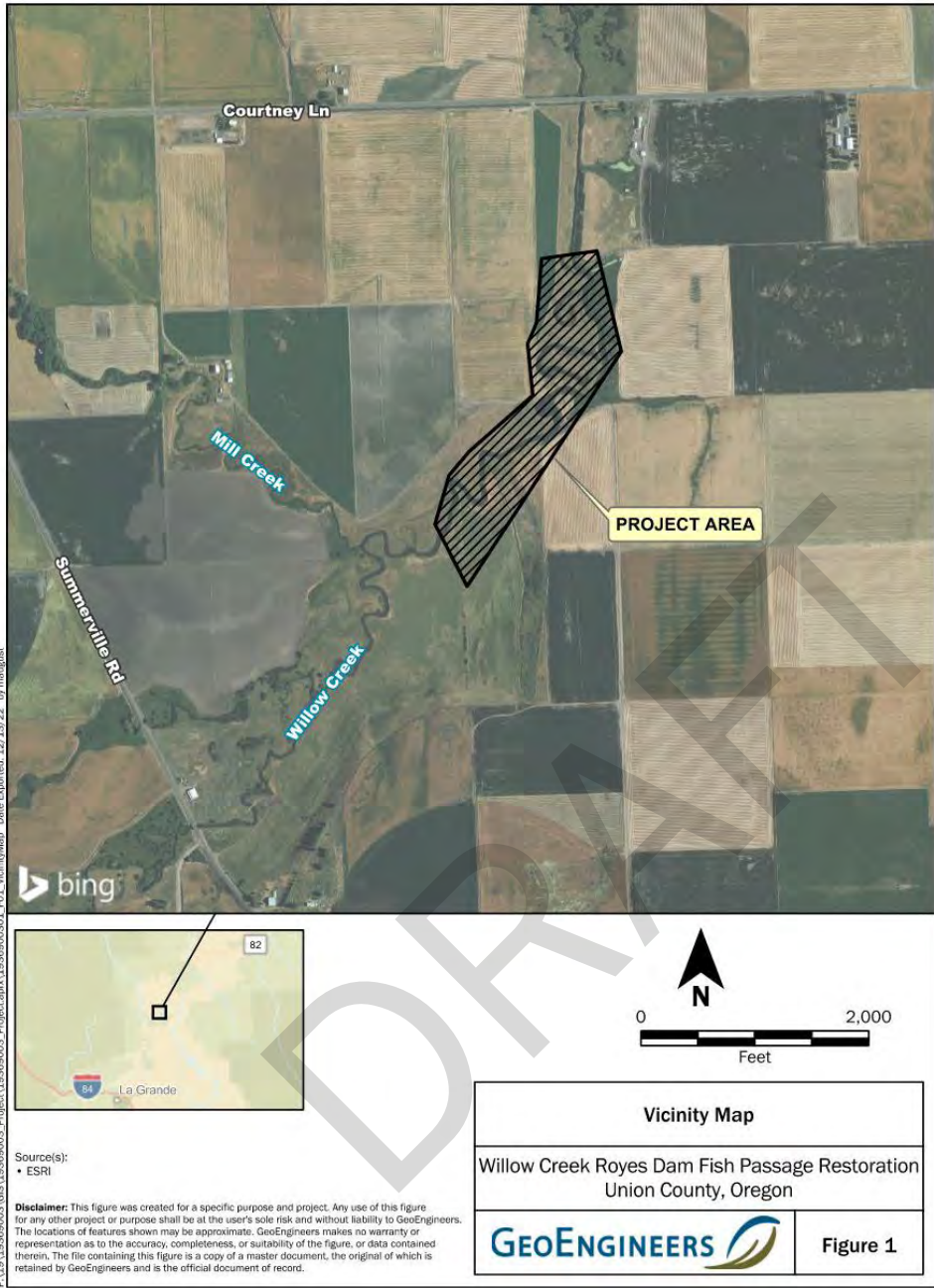


Figure 1. Vicinity Map



Figure 2. Site Plan

## 2.0 PROJECT BACKGROUND

The Willow Creek watershed is an important tributary system in the Grande Ronde River basin for summer steelhead and spring/summer Chinook Salmon. In its present configuration and operation, Royes Dam impedes and often fully blocks adult and juvenile salmonid migration within the Willow Creek system because it is a channel spanning structure and lacks effective fish passage facilities. In addition, the operation of Royes Dam creates a large low-velocity backwater area, which ultimately facilitates higher water temperatures and lower dissolved oxygen levels. Therefore, Royes Dam not only blocks fish passage but also degrades water quality conditions to a point that, during some times of the year, are potentially lethal to native salmonids.

The Union Soil and Water Conservation District (USWCD) is leading an effort to improve fish passage and irrigation delivery systems upstream of Royes Dam.

This report presents the process for completing the alternatives analysis; describes existing operation conditions; describes the alternative concepts that were analyzed; provides supporting technical information for alternative selection; and identifies the recommended alternative. The 30 percent design drawings for the alternatives upstream of the dam are presented in Appendix A, Draft Final Design Drawings.

### 2.1. Project Goal

The outcome of this project will be implementation-ready designs for improving fish passage at Royes Dam.

### 2.2. Objectives

- Develop fish passage designs for juvenile and adult summer steelhead and spring/summer Chinook Salmon during periods of migration that achieve Oregon Department of Fish and Wildlife (ODFW) and National Marine Fisheries Service (NMFS) fish passage criteria to the greatest extent practical.
- Develop fish passage designs that support and maintain the use of irrigation water for water users.
- Minimize long-term maintenance frequency and expense associated with project infrastructure following construction.
- Provide a sustainable, permittable, maintainable design at a reasonable cost.

### 2.3. Constraints

- Maintain surface water right delivery to water users within Willow and Mill Creek.
- All proposed pumps shall be designed at an elevation greater than the 100-year flow water surface elevation.

### 2.4. Previous Assessments and Designs

GeoEngineers completed the design development for the Royes Dam fish passage project and published a final basis of design report in April 2021 (GeoEngineers, 2021). The report provided a description of existing conditions, design flow rates, hydraulic modeling output and a description of the proposed fish passage solution. The design development process followed the Bonneville Power Administration (BPA) Habitat Improvement Program (HIP) review process. That process included an alternatives analysis,

30 percent, 80 percent, and final design submittals. The design for the GeoEngineers (2021) Royes Dam fish passage included a concrete pool-and-weir fishway proposed on the west side of Willow Creek. USWCD and local stakeholders have decided to revise the previous design and focus on the alternatives described below and include in-channel grade control and pump system upgrades.

After the 2021 design, GeoEngineers completed a 15 percent design-level alternative analysis, which was submitted to BPA. Based on information we have received from USWCD, we evaluated alternatives intended to improve fish passage and water quality conditions. Throughout our alternative evaluation, we concluded Royes Dam would remain in place as-is, and the manual operation of the dam would no longer require placement of channel-spanning boards to maintain the current upstream pool elevation. We concluded the irrigators will upgrade their pumping systems upstream of Royes Dam to withdraw water from the backwater locations on Willow Creek. We received comments on the 15 percent submittal as summarized in Section 4.0 below.

### **3.0 EXISTING SITE CONDITIONS**

#### **3.1. Royes Dam Existing Conditions**

The existing Royes Dam consists of three open bays with 12-inch-thick concrete walls in between each bay and retaining wall abutments on each end. During a site visit in 2019, we noted the dam had corroding steel beams and wood framing supporting an unattached bar-grating deck. We also observed deep scour pitting on the upstream faces of the 12-inch-thick walls (Photo 1). Based on these observations, we suspected that the walls were not reinforced. No as-built information about the dam was available.

We conducted a subsequent site visit in 2022 and completed data collection upstream and downstream of Royes Dam using Oregon Department of State Lands (ODSL) Stream Function Assessment Method (SFAM). Downstream of the dam, Willow Creek is an incised and straightened reach with an average slope of 0.7 percent. We measured an active channel width of 17 feet. The existing streambed material, downstream of Royes Dam, included sands, small gravel and a section of coarser angular material spanning the channel approximately 65 feet downstream of the dam. This section of coarser angular material appeared to provide a level of grade control. Upstream of the dam, we measured an active channel width of approximately 39 feet. The water users manually control the upstream pool water surface elevation (WSE) to provide sufficient hydraulic head for irrigation diversion by placing and removing boards within the dam's three bays. The Royes Dam operation presents a fish passage barrier starting in late April when irrigation season begins and before spring/summer Chinook Salmon have migrated.



Photo 1. Existing stop-log operation of Royes Dam facing east, Willow Creek flows from right to left

### 3.2. Peak Discharges

The U.S. Bureau of Reclamation (USBOR) Columbia/Snake Salmon Recovery Office, in coordination with the USWCD, developed a Conceptual Design Memorandum for Fish Passage at Royes Dam in June 2018 (USBOR, 2018). The USBOR calculated peak discharges for Willow Creek at the confluence with the Grande Ronde River using a generalized least square prediction equation for the Oregon east side watersheds—northeast using the USGS StreamStats Version 4 (USBOR, 2018). The 1.5-year event was not reported in the USBOR report. We extracted the 1.5-year flow with a best-fit curve on a log scale graph of the reported return periods and peak flows. We analyzed the hydraulic conditions using the reported results of the peak discharge calculations identified in Table 1 below.

**TABLE 1. WILLOW CREEK PEAK FLOW ESTIMATES AT THE GRANDE RONDE RIVER CONFLUENCE**

Return Period (yr)	Peak Flow (cfs)
1.5	480 <sup>1</sup>
2	614
5	979
10	1250

Return Period (yr)	Peak Flow (cfs)
20	1530
25	1620
50	1900
100	2180
500	2890

Notes:

cfs = cubic feet per second

<sup>1</sup> Extrapolated peak flow

### 3.3. Fish Passage Design Flows

The Oregon Administrative Rules (OARs) and ODFW require a hydraulic assessment of low design flow and the high design flow for fish passage (Oregon Secretary of State, 2022). We calculated the 95 and 5 percent exceedance flows at the project site using StreamStats (USGS, 2023) to assess fish passage during the low and high fish passage flows, respectively. StreamStats uses the regression equations published by the United States Geological Survey (USGS) for unregulated streams in Oregon for low-flow frequency (Risley, Stonewall, & Haluska, 2009). The 95 percent exceedance flow characterizes a low-flow condition where 95 percent of stream flows exceed the calculated value. The 5 percent exceedance flow characterizes a high fish passage flow condition that 5 percent of stream flows are greater than the calculated value. We considered August to be the migration period for adult spring/summer Chinook; March and April to be the migration period for adult steelhead; and July and August to be the migration period for juveniles of both species. The species, life stages, months of migration and design flow results are summarized in Table 2.

**TABLE 2. DESIGN FISH PASSAGE FLOWS**

Species/Life Stage	Months of Migration	5 Percent Exceedance Flow Design High Fish Passage Flow (cfs)	95 Percent Exceedance Flow Design Low Fish Passage Flow (cfs)
Spring Chinook/Adults	August	6.6	2.4
Steelhead/Adults	March and April	261.5	20.5
Steelhead and Chinook Juveniles	July and August	11.7	3.5

### 3.4. Work-Zone Isolation Monthly Exceedance Flow

GeoEngineers calculated monthly flow duration statistics using the USGS StreamStats program to inform the temporary channel diversion during project implementation. Based on the StreamStats monthly duration statistics, the 10 percent, and 50 percent exceedance for are reported in Table 3. The in-water work period for Willow Creek is between July 1 and October 15. We recommend work zone isolation structures be designed to accommodate 13.0 cfs, which is the highest monthly 10 percent exceedance flow during the in-water work period.

**TABLE 3. MONTHLY EXCEEDANCE FLOW**

Month	50 Percent Exceedance Flow (cfs)	10 Percent Exceedance Flow (cfs)
January	15.8	66.0
February	30.0	132.0
March	46.9	164.0
April	113.0	235.0
May	65.4	174.0
June	13.1	37.7
<b>July</b>	<b>5.4<sup>1</sup></b>	<b>13.0<sup>1</sup></b>
<b>August</b>	<b>3.2<sup>1</sup></b>	<b>5.6<sup>1</sup></b>
<b>September</b>	<b>2.2<sup>1</sup></b>	<b>4.8<sup>1</sup></b>
October	2.8	6.0
November	5.1	20.0
December	11.9	44.6

Notes:

<sup>1</sup> 10 and 50 percent exceedance flow during in-water work period**3.4.1. Water Rights**

The 2018 USBOR report summarized water rights within Willow Creek based on their research using the Oregon Water Resources Department (OWRD) database. The report indicates there are 14 surface water rights supported by the Royes Dam operation. The water rights are impacted by senior water rights held downstream of Royes Dam, and those require minimum overflow discharges as summarized in Table 4. The instream water rights range from 5 cfs to 34 cfs depending on month and available flow within Willow Creek. The flow rates identified in the Sum of Rate by Water Right Priority Flow represent discharge entering the Royes pool necessary to deliver the priority rate by year. The discharge values identified in the Sum Spill-Over Rates for Downstream Rights represent water rights downstream of Royes Dam.

**TABLE 4. PRIORITY RATE BY YEAR (USBOR, 2018)**

Priority Year	Sum of Rate by Water Right Priority Flow (cfs)	Sum Spill Over Rates for Downstream Rights (cfs)	Sum of Rate for Lower Willow Creek
1947	0	0.57	0.57
1949	9.86	1.37	11.23
1950	10.69	1.37	12.06
1955	10.69	3.62	14.31
1959	10.69	5.46	16.15
1960	11.67	9.46	21.13
1961	11.67	11.00	22.67
1962	21.90	14.20	36.10
1965	30.53	14.20	44.73

Priority Year	Sum of Rate by Water Right Priority Flow (cfs)	Sum Spill Over Rates for Downstream Rights (cfs)	Sum of Rate for Lower Willow Creek
1966	30.53	15.16	45.69
1971	30.53	15.74	46.27
1973	33.39	15.74	49.13
1974	33.39	16.74	50.13
1975	34.36	17.72	52.08
1991	34.36	22.97	57.33

### 3.4.2. Monthly Irrigation Operation

Based on the 50 percent exceedance discharge calculated with the StreamStats model, there are months that all water rights are not available. We summarized the spill-over flow rates by assessing the senior rights due downstream of Royes Dam and reporting those as a difference between the 50 percent exceedance for each month and the senior rights. For monthly 50 percent exceedance flow less than the sum rate of lower Willow Creek flows reported in Table 4, we subtracted the senior right from the available flow. Table 5 includes anticipated discharge rates over Royes Dam using monthly 50 percent exceedance discharges and subtracting the user water rights

**TABLE 5. MONTHLY LOW-FLOW FREQUENCIES AT HUBER DAM**

Month	50% Exceedance Flow (cfs)	Spill Over Royes Dam (cfs)
JAN	15.8	15.8
FEB	30.0	30.0
MAR	46.9	46.9
APR	113.0	112.6 <sup>1</sup>
MAY	65.4	31.0 <sup>1</sup>
JUN	13.1	3.6 <sup>1</sup>
JUL	5.4 <sup>1</sup>	0.6 <sup>1</sup>
AUG	3.2 <sup>1</sup>	0.6 <sup>1</sup>
SEP	2.2 <sup>1</sup>	0.6 <sup>1</sup>
OCT	2.8	0.6 <sup>1</sup>
NOV	5.1	5.1
DEC	11.9	11.9

Notes:

<sup>1</sup> Months and discharges impacted by water right distribution. Spill over calculated by subtracting senior water rights adjudicated to users upstream of Royes Dam..

### 3.5. Willow Creek Existing Irrigation Pumps

The project focuses on providing sufficient pool elevation to serve three in-stream irrigation pump deliveries upstream of Royes Dam, as shown in Figure 2, the design drawings in Appendix A, and in the site photographs in Appendix B. We assigned pump reference numbers arbitrarily, and information

regarding their certification numbers and water rights are included in the individual pump descriptions. All existing irrigation pump systems described include a suction pipe and screen that extends into Willow Creek. All centrifugal pumps described are located at an elevation higher than the approximate operating low-pool elevation between 2684.1 and 2684.4 feet (NAVD88).

### 3.5.1. Pump 1

Pump 1 is located on the channel right side of Willow Creek approximately 100 feet upstream of Royes Dam. Pump 1 provides irrigation water under OWRD certification numbers 21743, 32705, 32708, and 42681. We summarized information regarding the certified water rights in Table 6. We reported flow rates as cubic feet per second (cfs).

**TABLE 6. PUMP 1 WATER RIGHTS**

Certification Number	Priority Date	Flow Rate (cfs)
21743	08/01/1949	4.00
32705	02/17/1960	0.98
32708	01/19/1962	4.94
42681	10/09/1975	1.25
<b>Total</b>		<b>11.17</b>

Pump 1 is a centrifugal pump with a 100-horsepower (hp) 3-phase induction motor. The approximate pump elevation is 2690.0 (NAVD88). Pump 1 requires suction lift to provide sufficient hydraulic head for the total flow rate. Reference the photo log of pump 1 in Appendix B.

### 3.5.2. Pumps 2 and 3

Pumps 2 and 3 are adjacent to each other and are located on the right-hand side (eastern side) of Willow Creek between approximately 2,220 and 2,240 feet upstream of Royes Dam. Pumps 2 and 3 provide irrigation water under OWRD certification numbers 42542 and 54095. We summarized information regarding the certified water rights in Table 7.

**TABLE 7. PUMP 2 AND 3 WATER RIGHTS**

Certification Number	Priority Date	Flow Rate (cfs)
42542	10/04/1965	6.00
54095	03/01/1973	2.86
<b>Total</b>		<b>8.86</b>

Pump 2 is a centrifugal pump with a 75-hp 3-phase motor. Pump 2 is bolted to a concrete slab and housed in a shed. The approximate pump elevation is 2,694.6 (NAVD88). The pump 2 system, including intake pipe, concrete floor, electronic controls, and outlet pipe appeared to be custom designed and dated, and replacement, rather than upgrading, is likely the only option. Pump 3 is a centrifugal pump with a 100-hp 3-phase motor. Pump 3 is bolted to a concrete slab and housed in a shed slightly upstream of the pump 2 housing. The approximate pump elevation is 2,695.0 (NAVD88). Pumps 2 and 3 require suction lift to provide sufficient hydraulic head for the total flow rate (Figures B-3 through B-9 in Appendix B).

### 3.5.3. Pump 4

Pump 4 is located on the right-hand side of Willow Creek approximately 3,430 feet upstream of Royes Dam. Pump 4 provides irrigation water under OWRD certification number 42542. We summarized information regarding the certified water rights in Table 8.

**TABLE 8. PUMP 4 WATER RIGHTS**

Certification Number	Priority Date	Flow Rate (cfs)
42542	10/04/1965	6.00
<b>Total</b>		<b>6.00</b>

Pump 4 is a centrifugal pump with a 100-hp 3-phase motor. Pump 4 is bolted to a concrete slab and housed in a shed. The approximate pump elevation is 2694.0 (NAVD88). Like pumps 2 and 3, the pump 4 system including intake pipe, concrete floor, electronic controls, and outlet pipe are uniquely designed and is at the end of its design life. Replacement is proposed. The pump 4 intake pipe extends into Willow Creek and is adjacent to an existing concrete retaining wall located upstream of the pipe. Pump 4 requires suction lift to provide sufficient hydraulic head for the total flow rate (Figures B-10 through B-12 in Appendix B).

## 4.0 DESIGN DEVELOPMENT

GeoEngineers developed design alternatives to achieve the overall project goal and objectives described in Section 2.0. We considered the project objectives and project constraints to develop the alternatives. We considered the anticipated performance of the alternatives relative to the selection criteria to evaluate alternatives and make an informed decision based on site specific conditions.

We submitted 15 percent basis of design report (BDR) identifying and accompanying conceptual-level drawings dated December 22, 2022 (GeoEngineers, 2022). That report identified three alternatives to provide fish passage and to provide a minimum water surface elevation to four irrigation pumps upstream of Royes Dam.

- Single grade control upstream of Royes Dam
- Multiple grade controls within Willow Creek without pump upgrades
- Multiple grade controls within Willow Creek with pump upgrades

BPA provided comments on the 15 percent BDR and drawings. The selected alternative includes one in-channel constructed riffle grade control feature; one new pump relocated upstream of the proposed constructed riffle; and three new irrigation pump intake screens as described in Sections 4.2 through 4.4. We anticipate additional design criteria for future design stages following the alternative selection.

### 4.1. HIP 4 Biological Opinion Considerations

The proposed actions for the project include the following categories of action as defined by the BPA HIP Guidelines and included in the 15 percent design comments (Bonneville Power Administration, 2021). The categories of action may change as design development progresses.

- Category of Action: River, Stream, Floodplain and Wetland Restoration
  - **HIP Category 1b.** Consolidate or Replace Existing Irrigation Structures
  - **HIP Category 1c.** Headcut and Grade Stabilization
- Project Title: Willow Creek Royes Dam Fish Passage Restoration
- HUC 8:
  - Upper Grande Ronde: **17060104**
- ESA-Listed and State-Listed Species:
  - Mid-Columbia steelhead (*Oncorhynchus mykiss*)
  - Chinook Salmon (*Oncorhynchus tshawytscha*)

#### 4.1.1. HIP Category 1b Conservation Measures

Project conservation measures are described as HIP Category 1b—consolidate or replace existing irrigation structures (Bonneville Power Administration, 2021). The project does not propose to consolidate multiple points of diversion. Design guidelines applicable to this category for the proposed elements include the following.

- The placement of rock structures or constructed riffles to restrict headcutting and provide grade stabilization shall follow conservation measures described for activity category 1c (headcut and grade stabilization).
- HIP will only cover projects that use state-approved regulatory mechanisms (ORS 537.455-.500) for ensuring that water savings will be protected as instream water rights.
- The project design will include the installation of a totalizing flow meter on the new diversions (pumps) for which installation of this device is possible.
- The new pump diversions will be designed to incorporate Point of Diversion (POD) flow restrictions to limit the diverted flow to satisfy the irrigator’s water right at 95 percent exceedance stream flow stage.
- Treated wood and copper- or zinc-plated hardware shall not be used in the construction of irrigation diversions, including pumps. Concrete must be sufficiently cured or dried (48–72 hours depending on temperature) before coming into contact with stream flow.
- The three retrofitted intake screens will meet NMFS screen size and impingement velocity requirements.

NMFS engineering review is required for instream diversions greater than or equal to 3 vertical feet or for diversions greater than 3 cfs.

#### 4.1.2. HIP Category 1c Conservation Measures

The required project conservation measures are also defined as HIP Category 1c—headcut and grade stabilization (Bonneville Power Administration, 2021). Design guidelines applicable to this category for the proposed elements include the following.

- Provide fish passage over stabilized head-cut or constructed riffle according to NMFS 2011 (or most recent version). Passage can be provided through a series of log of rock weir structures or constructed riffles (NMFS, 2022).
- Armor features intended for grade stabilization with sufficient size and amounts of material to provide a structure capable of withstanding a 100-year flow event without further progressing the headcut or substantially degrading the riffle.
- Headcut stabilization structures and constructed riffles will be constructed utilizing an engineered stream simulation bed material, which will be pressure washed into place until surface flow is apparent and minimal subsurface material to ensure fish passage immediately following construction (if natural flows are sufficient). Successful washing will be determined by minimizing voids within placed matrix such that ponding occurs with little to no percolation losses.
- For grade stabilization efforts, design considerations should extend beyond the control structure to include the plunge pool downstream and the upstream approach. Also consider floodplain return flows and flanking that could create potential new headcut conditions, and potential changes in bank erosion conditions due to structure placement.
- Minimize lateral migration of the channel around the head cut or riffle (“flanking”) by designing the downstream face with a lower elevation in the center of the channel cross section to direct flows to the middle of channel.
- Materials used for construction can be native to the area if gradation is shown to be appropriate.

NMFS engineering review is required for headcut or grade stabilization actions greater than or equal to 18 inches in height.

#### **4.1.3. NMFS and ODFW Design Guidelines**

NMFS anadromous fish passage criteria restricts the design of constructed riffles. The maximum length is restricted to 150 longitudinal feet; maximum slope along the constructed riffle is restricted to 6 percent; and the minimum hydraulic depth during design low flow (95 percent exceedance) is 1 foot for adult passage (NMFS, 2022). Based on NMFS requirements, the effective screen area shall be large enough to restrict approach velocity to 0.4 fps for active screens, and the percent open area for any screen material must be at least 27 percent. Screen face openings must not exceed 3/32 inch diameter (NMFS, 1996).

ODFW constructed riffle fish passage design criteria are based on hydraulic model results. Oregon fish passage criteria are identified in the Oregon Administrative Rules (OAR) Section 635-412-0035, Fish Passage Criteria (Oregon Secretary of State, 2022). The OARs identify constructed riffles as a fishway and indicate the applicant must demonstrate how water depths and water velocities provide fish passage. Therefore, the NMFS hydraulic model results were considered applicable to demonstrate compliant fish passage conditions. The OARs also recommend a minimum width for passage during design low-flow conditions of 1 foot (Oregon Secretary of State, 2022).

The following subsections describe the project elements designed under the responsible charge of an engineer licensed in the state of Oregon. Each project element description will be summarized in more detail in the subsequent design stages. The general conservation measures are included on the design drawings in Appendix A.

**4.2. Project Element 1 - Constructed Riffle Grade Control and Royes Dam Modification**

The current use of Royes Dam involves the placement of wood boards on the steel frame, perpendicular to the channel to create sufficient head for the operation of the existing irrigation pumps. This operation creates a fish passage barrier. To discourage the continued use of Royes Dam in a manner that creates a fish passage barrier, the project proposes an agreement to remove the existing angle iron currently attached to the concrete piers that are used to hold boards in place and to remove the center pier from the structure. This proposed action is described by HIP Category 1b—consolidate or replace existing irrigation structures (Bonneville Power Administration, 2021). The agreement would require the removal of the elements within a 5-year period.

To replace the Royes Dam fish passage barrier, GeoEngineers designed a constructed riffle to provide grade control and maintain a minimum pool elevation sufficient for the operation of the three new irrigation pumps. The constructed riffle is located downstream of the pump 1 intake relocation to provide a minimum operating pool elevation. A summary of proposed conditions hydraulic modeling results, including depth at the proposed pump intakes, is included in Section 5.3. To provide the best practical fish passage conditions and maintain a medium risk classification (Bonneville Power Administration, 2021), the constructed riffle was designed with a crest elevation roughly equal to the current Royes Dam operating elevation of 2684.1 feet. The proposed pump 1 motor elevation will be placed above the existing conditions 100-year water surface.

**4.3. Proposed Element 2 – Replace Irrigation Pump and Retrofit Irrigation Pump Intakes**

The project proposes to replace one of the four existing irrigation pumps that divert water from Willow Creek as described by HIP Category 1b—consolidate or replace existing irrigation structures (Bonneville Power Administration, 2021). The project proposes to upgrade the existing intake structures at pumps 2, 3 and 4 upstream of Royes Dam to meet NMFS criteria for screen size and impingement velocity. The project does not propose to consolidate multiple points of diversion. Existing pumps 2 and 3 will be replaced with a single pump. Design guidelines applicable to this category for the pump replacement proposed element are described in Section 4.1.1.

The proposed end-of-pipe screens have maximum diameter face openings of 3/32 of an inch, and their minimum screen surface areas were calculated assuming a 70 percent open area and a maximum velocity of 0.4 fps. Screen sizes for each pump, based on their certified water right, are summarized in Table 9. We consulted with a pump specialist and identified intake screen diameters required for the water rights identified in Section 3.5 and the minimum intake screen areas identified in Table 9. Screen diameters and lengths for each of the four pumps are specified on the design drawings in Appendix A.

**TABLE 9. MINIMUM PUMP SCREEN SIZES**

Pump	Certified Water Right (cfs)	Minimum Screen Size (ft <sup>2</sup> )
1	11.17	40
2 and 3	8.86 <sup>1</sup>	32
4	6.00	21

Note:  
Pumps 2 and 3 design flow rates assume one replacement pump will provide the total permitted water right individually.

Turbine-style irrigation pumps allow pump impellers to be located below water surface elevation, which limits the required pool elevation. Therefore, a turbine-style pump is proposed to replace existing pump 1 located immediately upstream of Royes Dam. The locations and a schematic-level drawing of pump 1 and the proposed intake screen upgrades are included in Appendix A. We discussed minimum clearance above channel bed and minimum depth below pool with pump specialists. We also consulted with the water users regarding necessary minimum pool elevations for the operation of the four pumps. Based on those conversations, we targeted a minimum low-flow pool elevation of 2684.1 feet (NAVD88) at the proposed pump 1 location. The proposed minimum pool elevation provides a vertical separation of 0.5 feet between the stream bed and the bottom of the intake screen and a minimum depth above the top of the intake screens of 1.5 feet during low pool operation. A summary of targeted low-pool elevations for each pump location is included in

Table 10. The resulting low-flow pool elevation at pump 4 is based on channel roughness and longitudinal slope. A description of hydraulic model results is included in Section 5.3

**TABLE 10. PROPOSED PUMP MINIMUM POOL ELEVATION**

<b>Pump</b>	<b>Approximate Pump Elevation (Ft NAVD88)</b>	<b>Intake Screen Diameter (ft)</b>	<b>Intake Screen Bottom/Top Elevation (Ft NAVD88)</b>	<b>Minimum Low-Flow Pool Elevation (Ft NAVD88)</b>
1	2690.0	3.0	2677.5/2680.5	2682.0
2 and 3	2694.6	2.5	2679.0/2681.5	2683.0
4	2694.0	2.5	2680.5/2683.0	2684.5

#### 4.4. Proposed Element 3 – Sluiceway and Headgate

We identified sediment deposition upstream of the constructed riffle to be a potential risk to pump operations. To mitigate the risk of local sediment deposition and to reduce the maintenance requirements for the proposed pump 1 intake, we designed a sluiceway with a manually operated headgate on the eastern side of the constructed riffle along the outside bend of the meander. The sluiceway will be operated by raising the headgate at the end of irrigation season to accommodate higher annual flows over winter and prior to the start of irrigation season during the spring and summer. The proposed sluiceway and manually operated headgate are shown in the draft final design drawings in Appendix A.

## 5.0 HYDRAULIC MODELING AND ANALYSIS

### 5.1. Model Development

GeoEngineers developed a two-dimensional hydraulic model of the project reach using the U.S. Bureau of Reclamation’s Sedimentation and River Hydraulics—Two Dimensional (SRH-2D) Version 3.2.3 (USBR, 2017) computer program, a two-dimensional hydraulic and sediment transport numerical model (Aquaveo, 2018).

### **5.1.1. Model Elevation Surface**

The existing conditions channel geometry data in the model were developed from topographic surveys performed by Resource Specialists Inc. (RSI) in 2019 and in 2022. The survey data were supplemented with publicly available LiDAR. The proposed channel geometry was developed from the proposed grading surface created by GeoEngineers, Inc., representing the proposed constructed riffles and the proposed bank fill adjacent to pumps 2 and 3.

### **5.1.2. Model Domain and Computational Mesh**

The existing conditions hydraulic model includes approximately 525 feet of Willow Creek, downstream of the existing Royes Dam, and extends upstream to the confluence of Willow Creek and Mill Creek. The upstream model extents are approximately 1,780 feet upstream of pump 4. The model extents include approximately 5,700 feet of total channel length.

The existing conditions mesh, shown in Figure 3, has 26,055 nodes and 38,694 elements. The proposed conditions mesh, at the constructed riffles downstream of pump 1 and downstream of pumps 2 and 3, are shown in Figure 3. The proposed mesh has 28,913 nodes and 42,172 elements. The computational mesh elements were a combination of patched (quadrilateral) and paved (triangular) elements, with finer resolution in the channel and larger elements in the floodplain.

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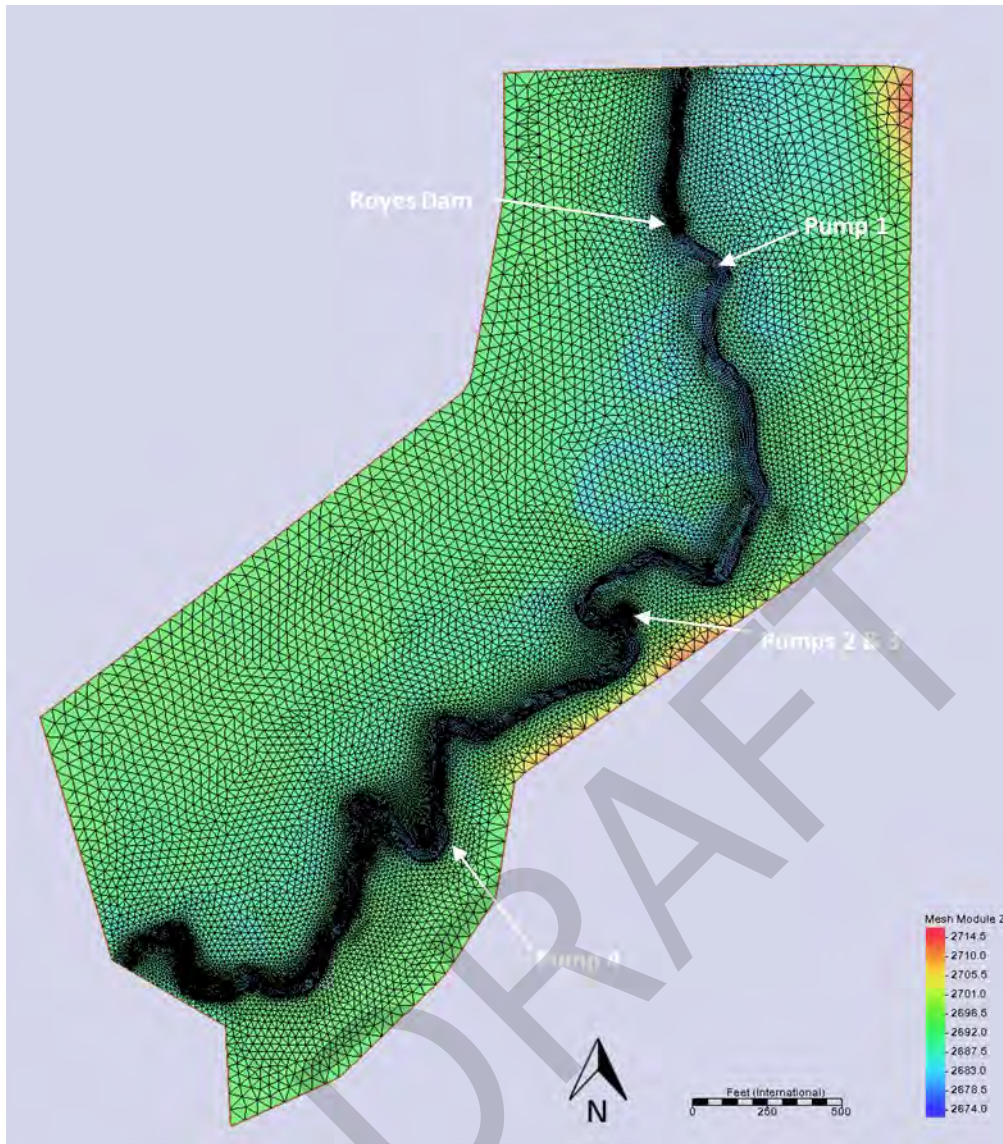


Figure 3. Existing conditions model computational mesh

### 5.1.3. Model Roughness

Manning's  $n$  is the parameter used to define roughness of dissimilar materials (i.e., surfaces) found within the model's extents. Material coverages that define the extents of Manning's  $n$  regions were delineated for the existing and proposed conditions models. We developed material coverages using the existing conditions survey, aerial photography, and information gathered from the site assessments. Calculations of selected Manning's  $n$  channel values are included in Appendix C, Hydrologic and Hydraulic Analysis.

Manning's  $n$  regions for floodplain areas, roadways, and valley slopes were delineated using aerial photography and field visit photos. Manning's  $n$  values representing each roughness region were selected from references and were based on observed conditions during the site assessments. The existing and

proposed conditions in-channel Manning’s n values are composite values based on combining tabular and photographic guidance (Yochum, 2018).

The existing conditions model contains two in-channel roughness regions. We modeled existing conditions in-channel roughness with one coverage and Royes Dam roughness separately. We modeled the existing floodplain with three material roughness regions to account for the gravel roads, upland grass, and the existing meander scrolls throughout the reach. Specific Manning’s n values and a description of the material coverages are included in Table 11.

The proposed conditions model contains five different in-channel roughness regions. Two are consistent with the existing conditions in-channel and the other represents the proposed constructed riffle and sluice roughness. We calculated the constructed riffle roughness Manning’s n to account for the proposed material gradation (Yochum, 2018). The roughness values of the proposed conditions upland areas match those used in the existing conditions model and are included in Table 11.

**TABLE 11. MANNING’S N HYDRAULIC ROUGHNESS COEFFICIENT VALUES USED IN THE SRH-2D MODELS**

Coverage Description	Model Condition	Manning’s n
In Channel	Existing/Proposed	0.047
Constructed Riffle	Proposed	0.052
Upland Grass	Existing/Proposed	0.070
Upland Relic Channel	Existing/Proposed	0.065
Gravel Roads	Existing/Proposed	0.025
Royes Dam	Existing/Proposed	0.020
Sluice Way	Proposed	0.048
Sheet Pile Wall	Proposed	0.022

**5.1.4. Boundary Conditions**

The SRH-2D model utilizes user-defined boundary conditions to reflect flow entering and exiting the model’s mesh. Boundary condition locations for the SRH-2D existing and proposed conditions hydraulic models are shown in Figure 4. A downstream, constant normal depth water surface elevation boundary condition was applied to all simulations of the existing and proposed condition models. The normal depth water surface elevation for each simulated flow was calculated using the downstream average slope (0.001 feet/feet) and composite Manning’s n value (0.047) as shown in Table 11.

Royes Dam was modeled by incorporating the vertical concrete elements into the model surface. Existing conditions were modeled under two conditions: with boards in and with boards out. We modeled the boards in condition using a weir boundary condition at the location of Royes Dam with a weir crest elevation equal to 2684.1 ft (NAVD88). The proposed conditions model assumed boards out at Royes Dam for all simulations.

