

**Trout Unlimited and Union Soil  
and Water Conservation  
District**

**Elmer Dam Fish Passage  
Catherine Creek, Oregon**

**Basis of Design Report**



June 2022

# Table of Contents

<b>1.0</b>	<b>Executive Summary .....</b>	<b>1</b>
<b>1.1</b>	<b>Name and Titles of Sponsor, Firms and Individuals Responsible for Design .....</b>	<b>1</b>
<b>1.2</b>	<b>List of project elements that have been designed by a licensed Professional Engineer. ....</b>	<b>1</b>
<b>1.3</b>	<b>Explanation and background on fisheries use (by life stage - period) and limiting factors addressed by project. ....</b>	<b>1</b>
<b>1.4</b>	<b>List of primary project features including constructed or natural elements. ....</b>	<b>2</b>
<b>1.5</b>	<b>Description of performance / sustainability criteria for project elements and assessment of risk of failure to perform, Risk to infrastructure, potential consequences and compensating analysis to reduce uncertainty. ....</b>	<b>4</b>
<b>1.6</b>	<b>Description of disturbance including timing and areal extent and potential impacts associated with implementation of each element. ....</b>	<b>9</b>
<b>2.0</b>	<b>Resource Inventory and Evaluation.....</b>	<b>10</b>
<b>2.1</b>	<b>Description of past and present impacts on channel, riparian and floodplain conditions. ....</b>	<b>10</b>
<b>2.2</b>	<b>Instream flow management and constraints in the project reach. ....</b>	<b>10</b>
<b>2.3</b>	<b>Description of existing geomorphic conditions and constraints on physical processes.....</b>	<b>11</b>
<b>2.4</b>	<b>Description of existing riparian condition and historical riparian impacts. ....</b>	<b>11</b>
<b>2.5</b>	<b>Description of lateral connectivity to floodplain and historical floodplain impacts.....</b>	<b>11</b>
<b>2.6</b>	<b>Tidal influence in project reach and influence of structural controls (dikes or gates). ....</b>	<b>11</b>
<b>3.0</b>	<b>Technical Data .....</b>	<b>11</b>
<b>3.1</b>	<b>Incorporation of HIPIV specific Activity Conservation Measures for all included project elements. ....</b>	<b>11</b>
<b>3.2</b>	<b>Summary of site information and measurements (survey, bed material, etc.) used to support assessment and design. ....</b>	<b>11</b>
<b>3.3</b>	<b>Summary of hydrologic analyses conducted, including data sources and period of record including a list of design discharge (Q) and return interval (RI) for each design element.....</b>	<b>12</b>
<b>3.4</b>	<b>Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design. ....</b>	<b>13</b>
<b>3.5</b>	<b>Summary of hydraulic modeling or analyses conducted and outcomes – implications relative to proposed design.....</b>	<b>14</b>

<b>3.6</b>	<b>Stability analyses and computations for project elements, and comprehensive project plan. ....</b>	<b>14</b>
<b>3.7</b>	<b>Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation.....</b>	<b>15</b>
<b>3.8</b>	<b>For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation. ....</b>	<b>16</b>
<b>3.9</b>	<b>For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.....</b>	<b>16</b>
<b>4.0</b>	<b>Construction – Contract Documentation.....</b>	<b>16</b>
<b>4.1</b>	<b>Incorporation of HIPIV General and Construction Conservation Measures .</b>	<b>16</b>
<b>4.2</b>	<b>Design – construction plan set including but not limited to plan, profile, section and detail sheets that identify all project elements and construction activities of sufficient detail to govern competent execution of project bidding and implementation. ....</b>	<b>16</b>
<b>4.3</b>	<b>List of all proposed project materials and quantities. ....</b>	<b>16</b>
<b>4.4</b>	<b>Description of best management practices that will be implemented and implementation resource plans including: .....</b>	<b>16</b>
<b>4.5</b>	<b>Calendar schedule for construction/implementation procedures. ....</b>	<b>18</b>
<b>4.6</b>	<b>Site or project specific monitoring to support pollution prevention and/or abatement. ....</b>	<b>18</b>
<b>5.0</b>	<b>Monitoring and Adaptive Management .....</b>	<b>19</b>
<b>6.0</b>	<b>References.....</b>	<b>19</b>
<b>7.0</b>	<b>Appendices .....</b>	<b>19</b>

## **1.0 Executive Summary**

### **1.1 Name and Titles of Sponsor, Firms and Individuals Responsible for Design**

<u>Sponsors:</u>	Trout Unlimited, Union Soil and Water Conservation District
<u>Project Manager:</u>	Chris Boyd, PE, River Structures Consulting, Inc
<u>Engineers of Record:</u>	Chris Boyd, PE, River Structures Consulting, Inc Nick Kraus, PE, Quadrant Consulting, Inc

### **1.2 List of project elements that have been designed by a licensed Professional Engineer.**

1. Vertical Slot Fishway
2. Dam Modifications
3. Pump Stations
4. Off-Channel Reservoir Connections
5. Off-Channel Oxbow Diversion Screens

### **1.3 Explanation and background on fisheries use (by life stage - period) and limiting factors addressed by project.**

The primary species of interest include spring/summer Chinook Salmon and summer Steelhead. While ideally the project will provide passage for all fish and aquatic species year-round, the primary objective is to provide passage for adult spring/summer Chinook salmon and summer Steelhead during periods of upstream migration. Adult Steelhead migration into Catherine Creek generally occurs from mid-March through May and spring Chinook return from mid-May to late July (see Figure 1-1). The fish return numbers and timing are based on data collected at the Catherine Creek trap approximately 30 miles upstream. The adult migration through the Elmer Dam occurs prior to the dates shown, but the data is considered relevant for the design of the proposed fishway.

The primary outmigration period for both summer Steelhead and spring Chinook juveniles occurs in April and May with a secondary spring Chinook outmigration in the fall/winter. It is also likely that juvenile Chinook and Steelhead over winter in this portion of the watershed.

Bull Trout are also present in Catherine Creek. They utilize this area both as a migratory corridor and potentially as a winter rearing area. The presence of Bull Trout in this reach is not well understood, but it is assumed that Bull Trout migrate downstream to mainstem areas after spawning in the fall and move upstream in the spring as stream temperatures elevate.

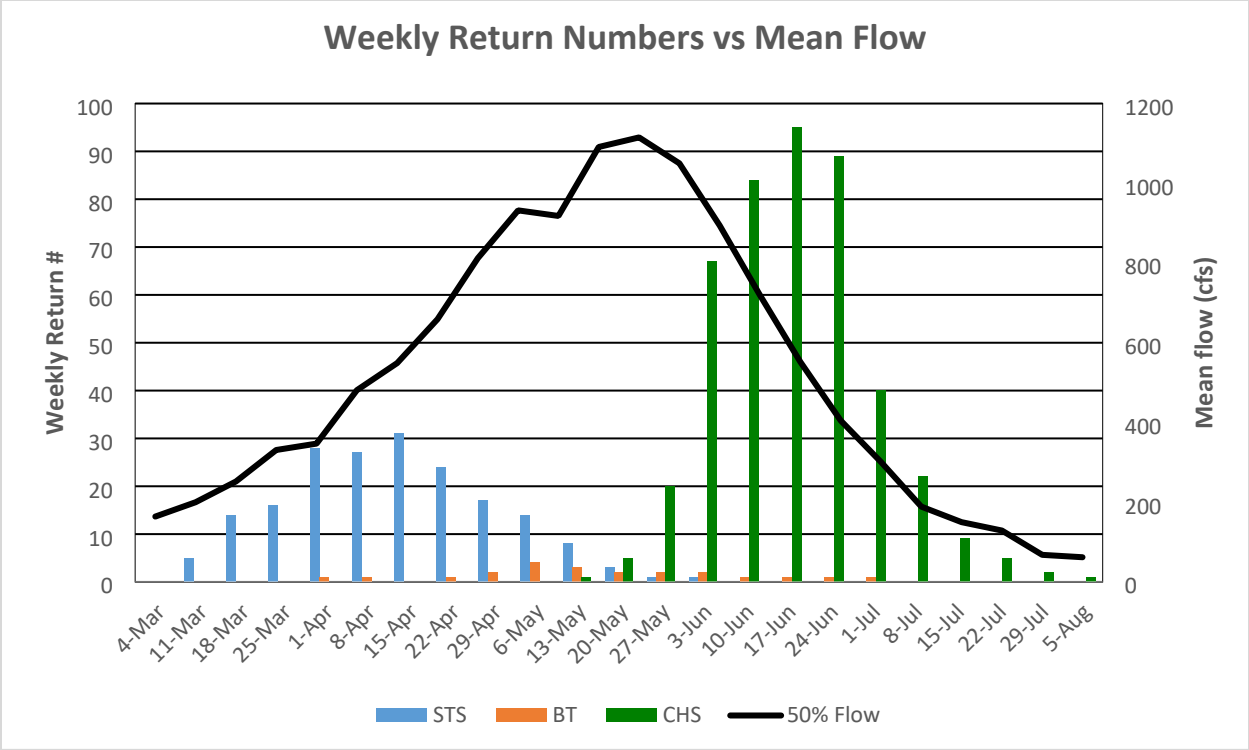


Figure 1-1. Fish Return Numbers vs Mean Flow

While not threatened or endangered, Lamprey are a species of interest in this drainage. For that reason, whatever improvements are selected will include consideration of Lamprey rearing and passage through this reach. This includes considerations like providing structures which are conducive to Lamprey passage as well as salmonids.

**1.4 List of primary project features including constructed or natural elements.**

*1. Vertical Slot Fishway*

A new concrete vertical slot fishway will replace the existing fishway on the left bank. The new fishway is designed to meet or exceed Oregon Administrative Rules and NMFS 2011 requirements between the 5<sup>th</sup> and 95<sup>th</sup> percentile flow rates, and to provide hydraulic connectivity at in-stream flows below the 95<sup>th</sup> percentile flow with active management. Multiple gated fishway entrance and exit orifices are provided to accommodate fish passage over a wide range of dam forebay and tailwater elevations while allowing the dam operator to regulate in-stream storage to fulfill their irrigation water rights.

Fishway operation will require the installation or removal of bulkheads in the vertical slots to maintain reservoir storage during the irrigation season while ensuring compliance with Oregon Administrative Rules and NMFS 2011 requirements.

## *2. Dam Modifications*

Modifications to the existing dam include replacement of the existing pool and weir fishway with a vertical slot fishway, as discussed above, installation of a new auxiliary spillway with an overshot gate, a retrofit of the existing spillway's stoplog stanchions and access grating, and installation of a sheet pile cutoff wall.

A new auxiliary spillway will be constructed to the left of the existing spillway, between the existing spillway and the new fishway. The new spillway will include a tilting weir overshot gate which can be used to regulate flow through the dam. The spillway slot will be 6-feet between concrete walls, providing 5-feet of clear space between the cable guards on each side. The guards will prevent debris from hanging up on the control cables. The new auxiliary spillway will compensate for the loss of hydraulic capacity of the existing pool-weir fishway.

The existing spillway will continue to operate similar to the current configuration utilizing vertical stanchions and stoplogs. The addition of the tilting weir spillway can be used to regulate instream flows during most moderate to low flow conditions, eliminating the need to remove stoplogs periodically throughout the season.

The sheet pile cutoff wall and concrete slab extension will be installed along the upstream face of the dam. The purpose of the slab extension and cutoff wall is to provide structural stability by resisting uplift and sliding forces.

## *3. Pump Stations*

The existing irrigation pump, which is located immediately upstream of the Elmer Dam, will be relocated to an off-channel pump station on the left bank. The relocated pump station will provide the following benefits:

- The pump station will allow the owner to access a greater volume of storage in Reservoir 4 (the on-channel reservoir) which is currently unavailable due to the elevation of the pump intakes. This modification will allow the reservoir to be operated consistently at a lower full pool elevation to reduce the total forebay to tailwater elevation difference, thereby reducing the total maximum elevation change through the fishway.
- A second intake for this pump station will be provided on the adjacent Reservoir 1 (the most downstream off-channel oxbow reservoir), allowing for more efficient use of the storage in Reservoir 1, and potentially reducing the late season withdrawal demands on Reservoir 4.

The existing intake pump at Booth Lane will be relocated to an off-channel intake to accommodate operation at a reduced full pool elevation in Reservoir 4.

Each pump station intake will include NMFS/ODFW compliant fish screens designed for a maximum approach velocity of 0.2 ft/s at a peak diversion demand of 4.46 cfs (2,000 gpm).

#### *4. Off-Channel Reservoir Connections*

Off-channel storage in Reservoirs 1, 2, and 3 (oxbow reservoirs) will be hydraulically connected to the relocated pump station adjacent to Elmer Dam. The oxbow reservoirs will be interconnected with approximately 1,500 linear feet of 24-in diameter pipeline. The pipelines will include control gates and trash racks at each reservoir inlet/outlet to provide operational control and debris exclusion.

#### *5. Oxbow Reservoir Diversion Fish Screens*

NMFS/ODFW compliant fish screens will be installed on new intakes for Reservoirs 1 and 2 to reduce the entrainment of ESA listed steelhead and chinook juveniles in the oxbows. The Reservoir 1 intake will be combined with the intake infrastructure for the pump station adjacent to Elmer Dam for construction cost and operations/maintenance efficiency. The existing intake for Reservoir 3 will be abandoned as Reservoir 3 will be filled from the adjacent Reservoir 2 using the Off-Channel Reservoir Connection pipelines described above.

#### *6. In-Channel Modifications*

The channel in the vicinity of the dam potentially contains culturally sensitive areas and any streambank modifications downstream of the dam would provide marginal benefits. For this reason, no in-channel modifications will be installed downstream of the dam.

The proposed alternatives could result in reduced reservoir water surface elevations for a greater portion of the water year with a corresponding range in the potential length of stream channel where channel and habitat improvements could be implemented at the upstream end of the reservoir. Two types of treatments have been discussed to achieve the intended channel and habitat improvements. These treatments include construction of Post-Line Willow-Weave (PLWW) structures and Small Wood Material (SMW) structures, both of which may be used in combination with each other and independently.

Any improvements installed within the reservoir would be a considerable distance upstream of the dam and intake improvements and are well outside of the project boundary. Therefore, we recommend that any potential upstream improvements be considered as part of a separate project.

### **1.5 Description of performance / sustainability criteria for project elements and assessment of risk of failure to perform, Risk to infrastructure, potential consequences and compensating analysis to reduce uncertainty.**

#### *1. Vertical Slot Fishway*

The vertical slot fishway is designed to provide adult and juvenile salmonid passage per the requirements specified in the Oregon Administrative Rules and NMFS 2011. To provide for operator management of the pool elevation in Reservoir 4, the fishway has been designed to actively accommodate multiple operating conditions. These operating conditions are intended to

facilitate fish passage between the 5<sup>th</sup> (449 cfs) and 95<sup>th</sup> (20 cfs) percentile flow rates within the typical expected operating conditions in Reservoir 4, and to provide hydraulic connectivity through the fishway at very low flow in-stream rates down to 8.5 cfs or during time periods (primarily outside of the irrigation season) when maintaining reservoir storage is not a priority.

Fishway design features include two exit openings each measuring 1.5 feet wide and 4 feet high. The upper exit is intended for use during the irrigation season when the operator is managing the reservoir for storage and for high flow conditions up to 449 cfs. The lower exit is intended for use at times when reservoir storage is not a priority. The exit openings will be opened or closed with manually operated slide gates for both operational control and maintenance access.

When the upper exit is in operation, bulkheads will be installed in the vertical slots along the length of the fishway to maintain a maximum of 6 inches of hydraulic drop between pools. Conversely, when the lower exit is in operation, most of the check boards or bulkheads will be removed from the vertical slots, leaving a 12 inch sill in place at each slot to maintain connectivity and at least minimally passable hydraulic conditions at very low in-stream flows.

The fishway also includes two entrance openings, each measuring 1.5 feet wide by 3 feet high. The lower entrance will be used during very low flow conditions up to in-stream flows of approximately 100 cfs. At flows above 100 cfs, tailwater depths increase sufficiently to use the higher elevation orifice to maintain attraction flow characteristics. The entrance openings will be opened or closed with manually operated slide gates for both operational control and maintenance access.

During the irrigation season, the reservoir will typically be managed to maintain the design full pool elevation. Between 20 cfs and 30 cfs, 100 percent of in-stream flow will pass through the fishway. At flows between approximately 30 cfs and 449 cfs, the overshot gate will be manually operated in conjunction with the fishway to maintain a full pool elevation in the reservoir which will maximize the percentage of total flow through the fishway. For flows at and above 449 cfs, the overshot gate and spillway will typically be fully open. This condition will allow upstream passage through the spillway openings. At flows exceeding the 1.05-year return interval (1099 cfs), the tailwater elevation is directly influenced by backwatering effects from the Grande Ronde River, which will also allow for upstream passage through the spillway openings.

Expected fishway performance at various flow rates is summarized in Table 1-1. The data provided is based on output from a two-dimensional (2D) hydraulic model developed to analyze fishway design.

Table 1-1. Vertical Slot Fishway Performance

Total Flow (cfs)	Fishway Flow (cfs)	Percent Total Flow	Forebay Water Surface El.	FISHWAY HYDRAULICS			
				Entrance Loss (feet)	Exit Loss (feet)	Entrance Condition	Exit Condition
8.5	8.5	100%	2680.1	0.2'	0.1'	Lower Entrance	Lower Exit
20	20	100%	2681.6	1.0'	0.1'		Upper Exit/Overshot Gate Closed
30	24	80%	2682.2	1.2'	0.2'		
40	25	63%	2682.4	1.1'	0.2'		
50	26	52%	2682.6	1.1'	0.2'		
100	29	29%	2683.2	0.8'	0.4'		
200	29	15%	2683.2	0.6'	0.4'	Upper Entrance	Upper Exit/Overshot Gate Partially Open
300	29	10%	2683.2	1.1'	0.4'		
400	29	7%	2683.2	0.9'	0.4'		Upper Exit/Overshot Gate Fully Open
449	29	6%	2683.2	0.9'	0.4'		

Hydraulic model output exhibits demonstrating in-stream velocity gradients and water surface elevations for select flow rates ranging from 20 cfs to 449 cfs are provided in Appendix 7.3.

Due to the low gradient of Catherine Creek and the relatively long reservoir length (approximately 54,000 linear feet), sediment accumulation has not historically been an issue at this location. Therefore, sediment buildup within the fishway is not expected to be a concern.

Floating debris such as logs, branches, or sticks could become lodged in the fishway. A grizzly trash rack with a 12-inch nominal bar spacing will be installed at the fishway exit (hydraulic entrance). Removable walkway grating will be installed over the top of the fishway to allow the operator to easily access the fishway slots to dislodge or remove any debris which may build up.

The fishway will require inspection and maintenance by the landowner. The dam and fishway are very near to the owner's residence and the site is easily accessed via an adjacent road. High flow approach velocities at the dam are relatively small in magnitude with values averaging less than

2 ft/s at the 100-year event due to backwatering effects from the Grande Ronde River. Debris management is therefore not expected to be a significant issue at this location.

## *2. Dam Modifications*

The removal of the existing 5-foot wide fishway reduces the effective hydraulic capacity of the dam to pass high flows. In order to offset this reduction in hydraulic capacity, a portion of the dam will be removed and replaced with a 6-foot-wide spillway and overshot gate. The overshot gate provides 6-inch cable guards on each side of the spillway to protect the operator cables while providing a 5-foot-wide hydraulic opening. The spillway provides more hydraulic capacity than the existing fishway. The new vertical slot fishway also provides additional hydraulic capacity, but has been conservatively neglected in the hydraulic analysis relative to performance at high in-stream flow events (greater than the 1.05-year return interval).