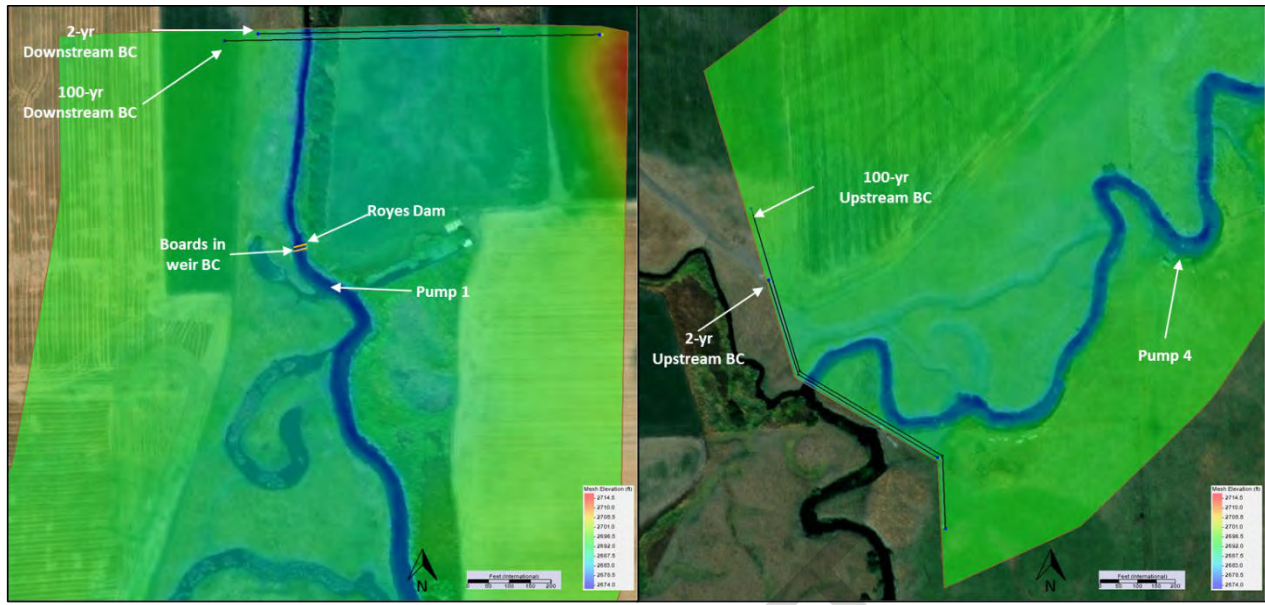


Figure 4. Willow Creek hydraulic model boundary conditions

## 5.2. Existing Conditions Model Results

We assessed the existing conditions SRH-2D model results to evaluate current hydraulic conditions for the fish passage 5 and 95 percent exceedance flows, the 2-, and 100-year peak flood events for Willow Creek through the project reach. Inundation extents and results extracted at selected cross section locations are discussed in the following section. We considered the 2-year flow event to be a surrogate for channel-forming flows and used hydraulic model results to assess impacts to sediment transport and bankfull width. We assessed the 100-year flow event to identify flood risk impacts. Model results were extracted at cross sections located at each proposed pump location and downstream of Royes Dam. The modeled existing condition WSEs at each proposed pump location are reported in Appendix C.

## 5.3. Proposed Conditions Model Results

We assessed the proposed conditions SRH-2D model results to evaluate resulting pool elevations during low-flow conditions to design constructed riffle material gradation, evaluate fish passage, and assess sediment transport conditions. Low-flow conditions were modeled using the 95 percent exceedance for low-flow fish passage (20.5 cfs) to inform the design under the proposed conditions model. Model results were extracted at cross sections located at each proposed pump location and downstream of Royes Dam. The modeled proposed condition WSEs at each proposed pump location are reported in Appendix C.

Inundation extents and results extracted at selected cross section locations are discussed in the following section. We considered the 2-year flow event and the 5 percent exceedance for high-flow fish passage to be surrogates for channel-forming flows and used hydraulic model results to assess impacts to sediment transport and bankfull width. We assessed the 100-year flow event to identify flood risk impacts.

### 5.3.1. Irrigation Pump Pool Elevations

During summer low-flow conditions, Willow Creek conveys discharges that approach zero cfs. Therefore, we assumed the minimum pool elevation available for pump discharge within Willow Creek at pump 1, is

equal to the design elevation at the constructed riffle downstream of the pump. We are not proposing a constructed riffle downstream of pumps 2, 3 and 4, and we modeled the low fish passage design flow for summer steelhead reported in Table 2 for the proposed conditions to inform the available pool elevation at pumps 2, 3 and 4. The constructed riffle and modeled pool elevations for each proposed pump location are included in Table 12. The available pool elevation shown in Table 12 exceed the minimum pool elevations assumed for pump replacement reported in Table 10.

**TABLE 12. AVAILABLE LOW POOL WATER SURFACE ELEVATIONS**

<b>Pump</b>	<b>Existing Condition Average Low-Flow Pool Elevation (ft NAVD88)</b>	<b>Proposed Condition Average Low-Flow Pool Elevation (Ft NAVD88)</b>	<b>Difference in Minimum Low-Flow Pool Elevation (ft NAVD88)</b>
Pump 1	2684.8	2684.8	+2.8
Pumps 2 and 3	2684.8	2684.8	+1.8
Pump 4	2684.8	2684.8	+0.3

Note:

Elevations based on design constructed riffle grade control elevation.

### 5.3.2. Channel Material Stability

GeoEngineers assessed material stability for the proposed roughened channel and the bank of the proposed sluiceway using the United States Forest Service (USFS) stream simulation methodology (USFS, 2008). We calculated a D<sub>50</sub> material gradation that was not mobilized during the 100-year peak flow event for both facilities. For the constructed riffle, a well-graded material with a maximum aggregate size equal to a 8-inch cobble was modeled as stable at the 100-year flow event. For the channel bank on the eastern side of the proposed sluiceway, a well-graded material with a maximum aggregate size equal to a 2.5-inch cobble was modeled as stable at the 100-year flow event. The proposed constructed riffle and channel bank of the sluiceway material sizes are shown in Table 13. The design drawings in Appendix A indicate the composition percentage and size classes necessary to create the proposed material gradations.

**TABLE 13. PROPOSED GRADED STREAMBED MATERIAL**

<b>Di</b>	<b>Constructed Riffle Material Diameter (inches)</b>	<b>Sluiceway Embankment Material Diameter (inches)</b>
D16	0.6	0.0
D50	2.2	0.8
D84	5.8	2.1
D95	7.3	2.4
D100	8.0	2.5

### 5.3.3. Headgate Scour and Scour Countermeasure

The proposed sluiceway headgate uses sheet pile walls to hold the headgate in place and a concrete sill at the bottom of the gate. The upstream limits of the sluiceway cause a contraction of flow while the headgate is open and flow is directed through the sluiceway. Sheet pile walls used on the eastern

channel bank cause a contraction of flow while the headgate is open. We followed methodology published in the Federal Highway Administration's (FHWA) Hydraulic Engineering Circular 18 (HEC-18) to calculate contraction scour depths at the upstream entrance into the sluiceway and at the headgate location for the 100-year flow. Within FHWA's Hydraulic Toolbox software program, contraction scour is computed for both clear water and live bed conditions (FHWA, 2012). We assessed the proposed sluiceway material gradation to identify the scour depth. . We calculated a contraction scour depth of 0.0 feet.

We designed a riprap scour countermeasure at the headgate location using the FHWA's Hydraulic Toolbox software program and hydraulic modeling results from proposed condition hydraulic model. We selected riprap material gradations defined in the Oregon Department of Transportation (ODOT) 2021 standard specifications (ODOT, 2021). Based on the results of the Hydraulic Toolbox analysis, an ODOT Class 50 riprap provides a stable material for the design scour flow event.

#### **5.3.4. Sediment Transport**

The critical shear method of sediment transport analysis is appropriate for channel with longitudinal slopes less than 5 percent (USFS, 2008). GeoEngineers compared the proposed conditions modeled shear stress to the existing conditions modeled shear for the design high fish passage flow of 261.5 cfs and the 2-year channel forming flow of 614.0 cfs to assess impacts to the sediment transport capacity of Willow Creek. Willow Creek sediment transport is controlled by peak runoff events that occur prior to the start of the annual irrigation season and prior to the implementation of the elevation controlling mechanisms in Royes Dam. The existing conditions model assumed a boards out scenario at Royes Dam and the proposed conditions model assumed the proposed headgate within the sluice way was open. The hydraulic impacts of Royes Dam are similar in the existing and proposed conditions hydraulic models and the model results provide a comparison of shear stress.

Based on the model results reported in Table 14, the 2-year peak recurrence interval shear stress results upstream of the constructed riffles match existing conditions upstream of the pump 1 constructed riffle. One-dimensional hydraulic results were extracted at a cross section upstream of the designed constructed riffle, at the proposed location of pump 1. The shear stress value modeled upstream of the constructed riffle at pump 1 were consistent in the existing and proposed conditions for both flow events. No constructed riffles are proposed downstream of pumps 2 and 3, and pump 4; therefore, bedload transport conditions were not compared between existing and proposed conditions. The results of the shear stress analysis indicate that there is minimal risk to sediment deposition at the pump 1 screen intake location. The proposed condition pool elevation provides sufficient depth to reduce the risk of maintenance requirements to maintain the function of the Pump 1 intake screen.

**TABLE 14. BEDLOAD TRANSPORT CONDITIONS CROSS SECTION UPSTREAM OF PROPOSED CONSTRUCTED RIFFLE**

Hydraulic Parameter	2-YEAR (614.0 cfs)		Design High Fish Passage Flow (261.5 cfs)	
	Existing Condition	Proposed Condition	Existing Condition	Proposed Condition
Average Velocity (fps)	1.6	1.5	1.4	1.1
Average Shear (lb/sf)	0.1	0.1	0.1	0.1

**5.3.5. Fish Passage Hydraulic Design**

We assessed the hydraulic design for the fish passage low-flow conditions for the proposed conditions at two locations. Hydraulic model results for the fish passage flow criteria listed in Table 2 were calculated at cross sections 1 (STA 5+45) and 2 (STA 6+28), shown in Figure 5. Cross section 1 is located at the downstream end of the proposed constructed riffle for pump 1. Cross section 2 is located at the crest of the constructed riffle for pump 1. Critical velocity at the downstream end of the roughened channel and critical depth at the upstream end of roughened are summarized in Tables 13 and 14, respectively. We modeled critical depth and critical velocity for spring/summer Chinook adults high fish passage flow (6.6 cfs) and low fish passage flow (2.4 cfs), and steelhead and Chinook juvenile high fish passage flow (11.7 cfs) and low fish passage flow (3.5 cfs) in FHWA’s Hydraulic Toolbox software program.

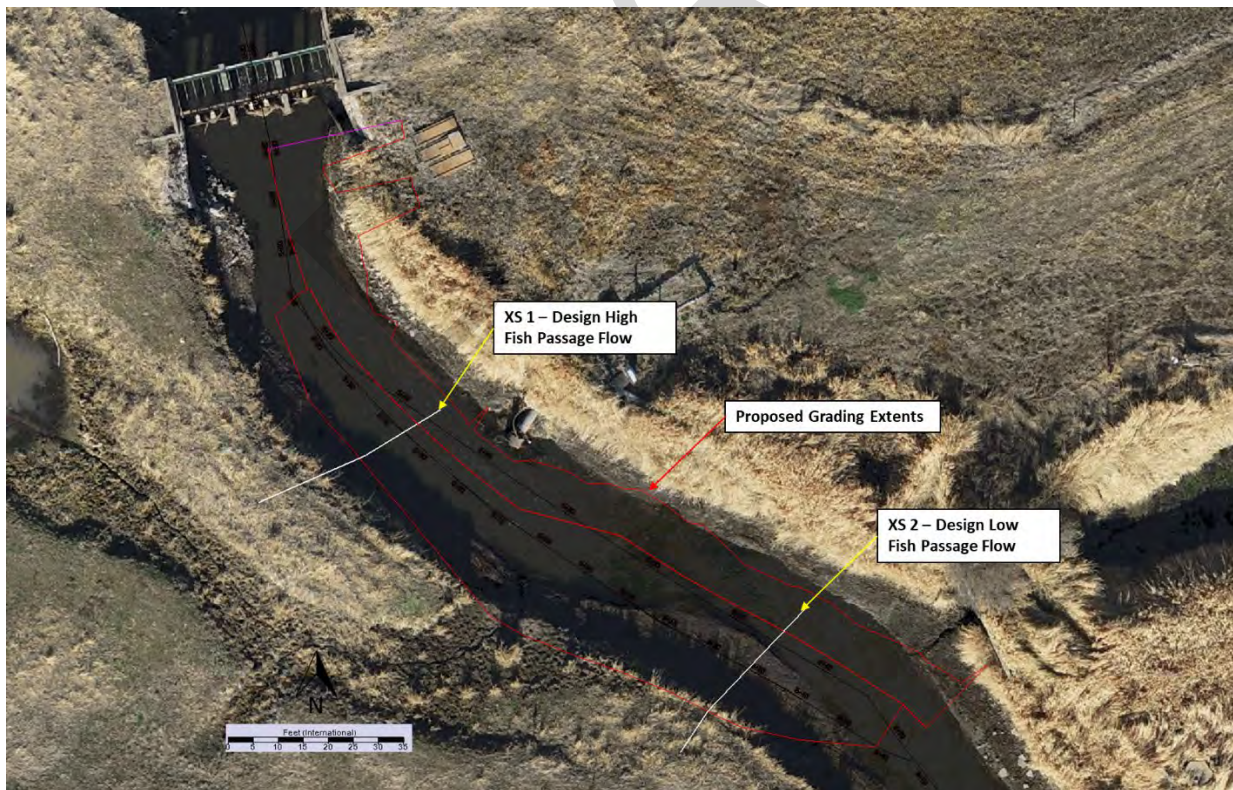


Figure 5. Fish passage cross section locations

**TABLE 15. DESIGN HIGH FISH PASSAGE FLOW VELOCITY**

Location	Species and Life Stage	Design High Fish Passage Flow (cfs)	Average Velocity (ft/s)
XS 1 – Pump 1	Spring Chinook/Adults	6.6	2.2
XS 1 – Pump 1	Steelhead/Adults	261.5	2.1
XS 1 – Pump 1	Steelhead & Chinook Juveniles	11.7	2.8

**TABLE 16. DESIGN LOW FISH PASSAGE FLOW DEPTH**

Location	Species and Life Stage	Design Low Fish Passage Flow (cfs)	Maximum Depth (ft)
XS 2 – Pump 1	Spring Chinook/Adults	2.4	0.4
XS 2 – Pump 1	Steelhead/Adults	20.5	0.3
XS 2 – Pump 1	Steelhead & Chinook Juveniles	3.5	0.5

## 6.0 CONSTRUCTION

### 6.1. Area of Potential Effects and Conservation Measures

The area of potential effect (APE) is shown on the design drawings in Appendix A. The APE includes access from public rights-of-way, staging and site disturbance boundaries. We recommend work zone isolation plans be designed for a flow of 13.0 cfs during construction. This flow is based on the 10 percent exceedance discharge for the project reach reported in Section 3.4 and Table 3. Conservation measures applicable to all actions are also shown on the design drawings in Appendix A.

### 6.2. Construction Quantities and Estimate of Anticipated Construction Costs

GeoEngineers calculated construction quantities and applied unit costs based on recent project experiences, engineering judgment, and published documentation (RS Means, 2023). We included a summary of the anticipated construction costs in Appendix E, Construction Quantities and Estimate of Anticipated Costs.

## 7.0 LIMITATIONS

We have prepared this report for Union Soil and Water Conservation District for the Willow Creek Royes Dam Fish Passage Restoration project in Union County, Oregon. Union Soil and Water Conservation District may distribute copies of this report to their authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of stream and river habitat enhancement, stabilization and restoration design engineering in this area at the time this report was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to our services and this report.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

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**APPENDIX A**  
**Draft Final Design Drawings**

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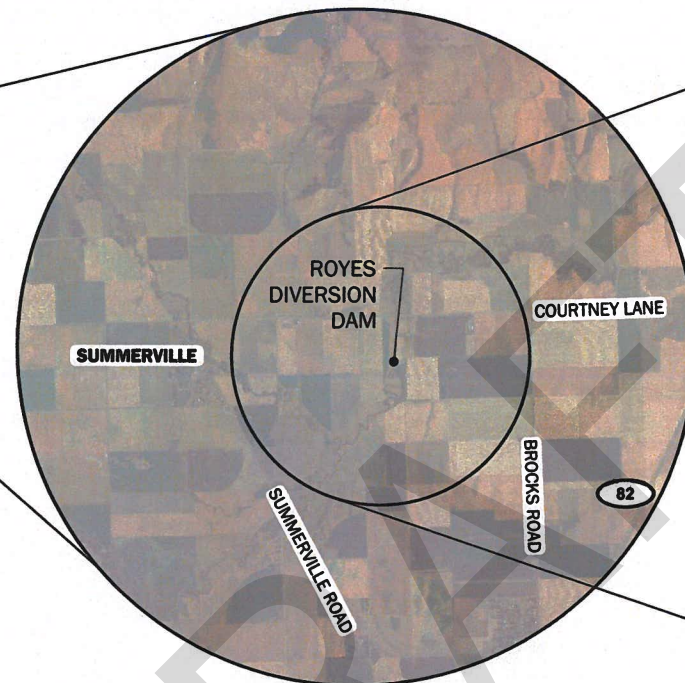
# ROYES DAM FISH PASSAGE RESTORATION

## SUMMERVILLE, OREGON

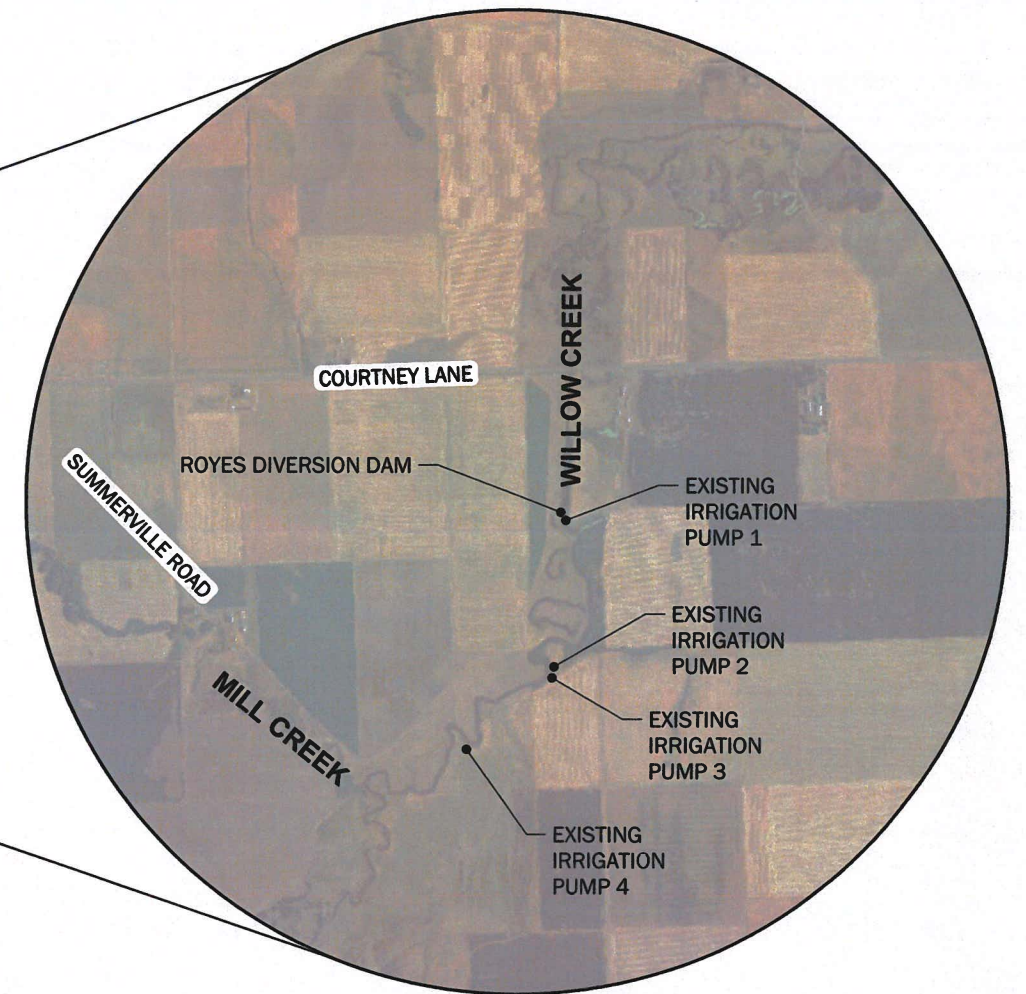
### DRAFT FINAL DESIGN



UNION COUNTY, OREGON



NOT TO SCALE



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#### SHEET INDEX

Sheet Number	Drawing Number	Sheet Title
1	1.0	Cover Sheet
2	1.1	General Notes, Quantities and Legend
3	2.0	Willow Creek Site Map
4	2.1	Pump 1 Existing Conditions
5	2.2	Pumps 2 and 3 Existing Conditions
6	2.3	Pump 4 Existing Conditions
7	3.0	Pump 1 Construction Access and Staging Plan
8	3.1	Pumps 2, 3 and 4 Construction Access and Staging Plan
9	3.2	Pump 1 Temporary Water Management Plan
10	3.3	Pumps 2 and 3 Temporary Water Management Plan and Intake Upgrade
11	3.4	Pump 4 Temporary Water Management Plan and Intake Upgrade
12	4.0	Pump 1 Channel Grading Plan and Profile
13	4.1	Pump 1 Plan and Section
14	5.0	Constructed Riffle and Sluice Typical Channel Section
15	5.1	Sluice Gate Details
16	6.0	Revegetation Plan
17	6.1	Revegetation Details and Quantities
18	7.0	BPA HIP IV - General Conservation Measures
19	7.1	BPA HIP IV - General Conservation Measures

#### CONTACT INFORMATION

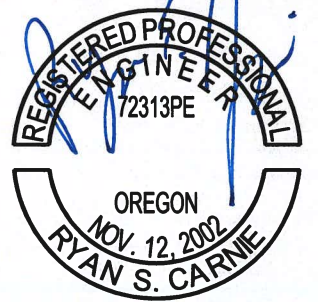
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**THIS PROJECT WAS DESIGNED IN ACCORDANCE WITH THE BPA HABITAT IMPROVEMENT PROGRAM, PROGRAMMATIC BIOLOGICAL OPINION (HIP IV).**



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DESIGNED BY: KHR
DRAWN BY: KHR/SCY
APPROVED BY: RSC
REVISION NO.: —
DATE: 06/30/23



ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON

**COVER SHEET**

DRAWING NUMBER:  
**1.0**  
 SHEET: 1 OF 19

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 Plot: 06/30/2023, 21:01 | sjf

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- GEOLOGIC CONDITIONS CAN CHANGE AND THESE DESIGNS ARE BASED ON CONDITIONS THAT EXISTED AT THE TIME THE DESIGN WAS PERFORMED. THE RESULTS OF THESE DESIGNS MAY BE AFFECTED BY THE PASSAGE OF TIME, BY MANMADE EVENTS SUCH AS CONSTRUCTION ON OR ADJACENT TO THE SITE, OR BY NATURAL EVENTS SUCH AS FLOODS, EARTHQUAKES, SLOPE INSTABILITY OR GROUNDWATER FLUCTUATIONS. ALWAYS CONTACT GEOENGINEERS BEFORE APPLYING THESE DESIGNS TO DETERMINE IF THEY REMAIN APPLICABLE.
- ALL RIVERS, STREAMS, ROCKS AND FISH PASSAGE STRUCTURES ARE POTENTIALLY DANGEROUS. THESE PROPOSED IMPROVEMENTS ARE INTENDED TO ADDRESS FISH PASSAGE CONSTRAINTS. THESE STRUCTURES ARE INHERENTLY DANGEROUS TO PEOPLE IN OR AROUND THEM. USWCD AND THE PROPERTY OWNER SHOULD ADDRESS SAFETY CONCERNS APPROPRIATELY.
- POTENTIAL REGULATORY CHANGES TO FLOOD ELEVATIONS AND FLOOD EXTENTS RESULTING FROM THE PROPOSED ENHANCEMENTS HAVE NOT BEEN ADDRESSED BY GEOENGINEERS AS PART OF THIS PROJECT.
- IN GENERAL, THE PROPOSED ENHANCEMENTS ARE INTENDED TO RESULT IN MORE STABLE STREAMBEDS, BANKS AND FLOODPLAINS. HOWEVER, CHANNEL EROSION, CHANNEL MIGRATION AND/OR AVULSIONS CAN BE EXPECTED TO OCCUR OVER TIME. THESE CHANNEL PROCESSES ARE NATURAL AND APPROPRIATE FOR THESE STREAM SYSTEMS.
- DESIGN SPECIFICS FOR STRUCTURES SHALL BE CONFIRMED AND/OR VERIFIED BY A QUALIFIED ENGINEER PRIOR TO OR DURING CONSTRUCTION AT EACH PROPOSED STRUCTURE LOCATION.
- THESE FIGURES WERE ORIGINALLY PRODUCED IN COLOR.

**PROJECT GOAL:**

IMPROVE FISH PASSAGE THROUGH THE ROYES DAM PROJECT REACH OF WILLOW CREEK.

**PROJECT OBJECTIVES:**

TO ACHIEVE THE PROJECT GOAL, OUTLINED ABOVE, THE FOLLOWING OBJECTIVES HAVE BEEN DEVELOPED:

- PROVIDE FISH PASSAGE FOR JUVENILE AND ADULT SUMMER STEELHEAD AND SPRING/SUMER CHINOOK SALMON DURING PERIODS OF MIGRATION.
- ACHIEVE ODFW AND NMFS FISH PASSAGE CRITERIA TO THE GREATEST EXTENT PRACTICABLE.
- DEVELOP FISH PASSAGE DESIGNS THAT SUPPORT AND MAINTAIN THE USE OF IRRIGATION WATER FOR WATER USERS.
- MINIMIZE LONG-TERM MAINTENANCE FREQUENCY AND EXPENSE ASSOCIATED WITH PROJECT INFRASTRUCTURE FOLLOWING CONSTRUCTION.
- PROVIDE A SUSTAINABLE, PERMITTABLE, MAINTAINABLE DESIGN AT A REASONABLE COST.

**CONSTRUCTION NOTES:**

- ALL CONTRACTORS WORKING WITHIN THE PROJECT BOUNDARIES ARE RESPONSIBLE FOR COMPLIANCE WITH ALL APPLICABLE SAFETY LAWS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL BARRICADES, SAFETY DEVICES AND CONTROL OF TRAFFIC WITHIN AND AROUND THE CONSTRUCTION AREA.
- ALL MATERIAL AND WORKMANSHIP FURNISHED ON OR FOR THE PROJECT MUST MEET THE MINIMUM REQUIREMENTS OF PROJECT PERMITS, APPROVING AGENCIES, SPECIFICATIONS AS SET FORTH HEREIN, OR WHICHEVER IS MORE RESTRICTIVE.
- ALL FEDERAL, STATE AND LOCAL PERMITS SHALL BE OBTAINED BY THE CLIENT PRIOR TO CONSTRUCTION ACTIVITY COMMENCEMENT.
- THE CONTRACTOR SHALL INSTALL AND MAINTAIN APPROPRIATE EROSION AND SEDIMENT CONTROL DEVICES THROUGHOUT THE WHOLE PROJECT SITE, INCLUDING THOSE ASSOCIATED WITH CONSTRUCTION ACCESS, STAGING AND STOCKPILE AREAS THROUGHOUT THE PROJECT'S CONSTRUCTION PERIOD. TEMPORARY CONSTRUCTION AND PERMANENT EROSION CONTROL MEASURES SHALL BE DESIGNED, CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS.
- CONSTRUCTION ACTIVITY SHALL BE LIMITED TO THE CONSTRUCTION AREAS AND ACCESS ROUTES TO MINIMIZE DISTURBANCE OF THE EXISTING VEGETATION AND LANDSCAPE. ALL PUBLIC AND PRIVATE PROPERTY EITHER INSIDE OR OUTSIDE THE CONSTRUCTION LIMITS IMPACTED BY CONSTRUCTION SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN THAT WHICH EXISTED PRIOR TO THE CONSTRUCTION. NO CONSTRUCTION-RELATED MATERIALS, DEBRIS, GARBAGE, EQUIPMENT, FUEL, PROVISIONS OF ANY KIND SHALL REMAIN ON SITE AFTER CONSTRUCTION. NO STOCKPILES OR EXCAVATIONS ARE TO REMAIN AFTER CONSTRUCTION UNLESS AUTHORIZED BY THE LANDOWNER. THE SITE WILL BE GRADED TO APPEAR NATURAL AND CONFORM TO THE NATURAL TOPOGRAPHY.
- CONSTRUCTION SHALL MINIMIZE DISTURBANCE TO, AND MAXIMIZE REUSE OF, EXISTING RIPARIAN VEGETATION TO REMAIN AND SALVAGE.
- ONLY APPROPRIATE APPROVED NATIVE RIPARIAN VEGETATION SHALL BE USED FOR CUTTINGS AND TRANSPLANTING. VEGETATION CUTTING, TRANSPLANTING, PLANTING AND IRRIGATION SHALL BE MANAGED BY AN APPROPRIATE PROFESSIONAL.
- CONSTRUCTION RECORDS AND AS-BUILT INFORMATION SHALL BE ACCURATELY RECORDED BY THE CONTRACTOR AND SUPPLIED TO THE OWNER AND GEOENGINEERS, REFERENCE AND MONITORING. SUBMITTAL OF RECORD INFORMATION IS A CONDITION OF FINAL ACCEPTANCE.
- THIS DESIGN HAS BEEN PERFORMED AND THESE PLANS HAVE BEEN PREPARED WITH THE EXPRESS UNDERSTANDING THAT GEOENGINEERS WILL BE ON-SITE DURING CONSTRUCTION TO HELP THE CONTRACT INTERPRET THE DESIGN PLANS AND INTENT.

**CONSTRUCTION QUANTITIES:**

Item #	NRCS Specification Pay Item #	Item Description	Units	No. of Units
1	1	Clearing	AC	1
2	3	Structure Removal (Irrigation Intakes)	EA	4
3	5	Pollution Control	LS	1
4	6	Seeding, Sprigging, Mulching	AC	0.4
5	7	Construction Surveys	Day	2
6	8	Mobilization and Demobilization	LS	1
7	11	Removal of Water	LS	1
8	13	Sheet Pile	SF	2500
9	21	Excavation	CY	220
10	23	Earthfill - Constructed Riffle Streambed	CY	210
11	23	Earthfill - Native Backfill	CY	275
12	26	Topsailing	CY	10
13	27	Diversions and Waterways	FT	300
14	32	Structure Concrete	CY	1
15	34	Steel Reinforcement	TON	0.5
16	53	Ductile Iron Pipe	FT	380
17	61	Rock Riprap	CY	9
18	71	Water Control Gates	LS	1
19	99	Pump 1 Intake screen and Pump	LS	1
20	99	Pump 2/3 Intake and Pump	LS	1
21	99	Pump 4 Intake and Pump	LS	1
22	99	Pump 4 Intake and Pump	LS	1

**LEGEND (EXISTING)**

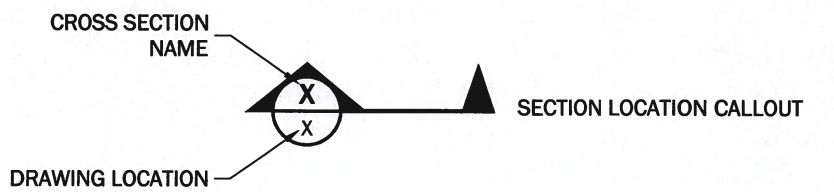
- EXISTING MAJOR CONTOUR LINE - 5'
- EXISTING MINOR CONTOUR LINE - 1'
- WILLOW CREEK ALIGNMENT
- PARCEL BOUNDARY
- APPROXIMATE EXISTING OWHM
- EXISTING OVERHEAD POWER LINE
- FLOW DIRECTION

**LEGEND (PROPOSED)**

- PROPOSED MAJOR CONTOUR LINE - 5'
- PROPOSED MINOR CONTOUR LINE - 1'
- TEMPORARY ACCESS ROUTE
- TEMPORARY STAGING, STORAGE AND REFUELING LOCATION
- APPROXIMATE DISTURBANCE BOUNDARY
- CONSTRUCTED RIFFLE FILL MATERIAL
- APPROXIMATE EXCAVATION BOUNDARY
- CONSTRUCTED RIFFLE GRADING LIMITS
- AREA OF POTENTIAL EFFECT (APE) BOUNDARY
- TEMPORARY WORK ZONE ISOLATION STRUCTURE
- FISH EXCLUSION NETTING
- TEMPORARY WORK ZONE ISOLATION PIPE
- WORK ZONE ISOLATION PUMP

**LEGEND (RESTORATION)**

- RIPARIAN ZONE
- UPLAND ZONE (SEED MIX)



- SURVEY NOTES:**
- SHEETS ARE PROJECTED IN OREGON STATE PLAN, NORTH, INTERNATIONAL FEET. NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
  - EXISTING SURVEY PROVIDED BY RSI, OCTOBER 2022.
  - AERIAL IMAGERY PROVIDED BY RSI, OCTOBER 2022.



P:\19193690\03\CAD\01\Royes\_Fish\_Passage\_Restoration\02\_Draft Final\193690301\_Sht 2\_1.1 [General Notes, Quantities and Legend].dwg

NO.	DATE	BY	ISSUE / DESCRIPTION

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DRAWN BY: KHR/SCY  
APPROVED BY: RSC  
REVISION NO.:  
DATE: 06/30/23

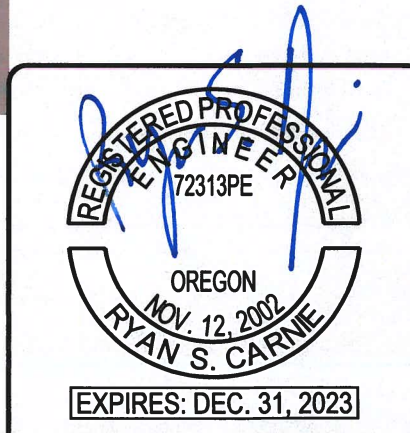
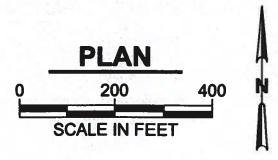
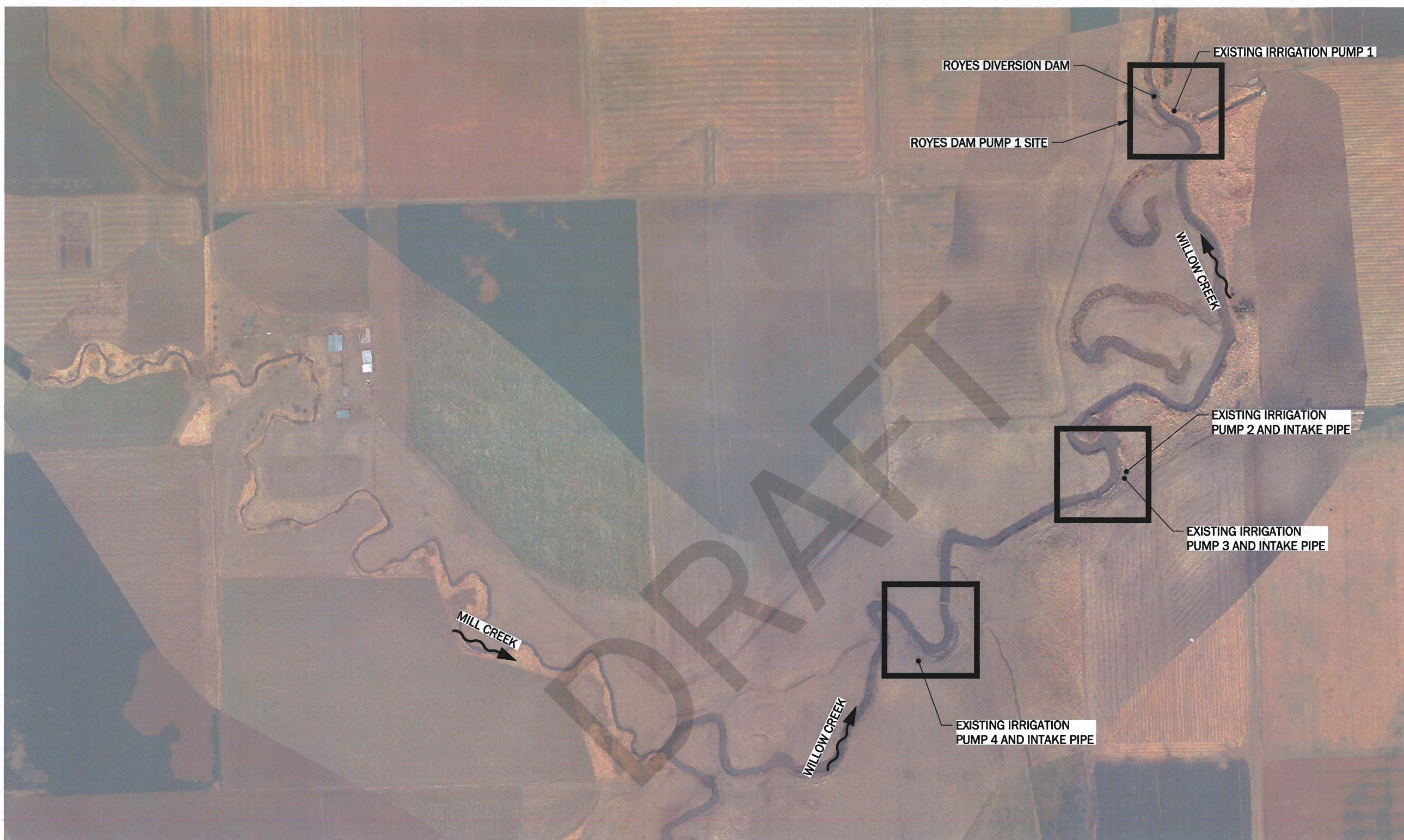


ROYES DAM FISH PASSAGE RESTORATION  
SUMMERVILLE, OREGON  
**GENERAL NOTES, QUANTITIES AND LEGEND**

DRAWING NUMBER:  
**1.1**  
SHEET: 2 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

P:\191936903\CAD\01\Royes\_Fish\_Passage\_Restoration\02\_Draft\_Final\193690301\_Sht 3\_2.0 Willow Creek Site Map.dwg  
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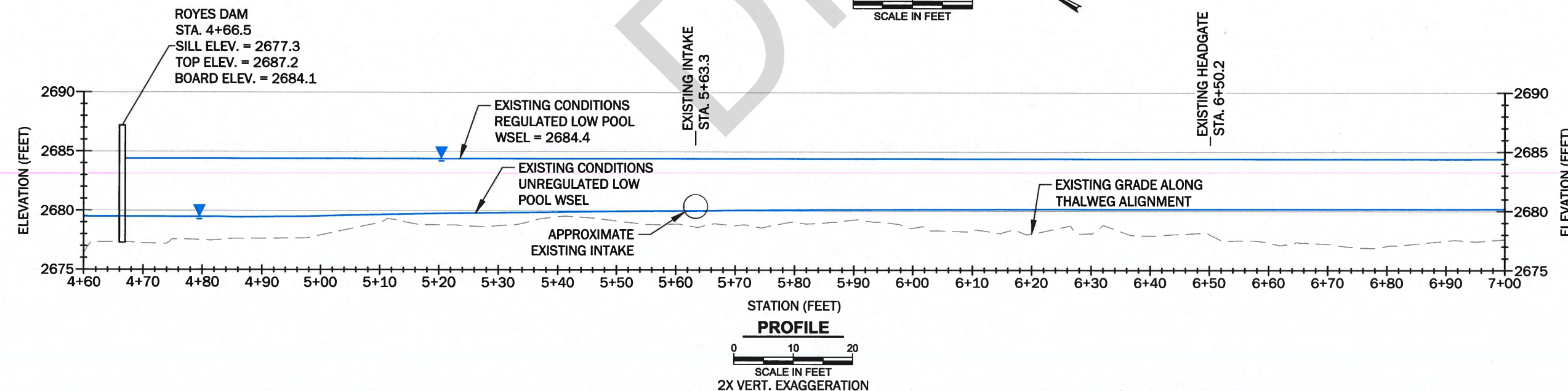
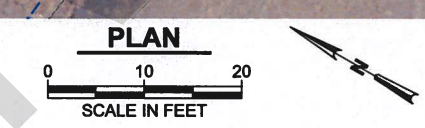
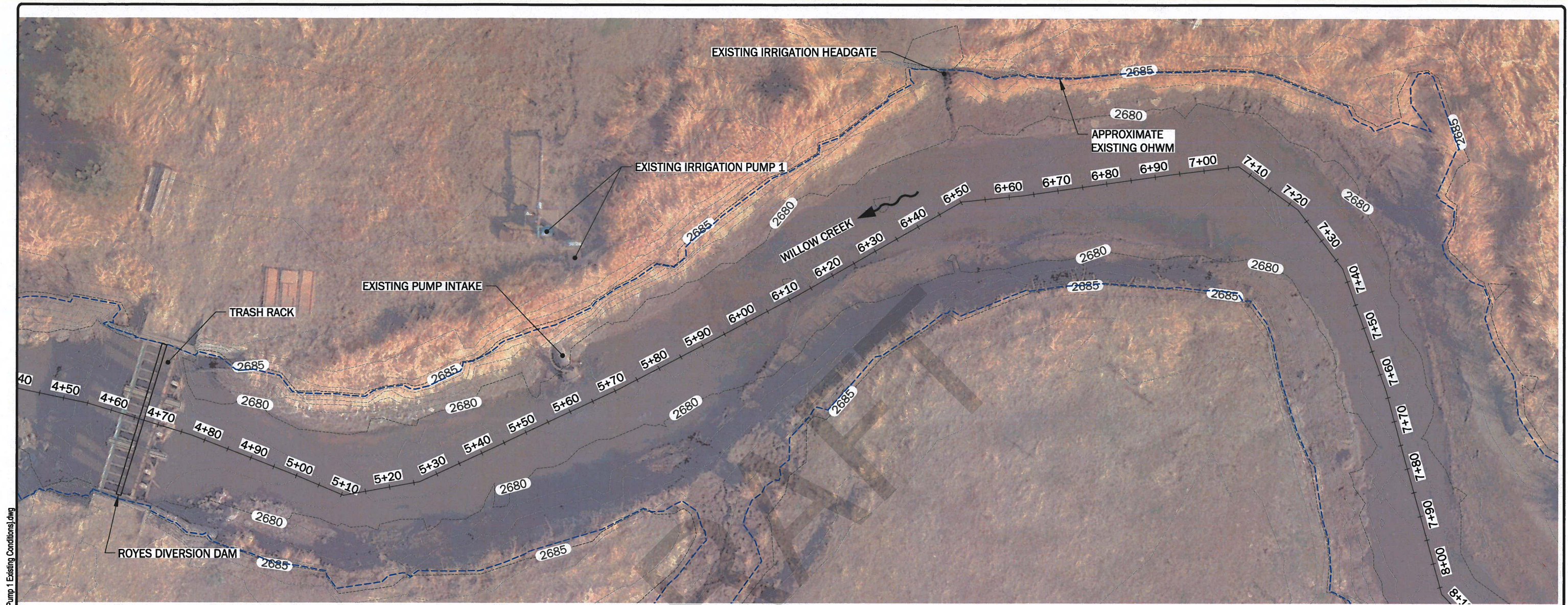


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**WILLOW CREEK SITE MAP**

DRAWING NUMBER:  
**2.0**  
 SHEET: 3 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

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**REGISTERED PROFESSIONAL ENGINEER**  
 72313PE  
 OREGON  
 NOV. 12, 2002  
 RYAN S. CARNIE  
 EXPIRES: DEC. 31, 2023

NO.	DATE	BY	ISSUE / DESCRIPTION

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 REVISION NO.:  
 DATE: 06/30/23

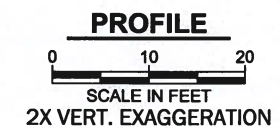
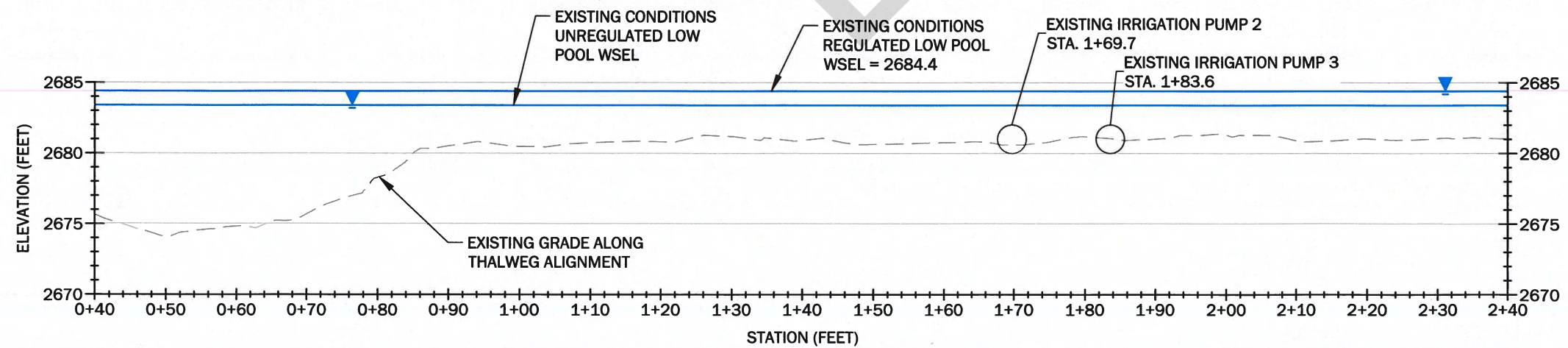
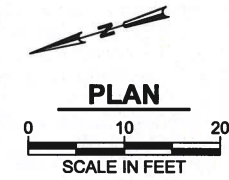
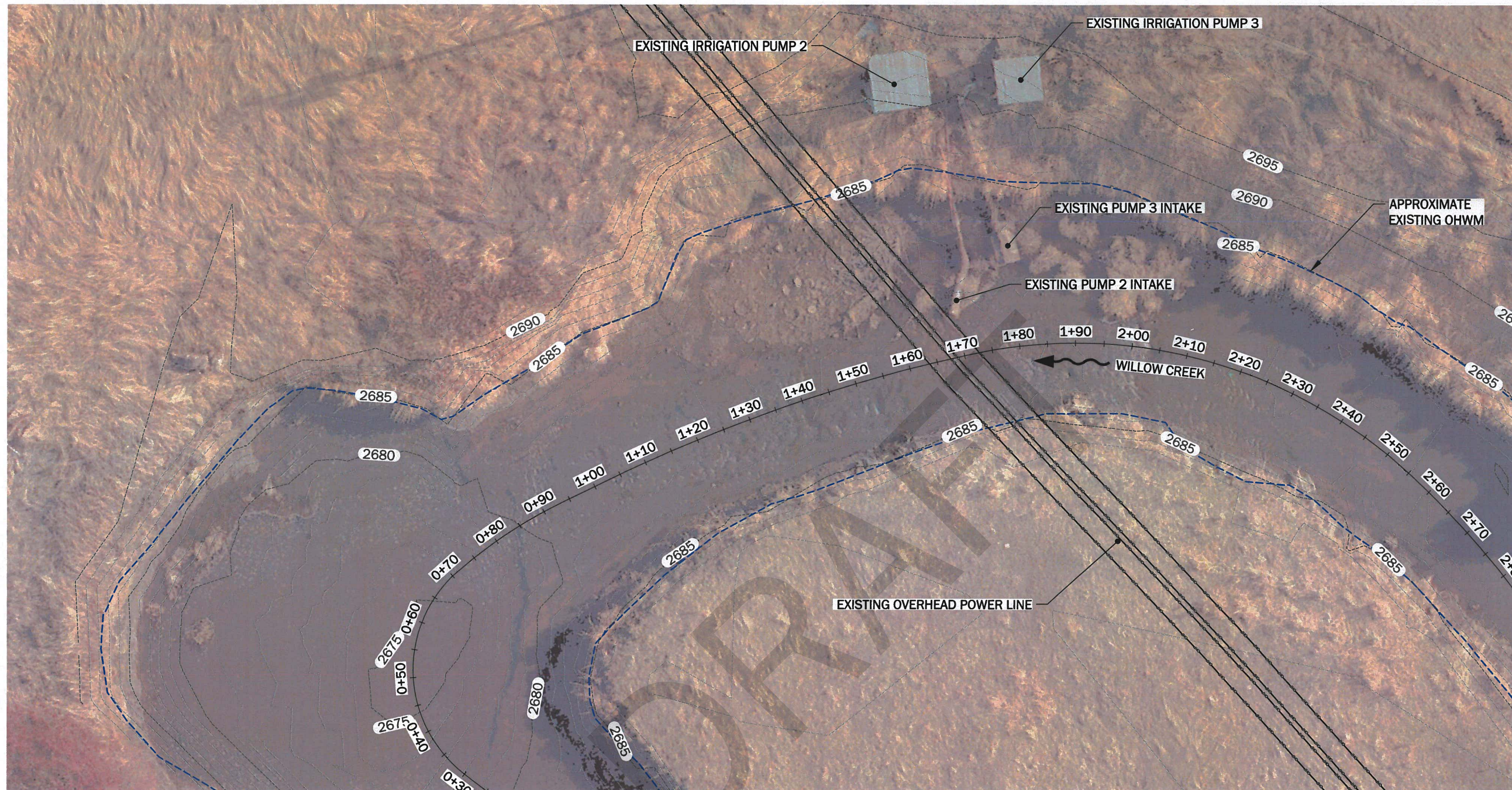


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 1 EXISTING CONDITIONS**

DRAWING NUMBER:  
**2.1**  
 SHEET: 4 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

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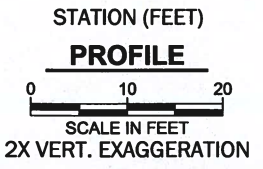
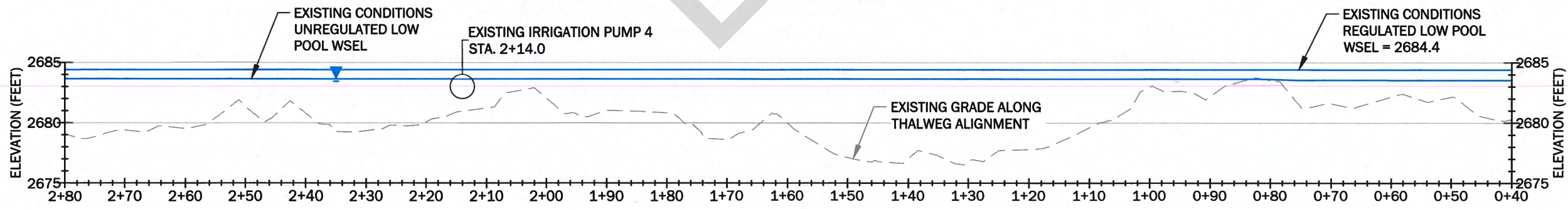
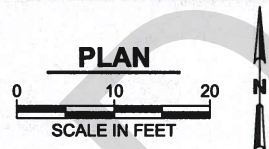
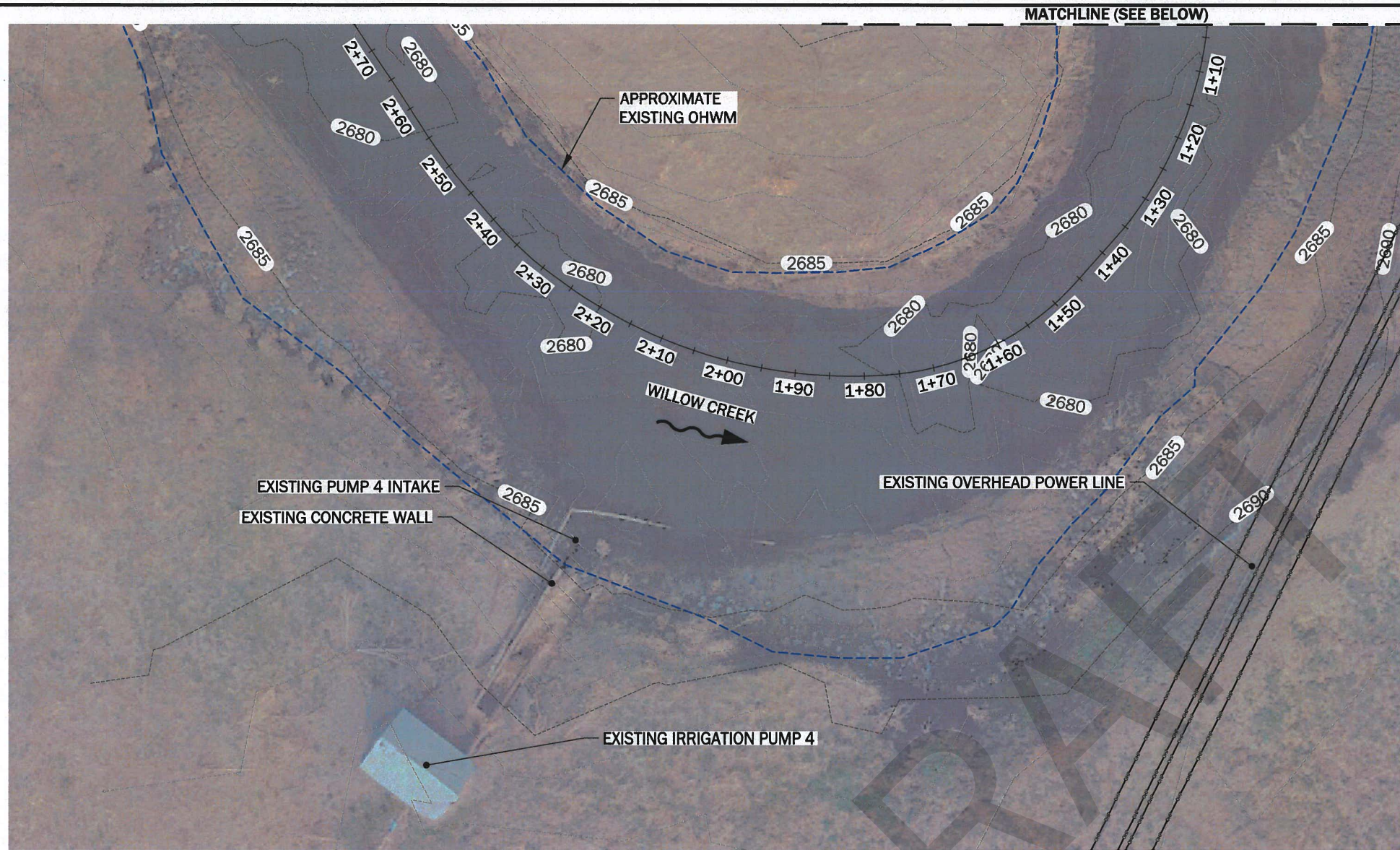


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMPS 2 AND 3 EXISTING CONDITIONS**

DRAWING NUMBER:  
**2.2**  
 SHEET: 5 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

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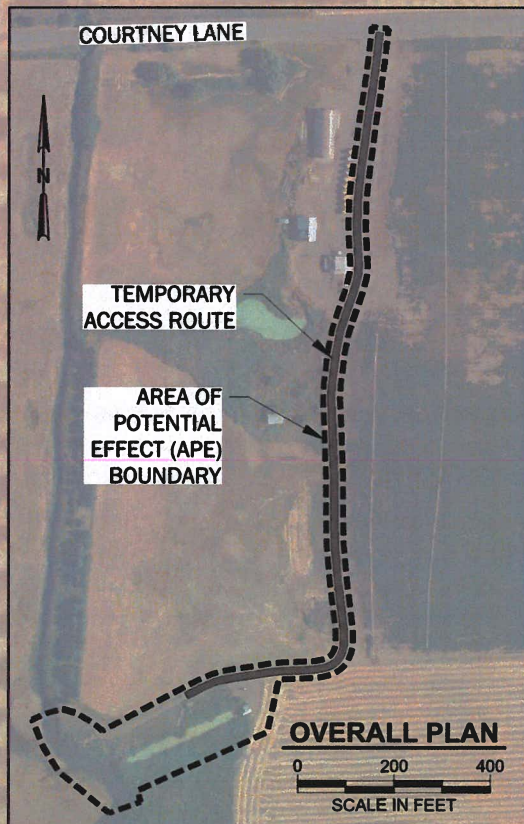
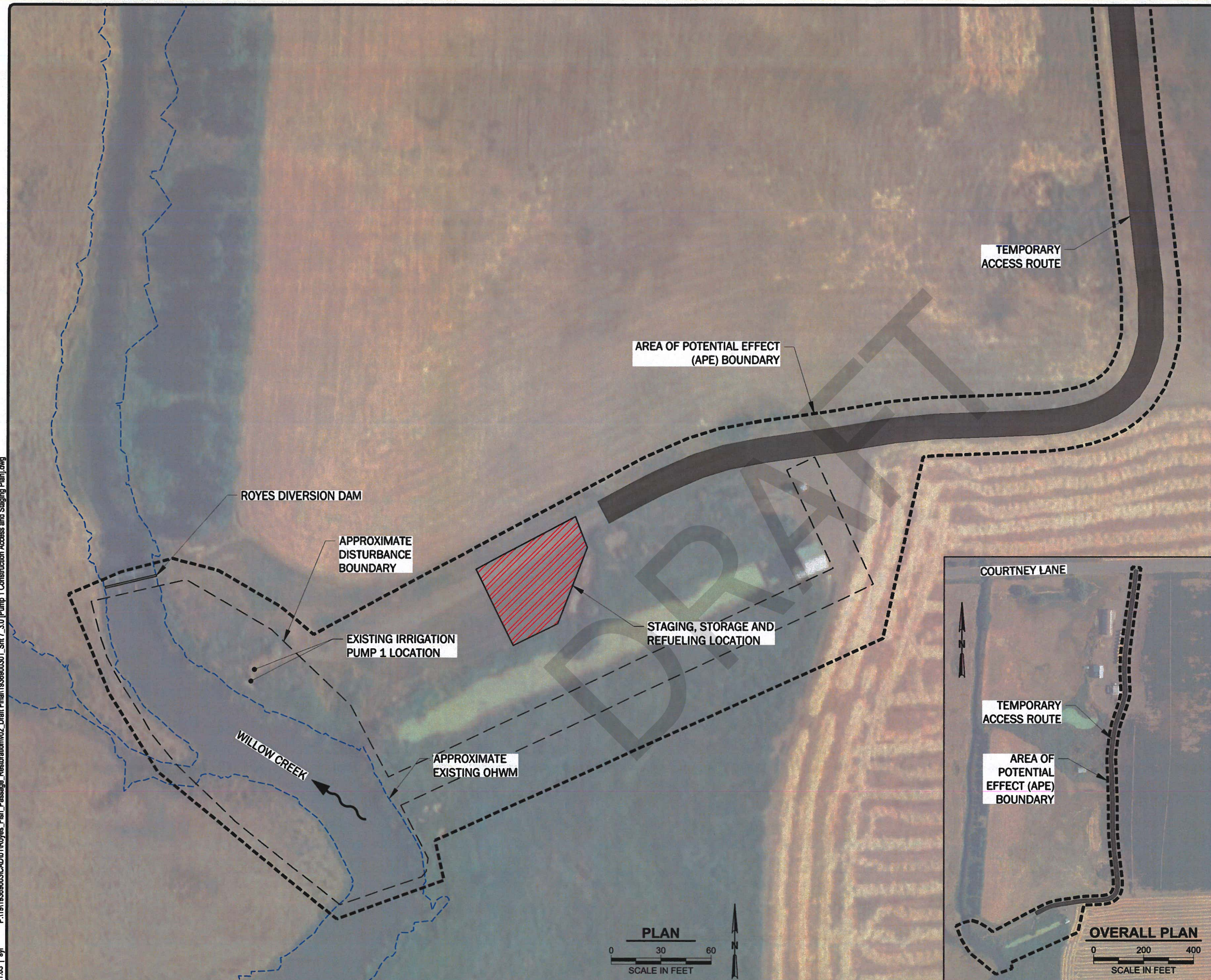


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 4 EXISTING CONDITIONS**

DRAWING NUMBER:  
**2.3**  
 SHEET: 6 OF 19

DRAFT FINAL SUBMITAL - NOT FOR CONSTRUCTION

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- CONSTRUCTION SEQUENCING NOTES:**
- 1 ACCESS THE SITE FROM COURTNEY LANE. ESTABLISH TEMPORARY ACCESS ROUTES THROUGHOUT THE SITE AS SHOWN. TEMPORARY ACCESS ROUTES SHALL MINIMIZE DISTURBANCE TO NATIVE VEGETATION.
  - 2 ESTABLISH STAGING, STORAGE AND REFUELING AS SHOWN. ALL FUEL STORAGE AND REFUELING ACTIVITIES SHALL OCCUR AFTER SPILL PREVENTION BMPs ARE INSTALLED. INSTALL PERIMETER SEDIMENT CONTROLS AROUND STAGING AREAS.
  - 3 INSTALL TEMPORARY SEDIMENT CONTROL BMPs.
  - 4 INSTALL TEMPORARY STREAM BYPASS PIPE TO EXTEND UPSTREAM OF THE WORK ZONE ISOLATION AND DOWNSTREAM OF THE PROPOSED COARSE GRAVEL GRADE CONTROL. INSTALL WORK ZONE ISOLATION DOWNSTREAM OF THE COARSE GRAVEL GRADE CONTROL AND UPSTREAM OF BYPASS OUTLET.
  - 5 INSTALL TEMPORARY WORK ZONE ISOLATION STRUCTURE AT FISHWAY EXIT. PERFORM FISH SALVAGE WITHIN ISOLATED WORK ZONE. DEWATER ISOLATED WORK ZONE.
  - 6 RESTORE DISTURBED AREAS WITHIN THE GRADING LIMITS



NO.	DATE	BY	ISSUE / DESCRIPTION

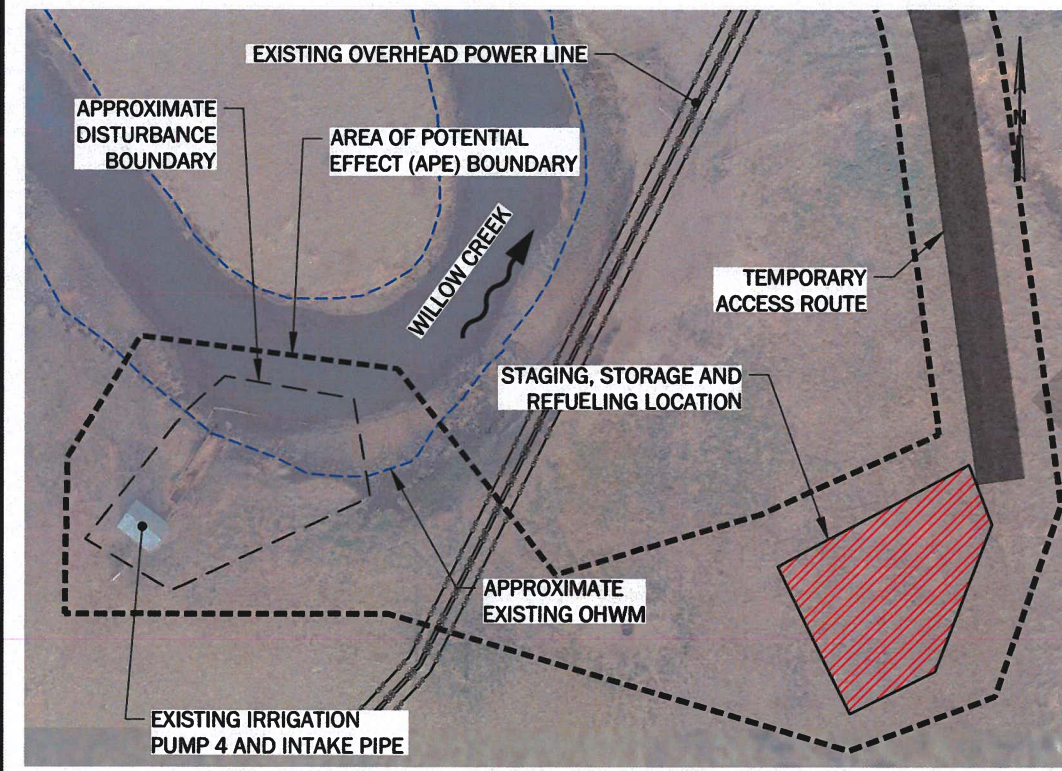
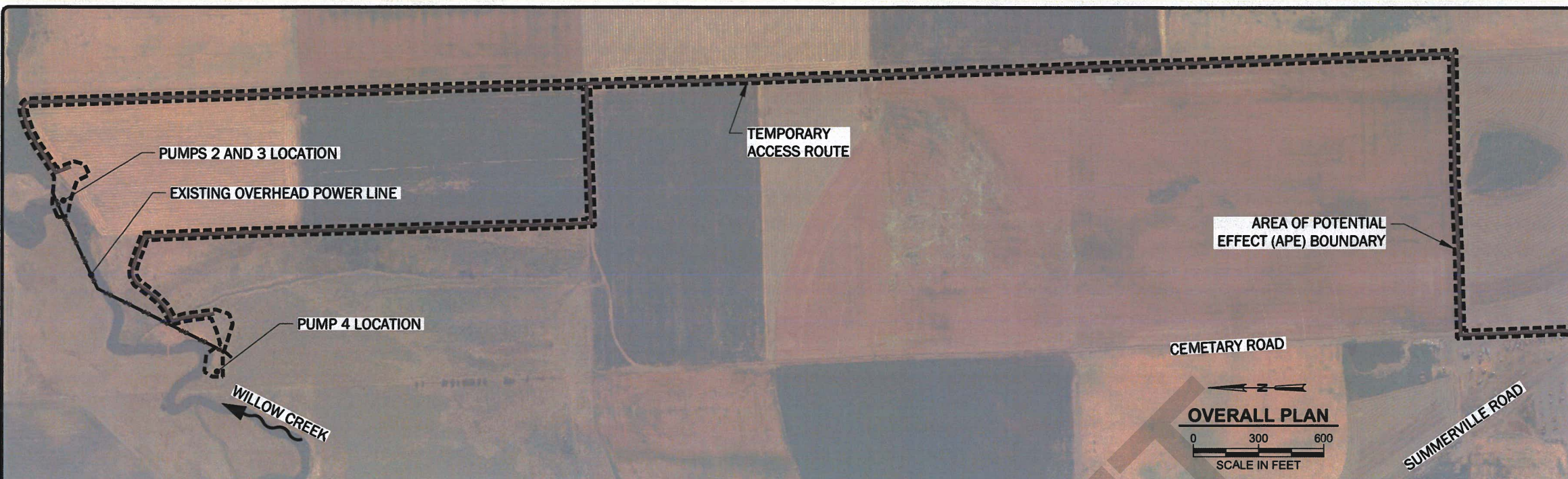
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 DATE: 06/30/23



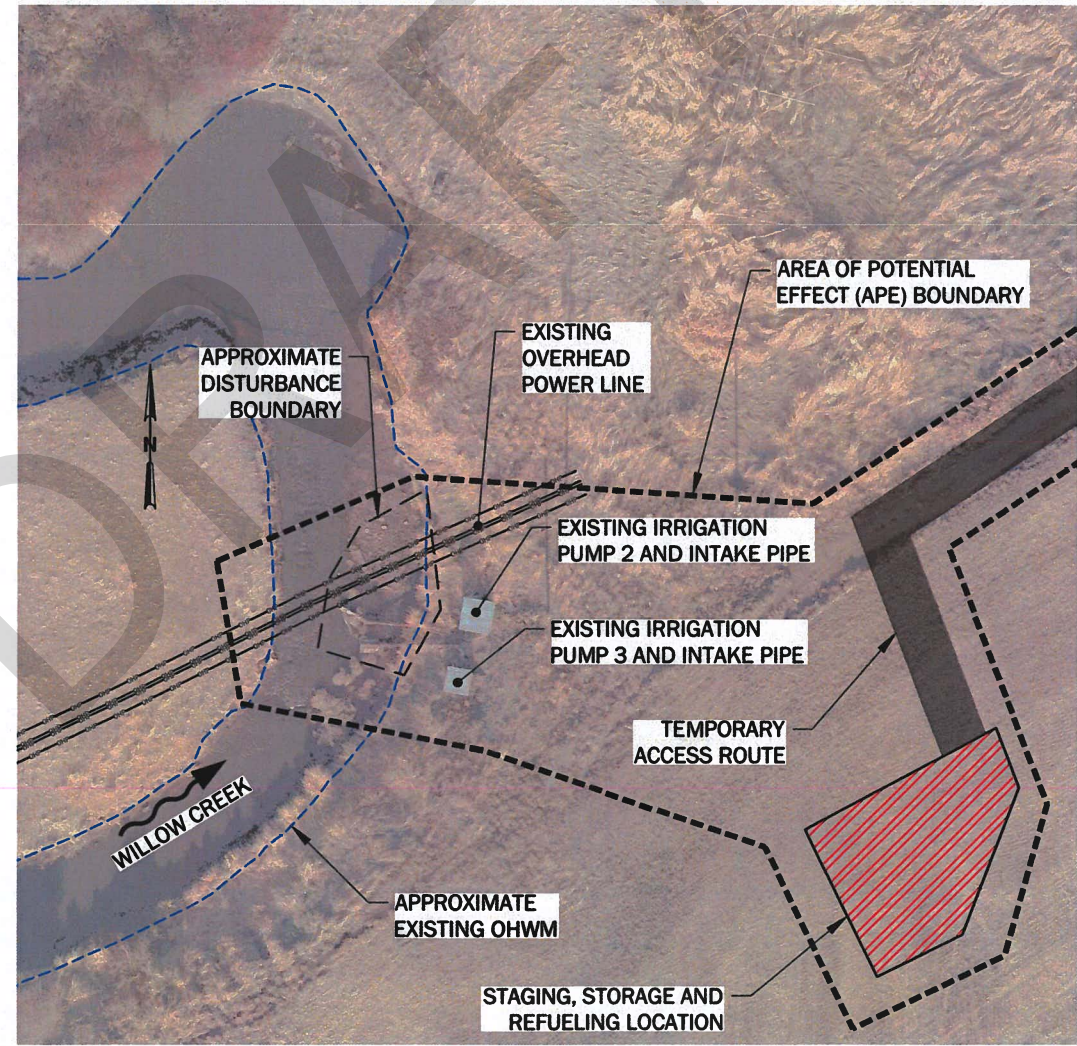
ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 1 CONSTRUCTION ACCESS AND STAGING PLAN**

DRAWING NUMBER:  
**3.0**  
 SHEET: 7 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION



**PUMP 4 STAGING, STORAGE, AND REFUELING PLAN**



**PUMPS 2 AND 3 STAGING, STORAGE, AND REFUELING PLAN**



- CONSTRUCTION SEQUENCING NOTES:**
- 1 ACCESS THE SITE FROM SUMMERVILLE ROAD. ESTABLISH TEMPORARY ACCESS ROUTES THROUGHOUT THE SITE AS SHOWN. TEMPORARY ACCESS ROUTES SHALL MINIMIZE DISTURBANCE TO NATIVE VEGETATION.
  - 2 ESTABLISH STAGING, STORAGE AND REFUELING AS SHOWN. ALL FUEL STORAGE AND REFUELING ACTIVITIES SHALL OCCUR AFTER SPILL PREVENTION BMPs ARE INSTALLED. INSTALL PERIMETER SEDIMENT CONTROLS AROUND STAGING AREAS.
  - 3 INSTALL TEMPORARY SEDIMENT CONTROL BMPs.
  - 4 INSTALL TEMPORARY STREAM BYPASS PIPE TO EXTEND UPSTREAM OF THE WORK ZONE ISOLATION AND DOWNSTREAM OF THE PROPOSED COARSE GRAVEL GRADE CONTROL. INSTALL WORK ZONE ISOLATION DOWNSTREAM OF THE COARSE GRAVEL GRADE CONTROL AND UPSTREAM OF BYPASS OUTLET.
  - 5 INSTALL TEMPORARY WORK ZONE ISOLATION STRUCTURE AT FISHWAY EXIT. PERFORM FISH SALVAGE WITHIN ISOLATED WORK ZONE. DEWATER ISOLATED WORK ZONE.
  - 6 RESTORE DISTURBED AREAS WITHIN THE GRADING LIMITS



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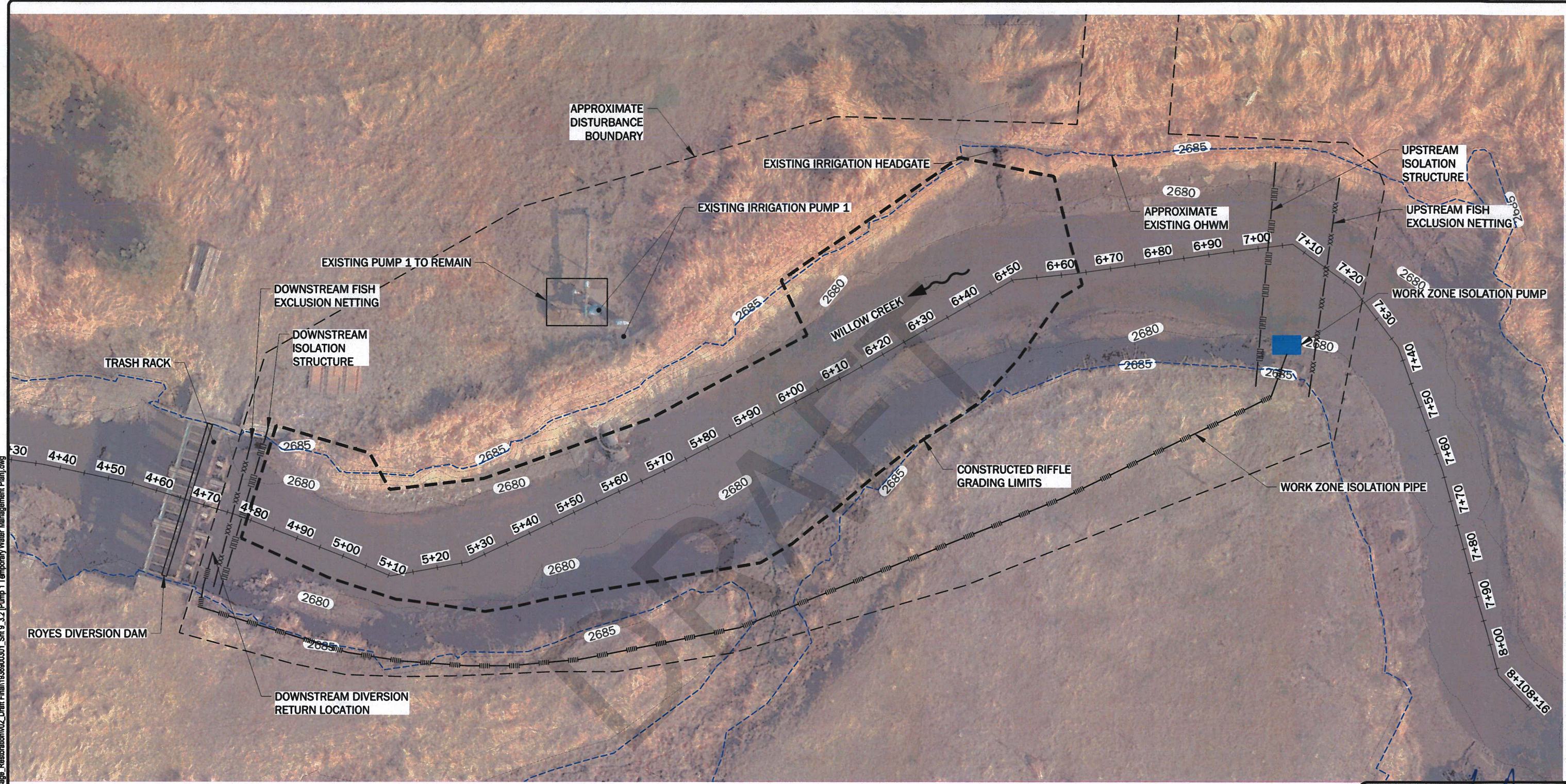


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMPS 2, 3 AND 4 CONSTRUCTION ACCESS AND STAGING PLAN**

DRAWING NUMBER:  
**3.1**  
 SHEET: 8 OF 19

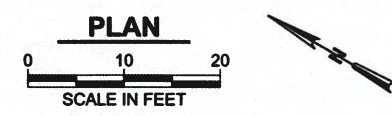
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 Plot: 06/30/2023, 21:03 | by



**WATER MANAGEMENT SEQUENCE NOTES:**

1. ESTABLISH STAGING AND REFUELING LOCATIONS AS SHOWN ON DRAWING 3.0.
2. CONDUCT FISH SALVAGE THROUGH THE PROJECT REACH AND INSTALL FISH EXCLUSION NETTING PRIOR TO DEWATERING.
3. ACCESS ORDINARY HIGH WATER AND INSTALL ISOLATION PUMP AND WORK ZONE ISOLATION PIPE.
4. INSTALL UPSTREAM AND DOWNSTREAM WORK ZONE ISOLATION STRUCTURES.
5. CONSTRUCT CONSTRUCTED RIFFLE AND PUMP UPGRADES AS SHOWN ON PLANS.
6. REMOVE DOWNSTREAM WORK ZONE ISOLATION STRUCTURE.
7. REMOVE PUMP AND WORK ZONE ISOLATION PIPE.
8. REMOVE UPSTREAM WORK ZONE ISOLATION STRUCTURE TO METER WATER BACK INTO THE CHANNEL.
9. REMOVE UPSTREAM AND DOWNSTREAM SEINE NETTING.