The current dam configuration includes a small riprap buttress on the left side of the spillway which will be removed for the installation of the auxiliary spillway and new fishway. This buttress is currently 2-4 feet thick and does not provide significant resistance to the sliding or uplift of the dam. A new spillway wall will be constructed adjacent to and connected to the existing left spillway wall, and the spillway apron has been designed with adequate foundation mass and cutoff walls to prevent uplift or sliding due to pressures on the existing and new spillway gates. The new spillway walls and aprons will be connected to the existing spillway and new fishway with dowels, ensuring that the new dam configuration results in a stable structure.

## *3. Pump Stations*

Two existing pumps, one at the dam and one at Booth Lane, will be moved to off-channel wet well locations. The new pump stations will include NMFS/ODFW compliant fish screens designed for a maximum approach velocity of 0.2 ft/s at a peak diversion demand of 4.46 cfs (2,000 gpm) to reduce the potential for ESA listed fish entrainment. The fish screens are proven commercially available pump intake screens with active pressure backwash cleaning mechanisms commonly used in similar irrigation facilities. It will be the responsibility of the landowner/irrigator to periodically inspect and maintain the fish screens to ensure that they are functioning properly and do not become plugged. The screens are housed in a concrete intake structure with control gates that can be closed to allow safe access for inspection and maintenance purposes. The landowner/irrigator will have a vested interest in ensuring the screens are maintained as the default screen failure mode will be to limit irrigation deliveries.

The new fish screen intakes will be lower in elevation than the current intakes, making sediment accumulation a design concern. To mitigate for potential sediment impacts, the elevation of the inlet control gates at the fish screens will be elevated a minimum of 12 inches above the bottom of the spillway opening at the dam, which correlates to approximately 24 inches above the reservoir bottom. The design intake elevation combined with statements from the landowner/irrigator indicating that sediment deposition behind or in the vicinity of the dam has not typically been an issue provides assurance that sediment impacts should be minimal. The concrete structures housing the fish screens have also been designed with control gates to allow

them to be isolated from the reservoir, allowing for the use of a portable trash pump to clean out any sediment which may accumulate over time or following very high-water events.

The design intent is to re-use the existing pumps and motors so that the operation and maintenance requirements will be comparable to the current arrangement.

#### *4. Off-Channel Reservoir Connections*

Off-channel storage in Reservoirs 1, 2, and 3 will be operated as a single reservoir by installing approximately 1,500 linear feet of interconnecting 24-inch diameter pipelines between the three reservoirs. The primary concern with this improvement is the accumulation of debris at the pipeline intakes and within the pipelines themselves. This concern will be mitigated by installing trash racks and control gates at each end of the interconnecting pipelines and providing manhole access at the midpoint of each pipeline. Pipeline locations have been selected to minimize the overall installed length and to provide convenient access for landowner/irrigator maintenance with a minimum of effort. The control gates will allow for active management of the storage volume in each reservoir and for pipeline isolation at very low water conditions to keep blowing debris and small animals from taking up residence.

#### *5. Oxbow Reservoir Diversion Screens*

New fish screens meeting NMFS/ODFW criteria will be installed on new intakes for Reservoirs 1 and 2. The primary concerns with the intakes will be accumulation of sediment or debris at the screens. The landowner/irrigator has indicated that sediment deposition in this reach is not typically an issue. However, to mitigate potential sediment deposition concerns, the elevation of the intake gates at the fish screens has been elevated a minimum of 12 inches above the bottom of the spillway opening at the dam. The concrete structures housing the fish screens have also been designed with control gates to allow them to be isolated from the reservoir, allowing for the use of a portable trash pump to clean out any sediment which may accumulate over time or following very high-water events.

It will be the responsibility of the landowner to periodically inspect and maintain the fish screens to ensure that they are functioning properly and do not become plugged. The landowner will have a vested interest in ensuring the screens are maintained to ensure irrigation deliveries.

#### *6. In-Channel Modifications*

We recommend that any potential upstream improvements be considered as part of a separate project.

## **1.6 Description of disturbance including timing and areal extent and potential impacts associated with implementation of each element.**

### *1. Vertical Slot Fishway and Dam Modifications*

The fishway and dam modifications, including construction of the new spillway and gate, will be constructed on the left bank near the location of the existing fishway. The required disturbance area will be approximately 25,000 square feet.

The in-water work on the dam and fishway will begin at the start of the in-water work window, with the first step including the installation of a cofferdam, temporary fishway, and bypass pipe in the forebay. This will allow the reservoir to be used throughout the irrigation season while excavating and dewatering for the construction of the new fishway and spillway. Additional information regarding temporary fish passage during construction is included in the Temporary Fish Passage Plan (see Appendix 7.8)

The construction of the spillway and fishway may extend beyond October 15, requiring an extension to work outside of the approved in-water work window. Preliminary schedule estimates indicate that construction of the fishway and spillway, including concrete curing and earth backfill, may take as long as November 15 to complete.

### *2. Pump Stations*

The new pump station at the dam will be constructed along the left bank. Most of the construction will occur within the existing levee footprint and be connected to the channel near the left dam abutment. The disturbance area to construct the pump station and intakes from Reservoirs 1 and 4 will be approximately 30,000 square feet. The work in the channel will be completed outside of the irrigation season, requiring a variance to the in-water work window.

The new pump station at Booth Lane will be constructed along the left bank near the existing pump station. The construction will occur between the channel and the road and be primarily confined to a footprint similar in size to the existing condition. The disturbance area to construct the new pump station will be approximately 17,500 square feet. The work in the channel will be completed outside of the irrigation season, requiring a variance to the in-water work window.

### *3. Off-Channel Reservoir Connections*

The connections between Reservoirs 1, 2 and 3 are all outside of the Catherine Creek channel. The disturbance area to construct the reservoir connections will be approximately 156,500 square feet. Approximately 90 percent of this disturbance will occur on lands subject to ongoing disturbance due to agricultural operations.

### *4. Oxbow Reservoir Diversion Screens*

The new off-channel reservoir fish screens will be constructed on the left bank near the existing oxbow intakes. The disturbance area to construct the new fish screens will be approximately 10,000 square feet each, or a total of 20,000 square feet. The work in the channel will be completed outside of the irrigation season, requiring a variance to the in-water work window.

## *5. Shoreline Modifications*

We recommend that any potential instream habitat improvements be considered as part of a separate project.

## **2.0 Resource Inventory and Evaluation**

### **2.1 Description of past and present impacts on channel, riparian and floodplain conditions.**

Catherine Creek is a snowmelt-dominated hydrologic system with a watershed that drains part of the Wallowa Mountains. As a result of channel relocation and realignment efforts in the 1950s, the project reach is situated within the former Grande Ronde River channel. This reach is comprised of a very low gradient, oversized channel with hydraulic characteristics that are controlled, in part, by backwater effects from the Grande Ronde River.

The Catherine Creek channel upstream of Elmer Dam has been over-widened and deepened to accommodate reservoir storage. In addition to the on-channel reservoir storage, the landowner uses abandoned meanders from the historic Grande Ronde channel to store irrigation water collected during high flows. The connection between the meanders and the main channel consists of buried pipes with tide gates on each end. The tide gates in the channel are opened during high flows, filling the meanders. The tide gates can then be manipulated during the irrigation season allowing them to either pump out of the meander directly or pass water back into the on-channel reservoir. The meanders also provide a recreational benefit to the landowner including swimming and fishing holes. Because the meanders get very warm in the summer, they provide habitat for warm water predatory fish which may be a nuisance if released into Catherine Creek.

Significant time and resources have been invested in Catherine Creek over the last several years, including habitat improvement work in the upper watershed. To maximize this investment, it is critical to facilitate upstream and downstream fish passage to and from these areas. Elmer Dam has been identified as an impediment to upstream and potentially downstream fish passage.

Due to the low velocities in the reservoir, channelized nature of the stream with levees on both banks, and warm water temperatures in the summer, the reach upstream of the dam is not conducive for the residence of the target species.

### **2.2 Instream flow management and constraints in the project reach.**

Flow in this reach is controlled by the operation of the Elmer Dam at the downstream end of the reach, and the Davis Dam upstream of this reach. The landowner operates one pump station located adjacent to the Elmer Dam and a second pump station located upstream at Booth Lane.

During high flows, water is diverted to the off-channel oxbow reservoirs where it is stored for irrigation and recreational use.

### **2.3 Description of existing geomorphic conditions and constraints on physical processes.**

Catherine Creek in this reach is located within the channelized remnants of the historic Grande Ronde River channel. The reach has been heavily modified by straightening, widening, and deepening the historic channel and is characterized as a low gradient, low velocity channel controlled by dams upstream and downstream of the reach.

### **2.4 Description of existing riparian condition and historical riparian impacts.**

The levees and channelized nature of this reach provides very little quality riparian habitat.

### **2.5 Description of lateral connectivity to floodplain and historical floodplain impacts.**

This reach is dominated by levees on both sides and agricultural land outside of the levees. The majority of the historic meanders and floodplain have been developed into agricultural land.

### **2.6 Tidal influence in project reach and influence of structural controls (dikes or gates).**

Not applicable.

## **3.0 Technical Data**

### **3.1 Incorporation of HIPIV specific Activity Conservation Measures for all included project elements.**

Habitat Improvement Program (HIP) IV draft conservations measures are included in the plan set and are part of the design considerations.

### **3.2 Summary of site information and measurements (survey, bed material, etc.) used to support assessment and design.**

The Project Team met with TU, USWCD, and the landowner for a site visit and kickoff meeting on June 18, 2020. At this site visit we discussed the operation of the farm, including the dam and the irrigation systems, as well as the concerns of the landowner. In addition, we conducted a review of the available survey data and a geomorphic field survey of the project reach with an emphasis on the dam location and points of diversion. We completed a review of the existing information from the USBR (2012) assessment and data acquired from the geomorphic survey within the context of understanding channel response to modifications of the dam structure and points of diversion. This evaluation included an analysis of the longitudinal profile, planform pattern, cross-section dimensions, cross-section hydraulics, riverbed and riverbank materials, and sediment transport conditions.

The following sources of topographic survey data were available and utilized for the design.

- Confederated Tribes of the Umatilla Indian Reservation Survey dated November 2019 of the Catherine Creek channel extending from approximately 850 feet upstream and downstream of Elmer Dam.
- Bureau of Reclamation Survey dated September 3, 2010 including Elmer Dam and appurtenant structures plus Catherine Creek floodplain data adjacent to the project reach.
- Telek Engineering as-built survey data dated November 18, 1973 for Reservoir 4 (Catherine Creek) extending from Elmer dam upstream approximately 54,000 feet.
- Detailed Quadrant Consulting topographic survey of Elmer Dam, the pump station sites, the oxbow reservoir intake locations, and the off-channel reservoir connection alignments.

Grande Ronde Basin Topobathymetric LiDAR collected by NV5 Geospatial in August 2020 under contract to the Columbia River Inter-Tribal Fish Commission.

### **3.3 Summary of hydrologic analyses conducted, including data sources and period of record including a list of design discharge (Q) and return interval (RI) for each design element.**

The U. S. Bureau of Reclamation (USBR) has completed recent analyses of Catherine Creek hydrology as part of a tributary assessment (USBR, 2012a) and reach assessment (USBR, 2012b). Elmer Dam is located at river mile (RM) 13.1 within Reach 1, as delineated by USBR.

USBR estimated a range of annual peak discharge magnitudes corresponding to a range of annual return periods. The discharge estimate location that applies to the Elmer Dam reach is identified by USBR as “Catherine Creek below Eckesley Creek” at RM 15.3 (Table 5 in USBR 2012b) or RM 15.8 (Table 8 in USBR 2012a). These peak discharge estimates are summarized in Table 3-1.

Table 3-1. Peak flow estimates for Elmer Dam reach. Q<sub>x</sub> is the discharge magnitude (cfs) corresponding to the return period (x) in years.

Location	Q1.05	Q1.5	Q2	Q5	Q10	Q25	Q50	Q100	Q500
Catherine Creek below Eckesley Creek (RM 15.3 – 15.8)	1,099	1,763	2,078	2,854	3,356	3,985	4,450	4,909	5,975

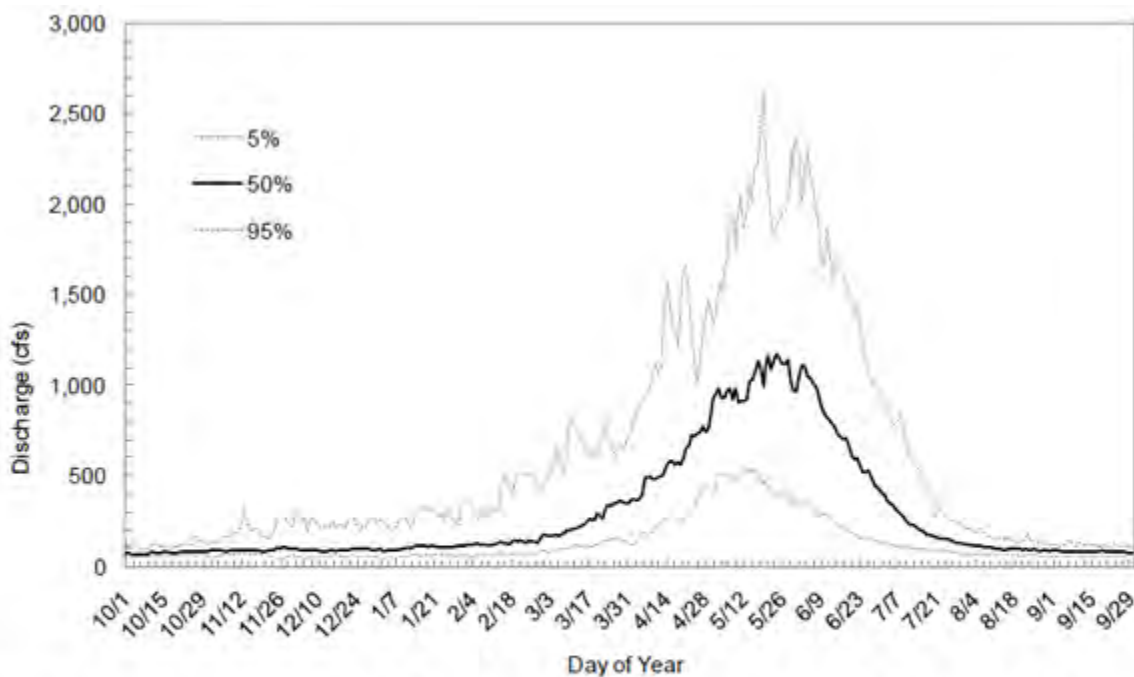
The above flow estimates were utilized by the design team for hydraulic model calibration and to assess project performance at high flow conditions.

In the absence of a more rigorous data analysis, design flows for fish passage analysis purposes (95<sup>th</sup> percentile to 5<sup>th</sup> percentile flows) were based on USGS StreamStats flow-duration statistics for the period of record (1912 – 1996) at the Catherine Creek near Union gage (USGS #13320000) at RM 36.5. This data identified a 95<sup>th</sup> percentile flow rate of 20 cfs and a 5<sup>th</sup> percentile flow rate of 449 cfs.

USBR estimated mean daily exceedance flows for Catherine Creek at the confluence with the Grande Ronde River (USBR, 2012a). The data used for the estimated flows do not account for

most water withdrawals and therefore overestimate July through October flows. Significant water withdrawals occur downstream of the “Catherine Creek near Union” stream flow gage, such that estimated September 95% exceedance flows are less than 2 cfs in the Elmer Dam reach (USBR, 2012a).

Based on professional judgment with respect to the USBR estimated mean daily exceedance flows (Figure 12 in USBR 2012a and shown below), the time period of interest for the project design corresponds to the post-peak runoff during the irrigation period, which is approximately from June 7 to October 1. Using the mean daily 50th percentile exceedance flow estimates, the fish passage design discharges of interest should fall within the range of approximately 20 cfs to 800 cfs (Figure 3-1). Therefore, the 95<sup>th</sup> to 5<sup>th</sup> percentile design flow range of 20 cfs to 449 cfs appears to be reasonable and appropriate.



**Figure 12.** Estimated mean daily flow percent exceedance values for Catherine Creek at the confluence with the Grande Ronde River. Note – the data used to extrapolate this graph are from the Catherine Creek near Union (13320000) stream gage and the data do not account for all water withdrawals, and therefore, overestimate July through October flow. The 50 percent value represents an average annual hydrograph.

Figure 3-1. Estimated mean daily flow exceedance values from USBR (2012a)

### **3.4 Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design.**

Due to the low gradient of the stream and the relatively large reservoir, sediment accumulation has not historically been an issue at this location.

### **3.5 Summary of hydraulic modeling or analyses conducted and outcomes – implications relative to proposed design.**

A two-dimensional (2D) hydraulic model of the project reach was developed extending from approximately 1 river mile downstream of Elmer Dam to 3.75 river miles upstream of Elmer Dam. The underlying topography was a combination of 2021 LiDAR data and the detailed survey data referenced in Paragraph 3.2. The 2D hydraulic model was calibrated to the USBR one-dimensional (1D) hydraulic model referenced in USBR 2012a at the Q1.05 and Q100 flow events. The calibration effort indicated that water surface elevations, in-stream velocity, and floodplain inundation extents are heavily influenced by backwater effects from the Grande Ronde River at flows equal to or exceeding the Q1.05 event (1,099 cfs). Due to the backwater effects, the forebay and tailwater elevations at Elmer Dam with the spillway gates open are nearly equal in elevation with a maximum elevation differential of approximately 0.2 feet and a negligible increase in velocity. Upstream fish passage under these flow conditions will predominately occur through the dam spillway openings. Critical infrastructure elevations (primarily electrical components for the pump stations) have been set at or above the predicted Q100 water surface elevations.

Hydraulic performance within the 5<sup>th</sup> to 95<sup>th</sup> percentile design flow range was analyzed using a subset of the 2D hydraulic model developed for the Q1.05 and larger flow events. The overall model extents were reduced to a project reach extending from approximately 400 feet downstream to 900 feet upstream of Elmer Dam. The modeled reach was shortened to coincide with the detailed on-the-ground survey extents completed by Quadrant staff and others as the 5<sup>th</sup> to 95<sup>th</sup> percentile flows are fully contained within the banks of Catherine Creek, eliminating the need to use the LiDAR based floodplain data in the analysis. Shortening the model extents also served to reduce the model run times from over 18 hours per iteration for flows at or above the Q1.05 event to less than 2 hours per iteration to allow for more detailed analysis of the proposed dam and fishway modifications within the design flow range.

Detailed fishway performance was modeled between the 95<sup>th</sup> percentile flow rate of 20 cfs and the 5<sup>th</sup> percentile flowrate of 450 cfs based on the assumption that the fishway will be operated to maintain the typical maximum operating forebay water surface elevation of 2683.0 (1-foot below top of dam crest). Based on this assumption, the maximum flow rate conveyed by the fishway will be approximately 29 cfs. Therefore, at in-river flow rates below approximately 30 cfs, 100 percent of available flow will be conveyed by the fishway. At in-river flow rates between 30 cfs and 450 cfs, the percentage of total flow in the fishway will vary between 100 percent at the low end and approximately 6 percent at the high end.

Specific details related to fishway performance at a range of operating conditions as developed from the hydraulic modeling effort are provided in Table 1-1.

### **3.6 Stability analyses and computations for project elements, and comprehensive project plan.**

The current dam configuration includes a small riprap buttress on the left side of the spillway which will be removed for the installation of the auxiliary spillway and new fishway. This buttress

is currently 2-4 feet thick and does not provide significant resistance to the sliding or uplift of the dam.

A new spillway wall will be constructed adjacent to and connected to the existing left spillway wall. The new wall will provide additional mass, as well as provide space for the embedded steel elements required for the tilting weir gate. The fishway will be constructed on the left side of the spillway, providing significant mass to resist sliding.

The combined spillway pier between the existing and the new spillways was analyzed based on the tributary area from each spillway. The pier is supported by a concrete apron, concrete cutoff wall on the downstream side of the dam, and a vinyl sheet pile cutoff wall on the upstream side of the dam. In addition, the apron will act as a diaphragm, transferring some of the shear force on the pier and gate to the fishway.