**REGISTERED PROFESSIONAL ENGINEER**  
 72313PE  
 OREGON  
 NOV. 12, 2002  
 RYAN S. CARNIE  
 EXPIRES: DEC. 31, 2023

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**GEOENGINEERS**  
 www.GEOENGINEERS.COM

PREPARED FOR:

ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 1 TEMPORARY WATER MANAGEMENT PLAN**

DRAWING NUMBER:  
**3.2**  
 SHEET: 9 OF 19

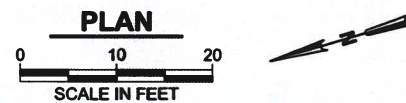
DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

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 Plotted: 06/30/2023, 2:04 | sji



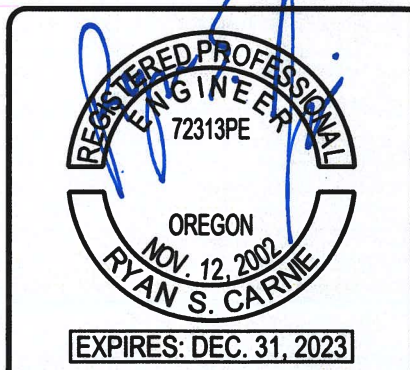
**WATER MANAGEMENT SEQUENCE NOTES:**

1. ESTABLISH STAGING AND REFUELING LOCATIONS AS SHOWN ON DRAWING 3.1.
2. INSTALL TEMPORARY FISH EXCLUSION NETTING AND REMOVE FISH FROM ISOLATED WORK ZONE.
3. INSTALL WORK ZONE ISOLATION STRUCTURE.
4. REMOVE TEMPORARY FISH EXCLUSION NETTING.
5. INSTALL AND OPERATE WORK ZONE ISOLATION PUMP IF NECESSARY.
6. INSTALL UPGRADES TO PUMP INTAKE SCREENS.
7. REMOVE WORK ZONE PUMP AND PIPE IF USED.
8. REMOVE WORK ZONE ISOLATION STRUCTURES.



**PUMPS 2 AND 3 INTAKE SCREEN NOTES:**

1. SCREENS SHALL BE 30-INCH DIAMETER BY 40-INCH LENGTH.
2. SCREEN SHALL BE COMPLIANT WITH NOAA FISH SCREEN REQUIREMENTS INCLUDING, BUT NOT LIMITED TO A 3/32 INCH OPENING SIZE.
3. CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING SCREENS.



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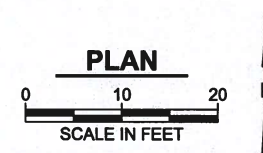
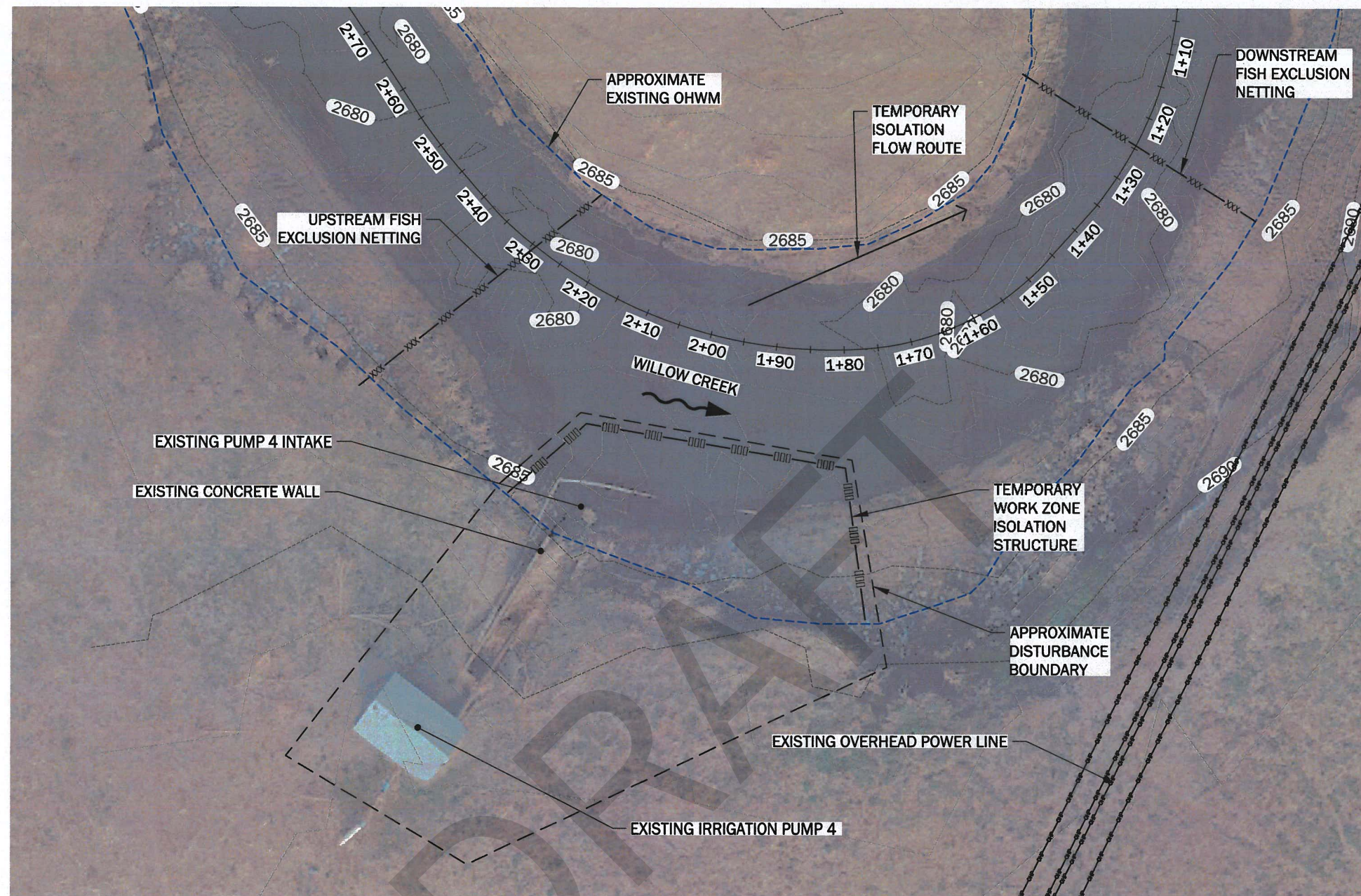


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMPS 2 AND 3 TEMPORARY WATER MANAGEMENT  
 PLAN AND INTAKE UPGRADE**

DRAWING NUMBER:  
**3.3**  
 SHEET: 10 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

P:\1911936903\CA\01\Royes\_Fish\_Passage\_Restoration\02\_Draft\_Final\193690301\_Sht 11\_3.4 [Pump 4 Temporary Water Management: Plan and Intake Upgrade].dwg  
 Plotted: 06/30/2023, 21:04 | sylv



**WATER MANAGEMENT SEQUENCE NOTES:**

1. ESTABLISH STAGING AND REFUELING LOCATIONS AS SHOWN ON DRAWING 3.1.
2. CONDUCT FISH SALVAGE THROUGH THE PROJECT REACH AND INSTALL SEINE NETTING PRIOR TO CHANNEL DIVERSION.
3. ACCESS ORDINARY HIGH WATER AND INSTALL WORK ZONE ISOLATION PIPE.
4. INSTALL WORK ZONE ISOLATION STRUCTURES.
5. REMOVE FISH NETTING TO PROVIDE DOWNSTREAM FISH PASSAGE.
6. REMOVE WORK ZONE ISOLATION STRUCTURE TO METER WATER BACK INTO THE CHANNEL.

**PUMP 4 INTAKE SCREEN NOTES:**

1. SCREENS SHALL BE 30-INCH DIAMETER BY 40-INCH LENGTH.
2. SCREEN SHALL BE COMPLIANT WITH NOAA FISH SCREEN REQUIREMENTS INCLUDING, BUT NOT LIMITED TO A 3/32 INCH OPENING SIZE.
3. CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING SCREENS.



NO.	DATE	BY	ISSUE / DESCRIPTION

DESIGNED BY: KHR  
 DRAWN BY: KHR/SCY  
 APPROVED BY: RSC  
 REVISION NO.: —  
 DATE: 06/30/23

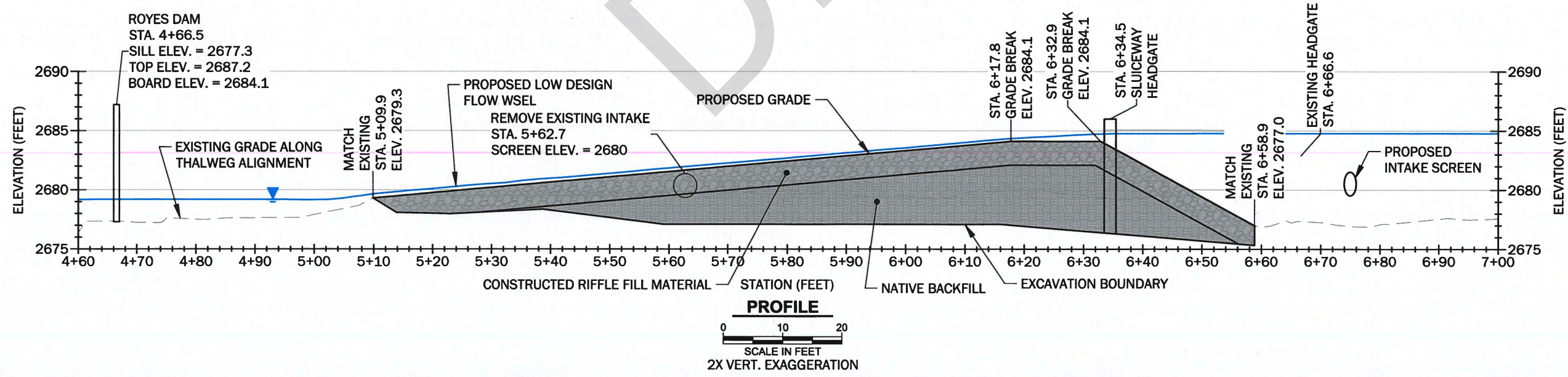
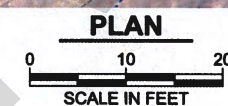
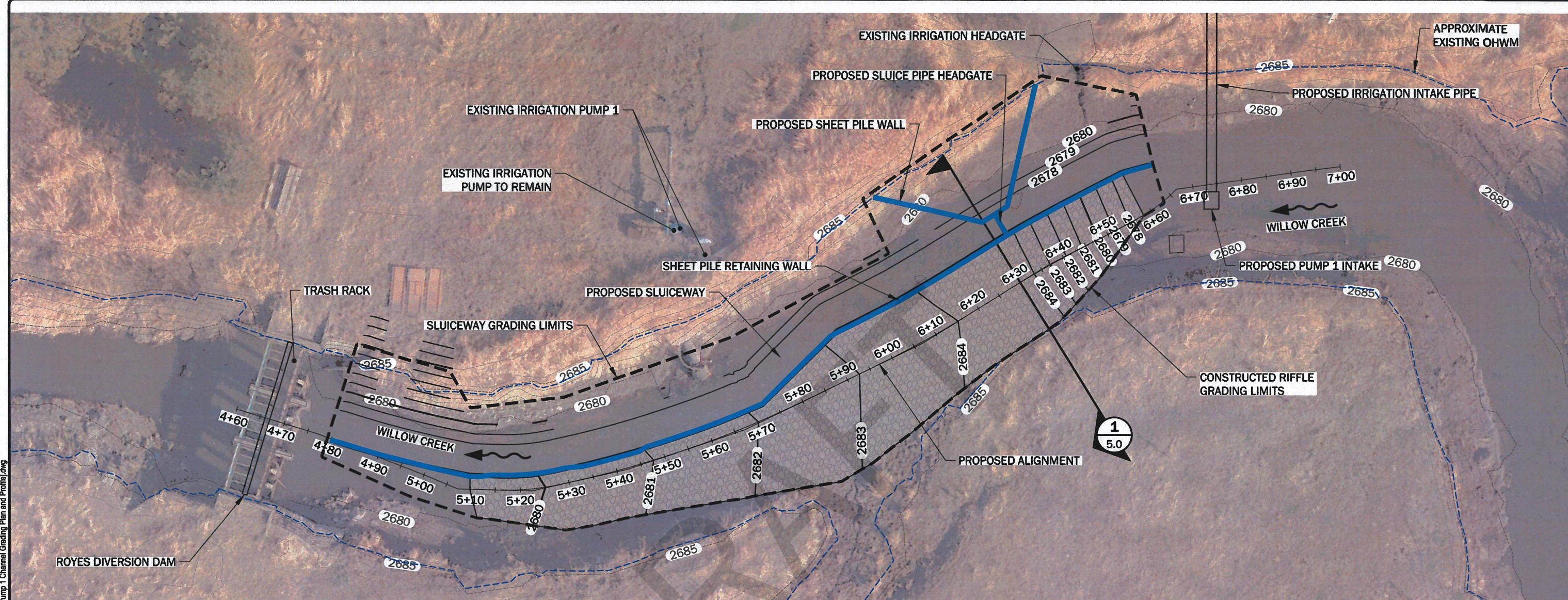


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 4 TEMPORARY WATER MANAGEMENT PLAN  
 AND INTAKE UPGRADE**

DRAWING NUMBER:  
**3.4**  
 SHEET: 11 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

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 07/03/2023, 14:05 | rcamie



**REGISTERED PROFESSIONAL ENGINEER**  
 72313PE  
 OREGON  
 NOV. 12, 2002  
**RYAN S. CARNIE**  
 EXPIRES: DEC. 31, 2023

NO.	DATE	BY	ISSUE / DESCRIPTION

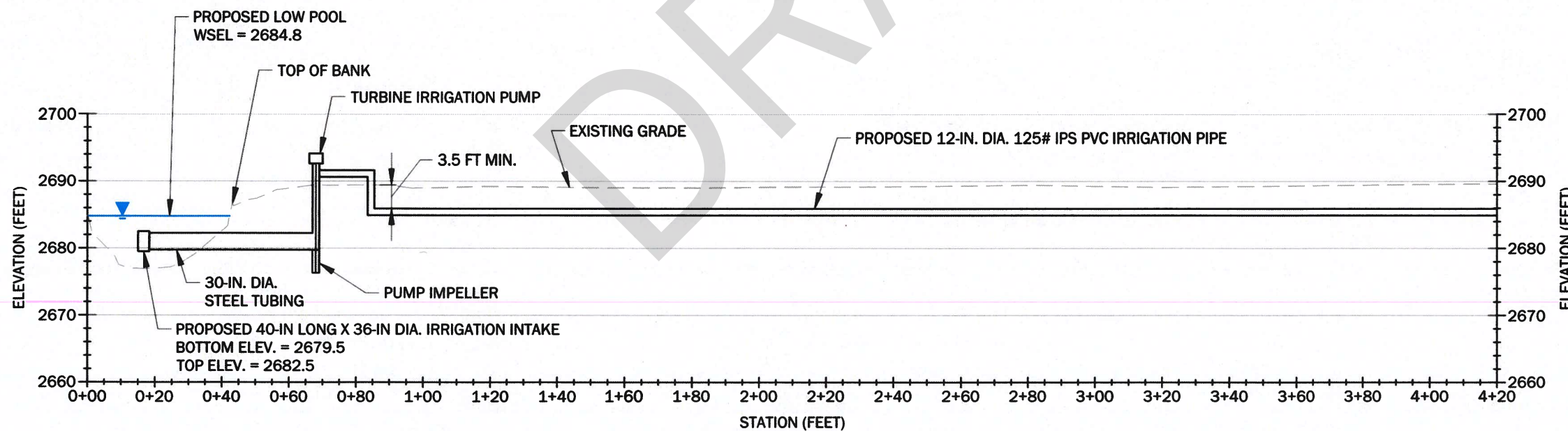
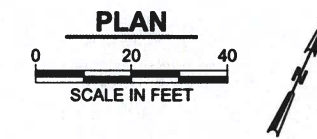
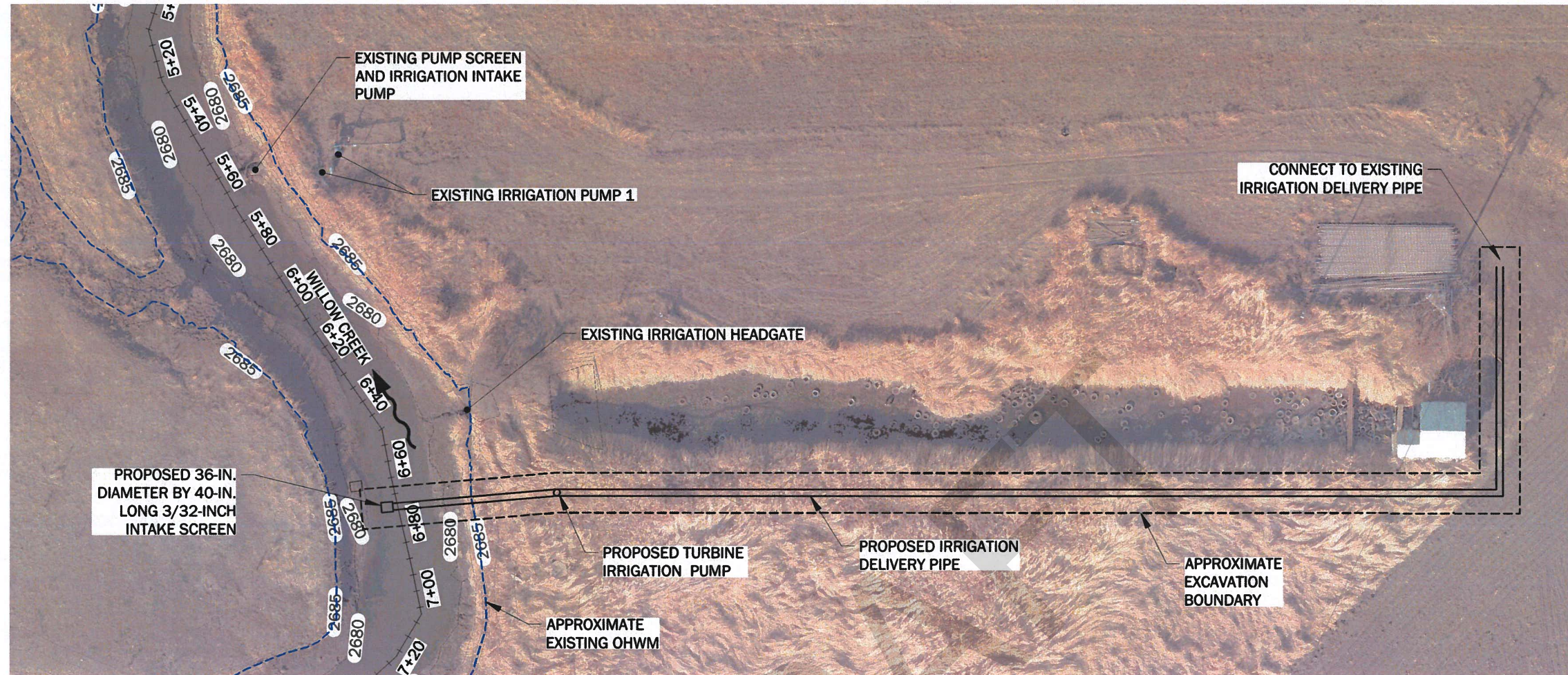
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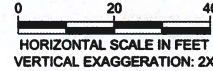
ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 1 CHANNEL GRADING PLAN AND PROFILE**

DRAWING NUMBER:  
**4.0**  
 SHEET: 12 OF 19

DRAFT FINAL SUBMITAL - NOT FOR CONSTRUCTION



**PUMP 1 SECTION VIEW 1**  
SCALE: 4.1



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 Plotted: 07/03/2023, 14:11 | rcamie

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DESIGNED BY: KHR  
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 DATE: 06/30/23

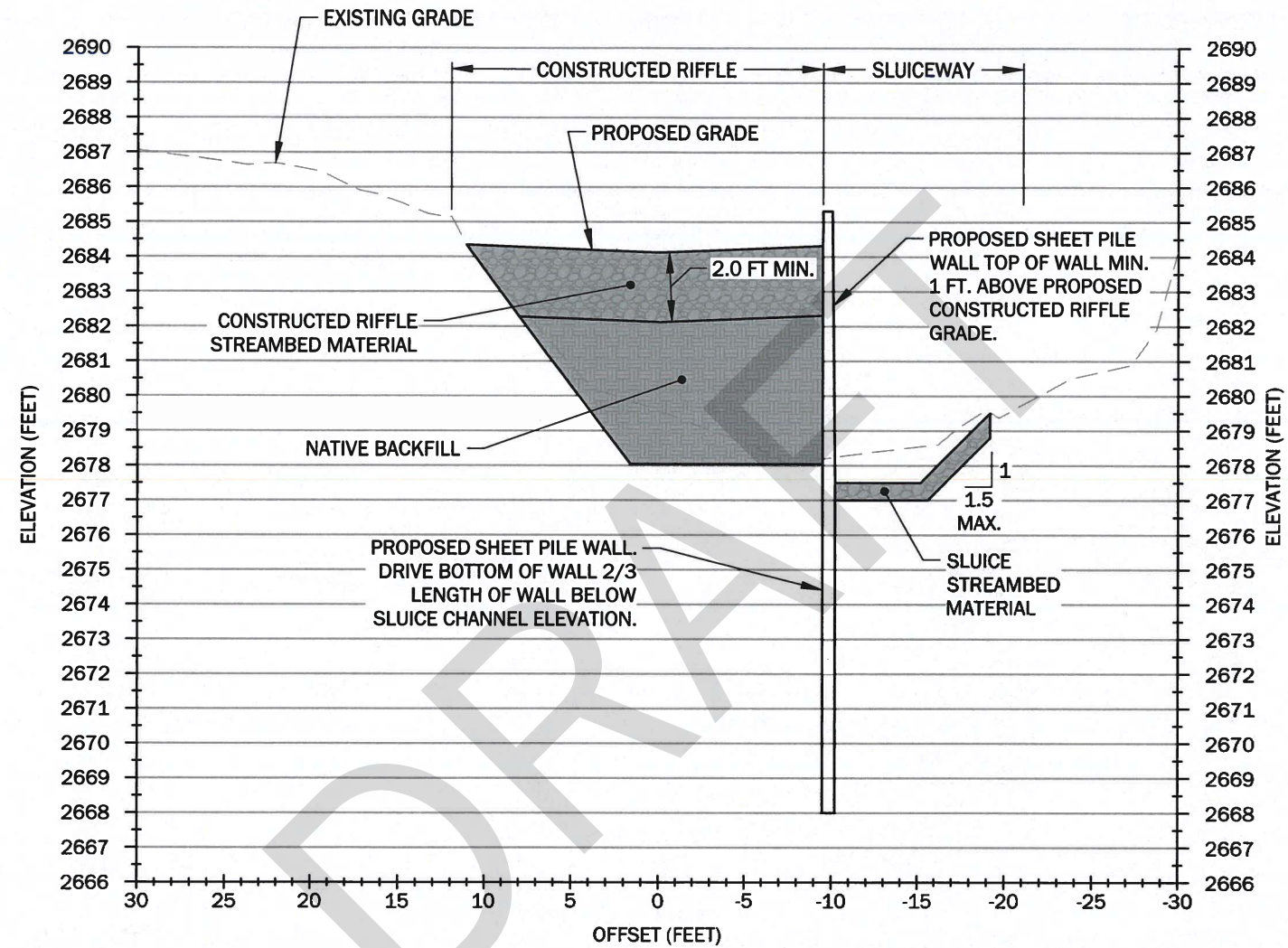


ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**PUMP 1 PLAN AND SECTION**

DRAWING NUMBER:  
**4.1**  
 SHEET: 13 OF 19

DRAFT FINAL SUBMITAL - NOT FOR CONSTRUCTION

P:\118193690\03\CAD\01\Royes\_Fish\_Passage\_Restoration\02\_Draft\Final\1836900301\_Sht\_14\_5.0 [Constructed Riffle and Sluice Typical Channel Section].dwg  
 Plotted: 06/30/2023 2:1:05 | s.j.

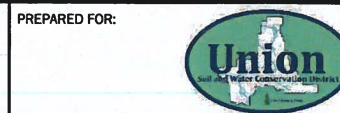


**CONSTRUCTED RIFFLE AND SLUICE TYPICAL CHANNEL SECTION - STATION 5+10 TO 6+60** 1  
 SCALE: 4.0



NO.	DATE	BY	ISSUE / DESCRIPTION

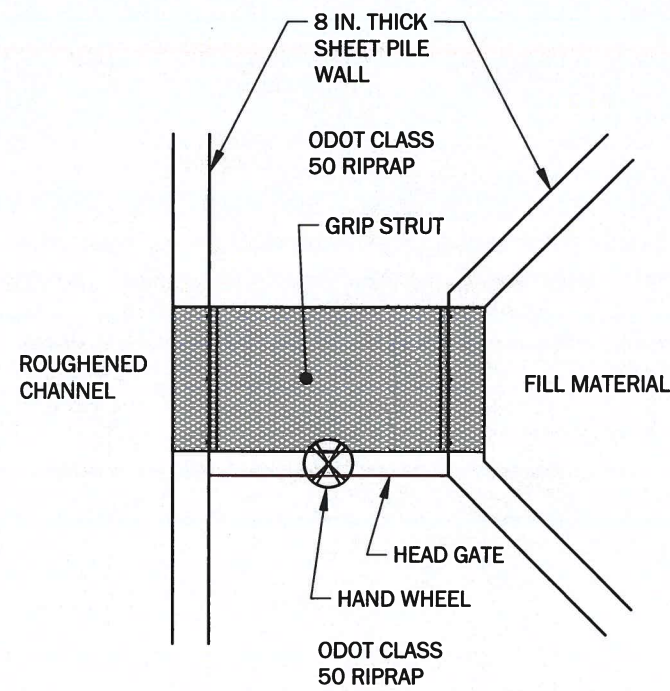
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 APPROVED BY: RSC  
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 DATE: 06/30/23



ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**CONSTRUCTED RIFFLE AND SLUICE TYPICAL  
 CHANNEL SECTION**

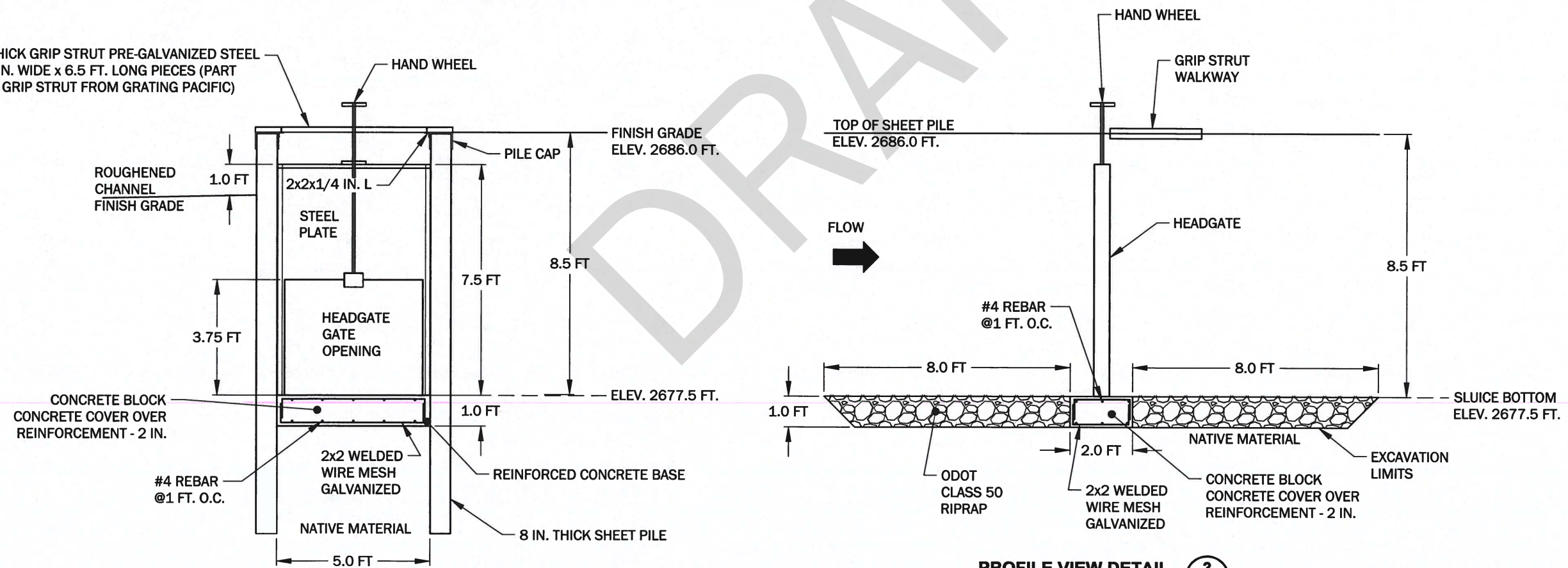
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**5.0**  
 SHEET: 14 OF 19

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**PLAN VIEW DETAIL 1**  
SCALE: 5.1

2 IN. THICK GRIP STRUT PRE-GALVANIZED STEEL  
(3) 12 IN. WIDE x 6.5 FT. LONG PIECES (PART  
52012 GRIP STRUT FROM GRATING PACIFIC)



**HEADGATE SECTION DETAIL 2**  
SCALE: 5.1

**PROFILE VIEW DETAIL 3**  
SCALE: 5.1



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APPROVED BY: RSC  
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DATE: 06/30/23

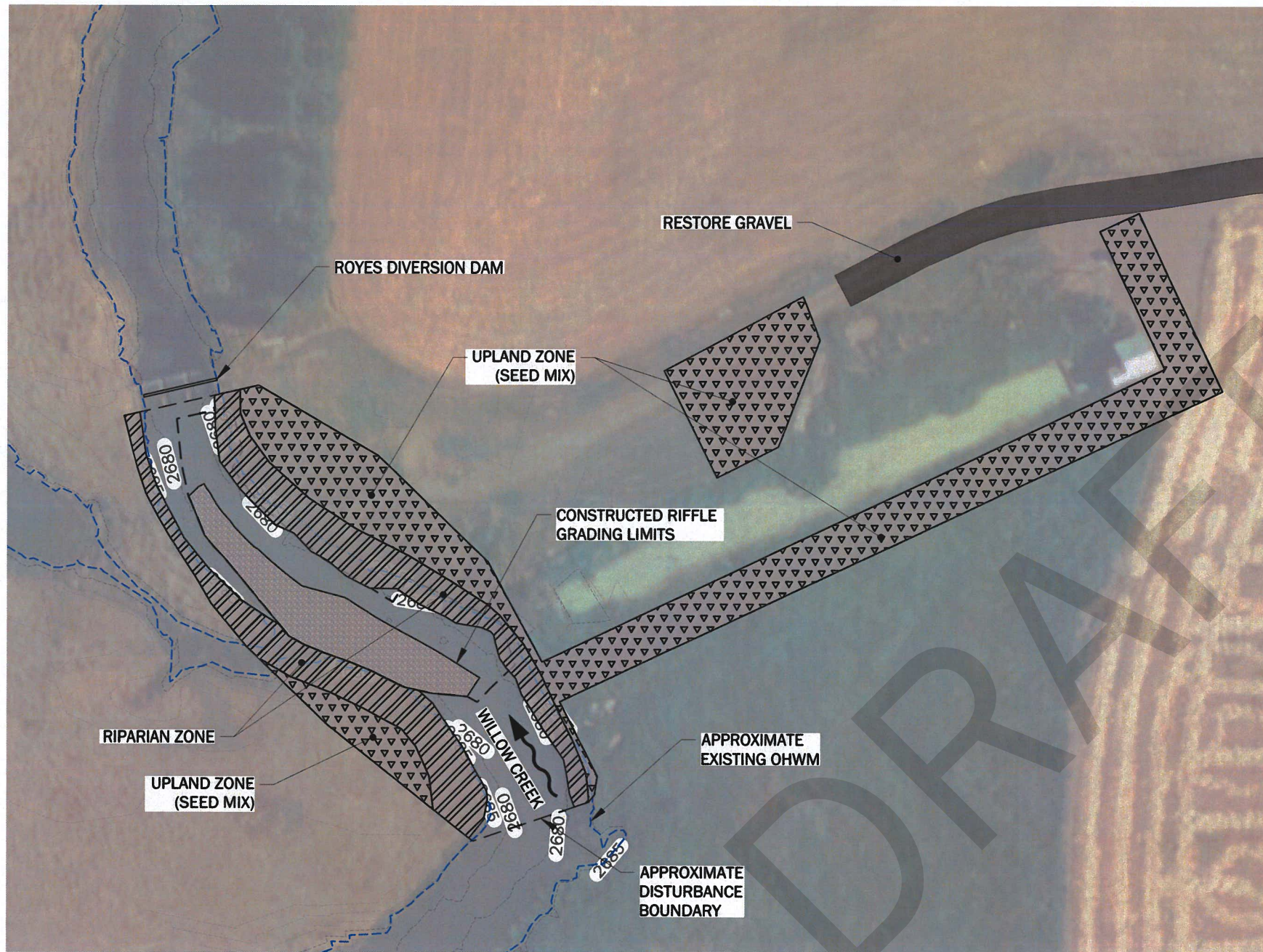


ROYES DAM FISH PASSAGE RESTORATION  
SUMMERVILLE, OREGON  
**SLUICE GATE DETAILS**

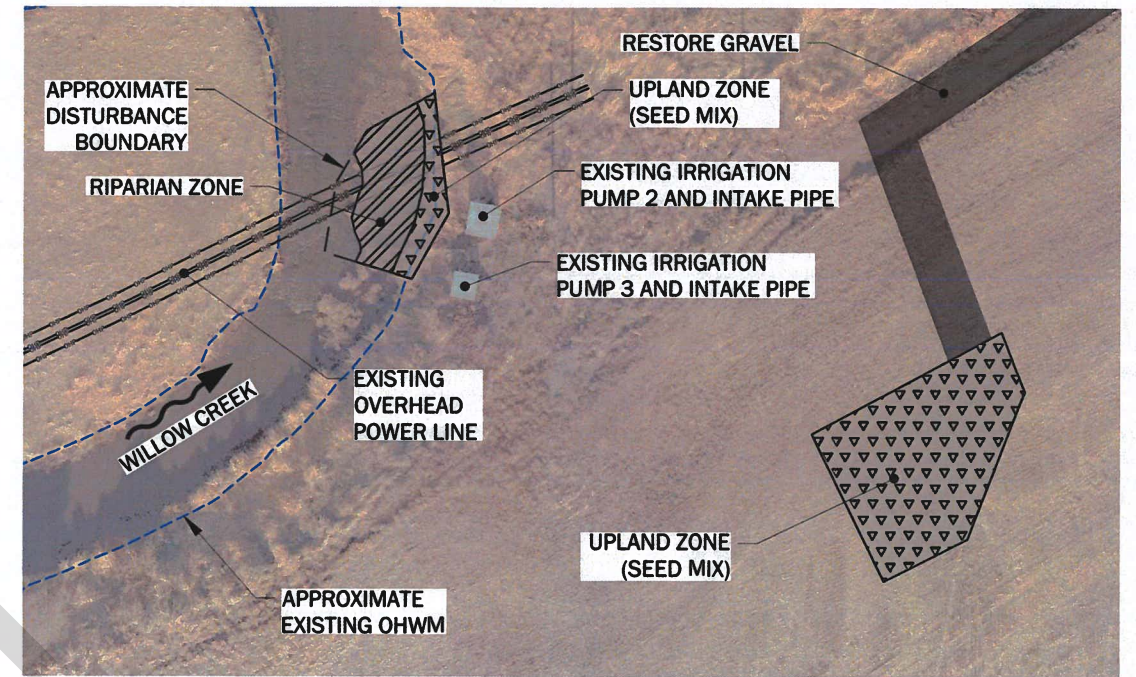
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**5.1**  
SHEET: 15 OF 19

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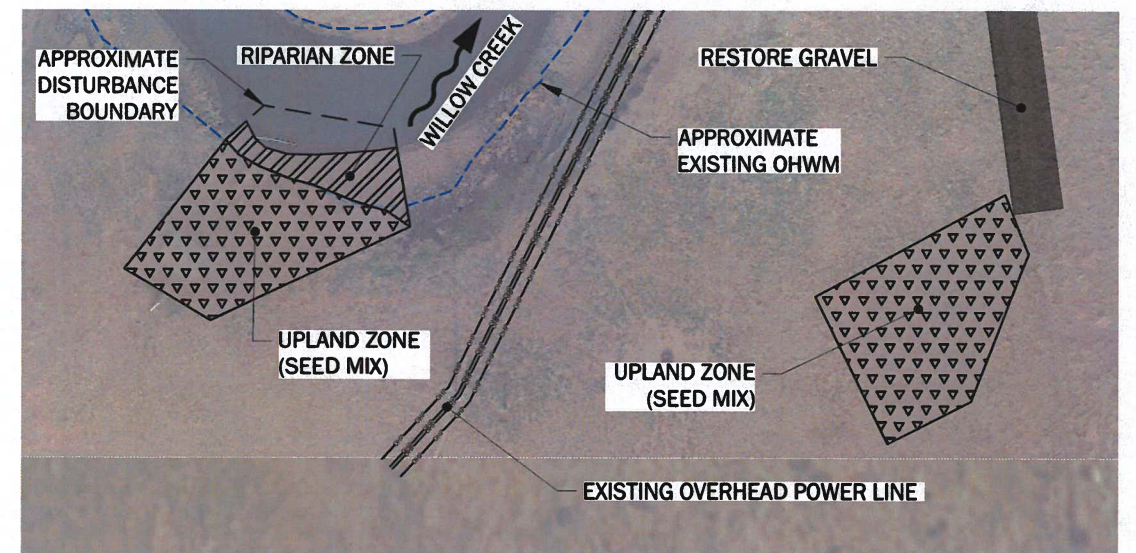
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 Plotted: 06/30/2023, 21:05 | syi



**PUMP 1 REVEGETATION PLAN**



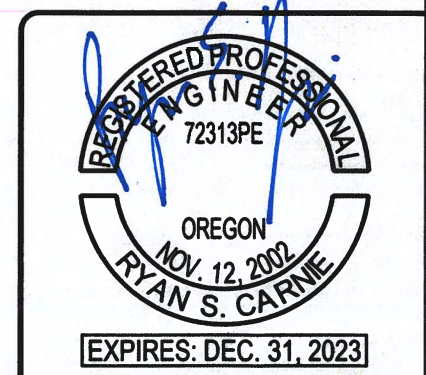
**PUMPS 2 AND 3 REVEGETATION PLAN**



**PUMP 4 REVEGETATION PLAN**

**LEGEND (RESTORATION)**

 RIPARIAN ZONE  
 UPLAND ZONE (SEED MIX)