The 20-ft vinyl sheet piles were designed to lengthen the seepage path and to reduce the uplift pressures on the spillway apron. The seepage analysis and stability analysis were based on the FERC Engineering Guidelines for the Evaluation of Hydropower Projects, Chapters 3 – Gravity Dams, and 10 – Other Dams (<https://www.ferc.gov/industries-data/hydropower/dam-safety-and-inspections/eng-guidelines>). The weighted creep ratio for the proposed spillway is 4.36. This exceeds the recommended thresholds for soft clay (3.0), medium clay (2.0), and sand, silt and >15% clay (4.0).

The center of gravity for the normal operating condition is maintained in the middle one-third of the spillway apron. The combined sliding resistance of the pier, spillway apron, and fishway provides a factor of safety greater than 1.5 for the normal operating condition.

The new spillway walls and aprons will be connected to the existing spillway and new fishway with dowels, ensuring that the new dam configuration results in a stable structure.

### **3.7 Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation.**

The U. S. Bureau of Reclamation (USBR) completed an analysis of Catherine Creek hydrology as part of a tributary assessment (USBR, 2012a) and reach assessment (USBR, 2012b). Elmer Dam is located at river mile (RM) 13.1 within Reach 1, as delineated by USBR.

The hydrology and hydraulic model developed by the USBR was used as a basis for 2D hydraulic model calibration for the 80% design.

**3.8 For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation.**

The Elmer Dam spillway and fishway will be modified to improve fish passage, but the hydraulic performance of the dam will not change in a manner which will affect the channel stability.

**3.9 For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.**

The Elmer Dam spillway and fishway will be modified to improve fish passage, but the hydraulic performance of the dam will not change in a manner which will affect the channel stability.

## **4.0 Construction – Contract Documentation**

### **4.1 Incorporation of HIPIV General and Construction Conservation Measures**

Habitat Improvement Program (HIP) IV draft conservations measures are included as sheets in the plan set and are part of the design considerations.

### **4.2 Design – construction plan set including but not limited to plan, profile, section and detail sheets that identify all project elements and construction activities of sufficient detail to govern competent execution of project bidding and implementation.**

Construction drawings are included in Appendix 7.1.

### **4.3 List of all proposed project materials and quantities.**

Quantity summaries and the engineer's opinion of probable construction costs (EOPCC) are included in Appendix 7.6.

### **4.4 Description of best management practices that will be implemented and implementation resource plans including:**

#### *1. Site Access Staging and Sequencing Plan*

The entire project is located within the 100-year floodplain. With the exception of the instream and riparian areas, the majority of the project locations consist of previously disturbed agricultural lands. The site access roads and staging areas will be located on existing farm access roads or

adjacent agricultural lands beyond the primary channel. The final stockpile and staging locations will be negotiated between the Contractor and the landowner outside of the Catherine Creek channel.

### *2. Work Area Isolation and Dewatering Plan*

It is proposed that the work be completed in two stages. The first stage will be the installation of the new intakes at Elmer Dam (Reservoir 1 and 4), Booth Lane (Reservoir 4), and the new Oxbow intake. The new wet wells and intake screens will be installed behind contractor designed cofferdams and will conform to the HIP IV draft conservation measures included in the plans and specifications. This work will be completed outside of the normal irrigation season (presumably November – March) and will require a variance to the in-water work window. The existing pumps will then be relocated to the new wet wells and connected to the existing irrigation system after the conclusion of the irrigation season.

The second stage will occur primarily during the second in-water work window (summer/fall), potentially requiring an extension to the in-water work window. During this period the new pump stations will be used for the operation of the farm, allowing the dam area to be dewatered for the construction of the new fishway and auxiliary spillway. The conceptual cofferdam and dewatering plan is shown on the drawings in Appendix 7.1 and the Temporary Fish Passage Plan in Appendix 7.8. A new sheet pile cofferdam and temporary fishway will be installed upstream of the dam, then a smaller cofferdam, presumably utilizing gravel bags, portadams, or a similar system will be installed in the tailrace. The dewatering and fish salvage will meet the requirements of the HIP IV draft conservation measures included in the plans and specifications.

Additional details regarding the dewatering plan and fish passage during construction are included in the Temporary Fish Passage Plan in Appendix 7.8.

### *3. Erosion and Pollution Control Plan*

The erosion and sediment control requirements are shown in the plans in Section 7.1 and will conform to the HIP IV draft conservation measures.

### *4. Site Reclamation and Restoration Plan*

Following construction of the intakes and fishway, the stream bank will be re-contoured to match the existing channel and hydroseeded with an approved seed mix. The access roads will be restored to equal or better condition than the existing access road, and the agricultural ground will be reseeded or prepared as requested by the landowner.

### *5. List proposed Equipment and Fuels Management Plan*

The project is located entirely within the 100-year floodplain. Equipment will be staged and refueled at least 150-feet from surface waters. Any equipment in the water will need to use biodegradable hydraulic fluids, as outlined in the HIP IV Programmatic requirements. Contractor will supply a spill containment kit and control plan. All other permit requirements will be used.

#### 4.5 Calendar schedule for construction/implementation procedures.

Funding and scheduling options are still be evaluated, but Table 4-1 includes the most recent draft procurements and construction schedule.

Table 4-1. Vertical Slot Fishway Performance

Task	Duration	Comments
Complete Design and Apply for Funding	Fall 2022	Pending Agency Approval
Advertise and Bid - Intakes and Diversions	Winter 2022/2023	Project may be bid as one 2-year project, or two 1-year projects
Procurement and Mobilization - Intakes and Diversions	Winter 2022/2023	
Construction - Intakes and Diversions	Winter/Spring 2023	Preferably outside of the irrigation season to minimize cofferdam & dewatering requirements
Connect New Intakes to Irrigation System	Spring 2023	
Advertise and Bid - Fishway and Spillway	Winter 2022/2023	
Procurement and Mobilization - Fishway and Spillway	Spring 2023	
Construction - Fishway and Spillway	July 1 - Nov 15, 2023	May require in-water work extension
Commissioning & Startup - Fishway and Spillway	Fall/Winter 2023	

#### 4.6 Site or project specific monitoring to support pollution prevention and/or abatement.

The Contractor will be working closely with the project sponsors, TU and USWCD, to carefully implement the project. Turbidity monitoring, following HIP IV protocols, will be in place at all locations where excavation is to occur.

The contractor will provide a spill containment and control plan, including a description of any hazardous products or material that will be used for the project as well as procedures for inventory, storage, handling, and monitoring. The plan will also identify notification procedures, specific clean up and disposal instructions for different products available on the site, proposed methods for disposal of spilled material, and employee training for spill containment. Additionally, if a Low Erosivity Waiver is not appropriate for the site, the contractor will prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) outlining erosion and sediment control measures in accordance with the EPA's General Construction Permit.

## 5.0 Monitoring and Adaptive Management

The project sponsors, TU and USWCD, will be on site during construction ensure the project is implemented as designed and permitted. Photo points will be taken before, during, and after construction and structures will be evaluated for functionality at least annually.

## 6.0 References

Atlas Technical Consultants, LLC. Geotechnical Investigation, Elmer Dam Renovations, May 19, 2021.

Federal Energy Regulatory Commission (FERC), Engineering Guidelines for the Evaluation of Hydropower Projects, <https://www.ferc.gov/industries-data/hydropower/dam-safety-and-inspections/eng-guidelines>

U.S. Bureau of Reclamation (USBR). 2012a. The Catherine Creek Tributary Assessment, Grande Ronde River Basin, Appendix A: Hydrology Report. Boise, ID. 50 p.

U.S. Bureau of Reclamation (USBR). 2012b. Catherine Creek Reach Assessment 1 and 2 Hydraulics. Report SRH-2013-04. Denver, CO. 135 p.

## 7.0 Appendices

See the following appendices for additional information

- 7.1 Project Plan Sheets
- 7.2 Project Specifications
- 7.3 Hydraulic Model Exhibits
- 7.4 Geotechnical Investigation
- 7.5 Spillway Seepage and Stability Analysis
- 7.6 Quantities and Engineer's Opinion of Probable Construction Costs (EOPCC)
- 7.7 HIP Review Comments and Responses
- 7.8 Temporary Fish Passage Plan

**Appendix 7.1**  
**Project Plan Sheets**

## **Appendix 7.2**

### **Project Specifications**

# Elmer Dam Fishway Modifications Project

## Technical Specifications Issued For Construction



RENEWALS: 12/31/23



Prepared For: Trout Unlimited/Union Soil &  
Water Conservation District

Prepared By: River Structures Consulting,  
Inc

Quadrant Consulting, Inc

June 2022

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## **SECTION 00 01 10 – TABLE OF CONTENTS**

### **TROUT UNLIMITED/UNION SWCD ELMER DAM MODIFICATIONS TECHNICAL SPECIFICATIONS**

#### **Division 02 – Sitework**

- Section 02 22 00 – Site Condition Surveys
- Section 02 41 00 – Demolition, Salvage, and Rehabilitation

#### **Division 03 – Concrete**

- Section 03 30 00 – Cast-In-Place Concrete
- Section 03 60 00 – Grout

#### **Division 05 – Metals**

- Section 05 50 00 – Miscellaneous Metalwork

#### **Division 31 – Earthwork**

- Section 31 11 00 – Site Preparation
- Section 31 22 19 – Soil Preparation and Seeding
- Section 31 23 18 – Dewatering
- Section 31 30 00 – Earthwork
- Section 31 35 00 – Erosion and Sediment Control
- Section 31 37 00 – Riprap

#### **Division 35 – Waterway and Marine Construction**

- Section 35 20 18 – Fabricated Slide Gates
- Section 35 20 90 – Fabricated Tilting Weir Gate

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## **SECTION 02 22 00 - SITE CONDITIONS SURVEYS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs and video tape recordings.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Videotape surveys, photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.
- B. Except as otherwise indicated, post-construction topographic mapping shall be submitted to the ENGINEER within 60 days of completing WORK.
- C. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### **3.1 PHOTOGRAPHS AND VIDEO RECORDINGS**

- A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing videotape surveys of the following:
  - 1. Roadways used to access the Site or haul materials and equipment to the Site.
  - 2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
  - 3. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
  - 4. Driveways, sidewalks, and buildings which might be affected by the WORK.
- B. Supplement videotape surveys with photographs and spot elevation surveys as required to thoroughly document the original condition and location of existing features and facilities.

- END OF SECTION -

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## SECTION 02 41 00 – DEMOLITION, SALVAGE, AND REHABILITATION

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall demolish and reconstruct existing civil, landscaping, structural, architectural, and mechanical facilities as indicated, in accordance with the Contract Documents.

#### 1.2 COORDINATION

- A. The CONTRACTOR shall carefully coordinate the WORK in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown.
- B. The CONTRACTOR shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of WORK as much as possible. Prior to bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of auxiliary utilities.
- C. While demolition and reconstruction are being performed, the CONTRACTOR shall provide adequate access for the continued operation and maintenance of the facilities. The CONTRACTOR shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the CONTRACTOR's employees and the OWNER's personnel at the plant. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the ENGINEER.

#### 1.3 CONTRACTOR SUBMITTALS

- A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the ENGINEER for approval. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

#### 1.4 DEMOLITION

- A. Existing pavement, structures, equipment, piping, valves, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part

of the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.

#### 1.5 EXISTING LEAD BASED COATING SYSTEMS

- A. It is unknown whether the existing coating systems at the project site, including those that are utilized on the existing miscellaneous metal and hand-rail systems, are lead-based paint (LBP) coatings or not. The CONTRACTOR shall conduct all of the demolition and disposal work in accordance with all local, state, and federal laws and regulations.

#### 1.6 REHABILITATION

- A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated.
- B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

#### 1.7 DISPOSAL

- A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### 3.1 GENERAL

- A. The CONTRACTOR shall coordinate demolition and reconstruction WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.
- B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.
- C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

#### 3.2 PROTECTION OF EXISTING FACILITIES

- A. Before beginning any reconstruction, the CONTRACTOR shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent

of reconstruction and coordination with the WORK. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with the contract requirements. Damaged existing facilities shall be repaired to the previous condition or replaced.

- B. Persons shall be afforded safe passages around areas of demolition.
- C. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.
- D. The CONTRACTOR shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the CONTRACTOR shall consult with the ENGINEER prior to the placement of such equipment or material.

### 3.3 DEMOLITION, SALVAGE, AND RELOCATION

- A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:
  - 1. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
  - 2. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
  - 3. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth which will not interfere with new construction, but not less than 24-inches below existing ground surface or future ground surface, whichever is lower.
  - 4. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 30 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

### 3.4 REHABILITATION

- A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.

### 3.5 DISPOSAL

- A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.
- B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.
- C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

### 3.6 OCCUPANCY AND POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.
- B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

### 3.7 CLEANING

- A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER or governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

- END OF SECTION -

## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide cast-in-place concrete, joints in concrete, reinforcement steel and appurtenant work, formwork, bracing, shoring, supports, and shall design and construct falsework, complete and in place, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with all contract documents.
- B. Shop Drawings
  - 1. Shop bending diagrams, placing lists, and drawings of reinforcing steel prior to fabrication.
  - 2. Details of the concrete reinforcing steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. Include bar placement diagrams which clearly indicate the dimensions of each bar splice.
  - 3. Where mechanical couplers are required or permitted to be used to splice reinforcing steel, submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.
  - 4. Manufacturer's information demonstrating compliance with requirements of the following:
    - a. Preformed joint filler
    - b. Bond breaker
    - c. Form ties and related accessories
    - d. Form gaskets
    - e. Form release agent
    - f. List of form materials and locations of use
    - g. Mill tests for cement

- h. Admixture certification. Chloride ion content shall be included.
    - i. Aggregate gradation test results and certification
    - j. Materials and methods for curing
  - 5. Placement drawings showing the location and type of joints for each structure.
- C. **Mix Designs:** Prior to beginning the WORK, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. The mix designs shall be checked by an independent testing laboratory acceptable to the ENGINEER. Costs related to such checking shall be the CONTRACTOR's responsibility. When a water reducing admixture is to be used, the CONTRACTOR shall furnish mix designs for concrete both with and without the admixture.
- D. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish certified delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring, and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amounts of water in the aggregate, added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each certificate shall state the mix number, total yield in cubic yards, and the time of day to the nearest minute, corresponding to the time when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

### 1.3 QUALITY CONTROL

#### A. Testing of Reinforcing Steel

- 1. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcing steel in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests, if material fails initial tests, shall be the CONTRACTOR's responsibility.

#### B. Testing of Materials

- 1. Tests on component materials and for compressive strength of concrete will be performed as indicated herein. Tests for determining slump will be in accordance with the requirements of ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- 2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness in accordance with ASTM C 33 - Concrete Aggregates.
- 3. The cost of laboratory tests on cement, aggregates, and concrete, will be paid by the OWNER. However, the CONTRACTOR shall pay the cost of any additional tests and investigations on WORK that does not meet the Specifications. The laboratory will meet or exceed the requirements of ASTM C 1077 - Standard Practice for

Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

4. Concrete for testing shall be furnished by the CONTRACTOR at no cost to the OWNER, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

C. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each class of concrete herein and at intervals thereafter as selected by the ENGINEER to insure continued compliance with these Specifications. Each set of test specimens will be a minimum of 4 cylinders.
2. Compression test specimens for concrete will be made in accordance with Section 9.2 of ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field. Specimens will be 6-inches diameter by 12-inches high cylinders.
3. Compression tests will be performed in accordance with ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinder will be held to verify test results, if needed.

D. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 318 - Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality", and as indicated herein.
2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.
3. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement as part of the WORK.

E. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so that the concrete is within the tolerances herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated. Where tolerances are not indicated, permissible deviations will be in accordance with ACI 117 - Standard Tolerance for Concrete Construction and Materials.

1. The variation from required lines or grades shall not exceed 1/4-inch in 10-feet and there shall be no offsets or visible waviness in the finished surface.

## PART 2 -- PRODUCTS

### 2.1 FORM AND FALSEWORK MATERIALS

- A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard.
  2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 - Construction and Industrial Plywood for Concrete Forms, Class I, and shall be edge sealed.
  3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade required. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
- B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to a 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

### 2.2 FORM TIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form-tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Removable taper ties may be used when approved by the ENGINEER.

### 2.3 REINFORCEMENT STEEL

- A. **General:** Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:
1. Bar reinforcement shall conform to the requirements of ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, for Grade 60 Billet Steel Reinforcement, unless otherwise indicated.
  2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement, and the details indicated. Welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10-inches. Welded wire fabric with longitudinal wires larger than W4 size shall be furnished in flat sheets only.

## B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.
2. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength than required for the concrete in which they are located. Where concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

## 2.4 CONCRETE MATERIALS

- A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.
- B. Materials for the WORK shall comply with the requirements of Sections 201, 203, and 204 of ACI 301- Structural Concrete for Buildings, as applicable.
- C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.
- D. Materials for concrete shall conform to the following requirements:
  1. Cement shall be standard brand portland cement conforming to ASTM C 150 - Portland Cement for Type II or Type V.
  2. Water shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.
  3. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as indicated. Lightweight sand for fine aggregate will not be permitted.
  4. Ready-mix concrete shall conform to the requirements of ASTM C 94 - Ready-Mixed Concrete.
  5. Air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining

agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement.

6. Admixtures: Admixtures may be added at the CONTRACTOR's option to control the set, affect water reduction, and increase workability. In either case, the addition of an admixture shall be at the CONTRACTOR's expense. The use of an admixture shall be subject to acceptance by the ENGINEER. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall conform to the requirements of ASTM C 494 - Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, shall be non-toxic after 30 Days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.
  - a. Concrete shall not contain more than one water-reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER.
  - b. Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
7. Calcium Chloride: Calcium chloride will not be permitted in concrete.

## 2.5 CURING MATERIALS

- A. Materials for curing concrete shall conform to the following requirements and ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete:
  1. Curing compounds shall be white-pigmented and resin-based. Sodium silicate compounds shall not be allowed. Curing compounds shall meet local VOC requirements.
  2. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 - Standard Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

## 2.6 JOINT MATERIALS

- A. Materials for joints in concrete shall conform to the following requirements:
  1. Joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and

Cork Expansion Joint Fillers for Concrete Paving and Structural Construction; for Type I, except as otherwise indicated.

2.7 MISCELLANEOUS MATERIALS

- A. Epoxy grout for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

2.8 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the OWNER. Mix changes shall be subject to review by the ENGINEER.
2. The CONTRACTOR is cautioned that the limiting parameters below are **NOT** a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability.

- B. **Water-Cement Ratio and Compressive Strength:** The minimum compressive strength and cement content of concrete shall be not less than the following tabulation.

Type of Work / Class of Concrete	Min 28-Day Compressive Strength, (psi)	Max Size Aggregate (inch)	Cement Content, (lbs/cu yd)	Max W/C Ratio (by weight)
Structural concrete	4,000	1	564 to 600	0.45
Lean concrete	2,000	1	376 (min)	0.60

2.9 CONSISTENCY

- A. Consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (inches)
All concrete unless indicated otherwise	2 to 4
Ductbank and pipe encasement	4 to 6

## 2.10 MEASUREMENT OF CEMENT AND AGGREGATE

- A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

## 2.11 MEASUREMENT OF WATER

- A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

## 2.12 READY-MIXED CONCRETE

- A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, placing, the supplementary requirements as required herein, and is in accordance with ASTM C 94.
- B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever comes first. In hot weather, under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.
- C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counter shall be actuated at the time of starting the mixer at mixing speed.
- D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
- E. Each batch of ready-mixed concrete delivered to the WORK shall be accompanied by a delivery ticket furnished to the ENGINEER in accordance with the requirements above.
- F. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

## PART 3 -- EXECUTION

### 3.1 GENERAL FORMWORK REQUIREMENTS

- A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and federal regulations. Design, construction, maintenance, preparation, and removal of forms shall be in accordance with ACI 347 - Guide to Formwork for Concrete and the requirements herein.
- B. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete.

### 3.2 CONSTRUCTION

- A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- B. **Construction Joints:** When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.
- C. **Form Ties**
  - 1. **Embedded Ties:** Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.
  - 2. **Removable Ties:** Where taper ties are approved for use, after the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast

neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink or regular cement grout. Exposed faces of walls shall have at least the outer 2-inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

### 3.3 REUSE OF FORMS

- A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view.

### 3.4 REMOVAL OF FORMS

- A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. Members which must support their own weight shall not have their forms removed until they have attained at least 75 percent of the 28-Day strength of the concrete. Forms for vertical walls and columns shall remain in place at least 48 hours after the concrete has been placed. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347.

### 3.5 GENERAL REINFORCEMENT REQUIREMENTS

- A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements indicated herein.

### 3.6 FABRICATION

#### A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the CONTRACTOR.
3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

- B. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner that will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

### 3.7 PLACING

- A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.
- B. The portions of accessories in contact with the formwork shall be made of concrete, plastic, or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.
- D. Bars additional to those indicated which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR as part of the WORK.
- E. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.
- F. The minimum spacing requirements of ACI 318 shall be followed for reinforcing steel.
- G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs. Slab bolsters shall be spaced not more than 30-inches on centers, shall extend continuously across the entire width of the reinforcing mat, and shall support the reinforcing mat in the plane indicated.
- H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

### 3.8 SPLICING

- A. **General:** Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be reviewed and accepted by the ENGINEER.
- B. Splices of Reinforcement
  - 1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.

2. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

### 3.9 CLEANING AND PROTECTION

- A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.
- B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and, if necessary recleaned.

### 3.10 PROPORTIONING AND MIXING

- A. **Proportioning:** Proportioning of the concrete mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.
- B. **Mixing:** Mixing of concrete shall conform to the requirements of Chapter 7 ACI 301.
- C. **Slump:** Slumps shall be as indicated herein.
- D. **Retempering:** Retempering of concrete or mortar which has partially hardened shall not be permitted.

### 3.11 PREPARATION OF SURFACES FOR CONCRETING

- A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. **Joints in Concrete:** Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the ENGINEER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, and foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- C. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent WORK; provided that construction joints shall be made only where acceptable to the ENGINEER.

D. Embedded Items

1. No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.
2. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated or by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

E. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days of age), the surface of the old concrete shall be thoroughly cleaned prior to the application of an epoxy bonding agent. Application shall be according to the bonding agent manufacturer's instructions and recommendations.

F. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the WORK. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to the review of the ENGINEER.

G. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

H. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided for during the placing of concrete.

I. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.

3.12 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section.

B. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete which is not placed in accordance with these Specifications or which is of inferior quality shall be removed and replaced.

- C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.
- D. **Placement in Wall and Column Forms**
1. Concrete shall not be dropped through reinforcement steel or into any deep form nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4-feet in walls and 8-feet in columns below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour.
  2. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces.
- E. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR'S conveying, hoisting, and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the required consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.
- F. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the required minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water, using ice, or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.

#### G. Cold Weather Placement

1. Placement of concrete shall conform to ACI - 306.1 - Cold Weather Concreting, and the following.
2. Earth foundations shall be free from frost or ice when concrete is placed upon or against them.
3. Maintain the concrete temperature above 50 degrees F for at least 72-hours after placement.

#### 3.13 PUMPING OF CONCRETE

A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

#### B. Pumping Equipment

1. The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.
2. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R - Placing Concrete by Pumping Methods.
3. Pumping equipment and hose conduits that are not functioning properly, shall be replaced.
4. Aluminum conduits for conveying the concrete shall not be permitted.

#### 3.14 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

B. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

### 3.15 FINISHING CONCRETE SURFACES

- A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.
- B. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects.
- C. **Unformed Surfaces (US):** After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Whenever the air temperature exceeds 85 degrees F or the wind speed exceeds 25 mph at the time of placement, the concrete shall be treated as follows. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each WORK operation as necessary to prevent drying shrinkage cracks. The classes of finish for unformed concrete surfaces are designated and defined as follows:
1. **Finish US1** - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
  2. **Finish US2** - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the ENGINEER.
  3. **Finish US3** - After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of irregularities.
  4. **Finish US4** - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.

D. Unformed surfaces shall be finished according to the following schedule:

<b>UNFORMED SURFACE FINISH SCHEDULE</b>	
<b>Area</b>	<b>Finish</b>
Grade slabs and foundations to be covered with concrete or fill material	US1
Slabs	US4
Top surface of walls	US3

3.16 CURING AND DAMPPROOFING

A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

<b>Surface to be Cured or Dampproofed</b>	<b>Method</b>
Unstripped forms	1
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
Concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Buried slabs and backfilled walls	5

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used, the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 4 below.

C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.

E. **Method 4:** The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.
2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.
3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms. Repairs required to be made to formed surfaces shall be made within the said 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.
5. During the curing period, no traffic of any nature and no depositing of any materials, temporary or otherwise, shall be permitted on surfaces coated with curing compound. Foot traffic and the depositing of materials may be allowed after 3 Days if the surface is covered with 5/8-inch plywood placed over polyethylene sheets.

F. **Method 5:** This method applies to both buried slabs and walls to be backfilled.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.
2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water through nozzles that atomize the flow so that the surface is not marred or washed.
3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. Edges shall be continuously held in place.
4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4 above.

6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.
7. Dampproofing: The exterior surfaces of buried roof slabs and backfilled walls shall be dampproofed as follows.
  - a. Immediately after completion of curing, the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated above.
  - b. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash
- G. The CONTRACTOR may submit alternate methods of curing which maintain the concrete in a continuously wet condition for acceptance by the ENGINEER.

### 3.17 PROTECTION

- A. The CONTRACTOR shall protect concrete against injury until final acceptance.
- B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

### 3.18 CURING IN COLD WEATHER

- A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.
- B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.
- C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 Days, 72 hour protection at a temperature not lower than 50

degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

- D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

### 3.19 TREATMENT OF SURFACE DEFECTS

- A. As soon as forms are removed, exposed concrete surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. Repairs and replacements shall be performed promptly.
- B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance or soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.
- C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
- D. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the requirements of this Section as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

### 3.20 CARE AND REPAIR OF CONCRETE

- A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, which becomes defective at any time prior to the final acceptance of the completed WORK, which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

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## SECTION 03 60 00 - GROUT

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents
- B. **Grout Types.** The following types of grout are covered in this Section:
  - 1. Non-Shrink Grout
  - 2. Epoxy Anchor Grout for Adhesive Anchors

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the contract documents.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

#### 1.3 QUALITY CONTROL

##### A. **Field Tests**

- 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.
- 2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 -

Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 30 00- Cast-in-Place Concrete, at intervals during construction selected by the ENGINEER.
4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes, Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.
5. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
6. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete, unless indicated otherwise.

#### 1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

##### A. **Manufacturer's Warranty**

1. Furnish one year warranty for WORK provided under this section.
2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

## PART 2 -- PRODUCTS

### 2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts and reinforcing steel.	Non-Shrink or Epoxy Anchor Brout
Beam and column base plates	Non-Shrink
Storage tanks and other non-motorized equipment	Non-Shrink

Application	Type of Grout
Pumps and motorized equipment	Non-Shrink
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Repair of holes and defects in concrete members	Non-Shrink
Any application not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise

## 2.2 NON-SHRINK GROUTS (cement-based)

### A. General

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
  - a. Minimum tensile splitting strength of 500-psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
  - b. Minimum flexural strength of 1000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
  - c. Minimum bond strength (concrete to grout) of 1900-psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
  - d. Grout shall be certified for use in freeze/thaw environments.
6. Non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7500-psi, when mixed at a fluid consistency.

7. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.
8. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
9. Non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
10. Non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
11. The grout when tested shall not bleed or segregate at maximum allowed water content.
12. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.

### 2.3 EPOXY ANCHOR GROUT

- A. Epoxy anchor grout shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class A, B and C, Grade 3 with the exception of gel time.
- B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.
- C. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.
- D. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
- E. Epoxy anchor grout shall be capable of being used in submersed applications once cured.
- F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
- G. Whenever possible, overhead anchors subject to vibration, anchors in fire-resistive construction or high fire risk areas, and anchors subject to working or operating temperatures above 100 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink grout and oversized holes.
- H. Unless specifically noted, embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.

## 2.4 CURING MATERIALS

- A. Curing materials shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete and as recommended by the manufacturer of prepackaged grouts.

## 2.5 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

## 2.6 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

## **PART 3 -- EXECUTION**

### 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

### 3.2 GENERAL

- A. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- B. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- C. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- D. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- E. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- F. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

### 3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. **Equipment, Tank, and Pipe Supports.** Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.
1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
  2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted for acceptance by the ENGINEER.
  3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.
- C. **Drilled Anchors and Reinforcing Bars**
1. General
    - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
    - b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.
  2. Epoxy Adhesive Anchors
    - a. Grout shall be proportioned and mixed with automatic equipment.
    - b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report.
    - c. Holes shall be dry.

### 3. Cement Based Non-Shrink Grout

- a. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report.
- b. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.
- c. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
- d. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

### 3.4 CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

### 3.5 CURING

- A. Cement based grouts shall be cured per Section 03 30 00 - Cast-in-Place Concrete and per the manufacturer's recommendations.

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## SECTION 05 50 00 - MISCELLANEOUS METALWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the contract requirements.

- B. **Shop Drawings**

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.
2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.
3. Grating
  - a. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, support seat angle and ledger details, and details of grating hold down fasteners.
  - b. Submit load and deflection tables for each style and depth of grating used.
4. Anchors
  - a. Submit an ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor.
  - b. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors.
  - c. Upon review by the ENGINEER, these instructions shall be followed specifically.
  - d. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

## PART 2 -- PRODUCTS

### 2.1 GENERAL REQUIREMENTS

#### A. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A 500 Grade B

#### B. Corrosion Protection

1. Unless otherwise indicated, miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

#### C. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

### 2.2 STEEL PIPE HANDRAILS

- A. Unless specifically noted otherwise, steel pipe handrails shall be standard 1.5-inch black steel pipe made up by welding, and shall be hot-dip galvanized after fabrication.

### 2.3 METAL GRATING

#### A. General

1. Metal grating shall be of the indicated design, size, and type.
2. Grating shall be supported around an opening by support members.
3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.
4. Banding
  - a. The grating shall be completely banded at edges and cutouts.
  - b. The banding material and cross-section shall be equivalent to the bearing bars.
  - c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support in two (2) locations.
6. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.
7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of ¼-inch or the span divided by 180, whichever is less.
8. Design Loading
  - a. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 600 pounds.

**B. Material**

1. Bar grating shall be fabricated from galvanized steel.
2. Plank grating shall be fabricated from galvanized steel.

**C. Bar Grating**

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.
2. Standard duty grating shall be composed of serrated bar grating.
3. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

**D. Safety Grating**

1. Safety grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections.
2. The open diamond shapes shall be approximately 1.875-inches by 11/16-inches in size.
3. Safety grating shall be **Grip Strut** by **Metal Products Division, United States Gypsum Company**, **Deck Span** by **IKG Industries**, or equal.

**E. Plank Grating**

1. Plank grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections.
2. The open diamond shapes shall be approximately 1.875-inches by 11/16-inches in size.

3. Plank grating shall be **Grip Strut**, or equal.

## 2.4 BOLTS AND ANCHORS

### A. **Standard Service (Non-Corrosive Application)**

1. Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be fabricated from carbon steel as indicated, and hot dip galvanized after fabrication.
2. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.
3. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following requirements:
  - a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized
  - b. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized
  - c. High-Strength Bolts, where indicated: ASTM A 325
  - d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

### B. **Corrosive Service**

1. Bolts, nuts, and washers in the locations listed below shall be fabricated from Type 316 stainless steel as indicated below, or as indicated otherwise on the Contract Drawings.
  - a. Buried locations
  - b. Submerged locations
  - c. Locations subject to seasonal or occasional flooding
  - d. Inside hydraulic structures below the top of the structure
  - e. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump
  - f. Locations indicated or designated by the ENGINEER to be provided with corrosion resistant steel bolts
2. **Stainless Steel Nuts on SS Bolts.** Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be fabricated from Type 316 stainless steel, Class 1, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.

### C. **Anti-seize Lubricant Coating**

1. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts.

2. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

**D. Bolt Requirements**

1. The bolt and nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts.
3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
4. Bolts and cap screws shall have hexagon heads and nuts.
5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.
6. The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

**2.5 Drilled Anchors in Concrete**

**A. General**

1. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.
2. No substitutions will be considered unless accompanied with an ICBO report verifying strength and material equivalency.
3. Expanding type anchors are not permitted unless specifically indicated otherwise in the Contract Documents.

**B. Epoxy Anchors**

1. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars.
2. Epoxy shall be in accordance with the requirements of Section 03 60 00 - Grout.
3. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.
4. Embedment depth shall be as the manufacturer recommends for the load to be supported.

**C. Non-Shrink Grouted Anchors**

1. Anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendations.

2. Embedment depth shall be as the manufacturer recommends for the load to be supported.

## **PART 3 -- EXECUTION**

### **3.1 FABRICATION AND INSTALLATION REQUIREMENTS**

#### **A. Fabrication and Erection**

1. Except as otherwise indicated, the fabrication of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

#### **B. Steel Railings**

1. Field welding of steel pipe handrail joints will be permitted only if approved by the ENGINEER, and then only in accordance with the ENGINEER's instructions.

### **3.2 WELDING**

#### **A. Methods & Qualifications**

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.
2. The qualification of the welders shall be in accordance with the AWS Standards.

#### **B. Quality**

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions.
2. Weld reinforcement shall be as indicated by the AWS Code.
3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.
5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

### **3.3 GALVANIZING**

- A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.

- B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.
- C. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.

**D. Field Repairs**

- 1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.
- 2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
- 3. The coating shall be applied to at least 3 mils dry film thickness.

**3.4 DRILLED ANCHORS**

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.
- C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- END OF SECTION -

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## SECTION 31 11 00 - SITE PREPARATION

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. In its initial move onto the Site, the CONTRACTOR shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

#### 1.2 SITE INSPECTION

- A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and facilities delineating the OWNER's property and right-of-way lines.

### PART 2 -- PRODUCTS (NOT USED)

### PART 3 -- EXECUTION

#### 3.1 PRIMARY SITE ACCESS

- A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.
- B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

#### 3.2 CLEARING, GRUBBING, AND STRIPPING

- A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.
- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

- C. The entire area to be affected by construction shall be stripped and the stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.
- D. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary, for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.

### 3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

- A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require over excavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site.

- END OF SECTION -

## SECTION 31 22 19 – SOIL PREPARATION AND SEEDING

### PART 1 -- GENERAL (NOT USED)

### PART 2 -- PRODUCTS

#### 2.1 MATERIALS

- A. Native seed mix shall be proposed by the CONTRACTOR for approval by Trout Unlimited, Union Soil and Water Conservation District, and the landowner prior to acquisition.
- B. Separate seed mixes will be required for shoreline/riparian applications and areas above the stream banks.

### PART 3 -- EXECUTION

#### 3.1 SEEDING PREPARATION

- A. All disturbed ground shall be prepped for seeding by CONTRACTOR. Organic layer/topsoil shall be placed in a manner to provide a loose layer (uncompacted) of organic material. The Owner may require the CONTRACTOR to rip to a minimum depth of 6 inches any area that is over compacted during placement or by construction traffic.
- B. Whenever feasible, CONTRACTOR shall take care to minimize the number of times the organic layer is handled and make every attempt to place it with the root side down.

#### 3.2 SEEDING

- A. All disturbed ground shall be prepped and seeded by the CONTRACTOR.
- B. Seeds are to be broadcast by hand or with a rotary spreader mounted.
- C. Seeds are to be pressed into the soil surface with a drum roller or similar.
- D. Seeding shall be performed immediately following completion of earthwork.

- END OF SECTION -

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## SECTION 31 23 19 - DEWATERING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section.
- B. Dewatering plans shall conform to all of the requirements of the project plans, specifications, permits, and all local, state and federal regulations.
- C. Conceptual cofferdam plans and details are included in the project plans. These drawings are provided for permitting and agency concurrence, and to provide the CONTRACTOR with an initial concept. It is the CONTRACTOR's responsibility for fully design the cofferdams and dewatering systems in conformance with all project permits and legal requirements.
  - 1. The forebay cofferdam and fishway shall be operable for a range of forebay water surface elevations from 2683-feet to 2675.5-feet.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed dewatering plan and operation schedule for dewatering of excavations. The CONTRACTOR shall specify the proposed materials and equipment, and shall verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times.
  - 1. The CONTRACTOR's dewatering plan is subject to review and approval by the ENGINEER.
- B. Structural cofferdam calculations shall be Stamped and Signed by a Professional Engineer licensed in the State of Oregon, and shall be submitted to the ENGINEER for approval.
- C. A geotechnical investigation has been conducted for the permanent structure locations and will be provided upon request.

#### 1.3 QUALITY CONTROL

- A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. It shall be the sole responsibility of the CONTRACTOR to ensure that the cofferdams and dewatering system is installed and operated in accordance with the approved submittals, and all applicable permits, laws and regulations.

- C. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.
- D. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, the responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

## **PART 2 -- PRODUCTS**

### **2.1 COFFERDAMS**

- A. The cost for the design, installation, and removal of the cofferdams are the responsibility of the CONTRACTOR.
- B. It is the CONTRACTOR's responsibility for fully design the cofferdams and dewatering systems in conformance with all project permits and legal requirements.
  - 1. The forebay cofferdam is anticipated to consist of driven sheet pile to maintain the reservoir elevation during the irrigation season, while providing for upstream and downstream fish passage and maintaining in-river flows as required by the State.
  - 2. The tailrace cofferdam is anticipated to consist of gravel bags, super sacks, portadams, or a similar cofferdam system to keep stream flow in the channel while isolating the work areas.
  - 3. The intake, pump station, and any other cofferdams shall be determined by the CONTRACTOR
  - 4. The cofferdam design and installation shall conform to all of the requirements of the conservation measures required by the plans and contract documents.

### **2.2 EQUIPMENT**

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. All instream work shall occur within the in-water work window of July 1 through October 15, or as specifically identified in the contract documents. In the event that conflicting dates are identified for the in-water work window, the CONTRACTOR shall request clarification from the project sponsors as soon as the discrepancy is identified.

### 3.2 COFFERDAMS

- A. Cofferdams are required for dewatering. The design, installation, and removal of the cofferdams are the responsibility of the CONTRACTOR.
- B. Coordination with the project sponsors and landowner will be required during the installation of the cofferdam and dewatering, including the timing and sequence of the installation and removal of the cofferdams, fish salvage, and disposal of the water.
- C. The cofferdam design and installation shall conform to all of the requirements of the conservation measures required by the plans and contract documents.

### 3.3 DEWATERING

- A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment.
- B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.
- C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.
- F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sand packed and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

- I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.
- J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.
- K. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms, unless a separate bid item has been established for dewatering.

- END OF SECTION -

## SECTION 31 30 00 - EARTHWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit samples of materials proposed for the WORK in conformance with the requirements of the contract documents. Sample sizes shall be as determined by the testing laboratory.

### PART 2 -- PRODUCTS

#### 2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

##### A. General

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.
2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

##### B. Suitable Materials

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.
2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.
4. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.
5. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

- C. **Types of Suitable Materials.** The following types of suitable materials are defined:

**Type C (Civil Fill) (Not for use beneath concrete foundations):** Civil Fill may consist of imported materials or natural on-site materials. Civil Fill may be a combination of Type AS material, Type GF, or Type SF material, or any readily compactible mixture thereof.