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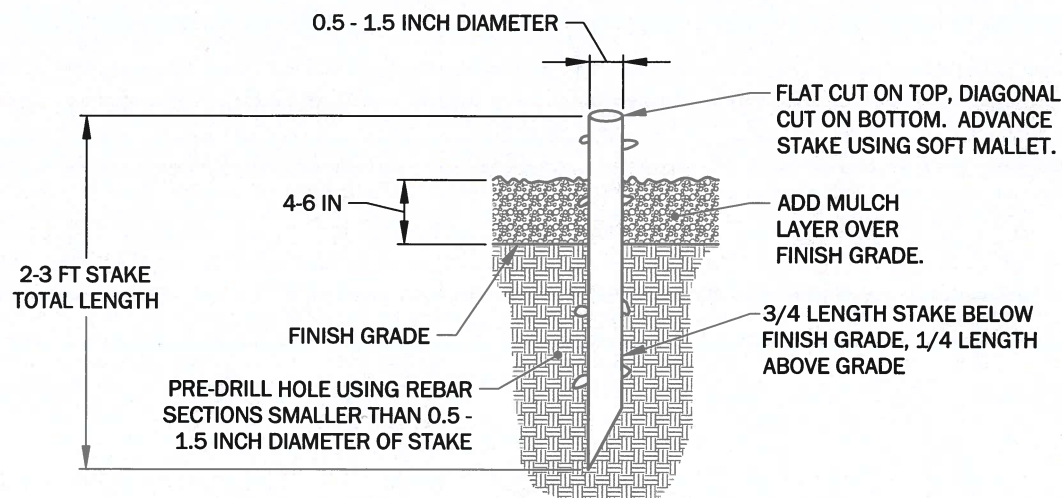
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ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**REVEGETATION PLAN**

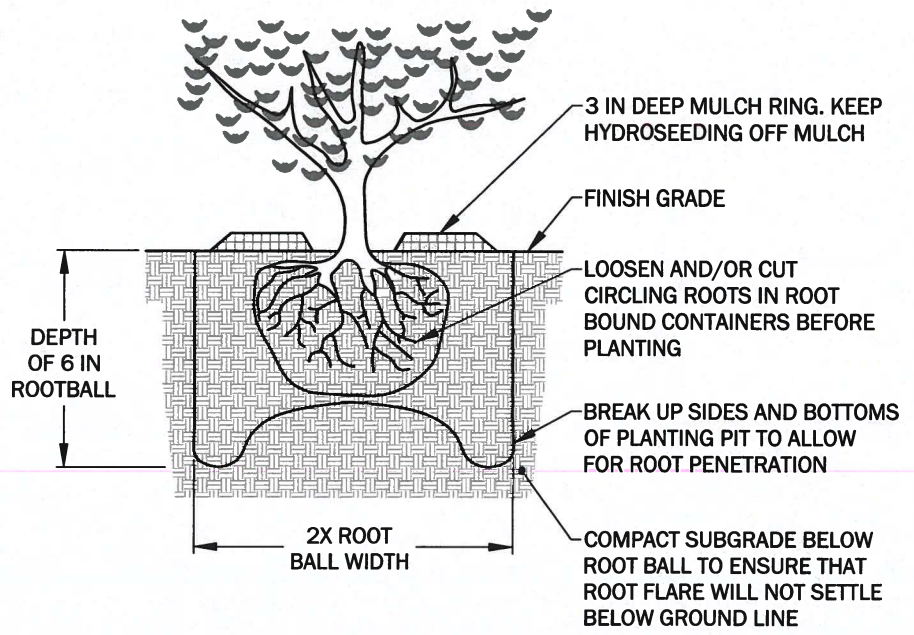
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 SHEET: 16 OF 19

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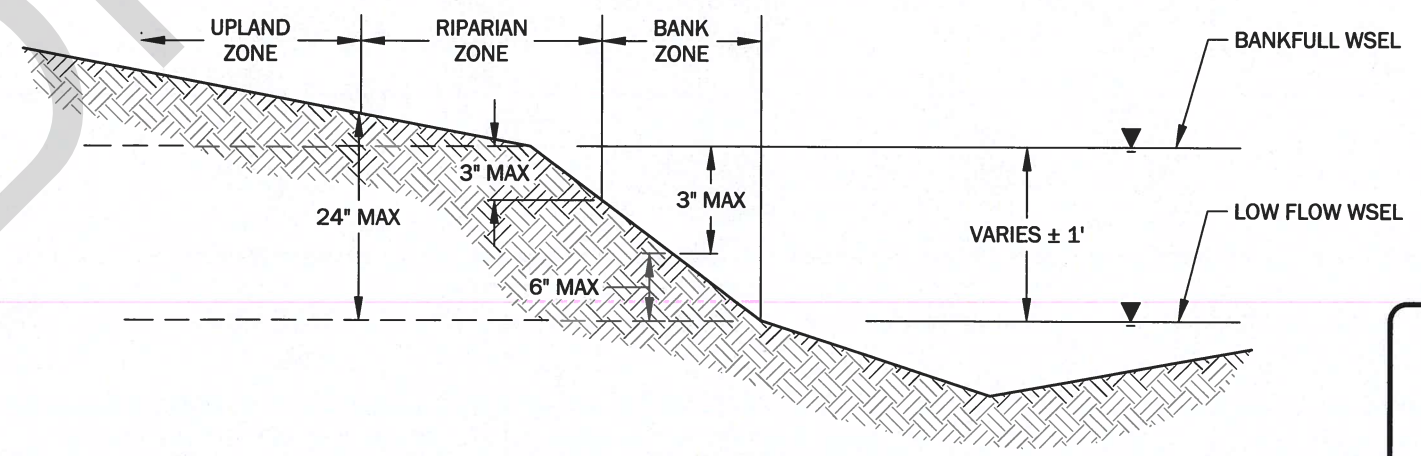


**LIVE STAKING (TYP) DETAIL 1**  
SCALE: NOT TO SCALE

Riparian Planting List					
Scientific Name	Common Name	Size	Avg. Spacing (ft.)	Row Length (ft)	Ea
<i>Salix lucida</i> spp caudata	Greenleaf Willow	Cutting	5	250	10
<i>Salix lutea</i>	Yellow Willow	Cutting	2	250	63
<i>Salix exigua</i>	Coyote Willow	Cutting	2	250	63
Upland Seed Mix			Area (SF)		
Scientific Name	Common Name	lbs PLS /acre	Percent of Mix	Lbs	
<i>Festuca arundinacea</i>	Tall Fescue	2.8	23%	0.0	
<i>Dactylis glomerata</i>	Orchardgrass	3.2	27%	0.0	
<i>Trifolium repens</i>	White Clover	1.2	10%	0.0	
<i>Elymus canadensis</i>	Canada Wild rye	1.6	13%	0.0	
<i>Elymus lanceolatus</i>	Streamside Wild rye	1.6	13%	0.0	
<i>Bromus carinatus</i>	Mountain brome	1.6	13%	0.0	
Total lbs of Seed Mix			12.0	100%	0.0
Upland Pasture Seed Mix			Area (SF)		
Scientific Name	Common Name	lbs PLS /acre	Percent of Mix	Lbs	
<i>Hordeum brachyantherum</i>	Timothy	1.5	100%	0.0	
Total lbs of Seed Mix					0.0



**SHRUB PLANTING (TYP) DETAIL 2**  
SCALE: NOT TO SCALE



**TYPICAL PLANTING ZONE 3**  
SCALE: NOT TO SCALE



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ROYES DAM FISH PASSAGE RESTORATION  
SUMMERVILLE, OREGON  
**REVEGETATION DETAILS AND QUANTITIES**

DRAWING NUMBER:  
**6.1**  
SHEET: 17 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

**HIP 4 GENERAL AQUATIC CONSERVATION MEASURES APPLICABLE TO ALL ACTIONS**

THE ACTIVITIES COVERED UNDER THE HIP IV ARE INTENDED TO PROTECT AND RESTORE FISH AND WILDLIFE HABITAT WITH LONG-TERM BENEFITS TO ESA-LISTED SPECIES. TO MINIMIZE THESE SHORT-TERM ADVERSE EFFECTS AND MAKE THEM PREDICTABLE FOR THE PURPOSES OF PROGRAMMATIC ANALYSIS, BPA WILL INCLUDE IN ALL PROJECTS IMPLEMENTED UNDER THIS HIP IV PROPOSED ACTION THE FOLLOWING GENERAL CONSERVATION MEASURES (DEVELOPED IN COORDINATION WITH USFWS AND NMFIS).

**PROJECT DESIGN AND SITE PREPARATION.**

**1) STATE AND FEDERAL PERMITS.** ALL APPLICABLE REGULATORY PERMITS AND OFFICIAL PROJECT AUTHORIZATIONS WILL BE OBTAINED BEFORE PROJECT IMPLEMENTATION. THESE PERMITS AND AUTHORIZATIONS INCLUDE, BUT ARE NOT LIMITED TO, NATIONAL ENVIRONMENTAL POLICY ACT, NATIONAL HISTORIC PRESERVATION ACT, AND THE APPROPRIATE STATE AGENCY REMOVAL AND FILL PERMIT, USACE CLEAN WATER ACT (CWA) 404 PERMITS, AND CWA SECTION 401 WATER QUALITY CERTIFICATIONS.

**2) TIMING OF IN-WATER WORK.** APPROPRIATE STATE (OREGON DEPARTMENT OF FISH AND WILDLIFE (ODFW), GUIDELINES FOR TIMING OF IN-WATER WORK WINDOWS (IWWW) WILL BE FOLLOWED.

A) BULL TROUT - WHILE UTILIZING THE APPROPRIATE STATE DESIGNATED IN-WATER WORK PERIOD WILL LESSEN THE RISK TO BULL TROUT, THIS ALONE MAY NOT BE SUFFICIENT TO ADEQUATELY PROTECT LOCAL BULL TROUT POPULATIONS. THIS IS ESPECIALLY TRUE IF WORK IS OCCURRING IN SPAWNING AND REARING AREAS BECAUSE EGGS, ALEVIN, AND FRY ARE IN THE SUBSTRATE OR CLOSELY ASSOCIATED HABITATS NEARLY YEAR ROUND. SOME AREAS MAY NOT HAVE DESIGNATED IN-WATER WORK WINDOWS FOR BULL TROUT OR IF THEY DO, THEY MAY CONFLICT WITH WORK WINDOWS FOR SALMON AND STEELHEAD. IF THIS IS THE CASE, OR IF PROPOSED WORK IS TO OCCUR WITHIN BULL TROUT SPAWNING AND REARING HABITATS, PROJECT PROPONENTS WILL CONTACT THE APPROPRIATE USFWS FIELD OFFICE TO INSURE THAT ALL REASONABLE IMPLEMENTATION MEASURES ARE CONSIDERED AND AN APPROPRIATE IN-WATER WORK WINDOW IS BEING USED TO MINIMIZE PROJECT EFFECTS.

B) LAMPREY - THE PROJECT SPONSOR AND/OR THEIR CONTRACTORS WILL AVOID WORKING IN STREAM OR RIVER CHANNELS THAT CONTAIN PACIFIC LAMPREY FROM MARCH 1 TO JULY 1 IN LOW TO MID ELEVATION REACHES (<5,000 FEET). IN HIGH ELEVATION REACHES (>5,000 FEET), THE PROJECT SPONSOR WILL AVOID WORKING IN STREAM OR RIVER CHANNELS FROM MARCH 1 TO AUGUST 1. IF EITHER TIMEFRAME IS INCOMPATIBLE WITH OTHER OBJECTIVES, THE AREA WILL BE SURVEYED FOR NESTS AND LAMPREY PRESENCE, AND AVOIDED IF POSSIBLE. IF LAMPREYS ARE KNOWN TO EXIST, THE PROJECT SPONSOR WILL UTILIZE DEWATERING AND SALVAGE PROCEDURES OUTLINED IN US FISH AND WILDLIFE SERVICE BEST MANAGEMENT PRACTICES TO MINIMIZE ADVERSE EFFECTS TO PACIFIC LAMPREY (2010).

C) EXCEPTIONS TO ODFW, WDFW, MFWP, OR IDFG IN-WATER WORK WINDOWS WILL BE REQUESTED THROUGH THE VARIANCE PROCESS (PAGE 2).

**3) CONTAMINANTS.** THE PROJECT SPONSOR WILL COMPLETE A SITE ASSESSMENT WITH THE FOLLOWING ELEMENTS TO IDENTIFY THE TYPE, QUANTITY, AND EXTENT OF ANY POTENTIAL CONTAMINATION FOR ANY ACTION THAT INVOLVES EXCAVATION OF MORE THAN 20 CUBIC YARDS OF MATERIAL:

- A) A REVIEW OF AVAILABLE RECORDS, SUCH AS FORMER SITE USE, BUILDING PLANS, AND RECORDS OF ANY PRIOR CONTAMINATION EVENTS;
- B) A SITE VISIT TO INSPECT THE AREAS USED FOR VARIOUS INDUSTRIAL PROCESSES AND THE CONDITION OF THE PROPERTY;
- C) INTERVIEWS WITH KNOWLEDGEABLE PEOPLE, SUCH AS SITE OWNERS, OPERATORS, AND OCCUPANTS, NEIGHBORS, OR LOCAL GOVERNMENT OFFICIALS; AND
- D) A SUMMARY, STORED WITH THE PROJECT FILE THAT INCLUDES AN ASSESSMENT OF THE LIKELIHOOD THAT CONTAMINANTS ARE PRESENT AT THE SITE, BASED ON ITEMS 4(A) THROUGH 4(C).

**4) SITE LAYOUT AND FLAGGING.** PRIOR TO CONSTRUCTION. THE ACTION AREA WILL BE CLEARLY FLAGGED TO IDENTIFY THE FOLLOWING:

- A) SENSITIVE RESOURCE AREAS, SUCH AS AREAS BELOW ORDINARY HIGH WATER, SPAWNING AREAS, SPRINGS, AND WETLANDS;
- B) EQUIPMENT ENTRY AND EXIT POINTS;
- C) ROAD AND STREAM CROSSING ALIGNMENTS;
- D) STAGING, STORAGE, AND STOCKPILE AREAS; AND
- E) NO-SPRAY AREAS AND BUFFERS.

**5) TEMPORARY ACCESS ROADS AND PATHS.**

A) EXISTING ACCESS ROADS AND PATHS WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER AND LENGTH OF TEMPORARY ACCESS ROADS AND PATHS THROUGH RIPARIAN AREAS AND FLOODPLAINS WILL BE MINIMIZED TO LESSEN SOIL DISTURBANCE AND COMPACTION, AND IMPACTS TO VEGETATION.

B) TEMPORARY ACCESS ROADS AND PATHS WILL NOT BE BUILT ON SLOPES WHERE GRADE, SOIL, OR OTHER FEATURES SUGGEST A LIKELIHOOD OF EXCESSIVE EROSION OR FAILURE. IF SLOPES ARE STEEPER THAN 30%, THEN THE ROAD WILL BE DESIGNED BY A CIVIL ENGINEER WITH EXPERIENCE IN STEEP ROAD DESIGN.

C) THE REMOVAL OF RIPARIAN VEGETATION DURING CONSTRUCTION OF TEMPORARY ACCESS ROADS WILL BE MINIMIZED. WHEN TEMPORARY VEGETATION REMOVAL IS REQUIRED, VEGETATION WILL BE CUT AT GROUND LEVEL (NOT GRUBBED).

D) AT PROJECT COMPLETION, ALL TEMPORARY ACCESS ROADS AND PATHS WILL BE OBLITERATED, AND THE SOIL WILL BE STABILIZED AND REVEGETATED. ROAD AND PATH OBLITERATION REFERS TO THE MOST COMPREHENSIVE DEGREE OF DECOMMISSIONING AND INVOLVES DECOMPACTING THE SURFACE AND DITCH, PULLING THE FILL MATERIAL ONTO THE RUNNING SURFACE, AND RESHAPING TO MATCH THE ORIGINAL CONTOUR.

E) TEMPORARY ROADS AND PATHS IN WET AREAS OR AREAS PRONE TO FLOODING WILL BE OBLITERATED BY THE END OF THE IN-WATER WORK WINDOW.

**1) TEMPORARY STREAM CROSSINGS.**

- A) EXISTING STREAM CROSSINGS WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER OF TEMPORARY STREAM CROSSINGS WILL BE MINIMIZED.
- B) TEMPORARY BRIDGES AND CULVERTS WILL BE INSTALLED TO ALLOW FOR EQUIPMENT AND VEHICLE CROSSING OVER PERENNIAL STREAMS DURING CONSTRUCTION. TREATED WOOD SHALL NOT BE USED ON TEMPORARY BRIDGE CROSSINGS OR IN LOCATIONS IN CONTACT WITH OR OVER WATER.
- C) EQUIPMENT AND VEHICLES WILL CROSS THE STREAM IN THE WET ONLY WHERE:
  - I. THE STREAMBED IS BEDROCK; OR
  - II. MATS OR OFF-SITE LOGS ARE PLACED IN THE STREAM AND USED AS A CROSSING.
- D) VEHICLES AND MACHINERY WILL CROSS STREAMS AT RIGHT ANGLES TO THE MAIN CHANNEL WHEREVER POSSIBLE.
- E) THE LOCATION OF THE TEMPORARY CROSSING WILL AVOID AREAS THAT MAY INCREASE THE RISK OF CHANNEL RE-ROUTING OR AVULSION.
- F) POTENTIAL SPAWNING HABITAT (I.E., POOL TAILOUTS) AND POOLS WILL BE AVOIDED TO THE MAXIMUM EXTENT POSSIBLE.
- G) NO STREAM CROSSINGS WILL OCCUR AT ACTIVE SPAWNING SITES, WHEN HOLDING ADULT LISTED FISH ARE PRESENT, OR WHEN EGGS OR ALEVINS ARE IN THE GRAVEL. THE APPROPRIATE STATE FISH AND WILDLIFE AGENCY WILL BE CONTACTED FOR SPECIFIC TIMING INFORMATION.
- H) AFTER PROJECT COMPLETION, TEMPORARY STREAM CROSSINGS WILL BE OBLITERATED AND THE STREAM CHANNEL AND BANKS RESTORED.

**7) STAGING, STORAGE, AND STOCKPILE AREAS.**

- A) STAGING AREAS (USED FOR CONSTRUCTION EQUIPMENT STORAGE, VEHICLE STORAGE, FUELING, SERVICING, AND HAZARDOUS MATERIAL STORAGE) WILL BE 150 FEET OR MORE FROM ANY NATURAL WATER BODY OR WETLAND, OR ON AN ADJACENT, ESTABLISHED ROAD AREA IN A LOCATION AND MANNER THAT WILL PRECLUDE EROSION INTO OR CONTAMINATION OF THE STREAM OR FLOODPLAIN.
- B) NATURAL MATERIALS USED FOR IMPLEMENTATION OF AQUATIC RESTORATION, SUCH AS LARGE WOOD, GRAVEL, AND BOULDERS, MAY BE STAGED WITHIN THE 100-YEAR FLOODPLAIN.
- C) ANY LARGE WOOD, TOPSOIL, AND NATIVE CHANNEL MATERIAL DISPLACED BY CONSTRUCTION WILL BE STOCKPILED FOR USE DURING SITE RESTORATION AT A SPECIFICALLY IDENTIFIED AND FLAGGED AREA.
- D) ANY MATERIAL NOT USED IN RESTORATION, AND NOT NATIVE TO THE FLOODPLAIN, WILL BE REMOVED TO A LOCATION OUTSIDE OF THE 100-YEAR FLOODPLAIN FOR DISPOSAL.

**8) EQUIPMENT.** MECHANIZED EQUIPMENT AND VEHICLES WILL BE SELECTED, OPERATED, AND MAINTAINED IN A MANNER THAT MINIMIZES ADVERSE EFFECTS ON THE ENVIRONMENT (E.G., MINIMALLY-SIZED, LOW PRESSURE TIRES; MINIMAL HARD-TURN PATHS FOR TRACKED VEHICLES; TEMPORARY MATS OR PLATES WITHIN WET AREAS OR ON SENSITIVE SOILS). ALL VEHICLES AND OTHER MECHANIZED EQUIPMENT WILL BE:

- A) STORED, FUELED, AND MAINTAINED IN A VEHICLE STAGING AREA PLACED 150 FEET OR MORE FROM ANY NATURAL WATER BODY OR WETLAND OR ON AN ADJACENT, ESTABLISHED ROAD AREA;
- B) REFUELED IN A VEHICLE STAGING AREA PLACED 150 FEET OR MORE FROM A NATURAL WATERBODY OR WETLAND, OR IN AN ISOLATED HARD ZONE, SUCH AS A PAVED PARKING LOT OR ADJACENT, ESTABLISHED ROAD (THIS MEASURE APPLIES ONLY TO GAS-POWERED EQUIPMENT WITH TANKS LARGER THAN 5 GALLONS).
- C) BIODEGRADABLE LUBRICANTS AND FLUIDS SHALL BE USED ON EQUIPMENT OPERATING IN AND ADJACENT TO THE STREAM CHANNEL AND LIVE WATER.
- D) INSPECTED DAILY FOR FLUID LEAKS BEFORE LEAVING THE VEHICLE STAGING AREA FOR OPERATION WITHIN 150 FEET OF ANY NATURAL WATER BODY OR WETLAND; AND
- E) THOROUGHLY CLEANED BEFORE OPERATION BELOW ORDINARY HIGH WATER, AND AS OFTEN AS NECESSARY DURING OPERATION, TO REMAIN GREASE FREE.

**9) EROSION CONTROL.** EROSION CONTROL MEASURES WILL BE PREPARED AND CARRIED OUT, COMMENSURATE IN SCOPE WITH THE ACTION, THAT MAY INCLUDE THE FOLLOWING:

- A) TEMPORARY EROSION CONTROLS.
  - I. TEMPORARY EROSION CONTROLS WILL BE IN PLACE BEFORE ANY SIGNIFICANT ALTERATION OF THE ACTION SITE AND APPROPRIATELY INSTALLED DOWNSLOPE OF PROJECT ACTIVITY WITHIN THE RIPARIAN BUFFER AREA UNTIL SITE REHABILITATION IS COMPLETE.
  - II. IF THERE IS A POTENTIAL FOR ERODED SEDIMENT TO ENTER THE STREAM, SEDIMENT BARRIERS WILL BE INSTALLED AND MAINTAINED FOR THE DURATION OF PROJECT IMPLEMENTATION.
  - III. TEMPORARY EROSION CONTROL MEASURES MAY INCLUDE FIBER WATTLES, SILT FENCES, JUTE MATTING, WOOD FIBER MULCH AND SOIL BINDER, OR GEOTEXTILES AND GEOSYNTHETIC FABRIC.
  - IV. SOIL STABILIZATION UTILIZING WOOD FIBER MULCH AND TACKIFIER (HYDRO-APPLIED) MAY BE USED TO REDUCE EROSION OF BARE SOIL IF THE MATERIALS ARE NOXIOUS WEED FREE AND NONTOXIC TO AQUATIC AND TERRESTRIAL ANIMALS, SOIL MICROORGANISMS, AND VEGETATION.
  - V. SEDIMENT WILL BE REMOVED FROM EROSION CONTROLS ONCE IT HAS REACHED 1/3 OF THE EXPOSED HEIGHT OF THE CONTROL.
  - VI. ONCE THE SITE IS STABILIZED AFTER CONSTRUCTION, TEMPORARY EROSION CONTROL MEASURES WILL BE REMOVED.
- B) EMERGENCY EROSION CONTROLS. THE FOLLOWING MATERIALS FOR EMERGENCY EROSION CONTROL WILL BE AVAILABLE AT THE WORK SITE:
  - I. A SUPPLY OF SEDIMENT CONTROL MATERIALS; AND
  - II. AN OIL-ABSORBING FLOATING BOOM WHENEVER SURFACE WATER IS PRESENT.

**10) DUST ABATEMENT.** THE PROJECT SPONSOR WILL DETERMINE THE APPROPRIATE DUST CONTROL MEASURES BY CONSIDERING SOIL TYPE, EQUIPMENT USAGE, PREVAILING WIND DIRECTION, AND THE EFFECTS CAUSED BY OTHER EROSION AND SEDIMENT CONTROL MEASURES. IN ADDITION, THE FOLLOWING

**CRITERIA WILL BE FOLLOWED:**

- A) WORK WILL BE SEQUENCED AND SCHEDULED TO REDUCE EXPOSED BARE SOIL SUBJECT TO WIND EROSION.
- B) DUST-ABATEMENT ADDITIVES AND STABILIZATION CHEMICALS (TYPICALLY MAGNESIUM CHLORIDE, CALCIUM CHLORIDE SALTS, OR LIGNINSULFONATE) WILL NOT BE APPLIED WITHIN 25 FEET OF WATER OR A STREAM CHANNEL AND WILL BE APPLIED SO AS TO MINIMIZE THE LIKELIHOOD THAT THEY WILL ENTER STREAMS. APPLICATIONS OF LIGNINSULFONATE WILL BE LIMITED TO A MAXIMUM RATE OF 0.5 GALLONS PER SQUARE YARD OF ROAD SURFACE, ASSUMING A 50:50 (LIGNINSULFONATE TO WATER) SOLUTION.
- C) APPLICATION OF DUST ABATEMENT CHEMICALS WILL BE AVOIDED DURING OR JUST BEFORE WET WEATHER, AND AT STREAM CROSSINGS OR OTHER AREAS THAT COULD RESULT IN UNFILTERED DELIVERY OF THE DUST ABATEMENT MATERIALS TO A WATERBODY (TYPICALLY THESE WOULD BE AREAS WITHIN 25 FEET OF A WATERBODY OR STREAM CHANNEL; DISTANCES MAY BE GREATER WHERE VEGETATION IS SPARSE OR SLOPES ARE STEEP).
- D) SPILL CONTAINMENT EQUIPMENT WILL BE AVAILABLE DURING APPLICATION OF DUST ABATEMENT CHEMICALS.
- E) PETROLEUM-BASED PRODUCTS WILL NOT BE USED FOR DUST ABATEMENT.
- 11) **SPILL PREVENTION, CONTROL, AND COUNTER MEASURES.** THE USE OF MECHANIZED MACHINERY INCREASES THE RISK FOR ACCIDENTAL SPILLS OF FUEL, LUBRICANTS, HYDRAULIC FLUID, OR OTHER CONTAMINANTS INTO THE RIPARIAN ZONE OR DIRECTLY INTO THE WATER. ADDITIONALLY, UNCURED CONCRETE AND FORM MATERIALS ADJACENT TO THE ACTIVE STREAM CHANNEL MAY RESULT IN ACCIDENTAL DISCHARGE INTO THE WATER. THESE CONTAMINANTS CAN DEGRADE HABITAT, AND INJURE OR KILL AQUATIC FOOD ORGANISMS AND ESA-LISTED SPECIES. THE PROJECT SPONSOR WILL ADHERE TO THE FOLLOWING MEASURES:
  - A) A DESCRIPTION OF HAZARDOUS MATERIALS THAT WILL BE USED, INCLUDING INVENTORY, STORAGE, AND HANDLING PROCEDURES WILL BE AVAILABLE ON-SITE.
  - B) WRITTEN PROCEDURES FOR NOTIFYING ENVIRONMENTAL RESPONSE AGENCIES WILL BE POSTED AT THE WORK SITE.
  - C) SPILL CONTAINMENT KITS (INCLUDING INSTRUCTIONS FOR CLEANUP AND DISPOSAL) ADEQUATE FOR THE TYPES AND QUANTITY OF HAZARDOUS MATERIALS USED AT THE SITE WILL BE AVAILABLE AT THE WORK SITE.
  - D) WORKERS WILL BE TRAINED IN SPILL CONTAINMENT PROCEDURES AND WILL BE INFORMED OF THE LOCATION OF SPILL CONTAINMENT KITS.
  - E) ANY WASTE LIQUIDS GENERATED AT THE STAGING AREAS WILL BE TEMPORARILY STORED UNDER AN IMPERVIOUS COVER, SUCH AS A TARPULIN, UNTIL THEY CAN BE PROPERLY TRANSPORTED TO AND DISPOSED OF AT A FACILITY THAT IS APPROVED FOR RECEIPT OF HAZARDOUS MATERIALS.
- 12) **INVASIVE SPECIES CONTROL.** THE FOLLOWING MEASURES WILL BE FOLLOWED TO AVOID INTRODUCTION OF INVASIVE PLANTS AND NOXIOUS WEEDS INTO PROJECT AREAS:
  - A) PRIOR TO ENTERING THE SITE, ALL VEHICLES AND EQUIPMENT WILL BE POWER WASHED, ALLOWED TO FULLY DRY, AND INSPECTED TO MAKE SURE NO PLANTS, SOIL, OR OTHER ORGANIC MATERIAL ADHERES TO THE SURFACE.
  - B) WATERCRAFT, WADERS, BOOTS, AND ANY OTHER GEAR TO BE USED IN OR NEAR WATER WILL BE INSPECTED FOR AQUATIC INVASIVE SPECIES.
  - C) WADING BOOTS WITH FELT SOLES ARE NOT TO BE USED DUE TO THEIR PROPENSITY FOR AIDING IN THE TRANSFER OF INVASIVE SPECIES.

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NO.	DATE	BY	ISSUE / DESCRIPTION

DESIGNED BY: KHR  
 DRAWN BY: KHR/SCY  
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 REVISION NO.: —  
 DATE: 06/30/23



ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**BPA HIP IV - GENERAL CONSERVATION MEASURES**

DRAWING NUMBER:  
**7.0**  
 SHEET: 18 OF 19



DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

**WORK AREA ISOLATION & FISH SALVAGE.**

ANY WORK AREA WITHIN THE WETTED CHANNEL WILL BE ISOLATED FROM THE ACTIVE STREAM WHENEVER ESA-LISTED FISH ARE REASONABLY CERTAIN TO BE PRESENT, OR IF THE WORK AREA IS LESS THAN 300-FEET UPSTREAM FROM KNOWN SPAWNING HABITATS. WHEN WORK AREA ISOLATION IS REQUIRED, DESIGN PLANS WILL INCLUDE ALL ISOLATION ELEMENTS, FISH RELEASE AREAS, AND, WHEN A PUMP IS USED TO DEWATER THE ISOLATION AREA AND FISH ARE PRESENT, A FISH SCREEN THAT MEETS NMFS'S FISH SCREEN CRITERIA (NMFS 2011, OR MOST CURRENT). WORK AREA ISOLATION AND FISH CAPTURE ACTIVITIES WILL OCCUR DURING PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES POSSIBLE, NORMALLY EARLY IN THE MORNING VERSUS LATE IN THE DAY, AND DURING CONDITIONS APPROPRIATE TO MINIMIZE STRESS AND DEATH OF SPECIES PRESENT.

- NATIONAL MARINE FISHERIES SERVICE. 2011. ANADROMOUS SALMONID PASSAGE FACILITY DESIGN. NORTHWEST REGION. AVAILABLE ONLINE AT: [HTTP://WWW.NWR.NOAA.GOV/SALMON-HYDROPOWER/FERC/UPLOAD/FISH-PASSAGE-DESIGN.PDF](http://www.nwr.noaa.gov/salmon-hydropower/ferc/upload/fish-passage-design.pdf)

- U.S. FISH AND WILDLIFE SERVICE. 2010. BEST MANAGEMENT PRACTICES TO MINIMIZE ADVERSE EFFECTS TO PACIFIC LAMPREY.

[HTTP://WWW.FWS.GOV/PACIFIC/FISHERIES/SPHABCON/LAMPREY/PDF/BEST%20MANAGEMENT%20PRACTICES%20FOR%20PACIFIC%20LAMPREY%20APRIL%202010%20VERSION.PDF](http://www.fws.gov/pacific/fisheries/sphabcon/lamprey/pdf/best%20management%20practices%20for%20pacific%20lamprey%20april%202010%20version.pdf)

FOR SALVAGE OPERATIONS IN KNOWN BULL TROUT SPAWNING AND REARING HABITAT, ELECTROFISHING SHALL ONLY OCCUR FROM MAY 1 TO JULY 31. NO ELECTROFISHING WILL OCCUR IN ANY BULL TROUT OCCUPIED HABITAT AFTER AUGUST 15. BULL TROUT ARE VERY TEMPERATURE SENSITIVE AND GENERALLY SHOULD NOT BE ELECTROSHOCKED OR OTHERWISE HANDLED WHEN TEMPERATURES EXCEED 15 DEGREES CELSIUS. SALVAGE ACTIVITIES SHOULD TAKE PLACE DURING PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES POSSIBLE, NORMALLY EARLY IN THE MORNING VERSUS LATE IN THE DAY, AND DURING CONDITIONS APPROPRIATE TO MINIMIZE STRESS TO FISH SPECIES PRESENT.

SALVAGE OPERATIONS WILL FOLLOW THE ORDERING, METHODOLOGIES, AND CONSERVATION MEASURES SPECIFIED BELOW IN STEPS 1 THROUGH 6. STEPS 1 AND 2 WILL BE IMPLEMENTED FOR ALL PROJECTS WHERE WORK AREA ISOLATION IS NECESSARY ACCORDING TO CONDITIONS ABOVE. ELECTROFISHING (STEP 3) CAN BE IMPLEMENTED TO ENSURE ALL FISH HAVE BEEN REMOVED FOLLOWING STEPS 1 AND 2, OR WHEN OTHER MEANS OF FISH CAPTURE MAY NOT BE FEASIBLE OR EFFECTIVE. DEWATERING AND REWATERING (STEPS 4 AND 5) WILL BE IMPLEMENTED UNLESS WETTED IN-STREAM WORK IS DEEMED TO BE MINIMALLY HARMFUL TO FISH, AND IS BENEFICIAL TO OTHER AQUATIC SPECIES. DEWATERING WILL NOT BE CONDUCTED IN AREAS KNOWN TO BE OCCUPIED BY LAMPREY, UNLESS LAMPREYS ARE SALVAGED USING GUIDANCE SET FORTH IN US FISH AND WILDLIFE SERVICE (2010)3.

**1) ISOLATE.**

- A) BLOCK NETS WILL BE INSTALLED AT UPSTREAM AND DOWNSTREAM LOCATIONS AND MAINTAINED IN A SECURED POSITION TO EXCLUDE FISH FROM ENTERING THE PROJECT AREA.
- B) BLOCK NETS WILL BE SECURED TO THE STREAM CHANNEL BED AND BANKS UNTIL FISH CAPTURE AND TRANSPORT ACTIVITIES ARE COMPLETE. BLOCK NETS MAY BE LEFT IN PLACE FOR THE DURATION OF THE PROJECT TO EXCLUDE FISH.
- C) IF BLOCK NETS REMAIN IN PLACE MORE THAN ONE DAY, THE NETS WILL BE MONITORED AT LEAST DAILY TO ENSURE THEY ARE SECURED TO THE BANKS AND FREE OF ORGANIC ACCUMULATION. IF THE PROJECT IS WITHIN BULL TROUT SPAWNING AND REARING HABITAT, THE BLOCK NETS MUST BE CHECKED EVERY FOUR HOURS FOR FISH IMPINGEMENT ON THE NET. LESS FREQUENT INTERVALS MUST BE APPROVED THROUGH A VARIANCE REQUEST.
- D) NETS WILL BE MONITORED HOURLY ANYTIME THERE IS INSTREAM DISTURBANCE.

**2) SALVAGE.** AS DESCRIBED BELOW, FISH TRAPPED WITHIN THE ISOLATED WORK AREA WILL BE CAPTURED TO MINIMIZE THE RISK OF INJURY, THEN RELEASED AT A SAFE SITE:

- A) REMOVE AS MANY FISH AS POSSIBLE PRIOR TO DEWATERING.
- B) DURING DEWATERING, ANY REMAINING FISH WILL BE COLLECTED BY HAND OR DIP NETS.
- C) SEINES WITH A MESH SIZE TO ENSURE CAPTURE OF THE RESIDING ESA-LISTED FISH WILL BE USED.
- D) MINNOW TRAPS WILL BE LEFT IN PLACE OVERNIGHT AND USED IN CONJUNCTION WITH SEINING.
- E) IF BUCKETS ARE USED TO TRANSPORT FISH:
  - I. THE TIME FISH ARE IN A TRANSPORT BUCKET WILL BE LIMITED, AND WILL BE RELEASED AS QUICKLY AS POSSIBLE;
  - II. THE NUMBER OF FISH WITHIN A BUCKET WILL BE LIMITED BASED ON SIZE, AND FISH WILL BE OF RELATIVELY COMPARABLE SIZE TO MINIMIZE PREDATION;
  - III. AERATORS FOR BUCKETS WILL BE USED OR THE BUCKET WATER WILL BE FREQUENTLY CHANGED WITH COLD CLEAR WATER AT 15 MINUTE OR MORE FREQUENT INTERVALS.
  - IV. BUCKETS WILL BE KEPT IN SHADED AREAS OR WILL BE COVERED BY A CANOPY IN EXPOSED AREAS.
  - V. DEAD FISH WILL NOT BE STORED IN TRANSPORT BUCKETS, BUT WILL BE LEFT ON THE STREAM BANK TO AVOID MORTALITY COUNTING ERRORS.
- F) AS RAPIDLY AS POSSIBLE (ESPECIALLY FOR TEMPERATURE-SENSITIVE BULL TROUT), FISH WILL BE RELEASED IN AN AREA THAT PROVIDES ADEQUATE COVER AND FLOW REFUGE. UPSTREAM RELEASE IS GENERALLY PREFERRED, BUT FISH RELEASED DOWNSTREAM WILL BE SUFFICIENTLY OUTSIDE OF THE INFLUENCE OF CONSTRUCTION.
- G) SALVAGE WILL BE SUPERVISED BY A QUALIFIED FISHERIES BIOLOGIST EXPERIENCED WITH WORK AREA ISOLATION AND COMPETENT TO ENSURE THE SAFE HANDLING OF ALL FISH.