**Type DRC (Drain-rock Coarse):** Crushed rock or gravel meeting the following gradation requirements.

Sieve Size	Percentage Passing
2-inch	100
1-1/2 inch	90 - 100
1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

**Type DRG (Drain-rock Graded):** Drain-rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The drainrock shall have a sand equivalent value greater than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4-inch	90 – 100
3/8-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

The finish graded surface of the drain rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

**Type GF (Granular Fill 3/4-inch minus):** Angular crushed rock, stone or gravel, and sand conforming to the requirements listed below. Do not use pea gravel as granular backfill: The material shall have a maximum liquid limit of 35 and a maximum plasticity index of 10. The material shall have a sand equivalent value greater than 75. (This material is also known as Class I crushed stone.)

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 6

**Type SF (Structural Fill / Foundation Base):** Crushed rock structural fill material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for fill material required beneath concrete foundations. At the option of the CONTRACTOR, the grading for either the 1-1/2 inch maximum size or 3/4-inch maximum size gradation may be used material beneath concrete foundations. The sand equivalent value shall be greater than 22. The material shall meet the following gradation requirements:

Sieve Size	Percentage Passing	
	1-1/2 inch Max Gradation	3/4-inch Max Gradation
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	81 - 91	90 – 100
No. 4	43 - 53	55 – 67
No. 16	23 - 29	28 – 38
No. 200	4 - 10	4 – 10

**Type T (Topsoil):** Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

**Schedule:** Earth materials shall be as indicated in the Contract Drawings. Where clear definition in the drawings is not defined, the following schedule may be used to define acceptable fill materials.

Work Area	Material Type
Bedding and Pipe Zone for Dielectrically coated steel, polyethylene encased, non-mortar (rock-shield) coated	GF
Bedding and Pipe Zone for HDPE Pipe	GF
Trench zone and final backfill under structures	Same as Above except where encasement is required
Replace pipeline trench over excavation	DRC with 6-inch top layer of PG, or non-woven filter fabric, or same as pipe zone backfill if trench is above water table.
Under hydraulic or water retaining structures with underdrains	DRG
Embankment Fill	C
Top 6-inches of embankment fills or backfills around structures	T

**D. Unsuitable Materials.**

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of PT, OH, CH, MH, or OL shall be classified as unsuitable materials.
2. In addition to the materials identified as unsuitable in the table above, a material shall be classified as unsuitable if one of the following conditions is present;
  - a. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.
  - b. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

**2.2 MATERIALS TESTING**

**A. Samples**

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the OWNER's CONTRACTOR's expense.
  2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.
- B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.
- C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- D. Unified Soil Classification System
1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.
  2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.
- E. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

## 2.3 IDENTIFICATION TAPE

- A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.
- B. Identification tape shall be 6-inches wide, yellow in color, composed of polyethylene, and provided with an integral metallic wire.
- C. Tape shall be labeled with CAUTION – BURIED UTILITIES.

## **PART 3 -- EXECUTION**

### 3.1 EXCAVATION AND BACKFILLING - GENERAL

- A. General
1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the WORK.
  2. The removal of such materials shall conform to the lines and grades indicated or ordered.
  3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.
5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.
7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

### 3.2 OVER-EXCAVATION

#### A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

#### B. Not Indicated

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

#### C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

### 3.3 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.

C. The CONTRACTOR shall remove and dispose of excess excavated material at a location selected by the CONTRACTOR and as approved by the ENGINEER or at an off-Site location selected and arranged for by the CONTRACTOR.

D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal. CONTRACTOR shall pay costs associated with the removal and disposal

### 3.4 BACKFILL

#### A. General

1. Backfill shall not be dropped directly upon any structure or pipe.
  2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.
  3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.
- B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.
- C. Pre-Placement Conditions
1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.
  2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.
- D. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.
- E. Moisture Content
1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
  2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.
- F. Excavation Beneath Structures and Embankments
1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.
  2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.
  3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.
  4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.

5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.
6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

G. Notification of ENGINEER

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

H. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.
  2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.
  3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.
- I. Flooding, ponding, and jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

J. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.
2. Each layer shall be moistened and aerated as necessary.
3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.
4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

K. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of twelve (12) inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.
3. Material thus cut shall be re-compacted along with the new material.
4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

L. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>) where the material is graded such that ten (10) percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than ten (10) percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

3.5 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

B. Trench Bottom

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.
2. Excavations for pipe bells and welding shall be made as required.

3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

#### C. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

#### D. Embankments, Fills and Structural Backfills

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.
2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

#### E. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.
2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.
3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.
4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

#### F. Placing and Spreading Of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory

compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:
  - a. one-half the diameter of the pipe; or
  - b. 24 inches, measured in the uncompacted state.
3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.
4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.
5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.
6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

#### G. Mechanical Compaction

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.
2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

#### H. Pipe And Utility Trench Backfill

##### 1. Pipe Zone Backfill

###### a. Definitions

- 1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.
- 2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.
- 3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

###### b. Final Trim

- 1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.
  - 2) Excavation for pipe bells and welding shall be made as required.
  - c. The pipe zone shall be backfilled with the indicated backfill material.
  - d. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.
  - e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
2. Trench Zone Backfill
- a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.
  - b. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.
3. Final Backfill
- a. Final backfill is defined as backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, backfill within 18 inches of the roadway subgrade.
- I. Identification Tape
1. Install identification tape as indicated.
  2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.
  3. The termination box shall be covered with a cast iron lid.
  4. The box shall be located at grade in paved areas or 6 inches above grade in unpaved areas.
- J. Trench Shield
1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.

2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

K. Compaction Requirements

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	95	70
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	55
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95	70
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	95	70

3.6 FIELD TESTING

A. General:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the OWNER's expense, except as indicated below.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.
2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 7382.
3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.
2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.
2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.
3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with hydroseeding.

- END OF SECTION -

## **SECTION 31 35 00 - EROSION AND SEDIMENT CONTROL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. Work includes furnishing all labor, materials and equipment required for the installation and maintenance of both permanent and temporary erosion and sediment control measures as shown on the drawings and as specified herein.
- B. Erosion and sediment control measures shall conform to the notes, plans and details included in the project plans and permits.
- C. All temporary erosion and sediment control measures shall be installed prior to commencement of construction.

#### **1.2 SUBMITTALS**

- A. Submit Erosion and Sediment Control Plans for acceptance in accordance with the contract documents and permits.
  - 1. Submit an Erosion and Sediment Control Plan for work during construction. Plan shall meet all federal, state, and local requirements.
  - 2. Submit proposed erosion control materials for approval.

### **PART 2 – PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION**

- A. Install erosion and sediment control measures per manufacturer's directions or as illustrated on the contract drawing or as required by the applicable regulatory agencies.

#### **3.2 MAINTENANCE AND REMOVAL**

- B. Repair and reinstall temporary soil erosion control measures as necessary to ensure proper function for the duration of ground disturbing activities and through the warranty period.
- C. Temporary erosion control devices shall be removed only after they have performed their intended function.
- D. All pipes, end sections, drainage curbs, sand bags, sediment fences, wattles and other materials which are removed from temporary erosion control devices and not incorporated into the permanent work shall become the property of the Contractor and shall be removed from the area. Contractor shall confirm when the erosion control devices can be removed.
- E. Straw mulch and grass seed can be used and maintained until the hydromulch and seed can be applied. The depth of straw mulch will need to be approved by the Engineer.

Typically, the straw is raked away and bagged for proper disposal before the final hydromulch and seed is applied.

- END OF SECTION -



1. Class 50:

Percent by Weight	Stone Weight (lbs)
20	50 - 30
30	30 - 15
40	15 - 2
10 - 0	2 - 0

2. Class 200:

Percent by Weight	Stone Weight (lbs)
20	200 - 140
30	140 - 70
40	70 - 7
10 - 0	7 - 0

C. The greatest dimension of 50 percent of the stones shall be at least two-thirds but not more than 1-1/2 times the diameter of the average size. Neither the breadth nor thickness of any piece of riprap shall be less than one-third its length. Material shall be of shapes which will form a stable protection structure of required depth. Rounded boulders or cobbles shall not be used.

D. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Durability Absorption Ratio	Acceptability
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio	<u>Durability Index (Coarse)</u> % absorption + 1

E. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be 2.5 as determined by AASHTO T 85.

F. Stones shall have less than 10 percent loss of weight after five cycles, when tested per ASTM C 88.

- G. Stones shall have a wear not greater than 40 percent, when tested per ASTM C 535.
- H. Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap.
- I. The acceptability of the stones will be determined by the ENGINEER prior to placement. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the CONTRACTOR's responsibility.

**2.2 FILTER MATERIAL**

- A. Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall conform to the following gradation:

1. Type 1

Size	Percentage Passing
4-inch	85 – 100
1-1/2 inch	45 – 75
3/4-inch	10 – 25

**PART 3 -- EXECUTION**

**3.1 SURFACE PREPARATION**

- A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material, and shall be brought to the line and grade indicated.
- B. If a boulder is encountered during excavation of areas where large riprap is to be placed, the CONTRACTOR shall excavate around the boulder. If the boulder is larger than the largest allowable stone size for that area, the CONTRACTOR shall break up the boulder to an acceptable size or remove it entirely.

**3.2 PLACEMENT OF FILTER BLANKET**

- A. Area of riprap placement shall be excavated to the bottom of the filter blanket as indicated and in accordance with Section 31 30 00 – Earthwork. After the excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 percent of maximum density. The finished grade shall be even, self-draining, and in conformance with the slope of the finished grade.

- B. Placement of filter material shall be in accordance with Section 31 00 00. Filter material shall be placed, spread, and compacted in lifts not to exceed 12-inches.
- C. The CONTRACTOR shall remove any portion of the filter blanket that has been disturbed to the degree that the layers become mixed. Replace the removed portion with the required sizes.
- D. Filter material shall be placed as follows, unless otherwise indicated.
  - 1. For Class 50 and Class 100 riprap, no filter is required.
  - 2. For Class 200 riprap, use 6-inches Type 1 filter material.
- E. No filter material is required if riprap is placed directly on bedrock.]

### 3.3 PLACEMENT OF RIPRAP

- A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread by bulldozers or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.
- B. Where riprap is placed over a geotextile fabric, the riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 3-feet, nor shall large stones be allowed to roll downslope.

- END OF SECTION -

**SECTION 35 20 18 – FABRICATED STEEL SLIDE GATES  
(AWWA C561 MODIFIED)**

**PART 1 -- GENERAL**

1.1 SUMMARY

- A. The CONTRACTOR shall provide slide gates, complete and operable, in accordance with the Contract Documents. This specification relates to the design, materials of construction, fabrication, and supply of or stainless-steel slide gates as shown on the Contract Drawings. See the Gate Schedule on the Contract Drawings for individual gate sizes and seating / unseating head requirements.
- B. Slide gates (GS-1, GS-2, GS-3, GS-4) shall be of the non-self-contained type with the guides designed to mount embedded in a channel or vault wall.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C561	Stainless Steel Slide Gates
ASTM A276	Stainless Steel Bars and Shapes
ASTM B21	Naval Brass Rod, Bar, and Shapes
ASTM B584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals, for ENGINEER’s review and approval.
  - 1. Submit the following:
    - a. drawings of gates, frames, slides, and actuators
    - b. design load calculations for deflection at the maximum expected head
    - c. calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.
- B. Technical Manuals
  - 1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
  - 2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

#### 1.4 QUALITY CONTROL

- A. **Leakage Allowance.** The leakage allowance for slide gates under the design seating and unseating heads shall be less than 70 percent of the latest AWWA C561 standard not to exceed 0.07 gpm per foot of sealing perimeter. Leakage tests shall be completed in the field.
- B. Equipment Factory Testing
  - 1. Each gate shall be factory-assembled and functionality-tested prior to delivery to the Site.
  - 2. Test certificates shall be submitted.
- C. Equipment Field Testing
  - 1. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.
  - 2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

#### 1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Installation and Startup Assistance
  - 1. Service and testing assistance by the Manufacturer's engineering representative for the gates shall be furnished to the CONTRACTOR during installation and startup. Manufacturer shall assume a minimum of one (1) full days of on-site technical assistance services plus travel time days to and from the project site.
- B. Instruction of OWNER's Personnel
  - 1. During the above one (1) on-site days of service, The CONTRACTOR shall arrange for the Manufacturer's engineering representative to provide a minimum of 1 to 2 hour period to instruct the OWNER's personnel in the operation and maintenance of the equipment.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. **Standards.** Where this section does not provide specific guidance on gate requirements, the gates shall comply with the following Standards:
  - 1. AWWA C561     Stainless Steel Slide Gates
- B. **Dimensions.** Gate actuators shall be sized, selected, and furnished by the gate manufacturer. Nominal gate dimensions shall be for concrete wall openings as shown on the contract drawings. Gate dimensions shall account for 6" radius fillet edges at the bottom of concrete opening. Concrete wall opening dimensions are shown below:

1. **SG-1 Concrete Wall Opening:** 1'-6" wide by 3'-0" tall
2. **SG-2 Concrete Wall Opening:** 1'-6" wide by 3'-0" tall
3. **SG-3 Concrete Wall Opening:** 1'-6" wide by 4'-0" tall
4. **SG-4 Concrete Wall Opening:** 1'-6" wide by 4'-0" tall

C. Gates and actuators throughout the project shall be products of a single manufacturer.

**D. Mounting Requirements for Non-Self-Contained Gates in Handrail System.**

1. Actuator position shall be coordinated by the contractor with all handrail to ensure conflicts are not present.

**2.2 FABRICATED STAINLESS STEEL SLIDE GATES (SG-1, SG-2, SG-3, SG-4)**

**A. Gate Schedule**

Equip. No. & Location	Gate Opening (inches)	Rated Seating Head* (ft)		Flush Bottom Seal Req'd?	Motor Operator
		Max. Unseating	Max. Seating		
<b>SG-1</b> Fishway Entrance (Outdoors)	18"W X 42"H	10.0 feet	8.5 feet	Yes	Operator, w/ manual handwheel
<b>SG-2</b> Fishway Entrance (Outdoors)	18"W X 42"H	10.0 feet	8.5 feet	Yes	Operator, w/ manual handwheel
<b>SG-3</b> Fishway Exit (Outdoors)	18"W X 54"H	0 feet	5.5 feet	Yes	Operator, w/ manual handwheel
<b>SG-4</b> Fishway Exit (Outdoors)	18"W X 54"H	0 feet	9.5 feet	Yes	Operator, w/ manual handwheel

\* Head defined from gate centerline elevation.

**B. Construction Materials**

1. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.
2. Unless otherwise indicated, materials of construction shall be as indicated below. Aluminum shall not be allowed for use in these gates

3. Materials used in the fabrication of the slide gates shall conform to the material standards indicated below:

Description	Material Standards
Leaf & Stiffeners	ASTM A276, Type 304 Stainless Steel
Yoke Support Beam	ASTM A36 Structural Steel or ASTM A276, Type 304 Stainless Steel
Frame & Guides	ASTM A276, Type 304 Stainless Steel
Stem and Coupling	ASTM A276, Type 304 Stainless Steel
Stem Guides (at base of Yoke or integral to pedestal style)	ASTM A276, Type 304 Stainless Steel with UHMW bushing
Stem Cover	Transparent plastic pipe with UV inhibitors, Sched. 40 minimum
Disc Seats	UHMW Polyethylene, ASTM D4020
Invert (Base) Seal	Frame Mounted Invert Seal, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Side and Top Seals	"J-bulb" Type or Self-Adjusting Neoprene Cord Seals, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Metal Contact Surfaces for Seals (invert sill & J-side seals where used)	ASTM A167, A 276, Type 304 Stainless Steel
Fasteners (including studs, anchors, assembly bolts, nuts and hardware)	ASTM F593, F594, Type 316 Stainless Steel

- C. **Design Hydraulic Loading.** Each slide gate shall be designed for the hydraulic loading characteristics as defined by the maximum seating head and unseating head conditions as specified in the Gate Schedule above.
- D. **Gate Design.** All fabricated steel gate components shall have a minimum thickness of 1/4-inch unless specified otherwise.
1. **Leaf and Stiffeners.** The gate leaf shall consist of a flat plate reinforced with structural or formed members welded to the plate.
    - a. The leaf is to be designed to limit deflection of the gate to 1/720 of its span or 1/16-inch at the sealing surface of the gate under maximum specified head.

- b. The working design stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
2. **Frame / Guides.** The gate frame shall consist of guides, invert member, and a fabricated operator yoke assembly. The guides shall be of a sandwiched type construction built up of plates, angles, and formed shapes. The guide slot shall engage the leaf plate a minimum of 1-inch.
  - a. Leaf and frame shall be designed to resist a hydraulic load of the gate being closed under maximum seating head conditions and also opening the gate under these conditions
  - b. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
  - c. The leaf and frame design shall be arranged such as to allow simple removal of the disc from the frame, when required for maintenance.
3. **Steel Yoke Support Beam.** Gate lifting and lowering shall be supported by a steel support framing system (yoke) designed and fabricated by the gate Manufacturer. The yoke shall be designed and fabricated according to the following:
  - a. Designed to span the open width (W) on the top deck as shown on the Contract Drawings.
  - b. Designed for the maximum output of the gate hoist.
  - c. Designed to transmit the full weight of the gate plus the hydraulic (friction) load created when the gate is closed and the seating heads are as defined above. The deflection not to exceed  $W/360$ , where W equals the width of the opening across which the Yoke is spanning.
  - d. Yoke shall be designed out of parallel C or box-channel members which shall not exceed 12-inches in height. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
  - e. Yoke shall be designed with an integral stem guide to be attached to the bottom of the yoke. Stem guide shall have bronze or UHMW or other approved bushing to guide the stainless steel stem.
4. **Seals.** Resilient seals shall be placed along the top, bottom, and both sides of the gate to prevent leakage. The seal attaching hardware shall be stainless steel and attached in a manner to permit replacement of the seals. The gate side and top seals may be of the "J-bulb" type style or may be designed as a self-adjusting neoprene cord seal as described below.
  - a. For the self-adjusting cord seal, the UHMW seats shall impinge on the slide (disc) by way of a continuous loop neoprene cord seal.
  - b. J-bulb seal corners shall be formed by continuous molded sections. Joints between the molded corners and top or side seals shall be a square butt type

located a minimum of 12-inches from the corner. The molded corner shall be bonded to the top and side seal and assembled to the gate disc in the manufacturer's shop. Mitered joints shall not be used.

“J-bulb” type seals or self-adjusting neoprene cord seals shall be retained by the frame to restrict leakage to the following limits:

- c. Under a design seating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm / lineal foot of gate perimeter.
  - d. Under a design unseating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm / lineal foot of gate perimeter.
5. **Guide Slots, Sill, and Yoke.** Prefabricated guide slots, sill, and yoke shall be provided as follows:
- a. Guides shall be extended to support no less than 1.66 times the height of the slide in the open position (as measured from the invert of the gate opening). For self-contained gates the frame shall extend at least 36 inches above the operating platform or as shown in the contract drawings. The yoke shall be designed to support the thrust of the actuator with a minimum safety factor of 4 in regard to the ultimate tensile, compressive and shear strengths of the materials. (*Manufacturer is referred to section 4.4.5.1 of AWWA C561-12*)
6. **Stems.** Stems shall be of solid construction, of the **rising-stem** type with threads of the cut Acme type. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 pounds effort on the crank or handwheel.
- a. The L/r ratio of the unsupported stem shall not exceed 200.
  - b. Stem guides, where required to limit the unsupported stem length, shall be UHMW or bronze bushed.
  - c. All gates having widths greater than two times their height shall be provided with two lifting devices connected by a tandem shaft for simultaneous operation.
7. **Stem Covers.** Rising stem gates shall be provided with clear stem covers to provide indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. Vent holes shall be provided to prevent condensation.

#### E. **Anchor / Mounting Bolts**

1. The diameter, length, quantity and location of the slide gate anchor hardware shall be determined by the slide gate Manufacturer and clearly shown in installation literature.

2. All anchor hardware including studs, adhesive anchor bolts, other bolts, nuts and washers shall be provided by the gate Manufacturer to the CONTRACTOR for installation. Use of expanding style wedge mechanical anchors shall not be allowed.

**F. Lifting Device / Gate Manual Actuator**

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.
3. Pedestal Mounting
  - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
  - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 3.5 feet above the floor for frame-mounted actuators.
5. Slide gate hoist heads shall be constructed of cast iron.
6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
7. Operating thrust shall be taken on roller or ball bearings.
8. Parts shall be provided with an alternative lubrication system.
9. Handwheel Crank
  - a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
  - b. Clockwise movement of the handwheel shall close the gate.
  - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

**G. Welding**

1. All welding shall be performed in accordance with AWS D1.1. All welders shall be certified with current AWS welder certifications.

## H. **Coatings**

1. Any exposed ferrous surfaces (non stainless steel components) shall be coated with per the manufacturer's recommendations and suitable for the project application.
2. Components not requiring painting, (e.g., non-metallic seating surfaces and all 316 stainless steel surfaces) shall be protected from overspray during the ferrous surface coating process.

## I. **Gate Manufacturers, or Equal**

1. Convey Keystone
2. Hydro Gate Corp.
3. Waterman Industries.
4. Fresno Valve
5. Golden Harvest

## **PART 3 -- EXECUTION**

### 3.1 FACTORY TESTING

- A. The slide gates shall be factory tested in accordance with the requirements of this section and AWWA C561.

### 3.2 WORKMANSHIP AND TOLERANCES

- A. Workmanship and tolerance allowances, metal fits, and finishes when not definitely specified shall conform with the best modern shop practices in the manufacture and fabrication of materials of the type covered by these specifications and also with the governing requirements of AWWA C513.

### 3.3 STORAGE AND INSTALLATION

- A. The CONTRACTOR shall handle, store, and install the fabricated roller slots, gate operating mechanism, stem guides, and accessories in strict accordance with the Manufacturer's approved shop-drawings and recommendations.
- B. The slide gates shall be installed in accordance with the Manufacturer's detailed technical installation procedures and recommendations
- C. As applicable, Operators shall be located as to avoid interference with handrails and structural members.

- END OF SECTION -

**SECTION 35 20 90 – FABRICATED TILTING WEIR GATES  
(AWWA C561 MODIFIED)**

**PART 1 -- GENERAL**

1.1 SUMMARY

- A. The CONTRACTOR shall provide slide gates, complete and operable, in accordance with the Contract Documents. This specification relates to the design, materials of construction, fabrication, and supply of stainless-steel tilting weir gates as shown on the Contract Drawings. See the Gate Schedule on the Contract Drawings for individual gate sizes and seating / unseating head requirements.
- B. Tilting Weir gates **TW-1** shall be wire rope actuated tilting weir/overshot gates with the guides designed to mount embedded in an edge wall. Cables shall not extend into the flow path during normal operational range of the gate.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C561	Stainless Steel Slide Gates
ASTM A276	Stainless Steel Bars and Shapes
ASTM B21	Naval Brass Rod, Bar, and Shapes
ASTM B584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the Contract Documents, for ENGINEER's review and approval.
  - 1. Submit the following:
    - a. drawings of gates, frames, slides, and actuators
    - b. design load calculations for deflection at the maximum expected head
    - c. calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.
- B. Technical Manuals
  - 1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
  - 2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

1.4 QUALITY CONTROL

- A. Equipment Factory Testing

1. Each gate shall be factory-assembled and functionality-tested prior to delivery to the Site.
2. Test certificates shall be submitted.

B. Equipment Field Testing

1. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.
2. Excessive leaks shall be corrected, and the equipment retested until found to be satisfactory.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Startup Assistance

1. Service and testing assistance by the Manufacturer's engineering representative for each gate shall be furnished to the CONTRACTOR during installation and startup. Manufacturer shall assume a minimum of two (2) full days of on-site technical assistance services plus travel time days to and from the project site.

B. Instruction of OWNER's Personnel

1. During the above two (2) on-site days of service, The CONTRACTOR shall arrange for the Manufacturer's engineering representative to provide a minimum of 1-to-2-hour period to instruct the OWNER's personnel in the operation and maintenance of the equipment.

**PART 2 -- PRODUCTS**

2.1 GENERAL

- A. **Standards.** Where this section does not provide specific guidance on gate requirements, the gates shall comply with the following Standards:
- B. **Dimensions.** Gate actuators shall be sized, selected, and furnished by the gate manufacturer.
  1. **TW-1 Concrete Wall Opening:** 5'-0" wide by 9'-6" tall
- C. Gate actuators throughout the project shall be products of a single manufacturer.

2.2 FABRICATED STAINLESS STEEL TILTING WEIR GATES (TW-1)

**A. Gate Schedule**

Equip. No. & Location	Conc. Wall Opening (inches)	Rated Seating Head* (ft)		Flush Bottom Seal Req'd?	Motor Operator
		Max. Unseating	Max. Seating		
TW-1 Spillway Tilting Weir Gate	60"WX 114"H	0 feet	102 inches	Yes	Manual Crank with Portable Operator Attachment

\* Head defined from gate invert elevation.

**B. Construction Materials**

1. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.
2. Unless otherwise indicated, materials of construction shall be as indicated below. Aluminum shall not be allowed for use in these gates.
3. Materials used in the fabrication of the slide gates shall conform to the material standards indicated below:

Description	Material Standards
Gate Leaf & Stiffeners	ASTM A276, Type 304 Stainless Steel
Frame, Hinge, Seal Retainers, & Guides	ASTM A276, Type 304 Stainless Steel
Hinge Bearing	ASTM B139
Metal Contact Surfaces for Seals (side seals where used)	ASTM A167, A 276, Type 304 Stainless Steel
Fasteners (including studs, anchors, assembly bolts, nuts and hardware)	ASTM F593, F594, Type 316 Stainless Steel
Wire Rope	RR-W-410, ASTM A1023M
Cable Drums	ASTM A276, Type 304 Stainless Steel
Gearboxes	ASTM A276, Type 304 Stainless Steel

- C. Design Hydraulic Loading.** Each tilting weir gate shall be designed for the hydraulic loading characteristics as defined by the maximum seating head and unseating head conditions as specified in the Gate Schedule above.

- D. **Gate Design.** All fabricated steel gate components shall have a minimum thickness of 1/4-inch unless specified otherwise.
1. **Gate Leaf and Stiffeners.** The gate leaf shall consist of a flat plate reinforced with structural or formed members welded to the plate.
    - a. The leaf is to be designed to limit deflection of the gate to 1/720 of its span or 1/16-inch at the sealing surface of the gate under maximum specified head.
    - b. The working design stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
  2. **Frame, Hinge, Seal Retainers, & Guides.** The gate frame shall consist of guides, invert member, and a cable drum hoist assembly.
    - a. Leaf and frame shall be designed to resist a hydraulic load of the gate being closed under maximum seating head conditions and also opening the gate under these conditions
    - b. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
    - c. The leaf and frame design shall be arranged such as to allow simple removal of the disc from the frame, when required for maintenance.
    - d. **For sill anchorage unit with hinge anchors to a concrete floor,** a stainless steel embed shall be grouted by the CONTRACTOR into a block-out of the concrete in the channel floor.
      - 1) The sill anchorage embedment shall consist of a Stainless-Steel nose angle with tiebacks with stainless steel anchor bolts secured and spaced to accept the hinge.
      - 2) The piano hinge bearing will utilize a bronze rod running in the stainless-steel piano hinge
  3. **Seals.** Seals shall be placed along the sides of the gate to prevent leakage.
  4. **Anchor / Mounting Bolts**
  5. The diameter, length, quantity and location of the gate anchor hardware shall be determined by the gate Manufacturer and clearly shown in installation literature.
  6. All anchor hardware including studs, adhesive anchor bolts, other bolts, nuts and washers shall be provided by the gate Manufacturer to the CONTRACTOR for installation. Use of expanding style wedge mechanical anchors shall not be allowed.

## E. Lifting Device / Gate Manual Actuator

1. Provide lifting devices complete with cable, cable drums, intermediate supports with steady bushings, gear reducer, hand wheel, or crank where indicated.
2. Wire rope shall be stainless steel designed with a safety factor to breaking strength of approximately 5:1.
  - a. Construction shall be 6 by 19 wire core. The connection to the gate shall be an open spelter socket. Wire rope shall be placed out of main water flow.
3. Cable drums shall be constructed of solid type 304 stainless steel and shall be grooved for the cable
  - a. Provision shall be made for a minimum of 2 to 2.5 dead wraps plus the normal hoisting requirements. Provision shall also be made for securing the cable end to the drum. Drums shall be placed such that a minimal fleet angle exists when the gate is in full closed position. Drum to cable ratio shall be a minimum of 12:1
4. The side mounted gearbox shall be in line helical gear reducer.
  - a. The steel machined drums are attached to a steel cross shaft, which is attached to the gear box via flex/rigid steel machined coupler. The gearbox shall be of the helical worm type with at least a worm ratio of 40:1. All gearboxes shall be fully enclosed of cast iron construction with oil bath lubrication. Gear shall be precision cut steel and shaft be mounted on ball bearing races.
5. Fully closed position shall place the gate leaf 60 degrees from horizontal.
6. The lifting devices shall be weatherproof.
7. Pedestal Mounting
  - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
  - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
8. Operating thrust shall be taken on roller or ball bearings.
9. Parts shall be provided with an alternative lubrication system.
10. Handwheel Crank
  - a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
  - b. Clockwise movement of the handwheel shall close the gate.
  - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

**F. Welding**

1. All welding shall be performed in accordance with AWS D1.1. All welders shall be certified with current AWS welder certifications.

**G. Coatings**

1. Any exposed ferrous surfaces (non-stainless-steel components) shall be coated with per the manufacturer's recommendations and suitable for the project application.
2. Components not requiring painting, (e.g., non-metallic seating surfaces and all 316 stainless steel surfaces) shall be protected from overspray during the ferrous surface coating process.

**H. Gate Manufacturers, or Equal**

1. Fresno Valve
2. Hydro Gate Corp.
3. Waterman Industries.

**PART 3 -- EXECUTION**

**3.1 FACTORY TESTING**

- A. The tilting weir gates shall be factory tested in accordance with the requirements of this section.

**3.2 WORKMANSHIP AND TOLERANCES**

**3.3 STORAGE AND INSTALLATION**

- A. The CONTRACTOR shall handle, store, and install the gate operating mechanism and accessories in strict accordance with the Manufacturer's approved shop-drawings and recommendations.
- B. The tilting weir gate shall be installed in accordance with the Manufacturer's detailed technical installation procedures and recommendations
- C. As applicable, Operators shall be located as to avoid interference with handrails and structural members.
- D. The Contractor shall be responsible for equipment field testing in the presence of the manufacturer's factory service representative. Excessive leaks shall be corrected, and the equipment retested until found to be satisfactory.

- END OF SECTION -

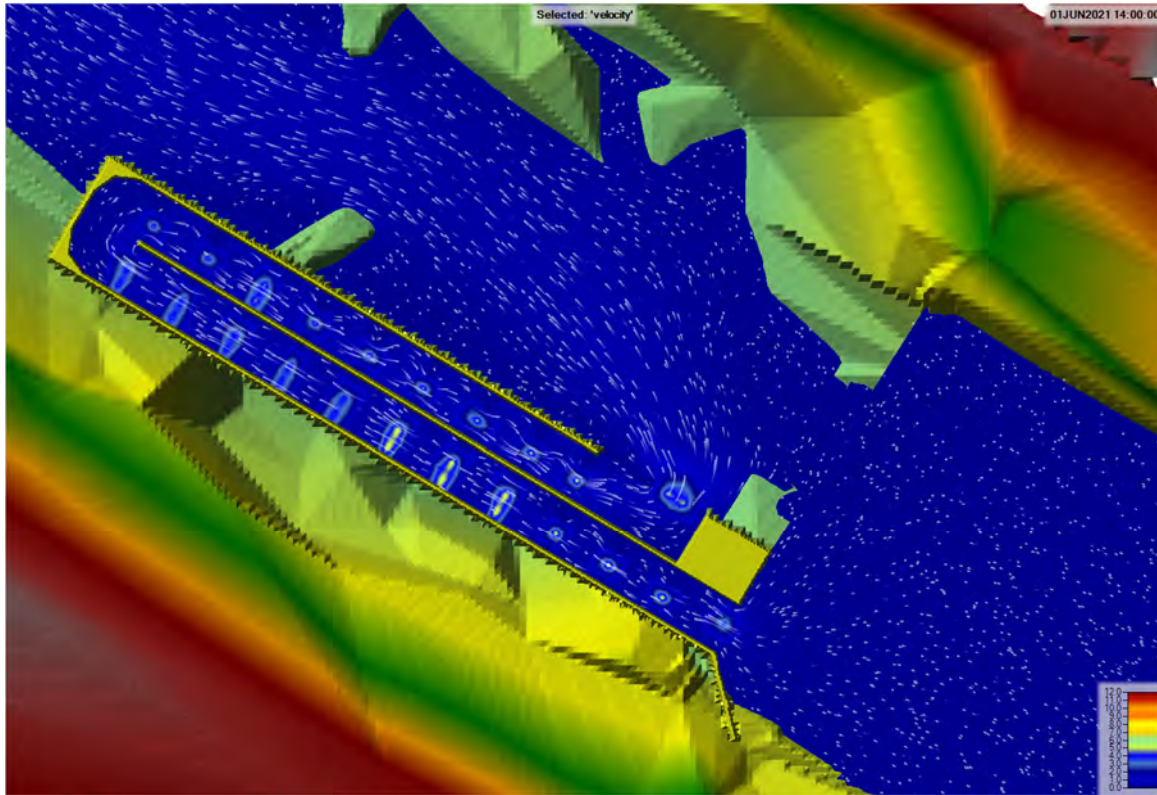
## **Appendix 7.3**

### **Hydraulic Model Exhibits**

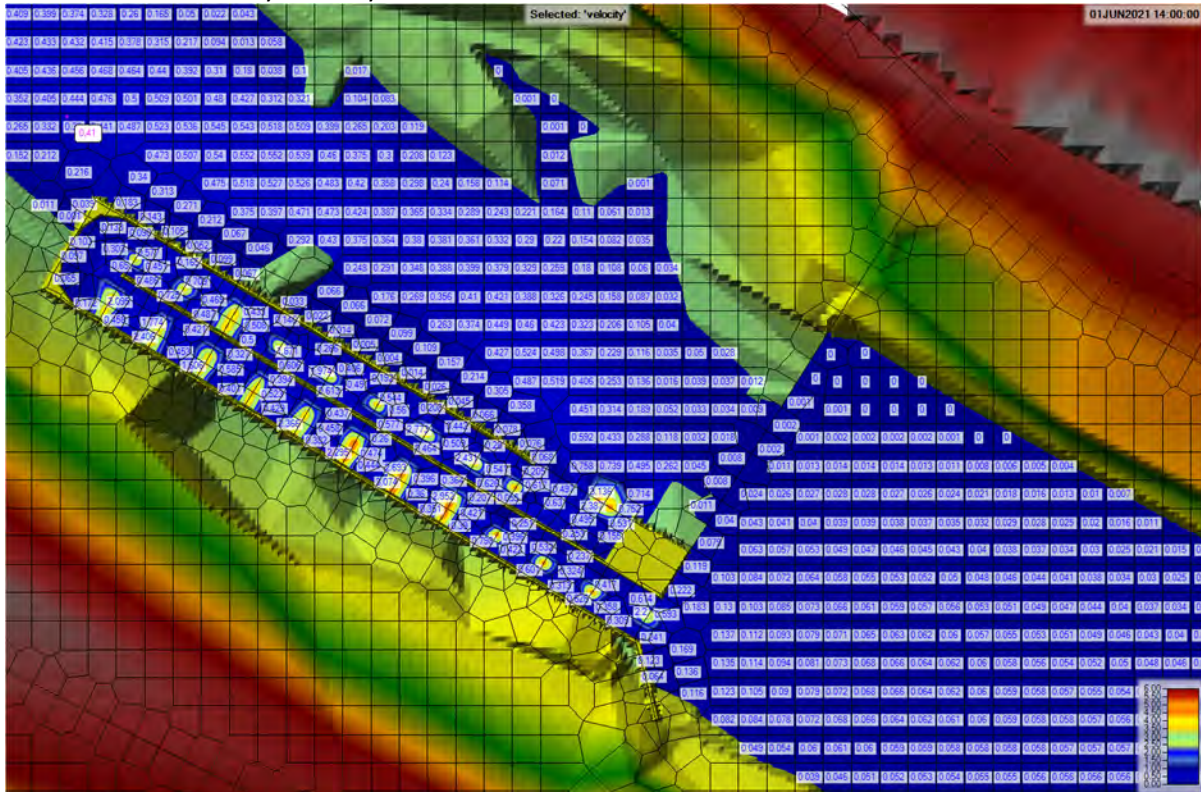
### **7.3 Fishway Performance Hydraulic Model Exhibits**

The following exhibits represent expected in-stream and fishway velocity gradients and water surface elevations relative to vertical slot fishway performance at flow rates including 20, 40, 100, and 449 cfs.

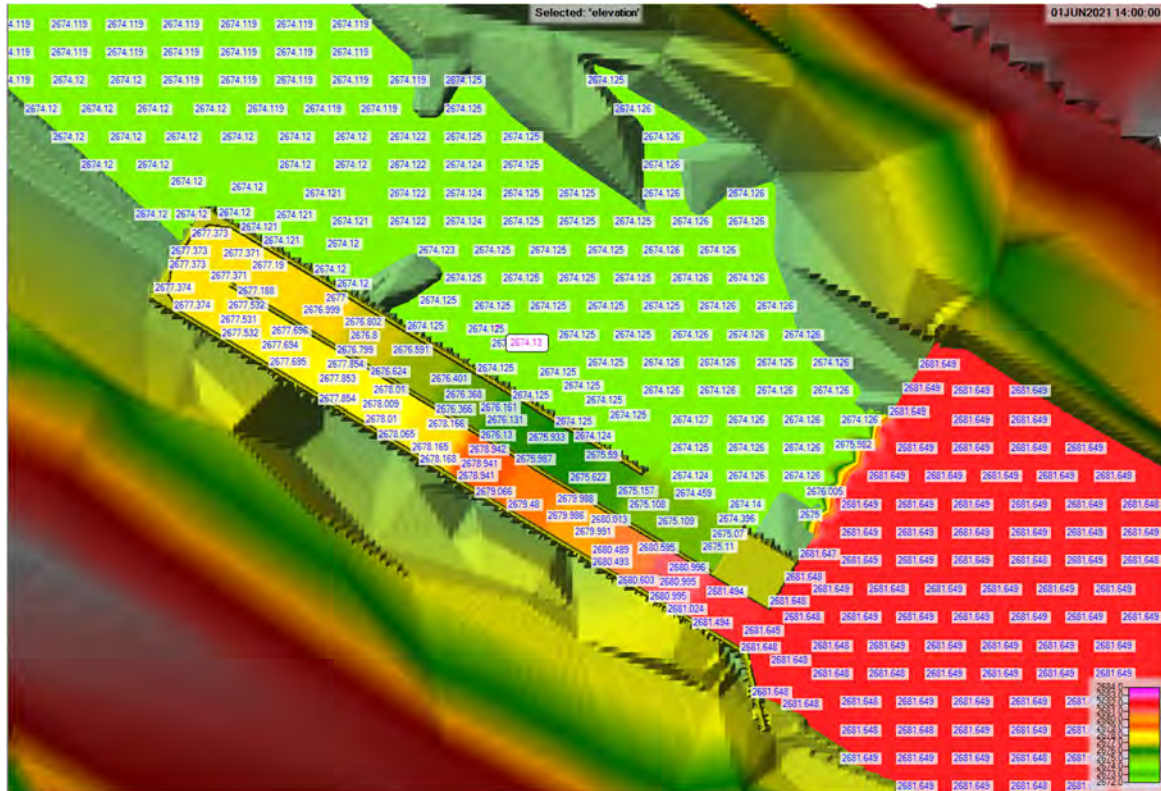
In-Stream and Fishway Velocity Gradients at 20 cfs.