**3) ELECTROFISHING.** ELECTROFISHING WILL BE USED ONLY AFTER OTHER SALVAGE METHODS HAVE BEEN EMPLOYED OR WHEN OTHER MEANS OF FISH CAPTURE ARE DETERMINED TO NOT BE FEASIBLE OR EFFECTIVE. IF ELECTROFISHING WILL BE USED TO CAPTURE FISH FOR SALVAGE, THE SALVAGE OPERATION WILL BE LED BY AN EXPERIENCED FISHERIES BIOLOGIST AND THE FOLLOWING GUIDELINES WILL BE FOLLOWED:

- A) THE NMFS'S ELECTROFISHING GUIDELINES (NMFS 2000).
- B) ONLY DIRECT CURRENT (DC) OR PULSED DIRECT CURRENT (PDC) WILL BE USED AND CONDUCTIVITY MUST BE

**TESTED.**

- I. IF CONDUCTIVITY IS LESS THAN 100 MS, VOLTAGE RANGES FROM 900 TO 1100 WILL BE USED.
- II. FOR CONDUCTIVITY RANGES BETWEEN 100 TO 300 MS, VOLTAGE RANGES WILL BE 500 TO 800.
- III. FOR CONDUCTIVITY GREATER THAN 300 MS, VOLTAGE WILL BE LESS THAN 400.
- C) ELECTROFISHING WILL BEGIN WITH A MINIMUM PULSE WIDTH AND RECOMMENDED VOLTAGE AND THEN GRADUALLY INCREASE TO THE POINT WHERE FISH ARE IMMOBILIZED.
- D) THE ANODE WILL NOT INTENTIONALLY CONTACT FISH.
- E) ELECTROFISHING SHALL NOT BE CONDUCTED WHEN THE WATER CONDITIONS ARE TURBID AND VISIBILITY IS POOR. THIS CONDITION MAY BE EXPERIENCED WHEN THE SAMPLER CANNOT SEE THE STREAM BOTTOM IN ONE FOOT OF WATER.
- F) IF MORTALITY OR OBVIOUS INJURY (DEFINED AS DARK BANDS ON THE BODY, SPINAL DEFORMATIONS, DE-SCALING OF 25% OR MORE OF BODY, AND TORPIDITY OR INABILITY TO MAINTAIN UPRIGHT ATTITUDE AFTER SUFFICIENT RECOVERY TIME) OCCURS DURING ELECTROFISHING, OPERATIONS WILL BE IMMEDIATELY DISCONTINUED, MACHINE SETTINGS, WATER TEMPERATURE AND CONDUCTIVITY CHECKED, AND PROCEDURES ADJUSTED OR ELECTROFISHING POSTPONED TO REDUCE MORTALITY.
- 4) **DEWATER.** DEWATERING, WHEN NECESSARY, WILL BE CONDUCTED OVER A SUFFICIENT PERIOD OF TIME TO ALLOW SPECIES TO NATURALLY MIGRATE OUT OF THE WORK AREA AND WILL BE LIMITED TO THE SHORTEST LINEAR EXTENT PRACTICABLE.
  - A) DIVERSION AROUND THE CONSTRUCTION SITE MAY BE ACCOMPLISHED WITH A COFFER DAM AND A BY-PASS CULVERT OR PIPE, OR A LINED, NON-ERODIBLE DIVERSION DITCH. WHERE GRAVITY FEED IS NOT POSSIBLE, A PUMP MAY BE USED, BUT MUST BE OPERATED IN SUCH A WAY AS TO AVOID REPETITIVE DEWATERING AND REWATERING OF THE SITE. IMPOUNDMENT BEHIND THE COFFERDAM MUST OCCUR SLOWLY THROUGH THE TRANSITION, WHILE CONSTANT FLOW IS DELIVERED TO THE DOWNSTREAM REACHES.
  - B) ALL PUMPS WILL HAVE FISH SCREENS TO AVOID JUVENILE FISH IMPINGEMENT OR ENTRAINMENT, AND WILL BE OPERATED IN ACCORDANCE WITH NMFS'S CURRENT FISH SCREEN CRITERIA (NMFS 2011.4, OR MOST RECENT VERSION). IF THE PUMPING RATE EXCEEDS 3 CUBIC FEET SECOND (CFS), A NMFS HYDRO FISH PASSAGE REVIEW WILL BE NECESSARY.
  - C) DISSIPATION OF FLOW ENERGY AT THE BYPASS OUTFLOW WILL BE PROVIDED TO PREVENT DAMAGE TO RIPARIAN VEGETATION OR STREAM CHANNEL.
  - D) SAFE REENTRY OF FISH INTO THE STREAM CHANNEL WILL BE PROVIDED, PREFERABLY INTO POOL HABITAT WITH COVER, IF THE DIVERSION ALLOWS FOR DOWNSTREAM FISH PASSAGE.
  - E) SEEPAGE WATER WILL BE PUMPED TO A TEMPORARY STORAGE AND TREATMENT SITE OR INTO UPLAND AREAS TO ALLOW WATER TO PERCOLATE THROUGH SOIL OR TO FILTER THROUGH VEGETATION PRIOR TO REENTERING THE STREAM CHANNEL.
- 4 NATIONAL MARINE FISHERIES SERVICE. 2011. ANADROMOUS SALMONID PASSAGE FACILITY DESIGN. NORTHWEST REGION. AVAILABLE ONLINE AT: [HTTP://WWW.NWR.NOAA.GOV/SALMON-HYDROPOWER/FERC/UPLOAD/FISH-PASSAGE-DESIGN.PDF](http://www.nwr.noaa.gov/salmon-hydropower/ferc/upload/fish-passage-design.pdf)
- 5) **SALVAGE NOTICE.** MONITORING AND RECORDING OF FISH PRESENCE, HANDLING, AND MORTALITY MUST OCCUR DURING THE DURATION OF THE ISOLATION, SALVAGE, ELECTROFISHING, DEWATERING, AND REWATERING OPERATIONS. ONCE OPERATIONS ARE COMPLETED, A SALVAGE REPORT WILL DOCUMENT PROCEDURES USED, ANY FISH INJURIES OR DEATHS (INCLUDING NUMBERS OF FISH AFFECTED), AND CAUSES OF ANY DEATHS.

**CONSTRUCTION AND POST-CONSTRUCTION CONSERVATION MEASURES.**

- 1) **FISH PASSAGE.** FISH PASSAGE WILL BE PROVIDED FOR ANY ADULT OR JUVENILE FISH LIKELY TO BE PRESENT IN THE ACTION AREA DURING CONSTRUCTION, UNLESS PASSAGE DID NOT EXIST BEFORE CONSTRUCTION OR THE STREAM IS NATURALLY IMPASSABLE AT THE TIME OF CONSTRUCTION. IF THE PROVISION OF TEMPORARY FISH PASSAGE DURING CONSTRUCTION WILL INCREASE NEGATIVE EFFECTS ON AQUATIC SPECIES OF INTEREST OR THEIR HABITAT, A VARIANCE CAN BE REQUESTED FROM THE NMFS BRANCH CHIEF AND THE FWS FIELD OFFICE SUPERVISOR. PERTINENT INFORMATION, SUCH AS THE SPECIES AFFECTED, LENGTH OF STREAM REACH AFFECTED, PROPOSED TIME FOR THE PASSAGE BARRIER, AND ALTERNATIVES CONSIDERED, WILL BE INCLUDED IN THE VARIANCE REQUEST.
- 2) **CONSTRUCTION AND DISCHARGE WATER.**
  - A) SURFACE WATER MAY BE DIVERTED TO MEET CONSTRUCTION NEEDS, BUT ONLY IF DEVELOPED SOURCES ARE UNAVAILABLE OR INADEQUATE.
  - B) DIVERSIONS WILL NOT EXCEED 10% OF THE AVAILABLE FLOW.
  - C) ALL CONSTRUCTION DISCHARGE WATER WILL BE COLLECTED AND TREATED USING THE BEST AVAILABLE TECHNOLOGY APPLICABLE TO SITE CONDITIONS.
  - D) TREATMENTS TO REMOVE DEBRIS, NUTRIENTS, SEDIMENT, PETROLEUM HYDROCARBONS, METALS AND OTHER POLLUTANTS LIKELY TO BE PRESENT WILL BE PROVIDED.

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NO.	DATE	BY	ISSUE / DESCRIPTION

DESIGNED BY: KHR  
 DRAWN BY: KHR/SCY  
 APPROVED BY: RSC  
 REVISION NO.:  
 DATE: 06/30/23



PREPARED FOR:

ROYES DAM FISH PASSAGE RESTORATION  
 SUMMERVILLE, OREGON  
**BPA HIP IV - GENERAL CONSERVATION MEASURES**

DRAWING NUMBER:  
**7.1**  
 SHEET: 19 OF 19

DRAFT FINAL SUBMITTAL - NOT FOR CONSTRUCTION

**APPENDIX B**  
**Site Photographs**

DRAFT



Pump 1 with electrical panel facing south



Pump 1 with delivery pipe facing east

**Site Photographs  
Pump 1 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-1**



Pump 1 model and serial number – Cornell Manufacturing Company



Pump 1 induction motor

<b>Site Photographs</b> <b>Pump 1 Photos</b>	
Willow Creek Fish Passage Royes Dam Union County, Oregon	
	<b>Figure B-2</b>



Pump 2 (foreground) and pump 3 (background) – facing south (upstream)

**Site Photographs  
Pump 2 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-3**



**Pump 2 housing facing northwest (downstream)**

**Site Photographs  
Pump 2 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-4**



Pump 2 and motor - outlet pipe to the left



Pump 2 (Previously referenced as Pump 9)

**Site Photographs  
Pump 2 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-5**



Pump 2 motor - 75 horsepower (Previously referenced as Pump 9)

**Site Photographs  
Pump 2 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-6**



Pump 3 housing and intake pipe (right) outlet pipe (left) (Previously referenced as Pump 10)

**Site Photographs  
Pump 3 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-7**



Pump 3 and motor (Previously referenced as Pump 10)



Pump 3 motor – 100 horsepower (Previously referenced as Pump 10)

Site Photographs  
Pump 3 Photos

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



Figure B-8



Pump 3 (Previously referenced as Pump 10)

**Site Photographs  
Pump 3 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Pump 4 housing, intake right and outlet right, facing west (upstream)**



**Pump 4 intake and concrete wall, facing upstream (Previously referenced as Pump 11)**

**Site Photographs  
Pump 4 Photos**

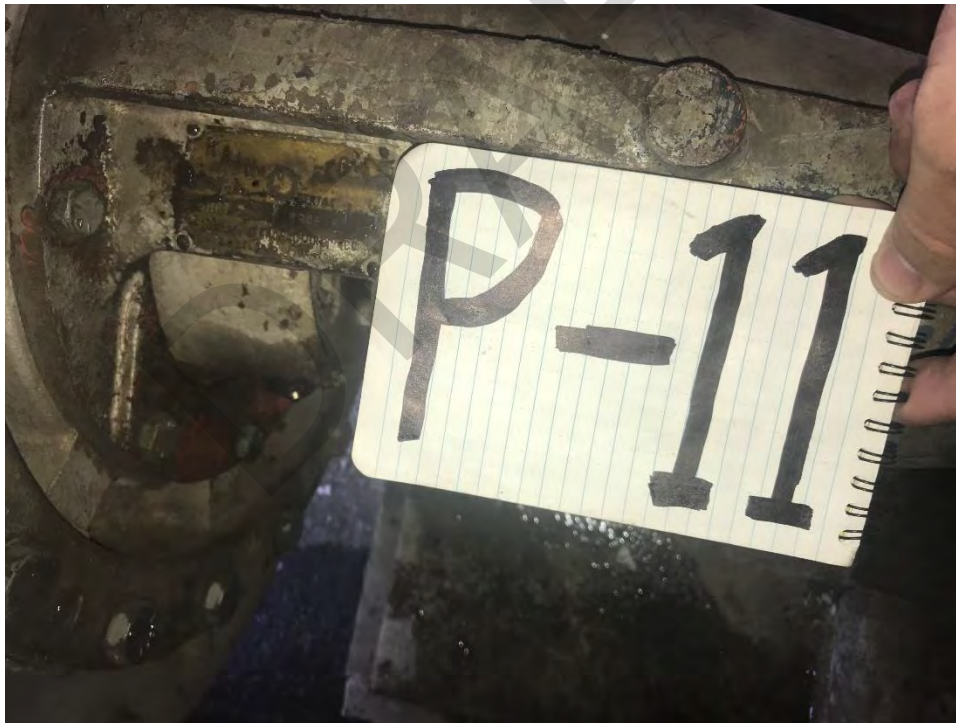
Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-10**



Pump 4 and electrical control panel (Previously referenced as Pump 11)



Pump 4 (Previously referenced as Pump 11)

**Site Photographs  
Pump 4 Photos**

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



**Figure B-11**



Pump 4 motor – 100 horsepower (Previously referenced as Pump 11)

Site Photographs  
Pump 4 Photos

Willow Creek Fish Passage Royes Dam  
Union County, Oregon



Figure B-12

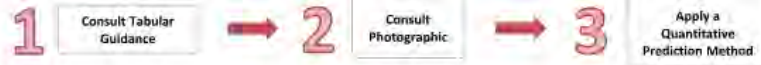
**APPENDIX C**  
**Hydrologic and Hydraulic Analysis**

DRAFT

Stream Name: Willow Creek Reach: Existing  
 Stream Slope, S (ft/ft): 0.00100 Date: 3/14/2023  
 Practitioner: Alex Pederson

Reach  $D_{50}$ ,  $D_{84}$  (mm): 20 35 Step  $D_{84}$  (mm)<sup>101</sup>:  
 Hydraulic Radius, R (ft):  
 Mean Flow Depth, d (ft)<sup>102</sup>:  
 Bedform Variation,  $\sigma_v$  (ft)<sup>103</sup>:  
 Median Thalweg Depth,  $h_m$  (ft)<sup>104</sup>:  
 Large Wood in Steps? (y/n)<sup>105</sup>: y

Notes:  
 (a) Required for Lee and Ferguson (2002) method, for step-pool streams ( $S > 0.027$ )  
 (b) Mean flow depth = hydraulic depth; Required for Bathurst (1985), Rickenmann and Recking (2011), and Aberle and Smart (2003) methods



Flow resistance in stream channels is due to roughness induced by bed and bank grain material, bedforms (such as dunes and step pools), platform, vegetation, large instream wood, and other obstructions. Flow resistance coefficient estimation (Manning's  $n$ , Darcy-Weisbach  $f$ ) is approximate, requiring redundancy (steps 1 through 3) for confidence in the implemented values. Dependence on quantitative methods alone is not recommended since utilized reaches in the derivations were intentionally selected to have little influence from sinuosity, instream large wood, streambank vegetation, bank irregularities, obstructions, etc.; these types of flow resistance are not lumped into the quantitative estimates. Also, flow resistance coefficients should be computed at the flow magnitude of interest for the objectives of the analysis, specifically at high, bankfull, or low flow.

**1 Tabular Guidance**  
 Sources: Brunner (2016), pp 3-14  
 Arcement and Schneider (1989): p 4  
 Aldridge and Garrett (1973): p 24  
 Note: Key references are provided in the spreadsheet package as file or are available for download through the links provided in the references of the supporting technical summary report (TS-103).

**2 Photographic Guidance**  
 Sources: USGS (online photo guidance)  
 Yochum et al. (2014): high gradient  
 Hicks and Mason (1991)  
 Aldridge and Garrett (1973)  
 Barnes (1967)

Use in Average? Enter "y"  
 Tabular Estimate:  $n$  0.050  $f$  — Y  
 Estimate from Photographic Guidance: — N

- Instructions: [See technical summary report, TS-103, for more detailed instructions and references.]
- (1) Grey cells indicate fields that should be populated. Results are provided in the salmon colored cells.
  - (2) Enter background information (cells D4, D5, I4 to I6), sediment size data (cells D8, E8, H8), and hydraulic information (cells D9 to D13). R is often approximated as the average depth for streams with a width/depth ratio  $> \sim 20$ .
  - (3) Consult tabular guidance and enter the best estimate in the grey box (cell I4); do not use in average if not confident of estimate). Tabular values are typically substantially underestimated for channels  $> \sim 3\%$  slope.
  - (4) Consult photographic guidance and enter an estimate in the grey box (cell I44).
  - (5) Applicable quantitative procedures will be automatically compute (per provided Applicable Range).
  - (6) Implement Arcement and Schneider (1989) procedure, if desired (cells T20 to Y20).

Stream Name: Willow Creek Reach: Existing  
 Slope, S (ft/ft): 0.00100 Date: 3/14/2023  
 Practitioner: Alex Pederson

$D_{50}$ ,  $D_{84}$ ,  $D_{84 \text{ step}}$  (m): 0.02 0.04 —  
 $R$  (ft, m): — —  
 $d$  (ft, m): — —  
 $\sigma_v$  (ft, m): — —  
 $h_m$  (ft, m): — —

Overall Average  $n$ : 0.047  
 $f$ : —  
 Quantitative Average  $n$ <sup>101</sup>: —  
 $f$ <sup>102</sup>: —  
 Arcement and Schneider (1989)  $n$ : 0.044  
 $f$ : —

**3 Quantitative Prediction**

Quasi-Quantitative:

Arcement and Schneider (1989)	$n$ <sup>104</sup>	$n_1$	$n_2$	$n_3$	$n_4$	$m$	Estimate	Enter "y"
$n = (n_1 + n_2 + n_3 + n_4) / m$	0.03	0	0	0.004	0.01	1	0.044	y
	base	Degree of irregularity	Variation in X-S	Effect of Obstruction	Amount of Vegetation	Degree of Meandering		

Fully Quantitative:

Method (Fit)	Relative Submergence	Estimate $n$	Estimate $f$	# Data Points	Applicable Range Slope (ft/ft)	Applicable Range Relative Sub. <sup>101</sup>	Use in Average? Enter "y"
Yochum et al. (2012)	—	—	—	78	0.02 to 0.20	$n_n / \sigma_n = 0.25$ to 12	
[ $R^2 = 0.78$ ; $f$ : $R^2 = 0.82$ ]							
Rickenmann and Recking (2011)	—	—	—	2890	0.00004 to 0.03	$d/D_{84} = 0.16$ to $\sim 100$	
Aberle and Smart (2003); in flume	—	—	—	94	0.02 to 0.10	$d/\sigma_v = 1.2$ to 12	
Lee and Ferguson (2002) <sup>101</sup>	—	—	—	81	0.027 to 0.184	$R/D_{84}$ (step) = 0.1 to 1.4	
[RMS error = 19%]							
Bathurst (1985)	—	—	—	44	0.00475 to 0.0373	$d/D_{84} = 0.71$ to 11.4	
[RMS error = ~34%]							
Jarrett (1984)	$n/a$	—	—	75	0.002 to 0.039	$n/a$	
[ave. std. error = 28%]							
Griffiths (1981); rigid bed	—	—	—	84	0.000085 to 0.011	$R/D_{50} = 1.8$ to 181	
[ $R^2 = 0.59$ ]							
Hey (1979); $a = 12.72$	—	—	—	30	0.00049 to $\sim 0.01$	$R/D_{84} = 0.8$ to 25	
Limerinos (1970)	—	—	—	50	0.00038 to 0.039	$R/D_{84} = 1.1$ to 69	
[ $R^2 = 0.77$ ]							

- Notes:
- (1) Quantitative average excludes the Arcement and Schneider (1989) method.
  - (2) In some situations it can be appropriate to assume that the quantitative average  $n$  is  $n_q$ , though this may result in overestimated flow resistance.
  - (3) Relative submergence is computed using either  $R$  (hydraulic radius) or  $d$  (mean depth) and the  $D_{84}$  (median bed material size) or  $D_{84}$  (184% of bed material smaller), or computed using either  $h_m$  (median thalweg depth) or  $d$  and  $\sigma_v$  (standard deviation of residuals of a thalweg longitudinal profile regression). For  $\sigma_v$  computation, see "S>0.03, Sigma 2" tab of this spreadsheet.
  - (4) This method can substantially underestimate flow resistance in steeper streams (slope>0.03) where large wood is

Stream Name: Willow Creek Reach: Pump 1  
 Stream Slope, S (ft/ft): 0.05900 Date: 3/14/2023  
 Practitioner: Alex Pederson

Reach  $D_{50}$ ,  $D_{84}$  (mm): 40 74 Step  $D_{50}$  (mm)<sup>TM</sup>:  
 Hydraulic Radius, R (ft):  
 Mean Flow Depth, d (ft)<sup>MD</sup>:  
 Bedform Variation,  $\sigma_v$  (ft)<sup>MD</sup>:  
 Median Thalweg Depth,  $h_m$  (ft)<sup>MD</sup>:  
 Large Wood in Steps? (y/n)<sup>MD</sup>: y

Notes:  
 (a) Required for Lee and Ferguson (2002) method, for step-pool streams (S>0.027)  
 (b) Mean flow depth = hydraulic depth; Required for Bathurst (1985), Rickenmann and Recking (2011), and Aberle and Smart (2003) methods



Flow resistance in stream channels is due to roughness induced by bed and bank grain material, bedforms (such as dunes and step pools), planform, vegetation, large instream wood, and other obstructions. Flow resistance coefficient estimation (Manning's n, Darcy-Weisbach f) is approximate, requiring redundancy (steps 1 through 3) for confidence in the implemented values. Dependence on quantitative methods alone is not recommended since utilized reaches in the derivations were intentionally selected to have little influence from sinuosity, instream large wood, streambank vegetation, bank irregularities, obstructions, etc.; these types of flow resistance are not lumped into the quantitative estimates. Also, flow resistance coefficients should be computed at the flow magnitude of interest for the objectives of the analysis, specifically at high, bankfull, or low flow.

**1 Tabular Guidance**  
 Sources: Brunner (2016): pp 3-14  
 Arcement and Schneider (1989): p 4  
 Aldridge and Garrett (1973): p 24

Note: Key references are provided in the spreadsheet packages as file or are available for download through the links provided in the references of the supporting technical summary report (TS-103)

**2 Photographic Guidance**  
 Sources: USGS (online photo guidance)  
 Yochum et al. (2014): high gradient  
 Hicks and Mason (1991)  
 Aldridge and Garrett (1973)  
 Barnes (1967)

Use in Average? Enter "y"  
 Tabular Estimate: n = 0.050 f =  
 Estimate from Photographic Guidance: n = f =

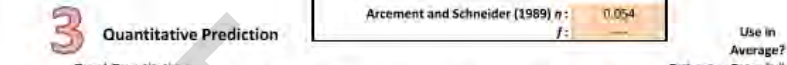
- Instructions:** (See technical summary report, TS-103, for more detailed instructions and references.)
- (1) Grey cells indicate fields that should be populated. Results are provided in the salmon colored cells.
  - (2) Enter background information (cells D4, D5, I4 to I6), sediment size data (cells D8, E8, H8), and hydraulic information (cells D9 to D13). R is often approximated as the average depth for streams with a width/depth ratio > ~20.
  - (3) Consult tabular guidance and enter the best estimate in the grey box (cell I43; do not use in average if not confident of estimate). Tabular values are typically substantially underestimated for channels > ~3% slope.
  - (4) Consult photographic guidance and enter an estimate in the grey box (cell I44).
  - (5) Applicable quantitative procedures will be automatically compute (per provided Applicable Range).
  - (6) Implement Arcement and Schneider (1989) procedure, if desired (cells T20 to Y20).



Stream Name: Willow Creek Reach: Pump 1  
 Stream Slope, S (ft/ft): 0.05900 Date: 3/14/2023  
 Practitioner: Alex Pederson

$D_{50}$ ,  $D_{84}$ ,  $D_{84,med}$  (m): 0.04 0.07  
 R (ft, m):  
 d (ft<sup>2</sup>, m<sup>2</sup>):  
 $\sigma_v$  (ft, m):  
 $h_m$  (ft, m):

Overall Average n: 0.052  
 f:  
 Quantitative Average n<sup>(1)</sup>:  
 f<sup>(1)</sup>:  
 Arcement and Schneider (1989) n: 0.054  
 f:



3 Quantitative Prediction

Quasi-Quantitative: Arcement and Schneider (1989)  
 $n = (n_2 + n_1 + n_2 + n_2 + n_2) / 5$

Method [Fit]	Relative Submergence	Estimate n	f	# Data Points	Applicable Range Slope (ft/ft)	Relative Sub. <sup>(2)</sup>	Use in Average? Enter
Yochum et al. (2012) [R <sup>2</sup> = 0.78; f: R <sup>2</sup> = 0.82]	---	---	---	78	0.02 to 0.20	$n_m / \sigma_v = 0.25$ to 1.2	Use in Average? Enter "y"
Rickenmann and Recking (2011)	---	---	---	2880	0.00004 to 0.03	$d/D_{50} = 0.18$ to ~100	Use in Average? Enter "y"
Aberle and Smart (2003); in flume	---	---	---	94	0.02 to 0.10	$d/\sigma_v = 1.2$ to 12	Use in Average? Enter "y"
Lee and Ferguson (2002) <sup>(4)</sup> [RMS error = 19%]	---	---	---	81	0.027 to 0.184	$R/D_{50}$ (step) = 0.1 to 1.4	Use in Average? Enter "y"
Bathurst (1985) [RMS error = ~34%]	---	---	---	44	0.00425 to 0.0373	$d/D_{50} = 0.71$ to 11.4	Use in Average? Enter "y"
Jarrett (1984) [ave. std. error = 28%]	n/a	---	---	75	0.002 to 0.039	n/a	Use in Average? Enter "y"
Griffiths (1981); rigid bed [R <sup>2</sup> =0.59]	---	---	---	84	0.000085 to 0.011	$R/D_{50} = 1.8$ to 181	Use in Average? Enter "y"
Hey (1979); a = 12.72	---	---	---	30	0.00049 to ~0.01	$R/D_{50} = 0.8$ to 25	Use in Average? Enter "y"
Limerinos (1970) [R <sup>2</sup> =0.77]	---	---	---	50	0.00038 to 0.039	$R/D_{50} = 1.1$ to 69	Use in Average? Enter "y"

- Notes:**
- (1) Quantitative average excludes the Arcement and Schneider (1989) method.
  - (2) In some situations it can be appropriate to assume that the quantitative average n is  $n_{20}$ , though this may result in overestimated flow resistance.
  - (3) Relative submergence is computed using either R (hydraulic radius) or d (mean depth) and the  $D_{50}$  (median bed material size) or  $D_{84}$  (84% of bed material smaller); or computed using either  $h_m$  (median thalweg depth) or d and  $\sigma_v$  (standard deviation of residuals of a thalweg longitudinal profile regression). For  $\sigma_v$  computation, see "S>0.03, Sigma z" tab of this spreadsheet.
  - (4) This method can substantially underestimate flow resistance in steeper streams (slope>0.03) where large wood is

Stream Channel Flow Resistance Coefficient Computation Tool (version 1.1, 2-2018)

Page 1 of 2

Stream Name: Willow Creek      Reach: Pumps 9 & 10  
 Stream Slope, S (ft/ft): 0.05350      Date: 3/14/2023  
 Practitioner: Alex Pederson

Reach  $D_{50}$ ,  $D_{84}$  (mm): 40    74    Step  $D_{84}$  (mm)<sup>(1)</sup>:  
 Hydraulic Radius, R (ft):  
 Mean Flow Depth, d (ft)<sup>(b)</sup>:  
 Bedform Variation,  $\sigma_z$  (ft)<sup>(b)</sup>:  
 Median Thalweg Depth,  $h_m$  (ft)<sup>(b)</sup>:  
 Large Wood in Steps? (y/n)<sup>(b)</sup>: y

Notes:  
 (a) Required for Lee and Ferguson (2002) method, for step-pool streams (S>0.027)  
 (b) Mean flow depth = hydraulic depth; Required for Bathurst (1985), Rickenmann and Recking (2011), and Aberle and Smart (2003) methods



Flow resistance in stream channels is due to roughness induced by bed and bank grain material, bedforms (such as dunes and step pools), planform, vegetation, large instream wood, and other obstructions. Flow resistance coefficient estimation (Manning's  $n$ , Darcy-Weisbach  $f$ ) is approximate, requiring redundancy (steps 1 through 3) for confidence in the implemented values. Dependence on quantitative methods alone is not recommended since utilized reaches in the derivations were intentionally selected to have little influence from sinuosity, instream large wood, streambank vegetation, bank irregularities, obstructions, etc.; these types of flow resistance are not lumped into the quantitative estimates. Also, flow resistance coefficients should be computed at the flow magnitude of interest for the objectives of the analyst, specifically at high, bankfull, or low flow.

**1 Tabular Guidance**  
 Sources: Brunner (2016); pp 3-14  
 Arcement and Schneider (1989); p 4  
 Aldridge and Garrett (1973); p 24

Note: Key references are provided in the spreadsheet package .zip file or are available for download through the links provided in the references of the supporting technical summary report (TS-103)

**2 Photographic Guidance**  
 Sources: USGS (online photo guidance)  
 Yochum et al. (2014); high gradient  
 Hicks and Mason (1991)  
 Aldridge and Garrett (1973)  
 Barnes (1967)

Use in Average? Enter "y"  
 Tabular Estimate:  $n$  = 0.050     $f$  = —    Y  
 Estimate from Photographic Guidance: —    —    N

Instructions: [\[See technical summary report, TS-103, for more detailed instructions and references.\]](#)

- (1) Grey cells indicate fields that should be populated. Results are provided in the salmon colored cells.
- (2) Enter background information (cells D4, D5, I4 to I6), sediment size data (cells D8, E8, H8), and hydraulic information (cells D9 to D13). R is often approximated as the average depth for streams with a width/depth ratio >~20.
- (3) Consult tabular guidance and enter the best estimate in the grey box (cell I43); do not use in average if not confident of estimate). Tabular values are typically substantially underestimated for channels with >3% slope.
- (4) Consult photographic guidance and enter an estimate in the grey box (cell I44).
- (5) Applicable quantitative procedures will be automatically compute (per provided Applicable Range).
- (6) Implement Arcement and Schneider (1989) procedure, if desired (cells T20 to Y20).



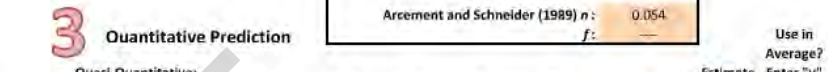
Stream Channel Flow Resistance Coefficient Computation Tool (version 1.1, 2-2018)

Page 2 of 2

Stream Name: Willow Creek      Reach: Pumps 9 & 10  
 Stream Slope, S (ft/ft): 0.05350      Date: 3/14/2023  
 Practitioner: Alex Pederson

$D_{50}$ ,  $D_{84}$ ,  $D_{84,med}$  (m): 0.04    0.07    —  
 R (ft, m): —    —  
 d (ft<sup>2</sup>, m<sup>2</sup>): —    —  
 $\sigma_z$  (ft, m): —    —  
 $h_m$  (ft, m): —    —

Overall Average  $n$ : 0.052  
 $f$ : —  
 Quantitative Average  $n^{(1)}$ : —  
 $f^{(1)}$ : —  
 Arcement and Schneider (1989)  $n$ : 0.054  
 $f$ : —



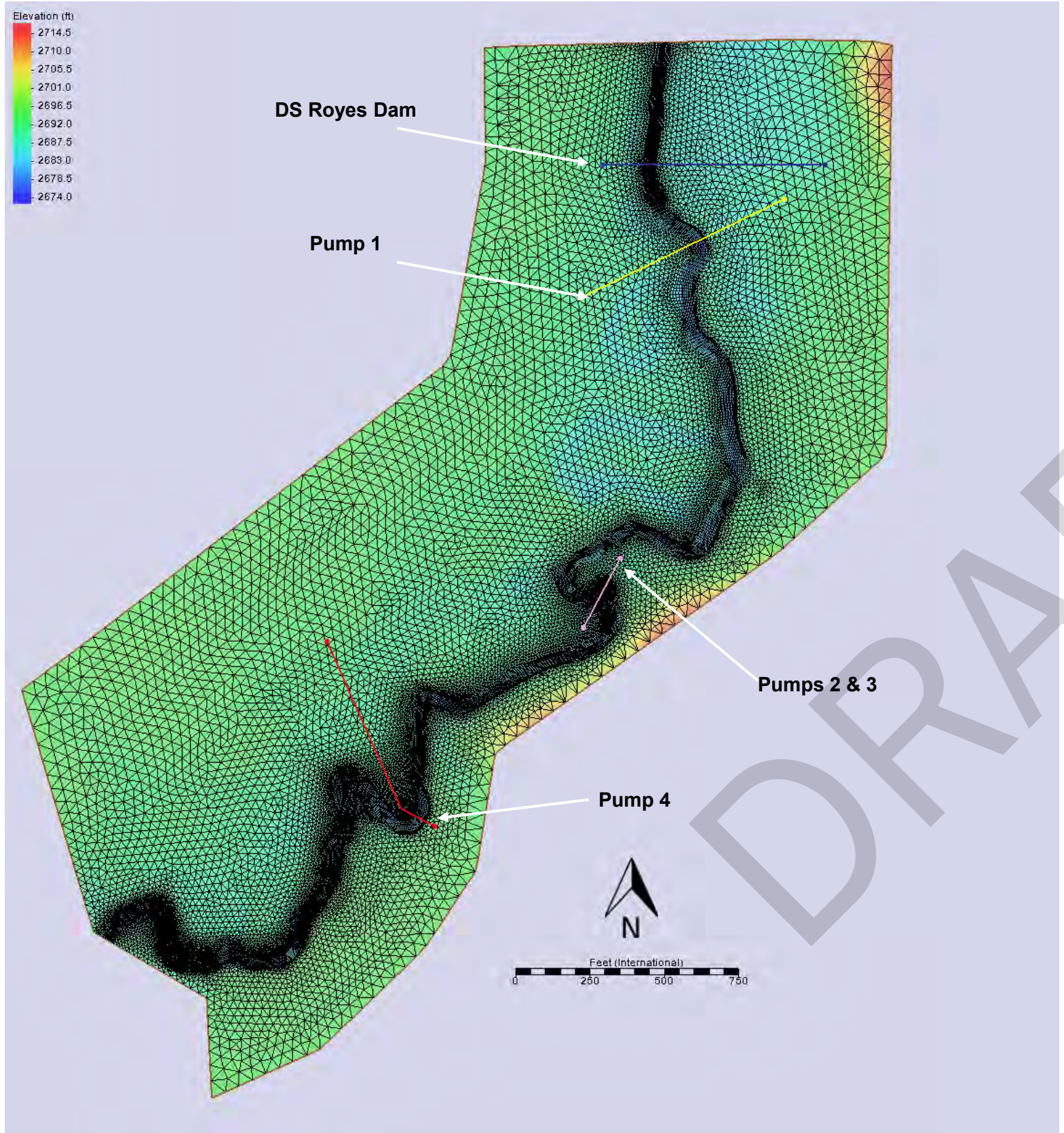
Quasi-Quantitative:

Arcement and Schneider (1989)	$n_a^{(4)}$	$n_1$	$n_2$	$n_3$	$n_4$	$m$	Estimate	Use in Average? Enter "y"
$n = (n_b + n_1 + n_2 + n_3 + n_4)m$	0.05	0	0	0.004	0	1	0.054	y
	Base	Degree of Irregularity	Variation in X-S	Effect of Obstruction	Amount of Vegetation	Degree of Meandering		

Fully Quantitative:

Method [Fit]	Relative Submergenc	Estimate $n$	$f$	# Data Points	Applicable Range Slope (ft/ft)	Relative Sub. <sup>(5)</sup>	Use in Average? Enter
Yochum et al. (2012) [R <sup>2</sup> = 0.78; f: R <sup>2</sup> = 0.82]	—	—	—	78	0.02 to 0.20	$h_m/\sigma_z = 0.25$ to 12	
Rickenmann and Recking (2011)	—	—	—	2890	0.00004 to 0.03	$d/D_{84} \leq 0.18$ to ~100	
Aberle and Smart (2003); in flume	—	—	—	94	0.02 to 0.10	$d/\sigma_z = 1.2$ to 12	
Lee and Ferguson (2002) <sup>(6)</sup> [RMS error = 19%]	—	—	—	81	0.027 to 0.184	$R/D_{84}$ (step) = 0.1 to 1.4	
Bathurst (1985) [RMS error = ~34%]	—	—	—	44	0.00429 to 0.0373	$d/D_{84} = 0.71$ to 11.4	
Jarrett (1984) [ave. std. error = 28%]	n/a	—	—	75	0.002 to 0.039	n/a	
Griffiths (1981); rigid bed [R <sup>2</sup> =0.59]	—	—	—	84	0.000085 to 0.011	$R/D_{50} = 1.8$ to 181	
Hey (1979); $a = 12.72$	—	—	—	30	0.00049 to ~0.01	$R/D_{84} = 0.8$ to 25	
Limerinos (1970) [R <sup>2</sup> =0.77]	—	—	—	50	0.00038 to 0.039	$R/D_{84} = 1.1$ to 69	


- Notes:
- (1) Quantitative average excludes the Arcement and Schneider (1989) method.
  - (2) In some situations it can be appropriate to assume that the quantitative average  $n$  is  $n_b$ , though this may result in overestimated flow resistance.
  - (3) Relative submergence is computed using either R (hydraulic radius) or d (mean depth) and the  $D_{50}$  (median bed material size) or  $D_{84}$  (84% of bed material smaller); or computed using either  $h_m$  (median thalweg depth) or  $d$  and  $\sigma_z$  (standard deviation of residuals of a thalweg longitudinal profile regression). For  $\sigma_z$  computation, see "S>0.03, Sigma z" tab of this spreadsheet.
  - (4) This method can substantially underestimate flow resistance in steeper streams (slope>0.03) where large wood is



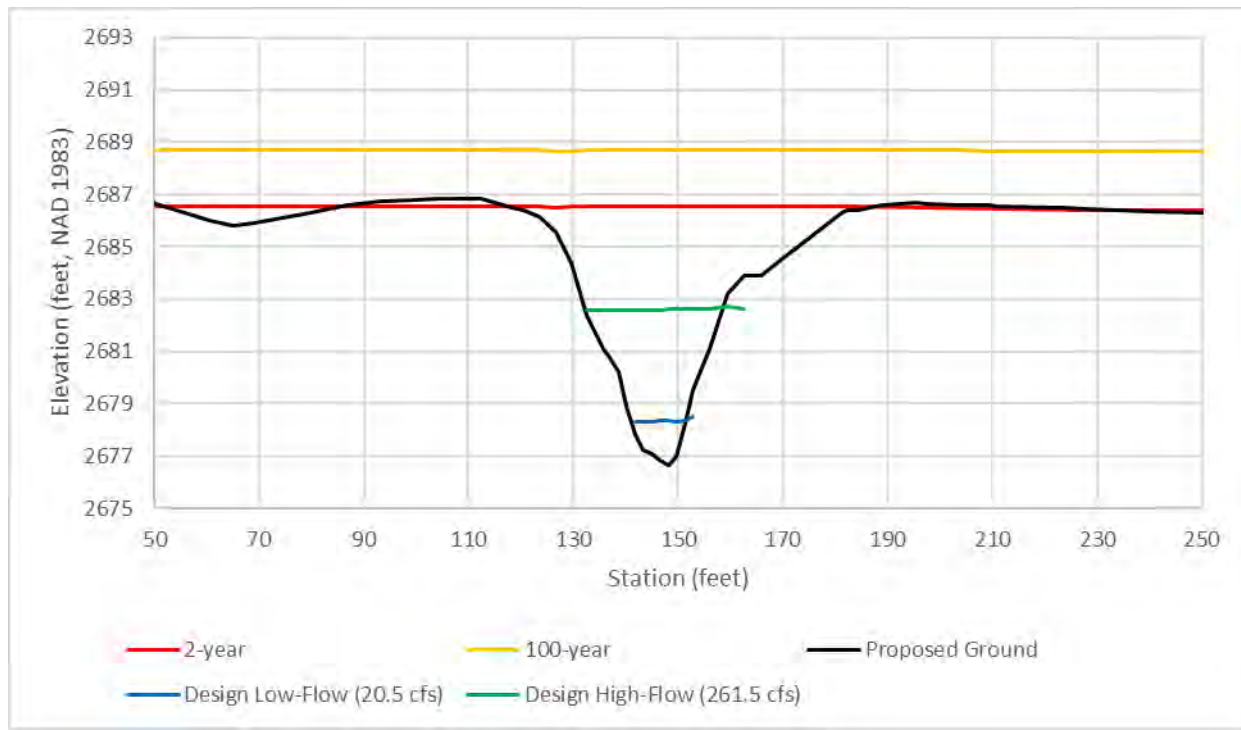
**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