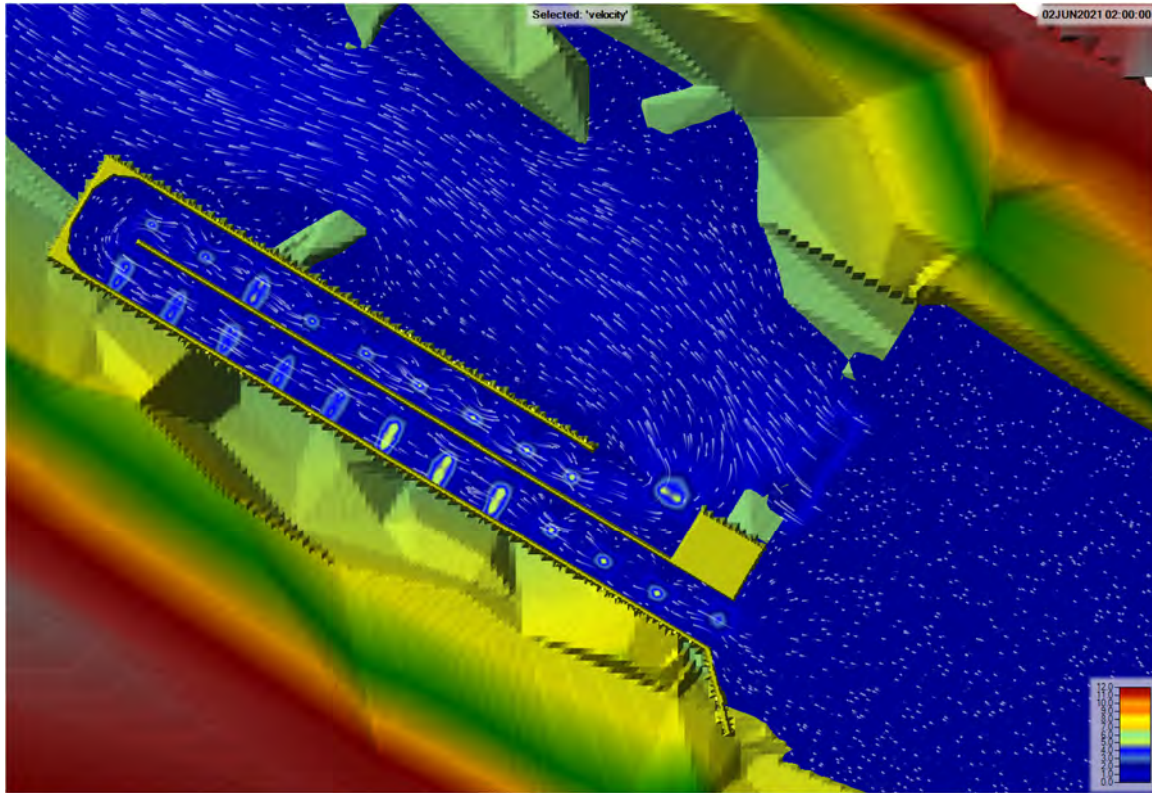
In-Stream and Fishway Velocity Values at 20 cfs.



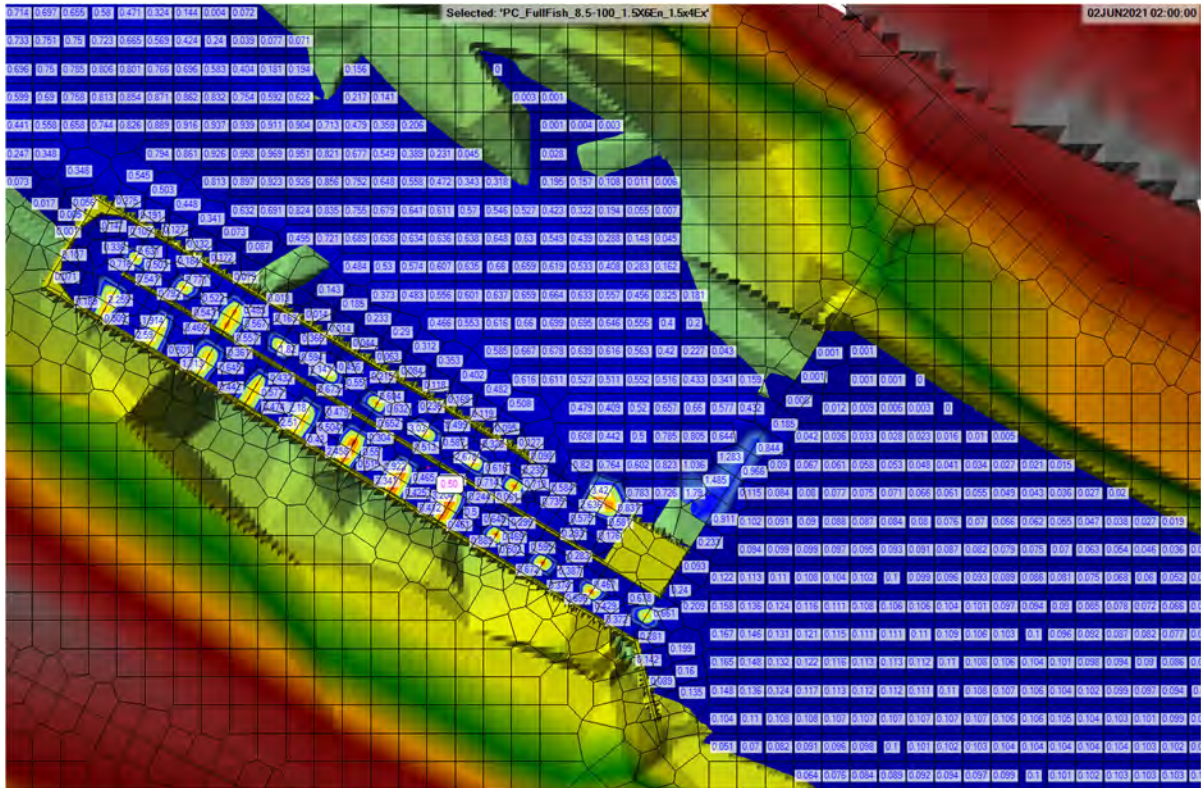
# Water Surface Elevations at 20 cfs.



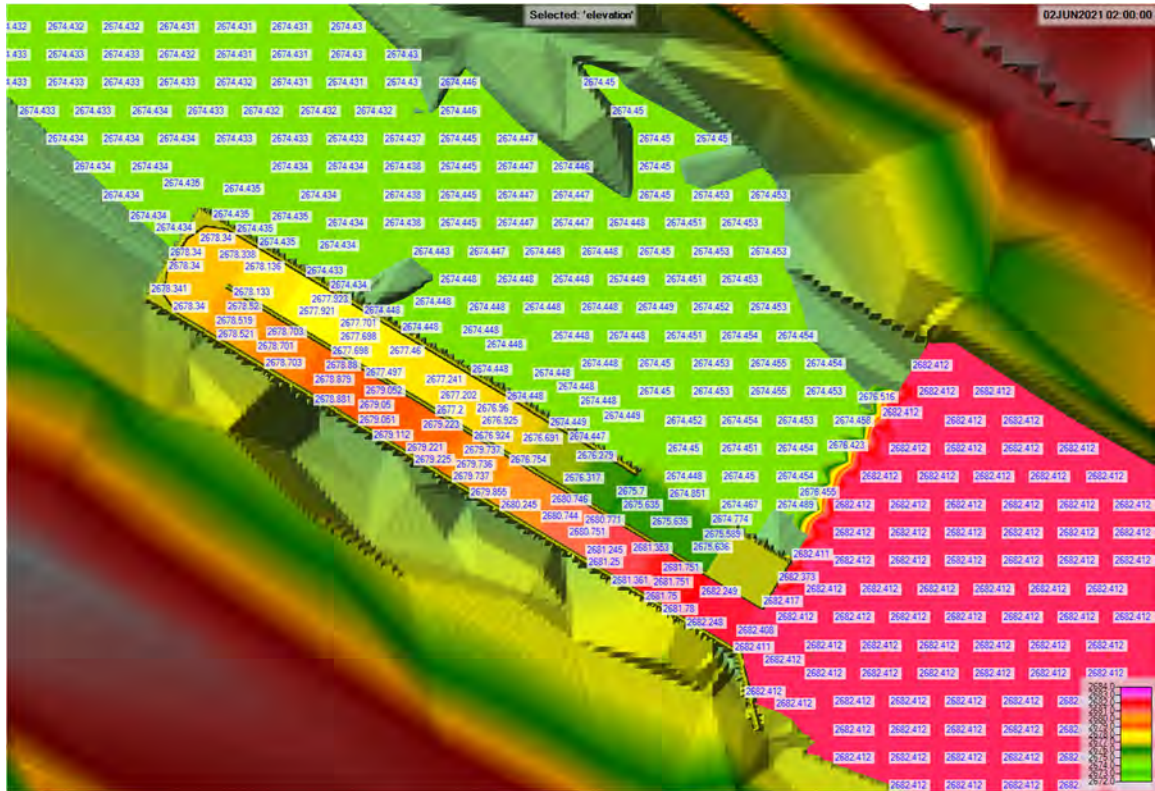
In-Stream and Fishway Velocity Gradients at 40 cfs.



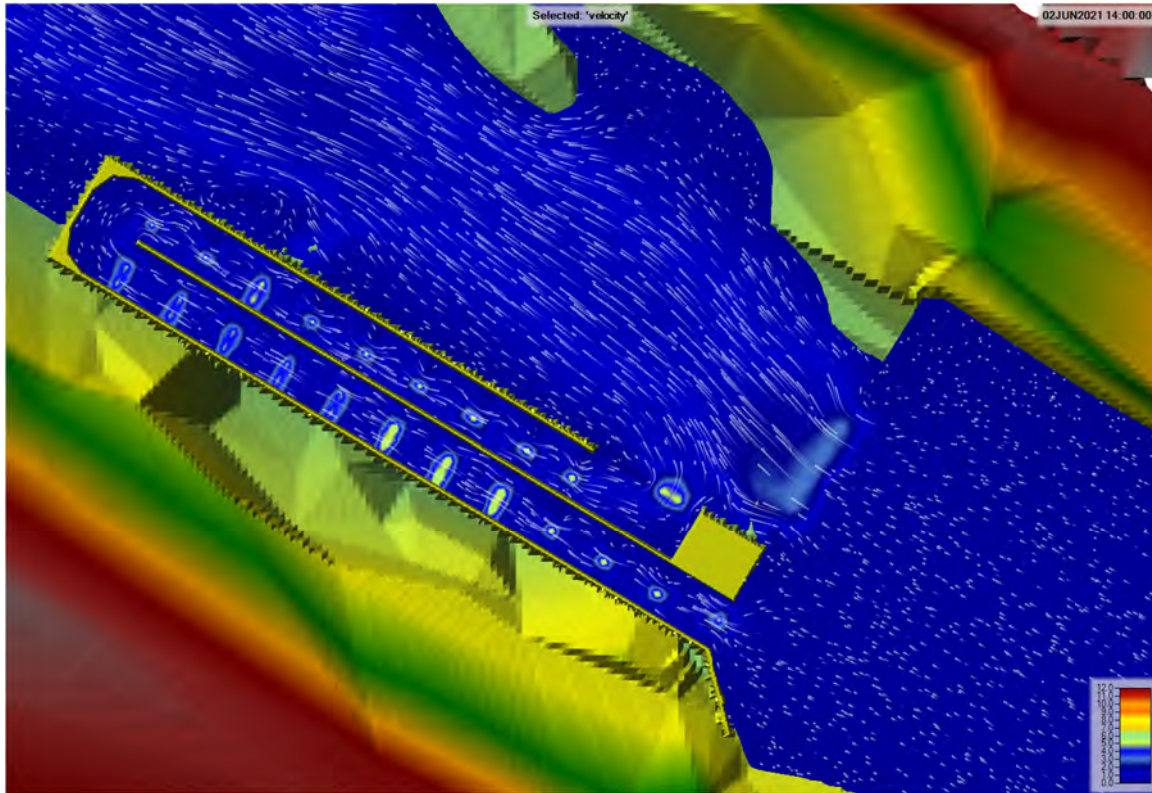
In-Stream and Fishway Velocity Values at 40 cfs.



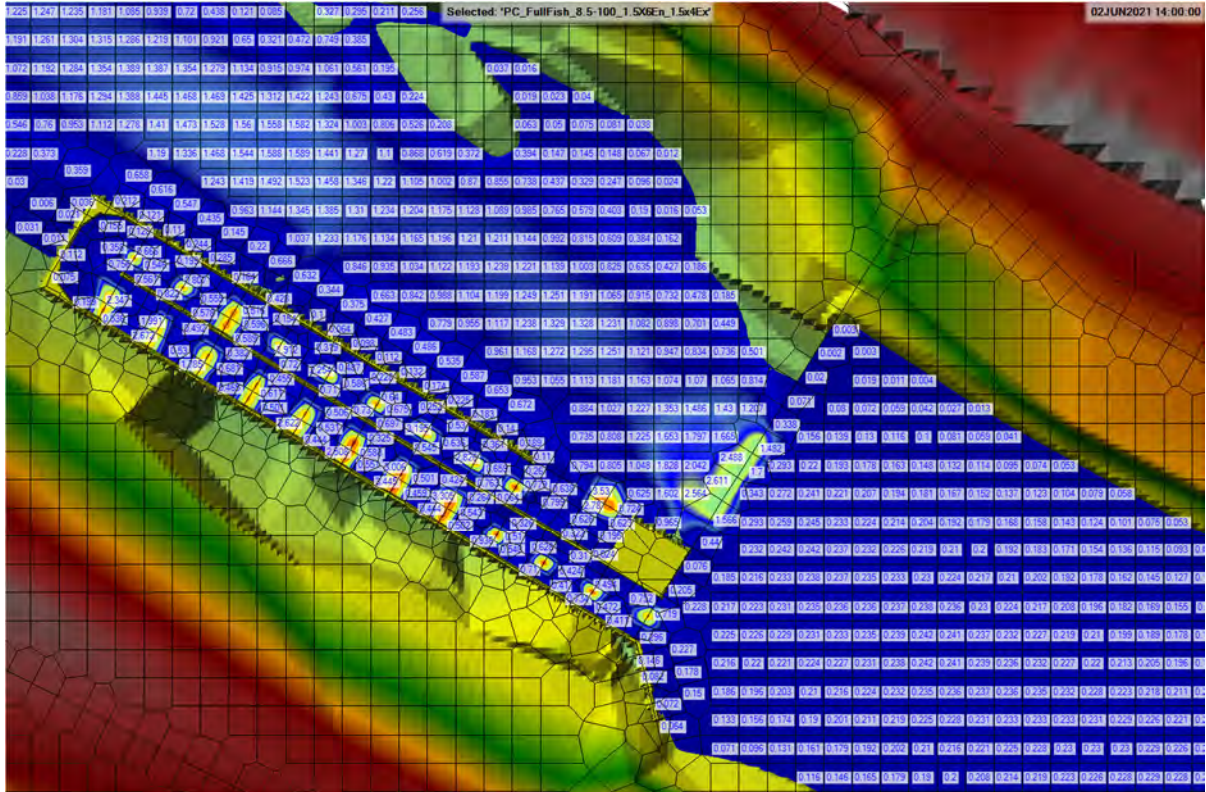
# Water Surface Elevations at 40 cfs.



In-Stream and Fishway Velocity Gradients at 100 cfs.

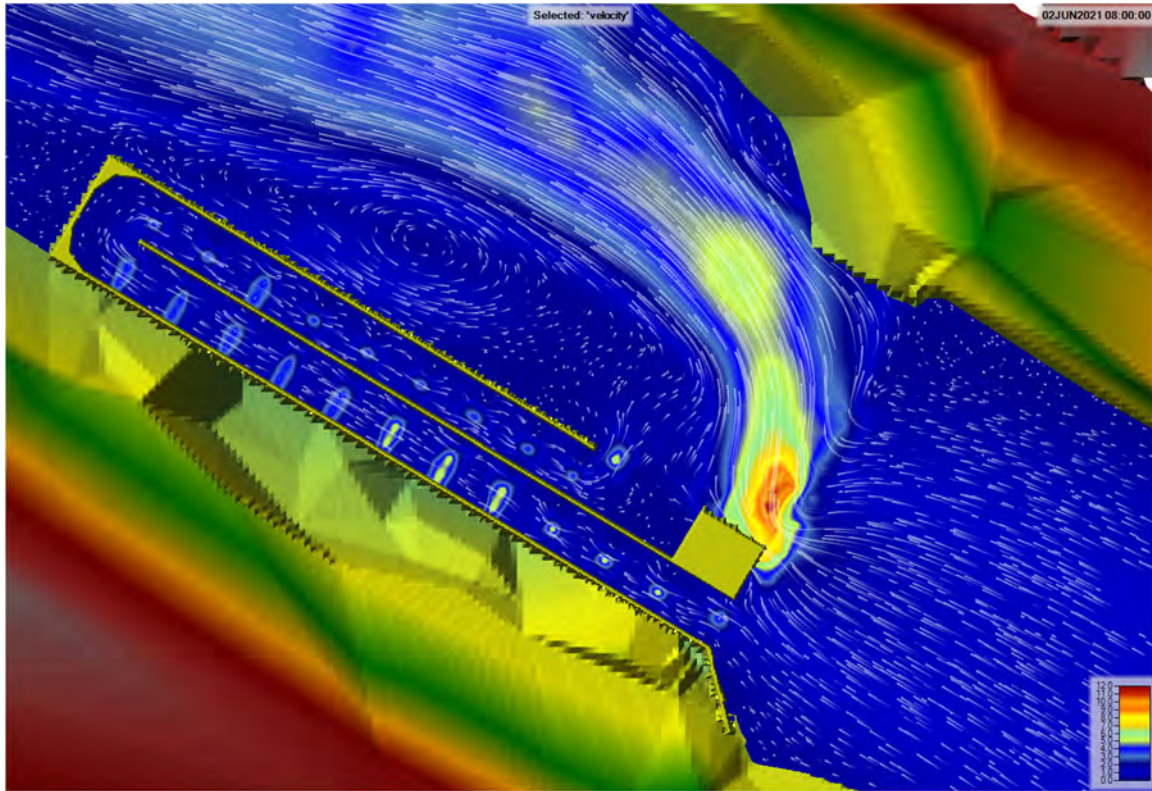


In-Stream and Fishway Velocity Values at 100 cfs.