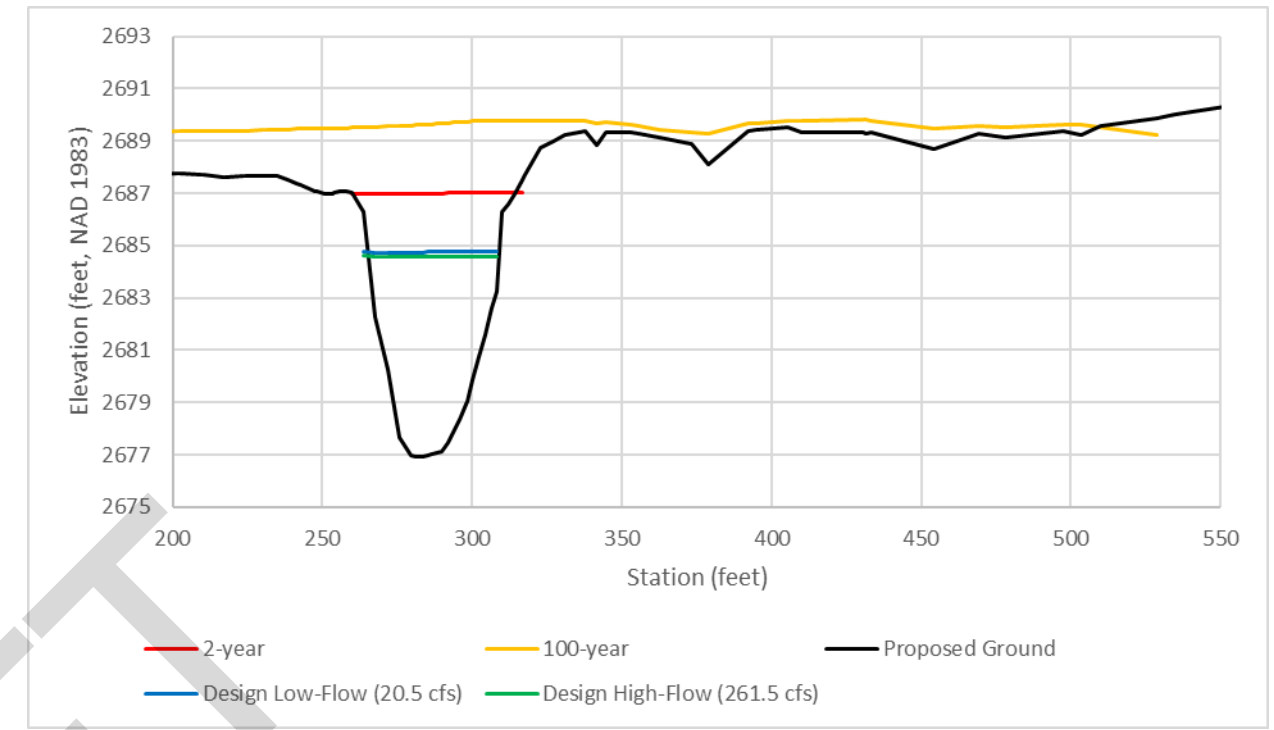
Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

<b>Cross Sections for Existing and Proposed Conditions Model Results Extraction</b>	
Willow Creek Union County, Oregon	
	<b>Figure C-1</b>

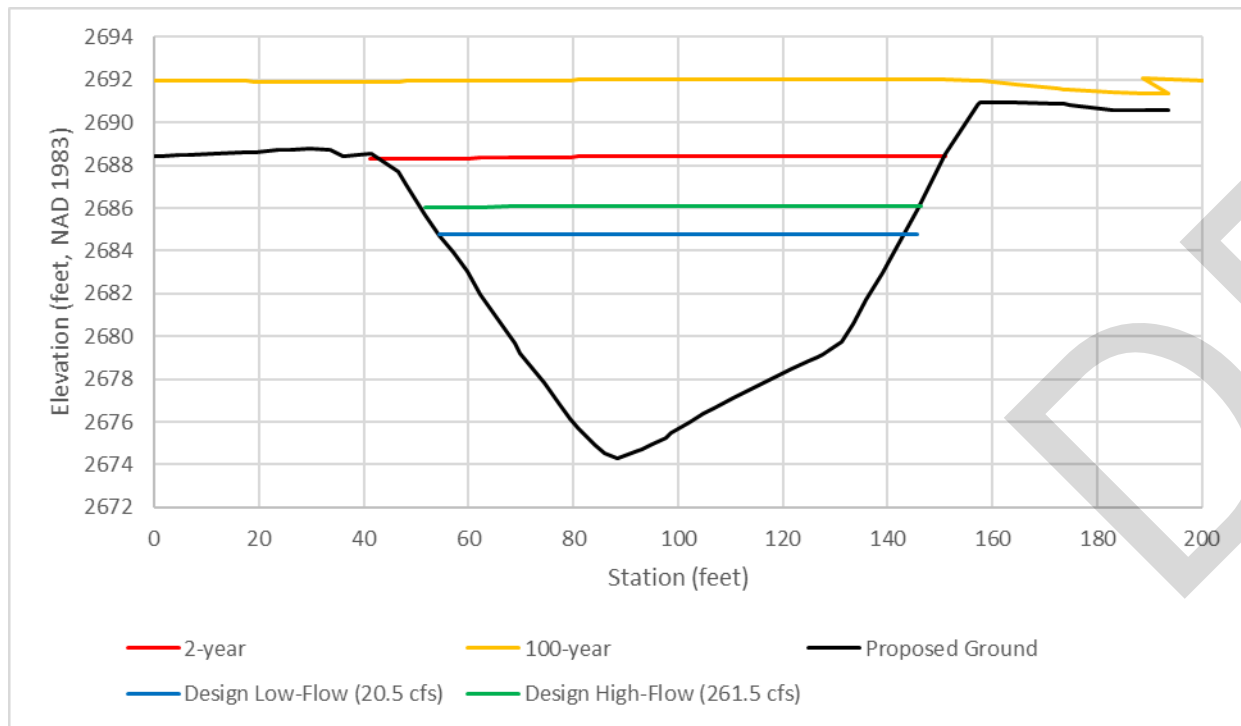
19369-003-01 Date Exported: 05/08/23



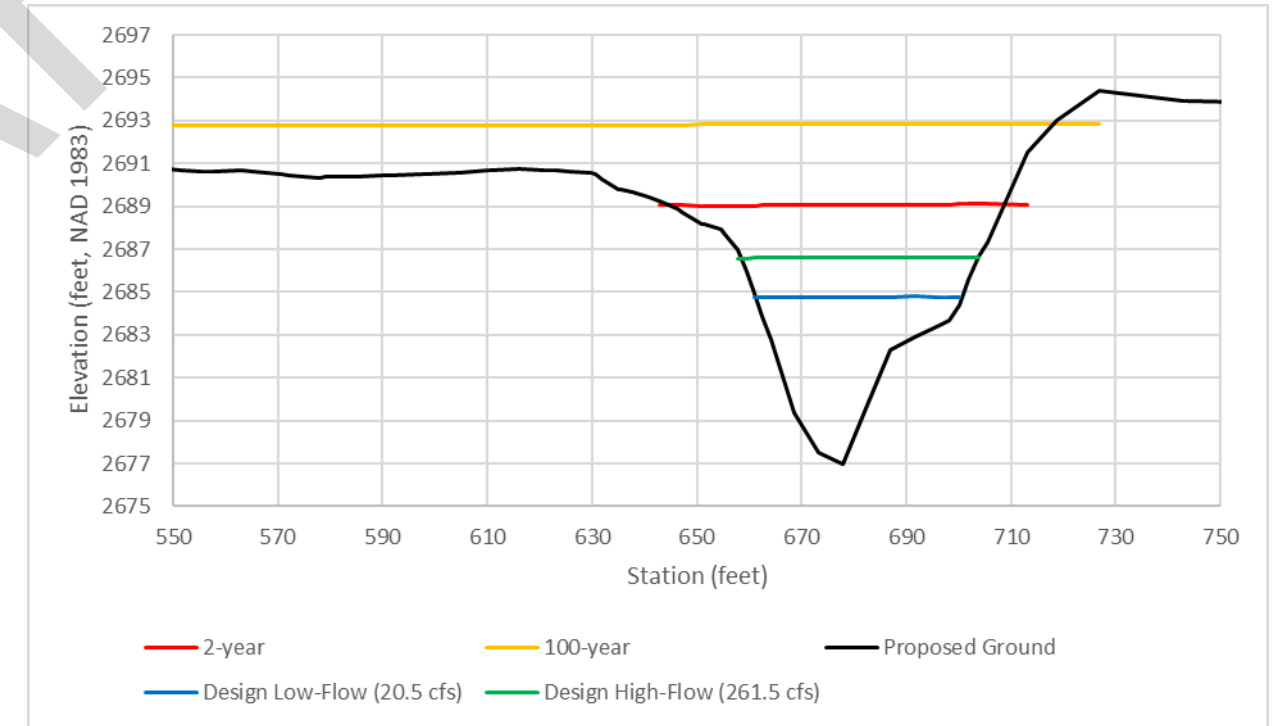
**Downstream Royes Dam**



**Pump 1**



**Pumps 2 and 3**



**Pump 4**

**Notes:**

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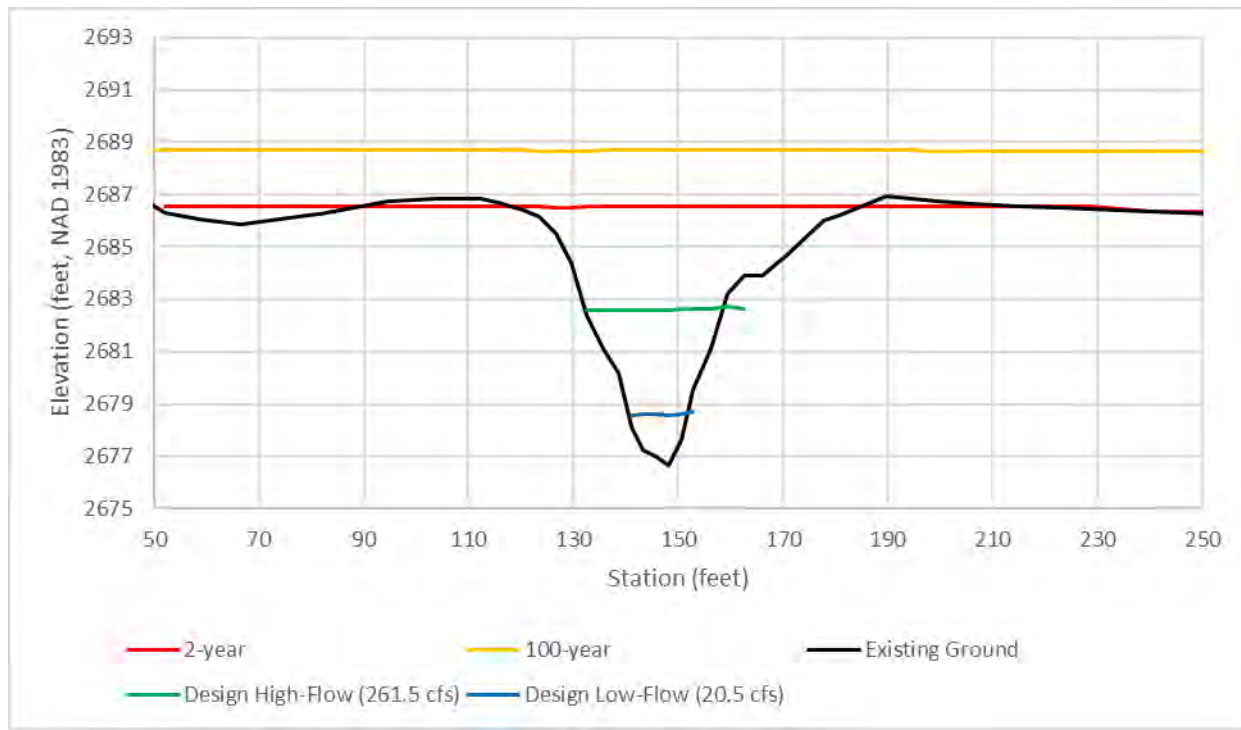
Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

**Proposed Conditions Water Surface Elevations at Cross Sections**

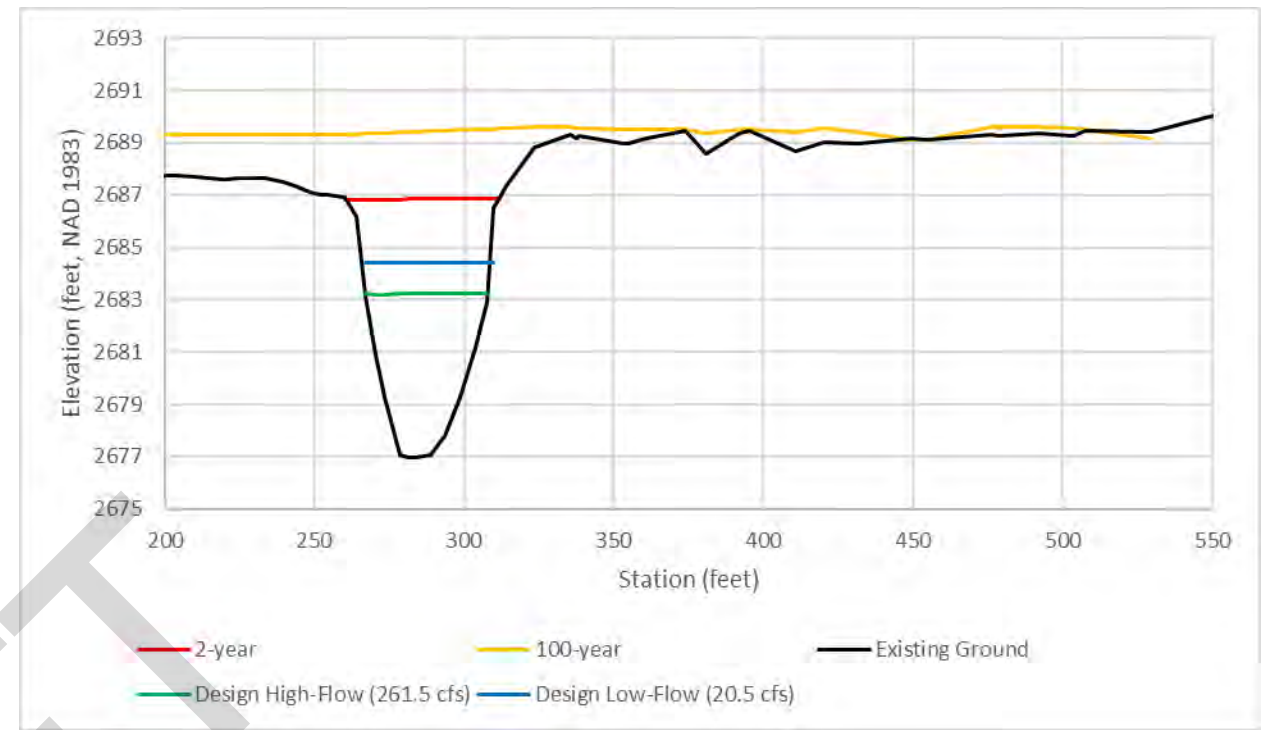
Willow Creek  
Union County, Oregon



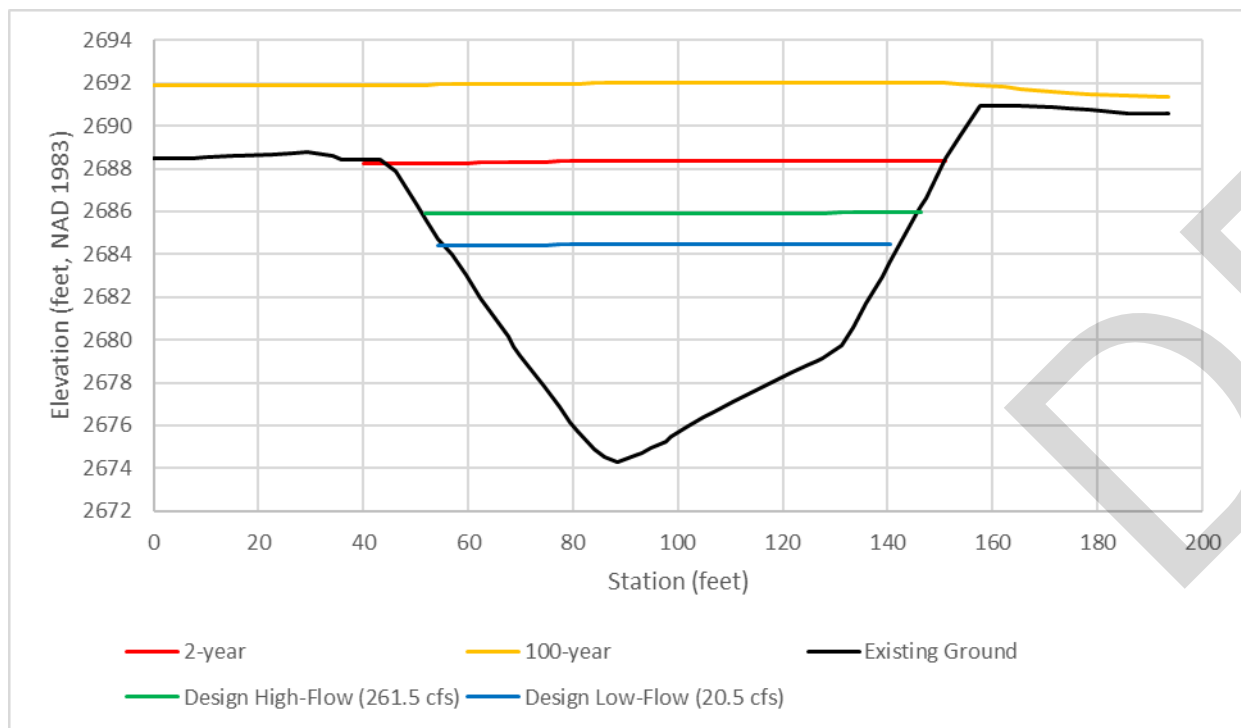
**Figure C-2**



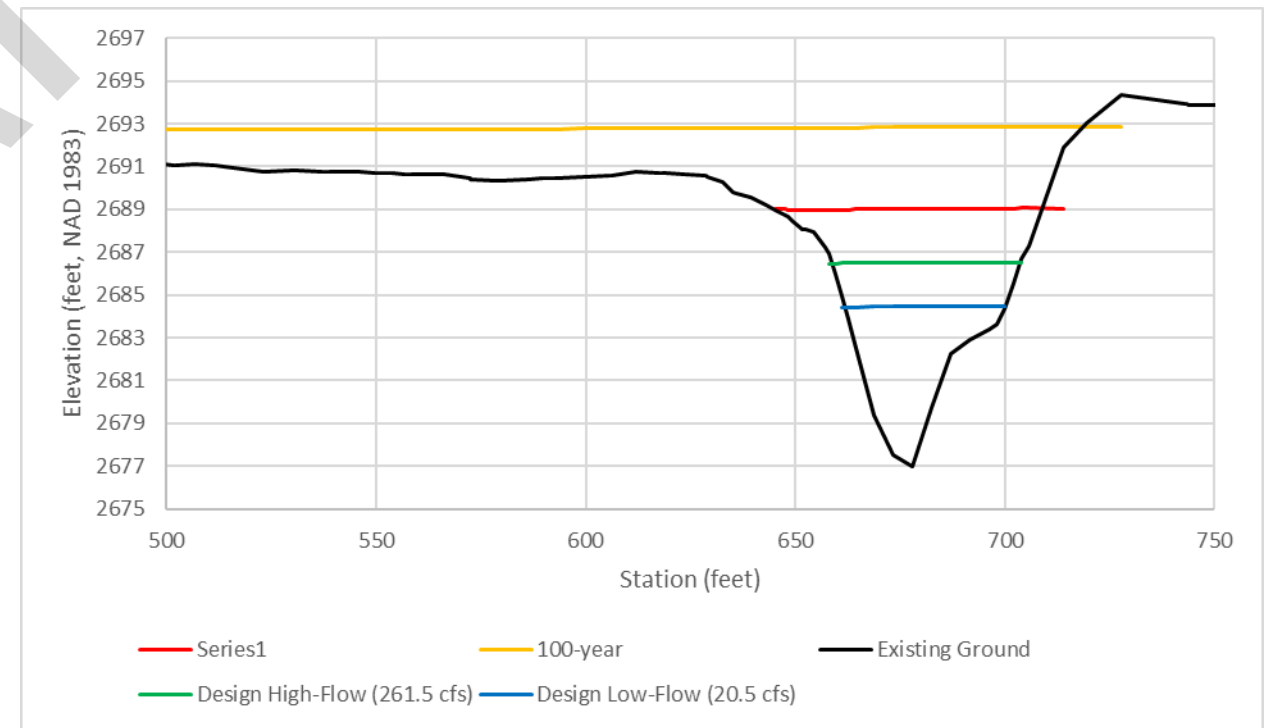
**Downstream Royes Dam**



**Pump 1**



**Pumps 2 and 3**




**Pump 4**

**Notes:**

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Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

<b>Existing Conditions Water Surface Elevations at Cross Sections</b>	
Willow Creek Union County, Oregon	
	<b>Figure C-3</b>

**APPENDIX D**  
**Sediment Mobility Analysis**

DRAFT

Design Gradation: Critical Shear				
Location: Proposed Constructed Riffle				
	D <sub>100</sub>	D <sub>84</sub>	D <sub>50</sub>	D <sub>16</sub>
ft	0.67	0.48	0.19	0.05
in	8.0	5.8	2.2	0.6
mm	203	146	57.0	14.6

Existing Gradation				
Location: Visual - Downstream of Royed Dam Influence				
	D <sub>100</sub>	D <sub>84</sub>	D <sub>50</sub>	D <sub>16</sub>
ft	0.16	0.11	0.07	0.01
in	2.0	1.4	0.8	0.1
mm	50	35	20.0	2.0

### Determining Aggregate Proportions

Per WSDOT Standard Specifications 9-03.11

Rock Size		Streambed Sediment	Streambed Cobbles					Streambed Boulders			D <sub>size</sub>
[in]	[mm]		4"	6"	8"	10"	12"	12"-18"	18"-28"	28"-36"	
36.0	914								100	100.0	
32.0	813								50	100.0	
28.0	711							100		100.0	
23.0	584							50		100.0	
18.0	457						100			100.0	
15.0	381						50			100.0	
12.0	305					100				100.0	
10.0	254					100	80			100.0	
8.0	203				100	80	68			100.0	
6.0	152			100	80	68	57			86.0	
5.0	127			80	68	57	45			77.8	
4.0	102		100	71	57	45	39			69.7	
3.0	76.2		80	63	45	38	34			61.5	
2.5	63.5	100	65	54	37	32	28			55.9	
2.0	50.8	80	50	45	29	25	22			44.3	
1.5	38.1	73	35	32	21	18	16			36.5	
1.0	25.4	65	20	18	13	12	11			28.6	
0.75	19.1	50	5	5	5	5	5			18.5	
0.19	4.75	35								10.5	
0.02	0.425	16								4.8	
0.00	0.0750	7								2.1	
% per category		30	0	0	70	0	0	0	0	0	--> 100%
% Cobble & Sediment											100.0%

References:					
United States Forest Service - Stream Simulation 2008					
Appendix E--Methods for Streambed Mobility/Stability Analysis					
Limitations:					
D <sub>84</sub> must be between 0.40 in and 10 in					
Uniform bed material (D <sub>i</sub> < 20-30 times D <sub>50</sub> )					
Slopes less than 5%		Yes			
Sand/gravel streams with high relative submergence		Yes			
2yr-depth		2.31	ft		
Relative Submergence:		0.97			
γ <sub>s</sub>		165	specific weight of sediment particle (lb/ft <sup>3</sup> )		
γ		62.4	specific weight of water (lb/ft <sup>3</sup> )		
τ <sub>D50</sub>		0.052	dimensionless Shields parameter for D <sub>50</sub> , use table E.1 of USFS manual or assume 0.045 for poorly sorted channel bed		
D <sub>50</sub> in mm		57.0			
Flow		2-YR	100-YR	2080 100-YR	500-YR
Average Modeled Shear Stress (lb/ft <sup>2</sup> )		0.4	1.0	0.0	0.0
τ <sub>ci</sub>					
	2.30	No Motion	No Motion	No Motion	No Motion
	2.22	No Motion	No Motion	No Motion	No Motion
	2.13	No Motion	No Motion	No Motion	No Motion
	2.01	No Motion	No Motion	No Motion	No Motion
	1.86	No Motion	No Motion	No Motion	No Motion
	1.76	No Motion	No Motion	No Motion	No Motion
	1.65	No Motion	No Motion	No Motion	No Motion
	1.56	No Motion	No Motion	No Motion	No Motion
	1.46	No Motion	No Motion	No Motion	No Motion
	1.34	No Motion	No Motion	No Motion	No Motion
	1.27	No Motion	No Motion	No Motion	No Motion
	1.19	No Motion	No Motion	No Motion	No Motion
	1.09	No Motion	No Motion	No Motion	No Motion
	1.03	No Motion	No Motion	No Motion	No Motion
	0.96	No Motion	No Motion	No Motion	No Motion
	0.88	No Motion	Motion	No Motion	No Motion
	0.78	No Motion	Motion	No Motion	No Motion
	0.72	No Motion	Motion	No Motion	No Motion
D <sub>16</sub>			0.6	in	
D <sub>50</sub>			2.2	in	
			0.187	ft	
D <sub>84</sub>			5.8	in	
D <sub>95</sub>			7.3	in	
D <sub>100</sub>			8.0	in	

Notes:

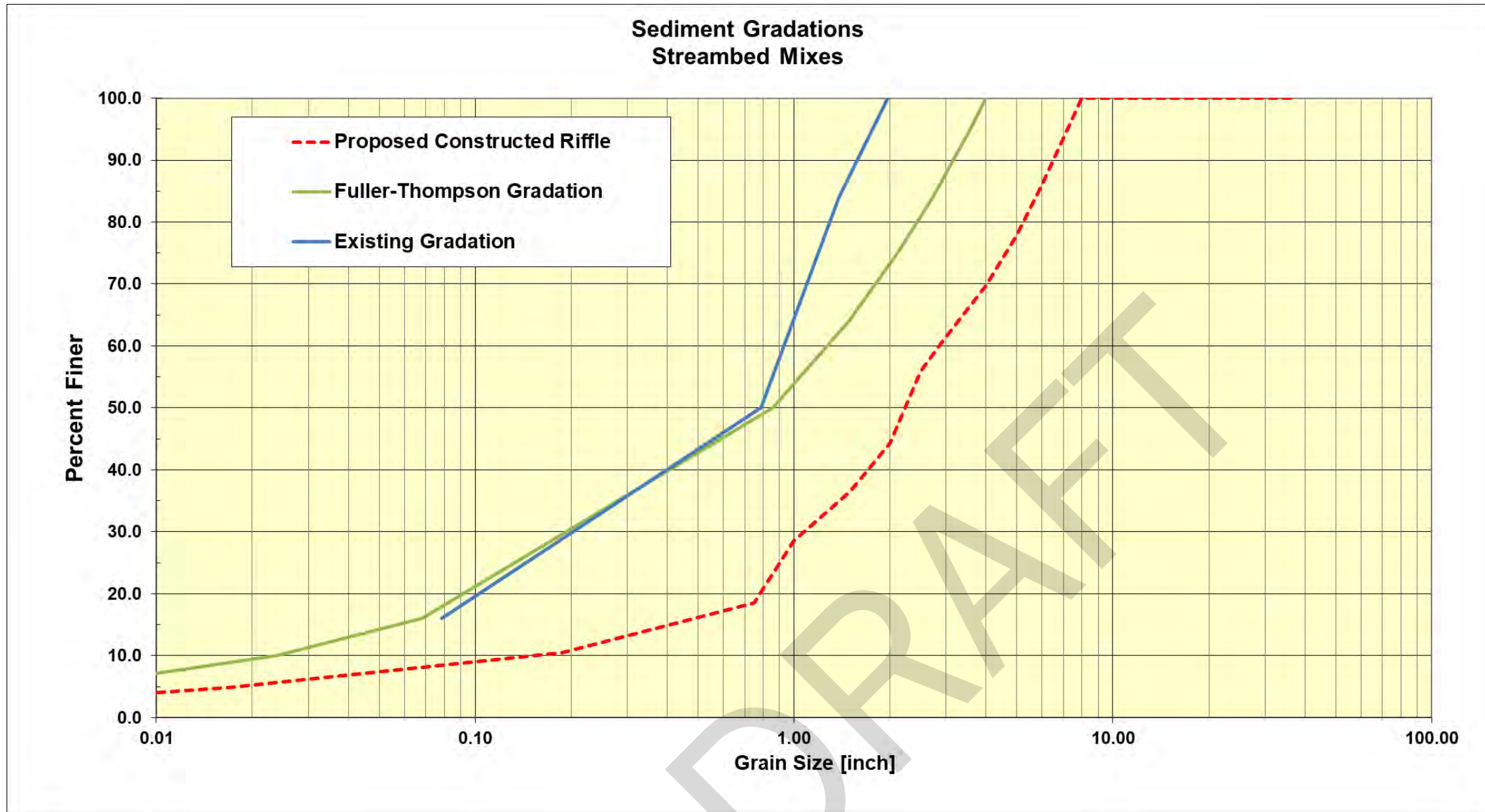
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Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

**Proposed Constructed Riffle Material Stability Worksheet**

Willow Creek  
Union County, Oregon

**Figure D-1**



<i>D<sub>i</sub></i> (ft)	<i>D<sub>i</sub></i> (in)	<i>D<sub>i</sub></i> (mm)	<b>D<sub>i</sub></b>	<b>τ<sub>ci</sub></b> (psf)	<b>2-YR</b>	<b>100-YR</b>	<b>2080 100-YR</b>	<b>500-YR</b>
0.048	0.574	14.581	D16	<b>0.66</b>	No Motion	Motion	No Motion	No Motion
0.187	2.25	57.041	D50	<b>1.00</b>	No Motion	No Motion	No Motion	No Motion
0.480	5.755	146.180	D84	<b>1.32</b>	No Motion	No Motion	No Motion	No Motion
0.607	7.286	185.057	D95	<b>1.42</b>	No Motion	No Motion	No Motion	No Motion
0.667	8.000	203.200	D100	<b>1.46</b>	No Motion	No Motion	No Motion	No Motion

**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

**Proposed Constructed Riffle Material Stability  
Worksheet**

Willow Creek  
Union County, Oregon



**Figure D-2**

Design Gradation: Critical Shear				
Location: Proposed Sluice Way				
	D <sub>100</sub>	D <sub>84</sub>	D <sub>50</sub>	D <sub>16</sub>
ft	0.21	0.18	0.06	0.00
in	2.5	2.1	0.8	0.0
mm	63	53	19.1	0.4

Existing Gradation				
Location: Visual - Downstream of Royed Dam Influence				
	D <sub>100</sub>	D <sub>84</sub>	D <sub>50</sub>	D <sub>16</sub>
ft	0.16	0.11	0.07	0.01
in	2.0	1.4	0.8	0.1
mm	50	35	20.0	2.0

### Determining Aggregate Proportions

Per WSDOT Standard Specifications 9-03.11

Rock Size		Streambed Sediment	Streambed Cobbles					Streambed Boulders			D <sub>size</sub>
[in]	[mm]		4"	6"	8"	10"	12"	12"-18"	18"-28"	28"-36"	
36.0	914									100	100.0
32.0	813									50	100.0
28.0	711							100			100.0
23.0	584							50			100.0
18.0	457							100			100.0
15.0	381							50			100.0
12.0	305							100			100.0
10.0	254					100	80				100.0
8.0	203				100	80	68				100.0
6.0	152			100	80	68	57				100.0
5.0	127			80	68	57	45				100.0
4.0	102		100	71	57	45	39				100.0
3.0	76.2		80	63	45	38	34				100.0
2.5	63.5	100	65	54	37	32	28				100.0
2.0	50.8	80	50	45	29	25	22				80.0
1.5	38.1	73	35	32	21	18	16				72.5
1.0	25.4	65	20	18	13	12	11				65.0
0.75	19.1	50	5	5	5	5	5				50.0
0.19	4.75	35									35.0
0.02	0.425	16									16.0
0.00	0.0750	7									7.0
% per category		100	0	0	0	0	0	0	0	0	--> 100%
% Cobble & Sediment											100.0%

References:					
United States Forest Service - Stream Simulation 2008					
Appendix E--Methods for Streambed Mobility/Stability Analysis					
Limitations:					
D <sub>84</sub> must be between 0.40 in and 10 in					
Uniform bed material (D <sub>i</sub> < 20-30 times D <sub>50</sub> )					
Slopes less than 5%		Yes			
Sand/gravel streams with high relative submergence		Yes			
2yr-depth		6.94	ft		
Relative Submergence:		0.11			
γ <sub>s</sub>		165	specific weight of sediment particle (lb/ft <sup>3</sup> )		
γ		62.4	specific weight of water (1b/ft <sup>3</sup> )		
τ <sub>D50</sub>		0.047	dimensionless Shields parameter for D <sub>50</sub> , use table E.1 of USFS manual or assume 0.045 for poorly sorted channel bed		
D50 in mm		19.1			
Flow		2-YR	100-YR	2080 100-YR	500-YR
Average Modeled Shear Stress (lb/ft <sup>2</sup> )		0.3	0.4	0.0	0.0
τ <sub>ci</sub>					
	0.96	No Motion	No Motion	No Motion	No Motion
	0.93	No Motion	No Motion	No Motion	No Motion
	0.89	No Motion	No Motion	No Motion	No Motion
	0.84	No Motion	No Motion	No Motion	No Motion
	0.78	No Motion	No Motion	No Motion	No Motion
	0.74	No Motion	No Motion	No Motion	No Motion
	0.69	No Motion	No Motion	No Motion	No Motion
	0.66	No Motion	No Motion	No Motion	No Motion
	0.61	No Motion	No Motion	No Motion	No Motion
	0.56	No Motion	No Motion	No Motion	No Motion
	0.53	No Motion	No Motion	No Motion	No Motion
	0.50	No Motion	No Motion	No Motion	No Motion
	0.46	No Motion	No Motion	No Motion	No Motion
	0.43	No Motion	No Motion	No Motion	No Motion
	0.40	No Motion	No Motion	No Motion	No Motion
	0.37	No Motion	No Motion	No Motion	No Motion
	0.33	No Motion	Motion	No Motion	No Motion
	0.30	No Motion	Motion	No Motion	No Motion
D16			0.0	in	
D50			0.8	in	
			0.063	ft	
D84			2.1	in	
D95			2.4	in	
D100			2.5	in	

Notes:

- The locations of all features shown are approximate.
- This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

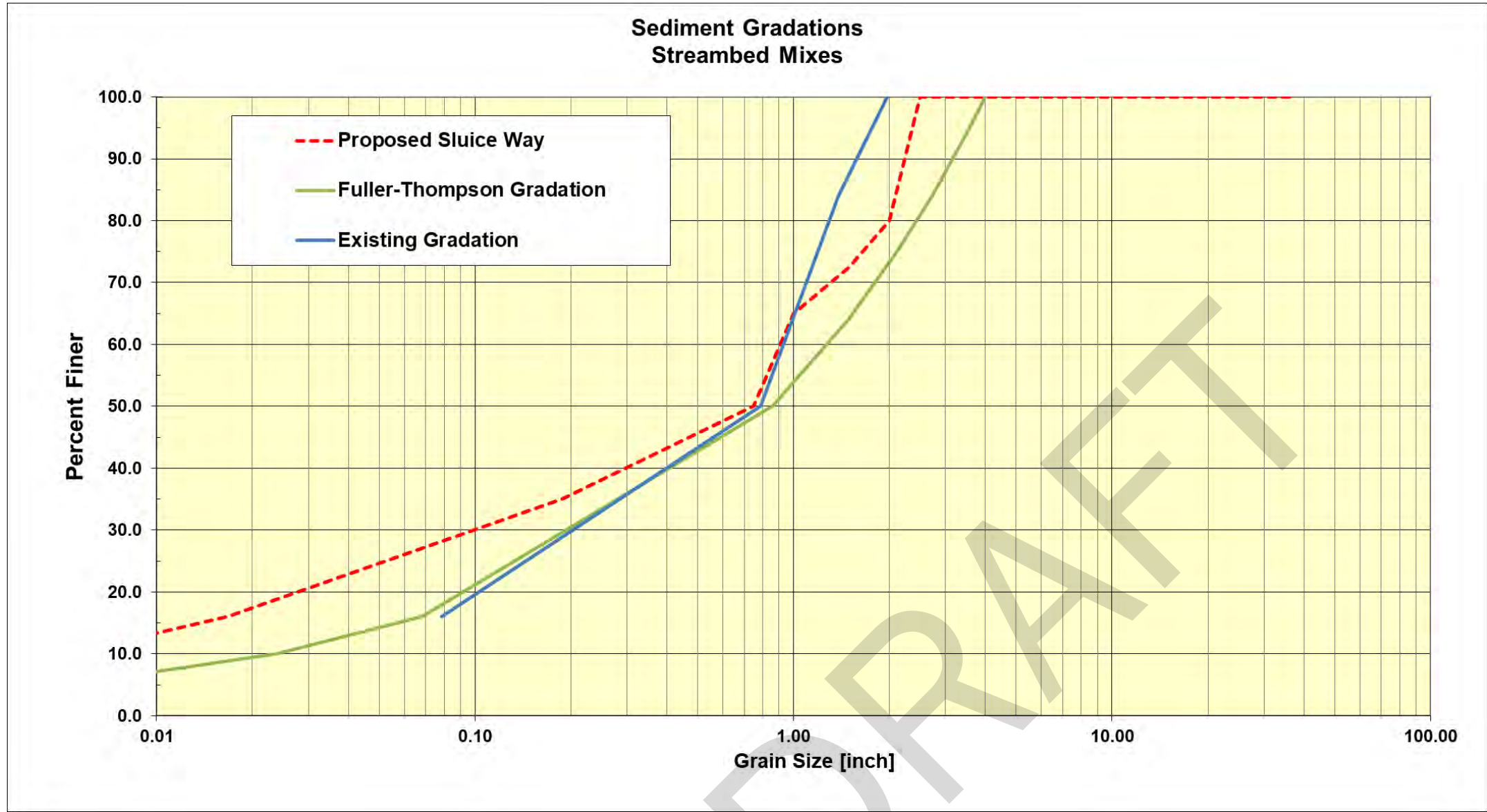
Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

Proposed Constructed Sluice Way Material Stability Worksheet

Willow Creek  
Union County, Oregon



Figure D-3



$D_i$ (ft)	$D_i$ (in)	$D_i$ (mm)	$D_i$	$\tau_{ci}$ (psf)	2-YR	100-YR	2080 100-YR	500-YR
0.001	0.017	0.425	D16	0.10	Motion	Motion	No Motion	No Motion
0.063	0.75	19.050	D50	0.30	No Motion	Motion	No Motion	No Motion
0.175	2.100	53.340	D84	0.41	No Motion	No Motion	No Motion	No Motion
0.198	2.375	60.325	D95	0.43	No Motion	No Motion	No Motion	No Motion
0.208	2.500	63.500	D100	0.43	No Motion	No Motion	No Motion	No Motion

**Notes:**

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

<b>Proposed Constructed Sluice Way Material Stability Worksheet</b>	
Willow Creek Union County, Oregon	
	<b>Figure D-4</b>

2-YR Contraction Scour Results

2-YR CONTRACTION SCOUR

Input Parameters

Average Depth Upstream of Contraction	7.13	ft
D50	18.29	mm
Average Velocity Upstream	1.29	ft/s

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported	6.07	ft/s
<u>Contraction Scour Condition</u>	Clear Water	

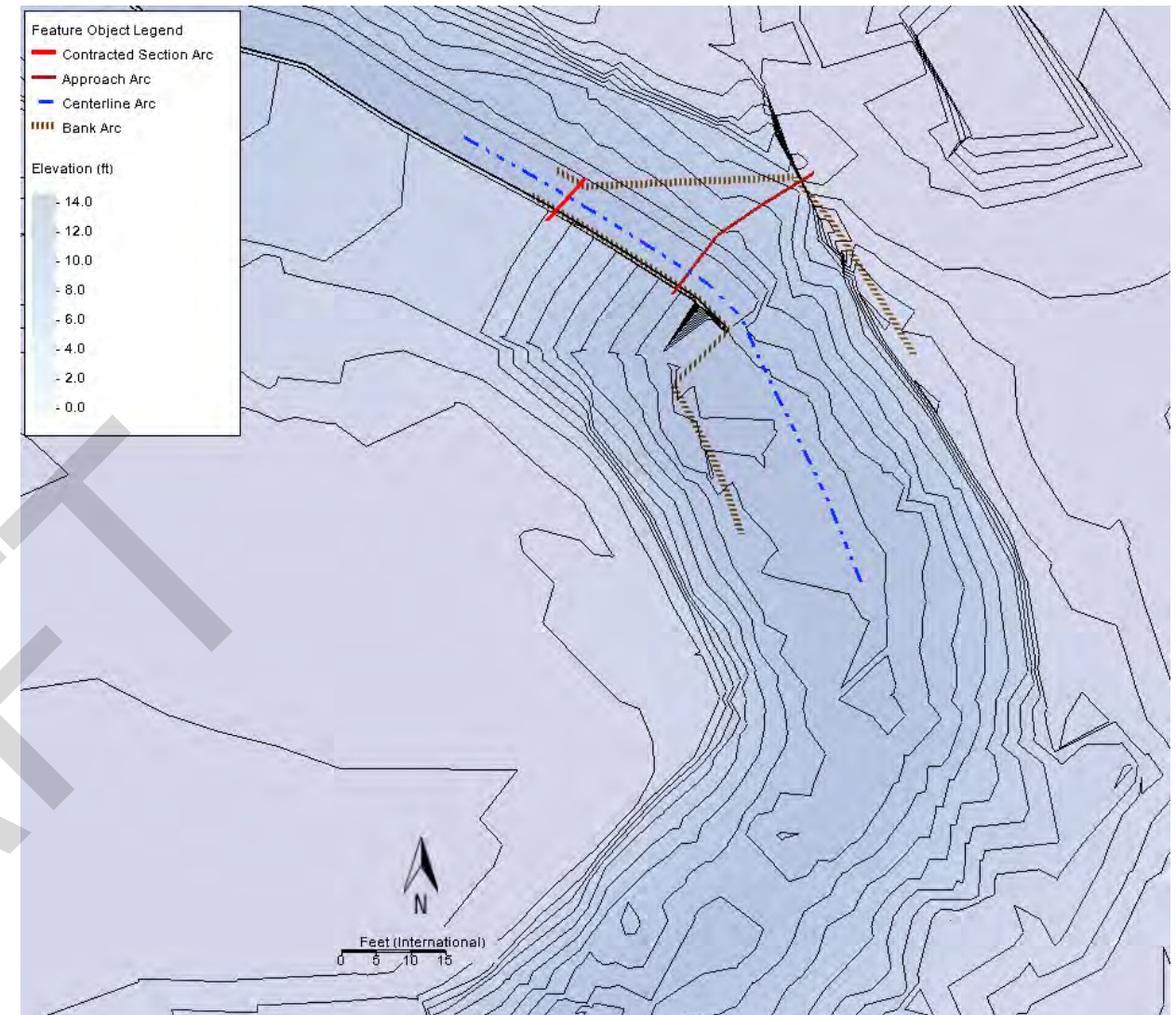
Clear Water Input Parameters

Discharge in Contracted Section	134.11	cfs
Bottom Width in Contracted Section	5.00	ft
Depth Prior to Scour in Contracted Section	9.34	ft

Results

Diameter of the smallest nontransportable particle in the bed material	22.86	mm
Average Depth in Contracted Section after Scour	4.37	ft
Scour Depth	-4.97	ft

\*Negative values imply 'zero' scour depth



2-YR Contraction Scour SMS Coverage

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: SMS Version 13.2 and SRH-2D Version 3.3.1; Simulation Date: April 2023

Hydraulic Toolbox Contraction Scour at Sluice Headgate

Willow Creek  
Union County, Oregon



Figure D-5

**APPENDIX E**  
**Construction Quantities and**  
**Estimate of Anticipated Costs**

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# Preliminary Cost Estimate

**Project:** Willow Creek Fish Passage  
**Project Number:** 19369-003-01

**Analyst:** R. Carnie  
**Date:** 6/30/2023

## Workbook Description

- This workbook contains spreadsheets that facilitate the analysis and/or design of this project.
- This spreadsheet lists the general project and workbook information that is consistent throughout the workbook.
- It also lists the titles of the spreadsheets contained in this workbook.
- This workbook is limited to the Construction Cost Estimate for modifications identified in the GeoEngineers Construction drawings and does **NOT** include the modifications proposed by others.
- This workbook is intended for use with ENGLISH UNITS.

**Filename:** *https://geoengineers.s*

### Sheet Titles:

Preliminary Cost Estimate  
Unit Costs  
Engineers's Construction Cost Estimate  
Bid Response Form

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## Unit Costs

Project:

Analyst

Ryan Carnie

Project Number:

Latest Revision

6/30/2023

- This spreadsheet calculates the costs associated with site preparation. Unit costs include materials, labor, equipment, overhead and contractor profit.  
 - Reference used for "unit costs" include:  
   (1) RS Means Database  
   (2) Engineering Experience & Recent Similar Projects  
   (3) Contractor or Supplier  
 - Inflation adjustment is negligible.  
 - Additional adjustments are based on engineering judgement, experience and site-specific degree of difficulty.  
 - Blank rows are provided at the bottom for additional items. Add new items & unit costs on this sheet, if necessary. These will be used to calculate costs on subsequent sheets.  
 - General mark-up percentages are also provided at the bottom.  
 - Specification # References the 2022 version of WSDOT's Standard Specifications for Road, Bridge, and Municipal Construction as amended in December 2021. Project-specific special provisions are affixed with "SP."

Item No.	NRCS Specification Pay Item #	Specification Pay Item	Unit Measure	Unit Cost
1	1	Clearing	AC	\$ 9,927.00
2	3	Structure Removal (Irrigation Intakes)	EA	\$ 3,500.00
3	5	Pollution Control	LS	\$ 12,000.00
4	6	Seeding, Sprigging, Mulching	AC	\$ 1,495.00
5	7	Construction Surveys	Day	\$ 2,500.00
6	8	Mobilization and Demobilization	LS	\$ 50,000.00
7	11	Removal of Water	LS	\$ 7,500.00
8	13	Sheet Pile	SF	\$ 58.00
9	21	Excavation	CY	\$ 35.00
10	23	Earthfill - Constructed Riffle Streambed	CY	\$ 130.00
11	23	Earthfill - Native Backfill	CY	\$ 70.00
12	26	Topsoiling	CY	\$ 31.89
13	27	Diversions and Waterways	FT	\$ 500.00
14	32	Structure Concrete	CY	\$ 530.00
15	34	Steel Reinforcement	TON	\$ 2,600.00
16	53	Ductile Iron Pipe	FT	\$ 220.00
17	61	Rock Riprap	CY	\$ 70.00
18	71	Water Control Gates	LS	\$ 10,000.00
19	99	Pump 1 Intake screen and Pump	LS	\$ 136,648.60
20	99	Pump 2/3 Intake and Pump	LS	\$ 8,000.00
21	99	Pump 4 Intake and Pump	LS	\$ 8,000.00
22	99	Pump 4 Intake and Pump	LS	\$ 8,000.00
			Taxes	8%

# Engineers' Construction Cost Estimate

Project: Willow Creek Fish Passage  
 Project No: 19369-003-01

Analyst: R Carnie  
 Latest Revision: 6/30/2023

- This spreadsheet summarizes the costs for construction of the culvert, roadway, and channel restoration measures.

Item No.	NRCS Specification Pay Item #	Specification Pay Item	Quantity	Unit Measure	Unit Cost	Estimated Cost
1	1	Clearing	1.0	AC	\$9,927.00	\$9,927
2	3	Structure Removal (Irrigation Intakes)	4.0	EA	\$3,500.00	\$14,000
3	5	Pollution Control	1.0	LS	\$12,000.00	\$12,000
4	6	Seeding, Sprigging, Mulching	0.4	AC	\$1,495.00	\$598
5	7	Construction Surveys	2.0	Day	\$2,500.00	\$5,000
6	8	Mobilization and Demobilization	1.0	LS	\$50,000.00	\$50,000
7	11	Removal of Water	1.0	LS	\$7,500.00	\$7,500
8	13	Sheet Pile	2500.0	SF	\$58.00	\$145,000
9	21	Excavation	220.0	CY	\$35.00	\$7,700
10	23	Earthfill - Constructed Riffle Streambed	210.0	CY	\$130.00	\$27,300
11	23	Earthfill - Native Backfill	275.0	CY	\$70.00	\$19,250
12	26	Topsoiling	10.0	CY	\$31.89	\$319
13	27	Diversions and Waterways	300.0	FT	\$500.00	\$150,000
14	32	Structure Concrete	1.0	CY	\$530.00	\$530
15	34	Steel Reinforcement	0.5	TON	\$2,600.00	\$1,300
16	53	Ductile Iron Pipe	380.0	FT	\$220.00	\$83,600
17	61	Rock Riprap	9.0	CY	\$70.00	\$630
18	71	Water Control Gates	1.0	LS	\$10,000.00	\$10,000
19	99	Pump 1 Intake screen and Pump	1.0	LS	\$136,648.60	\$136,649
20	99	Pump 2/3 Intake and Pump	1.0	LS	\$8,000.00	\$8,000
21	99	Pump 4 Intake and Pump	1.0	LS	\$8,000.00	\$8,000
22	99	Pump 4 Intake and Pump	1.0	LS	\$8,000.00	\$8,000
<b>SUBTOTAL CONSTRUCTION COST</b>						<b>\$705,303</b>
TAXES					8%	\$56,424
Construction Observation						\$0
<b>FINAL CONSTRUCTION COST</b>						<b>\$761,727</b>

## Bid Response Form

Project: Willow Creek Fish Passage  
 Project Number:

Analyst  
 Date

- This spreadsheet provides an outline of the Bid Response Form for inclusion with the bid package and construction contract.

Item No.	NRCS Specification Pay Item #	Specification Pay Item	Approx. Quantity	Unit Measure	Unit Cost	Estimated Cost
1	1	Clearing	1.0	AC		
2	3	Structure Removal (Irrigation Intakes)	4.0	EA		
3	5	Pollution Control	1.0	LS		
4	6	Seeding, Sprigging, Mulching	0.4	AC		
5	7	Construction Surveys	2.0	Day		
6	8	Mobilization and Demobilization	1.0	LS		
7	11	Removal of Water	1.0	LS		
8	13	Sheet Pile	2500.0	SF		
9	21	Excavation	220.0	CY		
10	23	Earthfill - Constructed Riffle Streambed	210.0	CY		
11	23	Earthfill - Native Backfill	275.0	CY		
12	26	Topsoiling	10.0	CY		
13	27	Diversions and Waterways	300.0	FT		
14	32	Structure Concrete	1.0	CY		
15	34	Steel Reinforcement	0.5	TON		
16	53	Ductile Iron Pipe	380.0	FT		
17	61	Rock Riprap	9.0	CY		
18	71	Water Control Gates	1.0	LS		
19	99	Pump 1 Intake screen and Pump	1.0	LS		
20	99	Pump 2/3 Intake and Pump	1.0	LS		
21	99	Pump 4 Intake and Pump	1.0	LS		
22	99	Pump 4 Intake and Pump	1.0	LS		
<b>Construction Sub-Total</b>						
Taxes						
<b>Final Construction Cost</b>						

**APPENDIX F**  
**Monitoring and Adaptive Management Plan**

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## **APPENDIX F MONITORING AND ADAPTIVE MANAGEMENT PLAN**

### **INTRODUCTION**

The Willow Creek watershed is an important tributary system in the Grande Ronde River basin for summer steelhead and spring/summer Chinook Salmon. The Royes Dam is located approximately 3.8 miles upstream of Willow Creek's confluence with the Grande Ronde River. In its present configuration and operation, the dam impedes and sometimes fully blocks adult and juvenile salmonid migration within the Willow Creek system because they are channel spanning and lack effective fish passage facilities. The project goal is to improve and maintain fish passage that achieve Oregon Department of Fish and Wildlife (ODFW) and National Marine Fisheries Service (NMFS) fish passage criteria to the greatest extent practical. Fish passage considerations include all life history stages of both steelhead and Chinook Salmon.

### **Project Elements**

The current use of Royes Dam involves the placement of wood boards on the steel frame perpendicular to the channel to create sufficient head for the operation of the existing irrigation pumps. This operation creates a fish passage barrier. To discourage the continued use of Royes Dam in a manner that creates a fish passage barrier, the project proposes to improve fish passage through installation of a fish passable constructed riffle in lieu of the current dam operations. Project element 1 is described by HIP Category 1b—consolidate or replace existing irrigation structures (Bonneville Power Administration 2021). The constructed riffle was designed with a crest elevation roughly equal to the current Royes Dam operating elevation of 2684.1 feet.

Project element 2 proposes to relocate and reconstruct pump 1, and upgrade the existing intake structures at pumps 2, 3 and 4 upstream of Royes Dam to meet NMFS criteria for screen size and impingement velocity. The project does not propose to consolidate multiple points of diversion.

Project element 3 includes a sluiceway and a manually operated headgate designed to maintain sediment transport through constructed riffle. The constructed riffle is located downstream of the pump 1 intake relocation to provide a minimum operating pool elevation.

### **RESPONSIBLE PARTIES**

The project team consists of representatives from USWCD (sponsor), GeoEngineers, Inc. (GeoEngineers) (design professionals), Living Water (irrigation pump supplier and installer) and the landowners. The project sponsor's project manager is Aaron Bliesner, 541.963.1313.

### **ASSESSMENT PROTOCOLS**

The National Oceanic and Atmospheric Administration (NOAA) Restoration Center Implementation Monitoring (NOAA 2022) identifies channel width, channel gradient, and jump height protocol for fish passage monitoring.

### Objective: Maintain Fish Passage

The current use of Royes Dam involves the placement of wood boards on the steel frame perpendicular to the channel. The project design element, to improve fish passage, is installation of a fish passable constructed riffle that controls the water surface elevation currently maintained by dam operations.

If a failure of the constructed riffle poses a risk to fish passage or sufficient pool elevation for irrigation intake operation, USWCD will be notified of the failure. If a system failure does arise, USWCD will work immediately with local support and engineers to develop a solution.

Table F-1 summarizes the monitoring protocols for fish passage based on NOAA monitoring protocol (NOAA 2022).

**TABLE F-1. SUMMARY OF MONITORING PROTOCOLS FOR FISH PASSAGE**

Monitoring Technique	Monitoring Metrics	Baseline Value	Design Channel (as-built)	Desired Condition	Frequency/Duration
Hand Measurement	Jump height	NA	= 0 ft	< 0.5 ft	Annual low and high flow
	Water depth	NA	> (riffle)	> 0.4 ft	Annual low flow
Survey	Gradient	NA	= 4.5%	< 6%	Flows in excess of 5-year or bi-annual (See future survey)

### Objective: Maintain Operable Pool Elevation

Concurrent with the project goal of providing reliable fish passage is a project objective to provide a pool elevation, upstream of the constructed riffle, that supports and maintains the use of irrigation water for water users. The project proposes a minimum pool elevation based on low-flow conditions as reported in the basis of design report summarized in Table F-2. Monitoring protocol for pool elevation is described below with as built and future surveys.

**TABLE F-2. SUMMARY OF LOW-FLOW POOL ELEVATIONS AND MINIMUM OPERATING ELEVATIONS**

Pump	Intake Screen Bottom / Top Elevation (Ft NAVD88)	Minimum Low-Flow Pool Elevation (Ft NAVD88)
1	2677.5/2680.5	2682.0
2 and 3	2679.0/2681.5	2683.0
4	2680.5/2683.0	2684.5

### ADAPTIVE MANAGEMENT TRIGGERS

Fish passage restoration of natural streams seeks to combine natural processes with engineering and construction techniques to provide fish passage to the greatest extent practicable over the design life of

the proposed enhancements. Natural stream systems are expected to experience gradual adjustment of the stream system over time; however, rapid channel change is generally not desired and often has a negative impact on passage. This monitoring plan includes monitoring attributes to provide a feedback loop of the trends and trajectory of the restoration efforts. The BPA review team will be notified if monitoring demonstrates values outside of the below outlined thresholds (Table F-3). If a Monitoring Metric is a “Pass,” then there is no action required. If, however, the Monitoring Metric is a “Fail,” then the BPA review team will make an evaluation of the failure and a determination of potential maintenance and/or corrective actions depending upon the severity and type of failure.

**TABLE F-3. MONITORING DATA, CONCLUSIONS, AND RESPONSES FOR SELECTED METRICS**

Project Objective	Monitoring Metric	Thresholds	Decision Pathway	Applicability
Fish Passage	Jump height	No barriers exceeding 0.5 feet hydraulic elevation differential	1. No barriers exceeding 0.5 ft (Pass) 2. Barriers exceeding 0.5 ft present. (Fail)	Constructed riffle
	Water depth	Depth of main channel thalweg of sufficient depth to allow passage of fish present	1. Continuous flow (low-flow depth) of at least 0.4 ft (Pass) 2. Discontinuous or very shallow flow depth (Fail)	Thalweg
Pool Elevation	Constructed Riffle Crest Elevation	> 2683.0	1. Elevation > 2683.0 (pass) 2. Elevation < 2683.0 (fall)	Crest thalweg

## ASSESSMENT FREQUENCY, TIMING, AND DURATION

### Project Baseline Survey

The baseline survey was completed as part of the original design. A summary of the topographic, bathymetric, geotechnical investigation, and stream function are described in the basis of design report. A summary of baseline conditions is that, in the present configuration and operation, Royes Dam impedes and sometimes fully blocks adult and juvenile salmonid migration within the Willow Creek system because it is channel spanning and lacks effective fish passage facilities.

In the present configuration and operation, Royes Dam provides operable pool elevations for irrigation water right delivery with the use of privately owned and operated pumping systems. The irrigation delivery is subject to water right restrictions and outside of this project’s scope.

### As-Built Survey

An as-built survey is recommended following construction of the proposed project elements. The as-built survey shall include four cross-sections through the length of the constructed riffle and four cross

sections through the length of the sluiceway. Additional survey requirements include top of bank lines, bankfull stage indicators, thalweg, water surface elevation, and the longitudinal profile of the constructed riffle and the sluiceway. The constructed riffle crest is crucial in providing a minimum upstream pool water surface elevation so the as-built survey will need to include the riffle crest elevation.

### **Future Surveys**

After the as-built survey occurs, if no observed changes exceed the identified threshold requiring corrective action are detected, then the next survey will take place after an approximate 5-year flood event. If changes that require corrective actions occur during the bankfull survey, then monitoring surveys will continue to occur after each bankfull event until no corrective action is necessary. As a contingency, monitoring surveys will be scheduled for every fifth year after construction so at least three surveys are completed in the first ten years following construction. Monitoring will cease after 10 calendar years from the date of project construction or as mutually agreed upon by the project review team.

### **REFERENCES**

- Bonneville Power Administration. 2021. *FY 2021 HIP Handbook Guidance of Programmatic Requirements and Process*. Portland, Oregon: Bonneville Power Administration.
- NOAA . 2022. "NOAA Restoration Center Implementation Monitoring." *Guidance for Proposing and Conducting Tier 1 Monitoring*. National Oceanic and Atmospheric Administration.

**APPENDIX G**  
**Bonneville Power Administration 30 Percent Submittal**  
**Comment Response**

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## HIP Project Review Comment Tracking

**Comments:**

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
1	BPA Functiona l	12/29/2022	15% BDR		<p>For future design submissions, please include the HIP4 General Conservation Measures Applicable to All Actions as well as the Category Specific Conservation Measures in the plan packet. These conservation measures can be found in the HIP4 Handbook or provided by the EC Lead.</p> <p>At the 15% Design stage, the currently applicable HIP categories are:</p> <ul style="list-style-type: none"> <li>• 1b) Consolidate or Replace Existing Irrigation Structures</li> <li>• 1c) Headcut and Grade Stabilization</li> </ul> <p>These categories may change as plans develop.</p>	GeoEngineers	June 30, 2023	Acknowledged, the HIP4 General Conservation Measures Applicable to All Actions are included on the draft final design drawings. Conservation measures and documentation of compliance for HIP categories 1b and 1c are described in the basis of design report.	To be Addressed at Next Review
2	BPA Functiona l	12/29/2022	15% Plans		For future design submissions, please add the statement "This project was designed in accordance with the BPA Habitat Improvement Program, Programmatic Biological Opinion (HIP IV)" on the Cover Sheet of the plans.	GeoEngineers	June 30, 2023	The statement is included on the draft final design drawings.	To be Addressed at Next Review
3	BPA Functiona l	12/29/2022	15% Plans		For final (100%) designs, please ensure that they are sealed by the Project Engineer per Oregon Revised Statutes 672.020 and 025.	GeoEngineers	June 30, 2023	Acknowledged, the final design drawings and associated reporting will be stamped and signed by an engineer licensed in the state of Oregon.	To be Addressed at Next Review
4	BPA Functiona l	12/29/2022	15% BDR		As design moves through stages, please provide regular updates on any new screen designs for pump intakes, as well as any applicable communications from ODFW, NMFS, etc. about fish screens.	GeoEngineers	June 30, 2023	Screen design specifications applicable to ODFW and NMFS are documented in the draft final design submittal and will be continually updated with each submittal milestone.	For Information Only



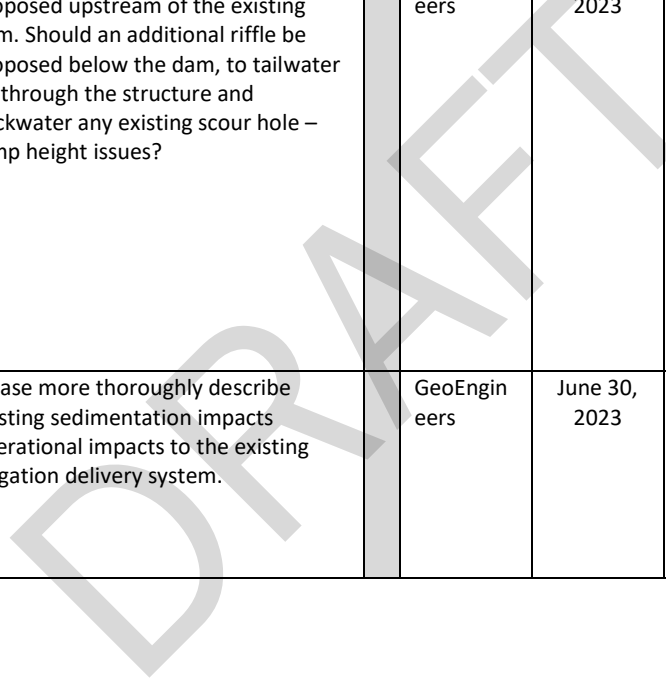
## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
5	BPA Functional	12/29/2022	15% BDR		The prior 106 cultural resources consultation for the Royes Dam fish ladder did not include the proposed project areas. Please provide initial estimate of project area scope, including potential staging areas and access, to the EC Lead with the 30% design submission so that a new 106 process may be initiated.	GeoEngineers	June 30, 2023	The draft final design submittal includes an estimated area of potential effects (APE) and it accounts for access and staging of the project.	To be Addressed at Next Review
6	ETS	1/25/2023	15% BDR		Obtain and provide BPA approval documentation from Oregon Department of Fish and Wildlife (ODFW) and National Marine Fisheries Service (NMFS) fish passage criteria that the project is compliant with fish passage and fish screening criteria.	GeoEngineers	June 30, 2023	Fish passage approval and documentation will be provided to BPA upon receipt following the draft final design review.	Open (Requirement)
7	ETS	1/25/2023	15% BDR		Obtain and provide BPA approval documentation from Oregon Department of Water Resources that the project is compliant with ODWR agencies requirements.	USWCD	June 30, 2023	Actions of this project do not change Point of Diversion, Point of Use, or other irrigation water regulations pertaining to certified water rights. Written documentation of no effect has been requested from OWRD and will be included upon receipt.	Open (Requirement)
8	ETS	1/25/2023	15% BDR		Please describe how the existing diversion dam will be modified as nonoperational. BPA does not want to assume the risk of project implementation being compromised by landowners reverting to historical operations.	USWCD	June 30, 2023	A legal agreement between the project sponsor and the land owners outlining the duration the Royes Dam will remain in place and intact will be drafted. A preliminary concept for this agreement is to assess the performance of the constructed riffle for multiple irrigation seasons. Possible contractual solutions regarding the Royes Dam include potential removal of the existing metal braces that currently hold boards and potential removal of the center pier.	Open (Requirement)



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
9	ETS	1/25/2023	15% BDR		Are the pump upgrades being proposed as a component of this project? If so, what other partners are being approached for cost share (NRCS OWEB?)	USWCD	June 30, 2023	The pump upgrades are included in the scope of the design project. The district will pursue all available funding opportunities to implement this project including through NRCS and OWEB.	Open (Requirement)
10	ETS	1/25/2023	15% BDR		All proposed riffle controls are proposed upstream of the existing dam. Should an additional riffle be proposed below the dam, to tailwater up through the structure and backwater any existing scour hole – jump height issues?	GeoEngineers	June 30, 2023	The proposed constructed riffle and sluiceway present limited impacts to the existing hydraulic conditions in Willow Creek downstream of the Royes Dam. An existing riffle exists between approximately 50 and 100 feet downstream of Royes Dam. Based on site investigation between 2018 and 2023, the existing riffle has shown no signs of erosion or degradation. Therefore, we believe the facility provides sufficient grade control and no additional site disturbance is proposed at this location.	Open (Requirement)
11	ETS	1/25/2023	15% BDR		Please more thoroughly describe existing sedimentation impacts operational impacts to the existing irrigation delivery system.	GeoEngineers	June 30, 2023	The draft final BDR includes a sediment transport subsection that shows existing conditions hydraulic model results and proposed conditions model results specific to sediment transport. A summary of potential impacts is included.	Open (Requirement)





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12	ETS	1/25/2023	15% BDR		<p>1. Hydrology: A hydrologic analysis shall be utilized to determine all pertinent fish passage, structural design and channel maintenance or morphologically significant discharges.</p> <p style="margin-left: 20px;">a. A flow duration analysis shall be performed for this period to identify the 95% exceedance Low Fish Passage Design Flow (LFPDF) and the 5% High Fish Passage Design Flow (HFPDF) for the period of migration defined in criteria 1.</p> <p style="margin-left: 20px;">b. A flood frequency analysis shall be performed to determine the 1.5, 2, 5, 10, 25, 50 and 100 year return interval floods.</p> <p>Please describe the irrigation withdrawals relative to water rights and fish passage flow conditions. It appears the water rights are well in excess of low flow conditions used in the passage analysis. Please also document the conditions within the stream reach during the low flow period (i.e. temperature, downstream senior water rights etc.)</p>	GeoEngineers	June 30, 2023	The draft final BDR summarizes hydrologic conditions in Willow Creek through the project reach. The reported flow rates include the high and low fish passage flows as well as the peak annual flows. A summary of monthly exceedance flow rates, water rights, and remaining monthly flow rates are included.	



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13	ETS	1/25/2023	15% BDR		<p>2. Hydraulics: A hydraulic analysis shall be performed of the existing and proposed condition that clearly identifies pre and post project hydraulic effects above, through and below the project reach. This shall include but not be limited to, water surface profiles, velocity profiles and shear stress profiles.</p> <p>a. The hydraulic analysis shall use the HFPDF and LFPDF as defined above to identify proposed features effects on fish passage. Any proposed feature shall clearly identify how minimum depths and velocities under the LFPDF and HFPDF have not exceeded the sustained swimming capability of the species and life stages present.</p> <p>b. Proposed features shall be designed for stability against the forces generated by the depths, velocities and shear stress occurring during</p>	GeoEngineers	June 30, 2023	<p>The draft final BDR includes a summary of existing and proposed conditions hydraulic modeling. The fish passage conditions including velocity and depth are summarized in the BDR. Material stability analysis and gradation designs are documented in the BDR for the roughened channel and bank stabilization sections. The design drawings include details for the sheet pile wall, sluiceway and headgate.</p>	
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					<p>the 50-year return period flood (or other flood magnitude as required in project specific design criteria (e.g. 100 year flood if base flood evaluation required) as identified above.</p> <p>c. All assumptions used in the hydraulic analysis shall be documented including cross-section locations, manning's coefficients and velocity head loss coefficients. These assumptions may be supported through site photos, aerial photography and survey information.</p> <p>Please provide computed water surface and velocity profiles through the stream reach. Please show all critical elevations (low, intermediate and high flow WS profiles relative to the Thalweg, and critical infrastructure elevations, intake inverts, intake diameters, sump elevations, riffle crest, riffle sluice elevations, dam foundation, splash pad etc.</p>				
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#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
14	ETS	1/25/2023	15% BDR		Please provide a draft operations manual that outlines recommended operational criteria for the project design. This document should outline recommended procedures for the operation of irrigation infrastructure to minimize impacts to listed aquatic species.	GeoEngineers	June 30, 2023	A draft Maintenance and Operations Manual is included in the draft final deliverable milestone.	
15	ETS	1/25/2023	15% BDR		Please review the HIP Handbook and ensure future submittals meet the Technical and Functional Review Junctures, and BDR requirements,	GeoEngineers	June 30, 2023	Acknowledged, the HIP handbook has been referenced for draft final submittal	
16	ETS	6/7/2023	30% Plans		Please consider adding a reinforced toe to the proposed FESL bank treatment. A detail was provided to the sponsor that shows a FESL treatment incorporated with a LWD toe.	GeoEngineers	June 30, 2023	The engineered soil lift bank stabilization has been removed from the design because the elevation of the proposed riffle crest provides sufficient pool elevation to leave pumps 2, 3 and 4 in place. The updated intake and location for pumps 2 and 3 is no longer necessary.	
17	ETS	6/7/2023	30% Plans		The intake locations and intake pipe lengths show the proposed passive screens in the middle of the channel. The required screen sizes appear to be fairly large. What is the propensity for damage and maintenance issues with these system elements extending so far into the channel? Will a backflush system be incorporated and please draw the screens to scale.	GeoEngineers	June 30, 2023	The additional depth provided by the updated constructed riffle and the retention of the existing intake locations and intake pipe support structures will mitigate maintenance issues for pumps 2, 3 and 4. Pump 1 includes a proposed backflush system.	
18	ETS	6/7/2023	30% Plans		An alternative passive vertical plate vault example was provide to the sponsor for consideration. This design can also incorporate a sweeper.	GeoEngineers	June 30, 2023	We appreciate the collaborative review and insightful design recommendations. A passive vault was not selected as a design alternative for the draft final, and a sheet pile wall was included to provide a sluiceway to convey sediment during high annual runoff conditions.	



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#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
19	ETS	6/7/2023	30% Plans		Please provide all the necessary details for all project elements in the 80% design (pump design, layout & elevations, foundation designs, vault designs, screen designs, riffle design etc. with pertinent structural details, excavation and compaction requirements, and resource plans (water management, work area isolation, site restoration – planting, erosion control, etc.).	GeoEngineers	June 30, 2023	The draft final design includes specifications on pump screen sizes, sheet pile wall, headgate and constructed riffle details. The pump 1 relocation and replacement, along with electrical connections are part of a proprietary pump manufacturer design layout and will be provided at final design.	
20	ETS	6/7/2023	30% Plans		Please see the alternative riffle sluicing detail provided to the sponsor.	GeoEngineers	June 30, 2023	The draft final design utilizes a sheet pile wall as provided for reference. We appreciate the collaborative design process and considerations provided by BPA.	
21	ETS	6/7/2023	30% Plans		There are inconsistencies in the presented low flow pool elevations at pump 4 (please check all locations) Page 23 of BDR LFP = 2684.4, Sheet 4.4 LFP = 2683.6, Table 8 BDR LFP = 2683.5. Per comment above, please provide all of these corrected elevations on the project profiles.	GeoEngineers	June 30, 2023	The updated design drawings reflect hydraulic model results for the high fish passage flow and low fish passage flow.	
22	ETS	6/7/2023	30% Plans		The hydraulic sections in the appendix only show 3 feet of depth at pump 4, the BDR identifies a 4 foot depth as criteria.	GeoEngineers	June 30, 2023	The updated BDR reflects water surface elevations representative of the heightened constructed riffle design. This error has been corrected on the draft final design drawings.	



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23	ETS	6/7/2023	30% Plans		Please ensure the 30% - 80% design process includes an assessment of landowner feasibility and understanding of the project. The LO will have the best available insight into pumping withdrawals relative to maintenance, channel impacts and operational needs. The sponsor described an upstream diversion with a passive screen that works well, and is a potential reference condition for this site. Please include this information as narrative in the BDR.	GeoEngineers	June 30, 2023	The draft final design includes a constructed riffle crest elevation that mimics the operating Royes Dam elevation of 2684.1 so landowners will experience similar pool elevations as the current operation.	
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**APPENDIX H**  
**Report Limitations and Guidelines for Use**

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## **APPENDIX H REPORT LIMITATIONS AND GUIDELINES FOR USE<sup>1</sup>**

This appendix provides information to help you manage your risks with respect to the use of this report.

### **Read These Provisions Closely**

Some clients, design professionals and contractors may not recognize that stream and river engineering analysis and design practices are less exact than other engineering and natural science disciplines. Such misunderstanding can create unrealistic expectations, sometimes leading to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

### **Stream and River Design Engineering Services Are Performed for Specific Purposes, Persons and Projects**

This report has been prepared for Union Soil and Water Conservation District and their authorized agents and regulatory agencies for use on the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than Union Soil and Water Conservation District may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project(s), and its (their) schedule and budget, our services have been executed in accordance with our Agreement with the Client dated September 1, 2022 and generally accepted practices in this area at the time this report was prepared. We do not authorize and will not be responsible for, the use of this report is not recommended for any purposes or projects other than those identified in the report.

### **A Stream or River Design Engineering Report is Based on a Unique Set of Project-Specific Factors**

This report has been prepared for the Willow Creek Royes Dam Fish Passage Restoration project (“Project”) in Union County, Oregon. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site, or
- completed before project changes were made.
- For example, changes that can affect the applicability of this report include those that affect:

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<sup>1</sup> Developed based on material provided by GBA, GeoProfessional Business Association; [www.geoprofessional.org](http://www.geoprofessional.org).

- the function of the proposed design and/or structure;
- elevation, configuration, location, orientation or weight of the proposed structures;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations in the context of such changes. Based on that review, we can provide written modifications or confirmation, as appropriate.

### **Conditions Can Change**

This report is based on conditions that existed at the time the study/design was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability, stream flow fluctuations or stream channel fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

### **Report Recommendations and Designs Are Not Final**

The recommendations included in this report are preliminary and should not be considered final. The designs depicted herein are approximate and are intended to express the overall design intent of the Project, and need to be adjusted in the field during construction in order to meet the specific-site conditions and intended function. GeoEngineers' recommendations can be finalized only by observing actual site-specific conditions revealed during construction.

We recommend that you allow sufficient monitoring and consultation by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated in the report, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated and to evaluate whether construction activities are completed in accordance with our recommendations. GeoEngineers cannot assume responsibility for the recommendations in this report if we do not perform construction observation.

### **Report Could Be Subject to Misinterpretation**

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

To help reduce the risk of problems, we recommend giving contractors the complete report, including these "Report Limitations and Guidelines for Use." When providing the report, you preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

### **Hazards of Instream Habitat Structures**

Instream habitat structures (“Structures”) create potential hazards, including, but not limited to:

- persons falling from the Structures and associated injury or death;
- collisions of recreational users’ and their watercraft with the Structures, and associated risk of injury, and damage of the watercraft;
- mobilization of a portion or all of the Structures during high water flow conditions and related damage to downstream persons and property;
- flooding;
- erosion; and
- channel avulsion.

In some cases, instream habitat structures are only intended to be temporary, providing temporary stabilization while riparian vegetation becomes established while or stream/river processes stabilize. This gradual deterioration with age and vulnerability to major flood events make the risks with temporary Structures inherently greater with their increasing age.

GeoEngineers strongly recommends that the Client appropriately address safety concerns, including but not limited to warning construction workers of hazards associated with working in or near deep and fast moving water and on steep, slippery and unstable slopes. In addition, signs should be placed along the enhanced stream reaches in prominent locations to warn third parties, such as nearby residents and recreational users, of the potential hazards noted above.

### **Increased Flood Elevations and Wetland Expansion Are Possible**

The proposed stream enhancements may result in increased flood elevations and expansion of wetlands. These impacts are generally considered advantageous for aquatic and riparian habitat in the project locations of these stream systems, but the analysis, consideration and quantification of these impacts is beyond the scope of this report, unless expressly included within GeoEngineers’ scope of services.

### **Channel Erosion and Migration Are Possible**

In general, river and stream enhancements result in more stable streambeds, banks and floodplains. In some cases, stream enhancement and channel stability includes reestablishing the natural balance of sediment erosion, distribution and deposition, which in some cases may induce channel meandering and migration. Therefore, channel erosion, channel migration and/or avulsions can occur over time.

### **Importance of Monitoring and Maintenance**

In some instances, GeoEngineers may have purposely excluded piles, anchors, chains, cables, reinforcing bars, bolts and similar fasteners from woody habitat structures with the intent of mimicking naturally-

occurring instream wood structures. In other instances, GeoEngineers may have purposely included such fasteners may have purposely been included in woody habitat Structures, if considered appropriate. While GeoEngineers designs Structures to be relatively stable during flood events, some movement of these Structures is expected. We recommend that the Client implement appropriate monitoring and maintenance procedures to minimize potential adverse impacts at or near areas of concern, such as at downstream road, bridge and/or culvert crossings, including replacing, adjusting and removing damaged, malfunctioning or deteriorated components of Structures, particularly after a major storm event.

### **Contractors Are Responsible for Site Safety on Their Own Construction Projects**

Our recommendations are not intended to direct the contractor's procedures, means, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

### **Information Provided by Others**

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

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