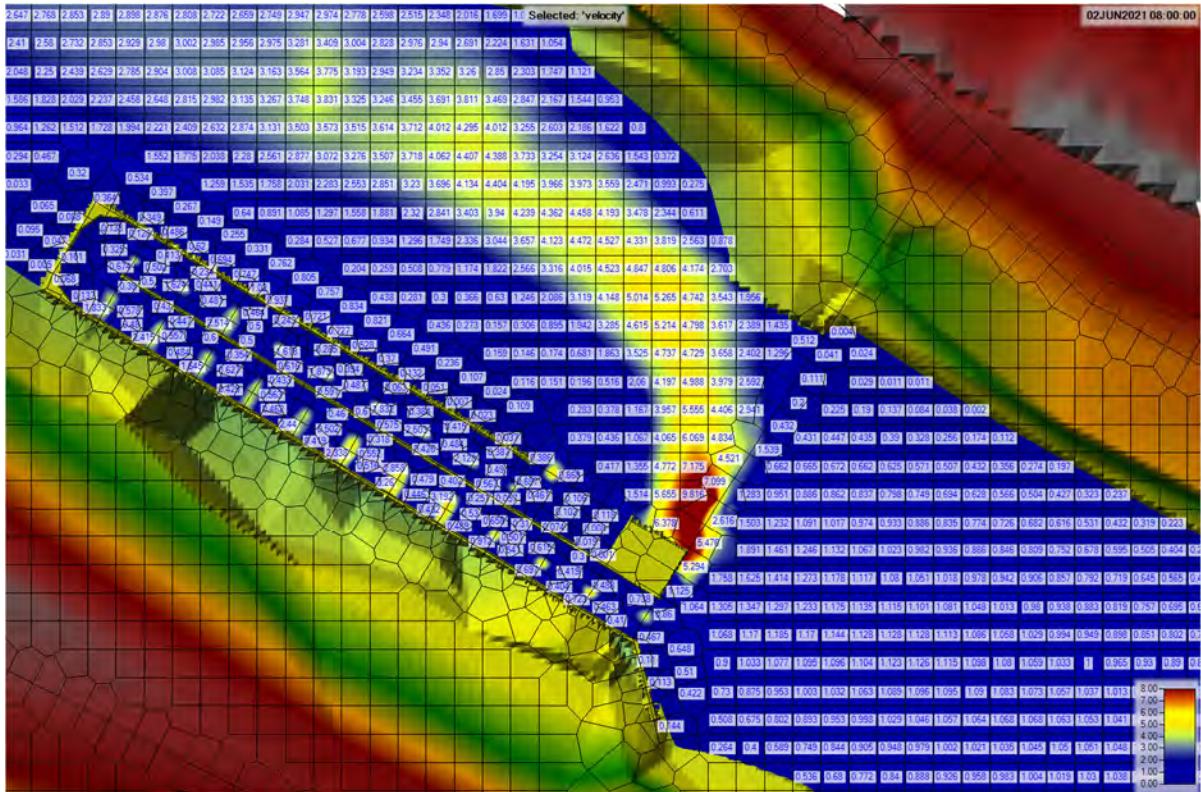




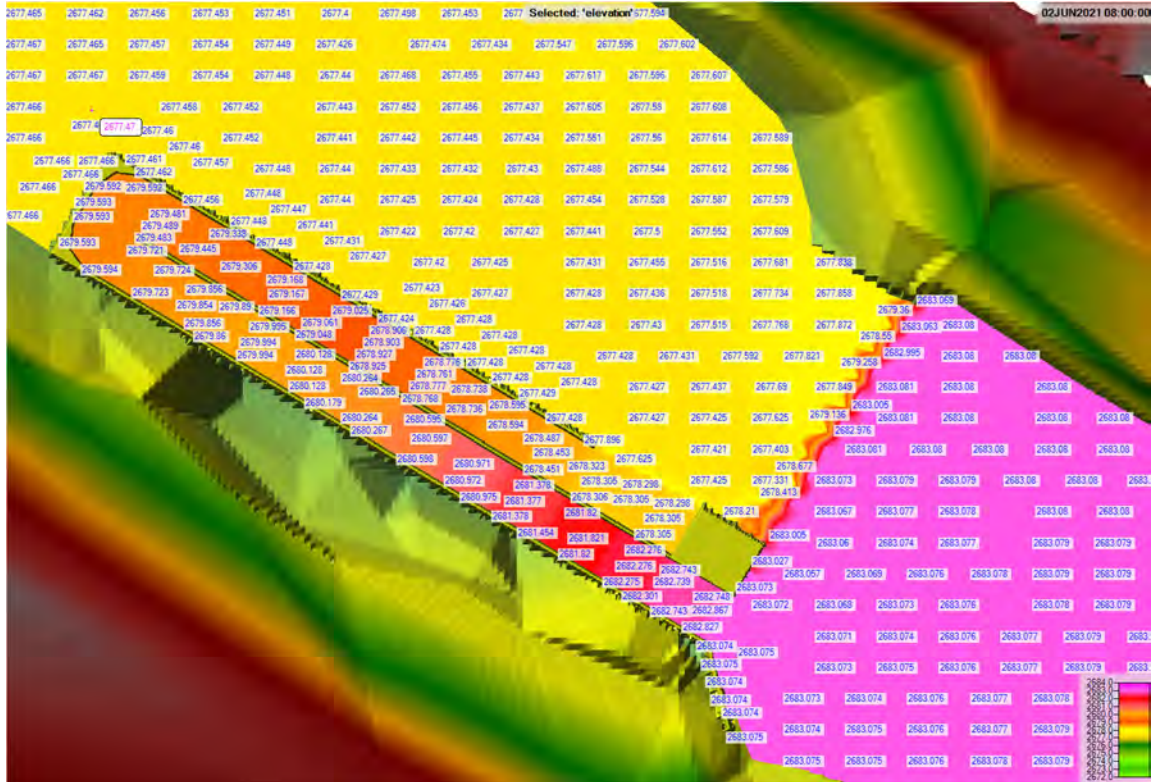
In-Stream and Fishway Velocity Gradients at 449 cfs.



In-Stream and Fishway Velocity Values at 449 cfs.



# Water Surface Elevations at 449 cfs.



## **Appendix 7.4**

### **Geotechnical Investigation**



# ATLAS

## **GEOTECHNICAL INVESTIGATION**

### **ELMER DAM RENOVATIONS**

Booth Lane  
La Grande, OR

#### **PREPARED FOR:**

Mr. Chris Boyd  
River Structures Consulting, Inc.  
PO Box 1643  
Boise, ID 83701

#### **PREPARED BY:**

Atlas Technical Consultants, LLC  
2791 South Victory View Way  
Boise, ID 83709

May 19, 2021  
B210090g



May 19, 2021

Atlas No. B210090g

Mr. Chris Boyd  
River Structures Consulting, Inc.  
PO Box 1643  
Boise, ID 83701

**Subject: Geotechnical Investigation  
Elmer Dam Renovations  
Booth Lane  
La Grande, OR**

Dear Mr. Boyd:

In compliance with your instructions, Atlas has conducted a soils exploration and foundation evaluation for the above referenced development. Fieldwork for this investigation was conducted on April 12, 2021. Data have been analyzed to evaluate pertinent geotechnical conditions. Results of this investigation, together with our recommendations, are to be found in the following report. We have provided a PDF copy for your review and distribution.

Often, questions arise concerning soil conditions because of design and construction details that occur on a project. Atlas would be pleased to continue our role as geotechnical engineers during project implementation.

If you have any questions, please call us at (208) 376-4748.

Respectfully submitted,

*Jacob Schlador*

Jacob Schlador, PE (ID)  
Geotechnical Engineer

Elizabeth Brown, PE (ID)  
Geotechnical Services Manager

David O. Cram, PE, GE  
Senior Vice President  
Exp. 12/31/2021  
5/19/2021

## CONTENTS

<b>1. INTRODUCTION.....</b>	<b>1</b>
1.1 Project Description .....	1
1.2 Authorization .....	1
1.3 Scope of Investigation .....	1
<b>2. SITE DESCRIPTION.....</b>	<b>2</b>
2.1 Site Access .....	2
2.2 Regional Geology.....	2
2.3 General Site Characteristics.....	2
2.4 Regional Site Climatology and Geochemistry.....	2
<b>3. SEISMIC SITE EVALUATION .....</b>	<b>3</b>
3.1 Geoseismic Setting .....	3
3.2 Seismic Design Parameter Values .....	3
<b>4. SOILS EXPLORATION.....</b>	<b>4</b>
4.1 Exploration and Sampling Procedures.....	4
4.2 Laboratory Testing Program.....	4
4.3 Soil and Sediment Profile .....	4
4.4 Volatile Organic Scan.....	5
<b>5. SITE HYDROLOGY .....</b>	<b>5</b>
5.1 Groundwater .....	5
5.2 Soil Infiltration Rates .....	6
<b>6. LATERAL EARTH PRESSURES .....</b>	<b>6</b>
6.1 Retaining Wall Backfill Materials: Un-drained Conditions .....	7
6.2 Retaining Wall Backfill Materials: Drained Conditions.....	8
6.3 Retaining Wall Drainage.....	9
<b>7. FOUNDATION AND SLAB DISCUSSION AND RECOMMENDATIONS.....</b>	<b>9</b>
7.1 Foundation Design Recommendations.....	10
7.2 General Foundation Recommendations .....	12
7.3 Shallow Floor Slab-on-Grade .....	12
<b>8. CONSTRUCTION CONSIDERATIONS .....</b>	<b>13</b>
8.1 Earthwork.....	13
8.2 Dry Weather.....	14
8.3 Wet Weather .....	14
8.4 Soft Subgrade Soils.....	14
8.5 Frozen Subgrade Soils.....	15
8.6 Structural Fill .....	15
8.7 Backfill of Walls .....	16
8.8 Excavations.....	16

8.9 Groundwater Control .....	17
<b>9. GENERAL COMMENTS .....</b>	<b>17</b>
<b>10. REFERENCES.....</b>	<b>18</b>

## **TABLES**

Table 1 – Seismic Design Values.....	3
Table 2 – Lateral Earth Pressure Values for Native Soil.....	7
Table 3 – Lateral Earth Pressure Values for Fill Materials.....	7
Table 4 – Lateral Earth Pressure Values for Native Soil.....	8
Table 5 – Lateral Earth Pressure Values for Fill Materials.....	8
Table 6 – Fish Ladder - Shallow Spread Footings.....	10
Table 7 – Pump Station and Inlet Screen – Raft or Mat Slab.....	10

## **APPENDICES**

Appendix I	Warranty and Limiting Conditions
Appendix II	Vicinity Map
Appendix III	Site Map
Appendix IV	Geotechnical Investigation Boring Log
Appendix V	Geotechnical General Notes
Appendix VI	Important Information About This Geotechnical Engineering Report



## **1. INTRODUCTION**

This report presents results of a geotechnical investigation and analysis in support of data utilized in design of structures as defined in the 2019 Oregon Structural Specialty Code (OSSC). Information in support of groundwater and stormwater issues pertinent to the practice of Civil Engineering is included. Observations and recommendations relevant to the earthwork phase of the project are also presented. Revisions in plans or drawings for the proposed structures from those enumerated in this report should be brought to the attention of the soils engineer to determine whether changes in the provided recommendations are required. Deviations from noted subsurface conditions, if encountered during construction, should also be brought to the attention of the soils engineer.

### **1.1 Project Description**

The proposed development is in the east of the City of La Grande, Union County, OR, and occupies portions of the N $\frac{1}{2}$  of Section 30 & SW $\frac{1}{4}$ SW $\frac{1}{4}$  of Section 29, Township 2 South, Range 40 East, Willamette Meridian. This project will consist of replacing an existing fishing ladder, construction of two new pump intakes and wet wells, and a new intake and inlet/fish screen. Total settlements are limited to 1 inch. Loads of up to 4,000 pounds per lineal foot for wall footings were assumed for settlement calculations. Retaining walls are anticipated as part of the project. Atlas has not been informed of the proposed grading plan.

### **1.2 Authorization**

Authorization to perform this exploration and analysis was given in the form of a written authorization to proceed from Mr. Chris Boyd of River Structures Consulting, Inc. to Jacob Schlador of Atlas Technical Consultants (Atlas), on January 22, 2021. Said authorization is subject to terms, conditions, and limitations described in the Professional Services Contract entered into between River Structures Consulting, Inc. and Atlas. Our scope of services for the proposed development has been provided in our proposal dated December 11, 2020 and repeated below.

### **1.3 Scope of Investigation**

The scope of this investigation included review of geologic literature and existing available geotechnical studies of the area, visual site reconnaissance of the immediate site, subsurface exploration of the site, field and laboratory testing of materials collected, and engineering analysis and evaluation of foundation materials.

## 2. SITE DESCRIPTION

### 2.1 Site Access

Access to the site may be gained via Interstate 84 to the Foothill Road exit just outside of La Grande, OR. Proceed east on Foothill Road approximately 0.1 mile to its intersection with Pierce Road. From this intersection, proceed north on Pierce Road 7.6 miles to Highway 82. Travel northeast on Highway 82 for 0.7 mile to Booth Lane. Travel east 6.4 miles on Booth Lane where the road turns to the south. The site resides to the east of this turn in Booth Lane. The location is depicted on site maps included in the **Appendix**.

### 2.2 Regional Geology

The subject site is located near the eastern flank of the Grande Ronde Valley in northeastern Oregon. The Grande Ronde Valley is a fault-bounded alluvial plain. The valley is bounded to the east by the Wallowa Mountains and to the west by the Blue Mountains and Elkhorn Mountains. The valley is filled with up to 2,000 feet of alluvial sediments. Sediments within the valley generally consist of varying gravel, sand, and silt mixtures overlain by fine sand and silt deposits. Faults along the margins of the valley have vertical offsets of up to 3,400 feet, and were active during the Late Quaternary (Ferns, 2006).

### 2.3 General Site Characteristics

The site consists of a gravel roadway adjacent to the Grande Ronde River. The area surrounding the river consists of agricultural fields. Vegetation on the site consists primarily of shrubs, bunchgrass, and agricultural crops. Slopes near the river and the adjacent canals/reservoirs were measured at approximately 1.5 feet horizontal to 1 foot vertical (1.5:1) to 0.75:1. The site is relatively flat and level. However, a slight drop in elevation occurs from north to south.

Regional drainage is north and west toward the Grande Ronde River. Stormwater drainage for the site is achieved percolation through surficial soils. The site is situated so that it is unlikely that it will receive any drainage from off-site sources. Stormwater drainage collection and retention systems are not in place on the project site and were not noted within the vicinity of the project site.

### 2.4 Regional Site Climatology and Geochemistry

According to the Western Regional Climate Center, the average precipitation near La Grande is on the order of 9 to 12 inches per year, with an annual snowfall of approximately 36 inches. The monthly mean daily temperatures range from -21°F to 104°F. Winds are generally to the northwest or south with an annual average wind speed of approximately 6.5 miles per hour (mph) and a maximum of 66 mph. Soils and sediments in the area are primarily derived from siliceous materials and exhibit low electro-chemical potential for corrosion of metals or concretes. Local aggregates are generally appropriate for Portland cement and lime cement mixtures. Surface water, groundwater, and soils in the region typically have pH levels ranging from 6.6 to 8.0.

### 3. SEISMIC SITE EVALUATION

#### 3.1 Geoseismic Setting

Soils on site are classed as Site Class D in accordance with Chapter 20 of the American Society of Civil Engineers (ASCE) publication ASCE/SEI 7-16. Structures constructed on this site should be designed per OSSC requirements for such a seismic classification. Our investigation did not reveal hazards resulting from potential earthquake motions including: slope instability, liquefaction, and surface rupture caused by faulting or lateral spreading. Incidence and anticipated acceleration of seismic activity in the area is low.

#### 3.2 Seismic Design Parameter Values

The United States Geological Survey National Seismic Hazard Maps (2008), includes a peak ground acceleration map. The map for 2% probability of exceedance in 50 years in the Western United States in standard gravity (g) indicates that a peak ground acceleration of 0.228 is appropriate for the project site based on a Site Class D.

The following section provides an assessment of the earthquake-induced earthquake loads for the site based on the Risk-Targeted Maximum Considered Earthquake ( $MCE_R$ ). The  $MCE_R$  spectral response acceleration for short periods,  $S_{MS}$ , and at 1-second period,  $S_{M1}$ , are adjusted for site class effects as required by the 2019 OSSC. Design spectral response acceleration parameters as presented in the 2019 OSSC are defined as a 5% damped design spectral response acceleration at short periods,  $S_{DS}$ , and at 1-second period,  $S_{D1}$ .

The USGS National Seismic Hazards Mapping Project includes a program that provides values for ground motion at a selected site based on the same data that were used to prepare the USGS ground motion maps. The maps were developed using attenuation relationships for soft rock sites; the source model, assumptions, and empirical relationships used in preparation of the maps are described in Petersen and others (1996).

**Table 1 – Seismic Design Values**

Seismic Design Parameter	Design Value
Site Class	D “Stiff Soil”
$S_s$	0.340 (g)
$S_1$	0.122 (g)
$F_a$	1.528
$F_v$	2.355
$S_{MS}$	0.520
$S_{M1}$	0.288
$S_{DS}$	0.347
$S_{D1}$	0.192

## 4. SOILS EXPLORATION

### 4.1 Exploration and Sampling Procedures

Field exploration conducted to determine engineering characteristics of subsurface materials included a reconnaissance of the project site and investigation by soil boring. Boring locations were selected by Mr. Chris Boyd with River Structures Consulting, Inc and provided to Atlas via a map. Borings were located in the field by means of a Global Positioning System (GPS) device and are reportedly accurate to within ten feet. Borings were advanced by means of a truck-mounted drilling rig equipped with continuous flight hollow-stem augers. At specified depths, samples were obtained using a standard split-spoon sampler and Standard Penetration Test (SPT) blow counts were recorded. Uncorrected SPT blow counts are provided on logs, which can be found in the **Appendix**. Delayed water level observations were made in open borings to evaluate groundwater levels. At completion of exploration, borings were backfilled with bentonite holeplug.

Samples have been visually classified in the field by professional staff, identified according to boring number and depth, placed in sealed containers, and transported to our laboratory for additional testing. Subsurface materials have been described in detail on logs provided in the **Appendix**. Results of field and laboratory tests are also presented in the **Appendix**. Atlas recommends that these logs **not** be used to estimate fill material quantities.

### 4.2 Laboratory Testing Program

Along with our field investigation, a supplemental laboratory testing program was conducted to determine additional pertinent engineering characteristics of subsurface materials necessary in an analysis of anticipated behavior of the proposed structures. Laboratory tests were conducted in accordance with current applicable American Society for Testing and Materials (ASTM) specifications, and results of these tests are to be found in the **Appendix**. The laboratory testing program for this report included: Atterberg Limits Testing – ASTM D4318 and Grain Size Analysis – ASTM C117/C136.

### 4.3 Soil and Sediment Profile

The profile below represents a generalized interpretation for the project site. Note that on site soils strata, encountered between boring locations, may vary from the individual soil profiles presented in the logs, which can be found in the **Appendix**.

At ground surface within boring 4 were poorly graded sand with gravel fill materials. Poorly graded sand fills were light brown, dry to slightly moist, medium dense to dense, and contained fine to coarse-grained sand and fine to coarse gravel. At ground surface throughout the majority of the site and underlying the surficial fills in boring 4 were silt with sand soils. Silts with sand were brown to light brown, dry to moist, soft to stiff, and contained fine-grained sand. Beneath the silt soils were varying layers of fat clay soils and lean clay soils. These clayey soils were dark brown, dark gray, gray, and brown, dry to saturated, soft to hard, with fine to medium-grained sand. In boring 4, silty sand sediments were encountered below a fat clay layer. Silty sands were dark reddish brown, moist to saturated, loose to medium dense, and contained fine to medium-grained sand.

During excavation, boring sidewalls were generally stable. However, moisture contents will affect wall competency with saturated soils having a tendency to readily slough when under load and unsupported.

#### 4.4 Volatile Organic Scan

No environmental concerns were identified prior to commencement of the investigation. Therefore, soils obtained during on-site activities were not assessed for volatile organic compounds by portable photoionization detector. Samples obtained during our exploration activities exhibited no odors or discoloration typically associated with this type of contamination. Groundwater encountered did not exhibit obvious signs of contamination.

## 5. SITE HYDROLOGY

Existing surface drainage conditions are defined in the **General Site Characteristics** section. Information provided in this section is limited to observations made at the time of the investigation. Either regional or local ordinances may require information beyond the scope of this report.

### 5.1 Groundwater

During this field investigation, groundwater was encountered in borings at depths ranging from 9.3 to 24.4 feet bgs. Soil moistures in the borings were generally dry to moist within surficial soils. Within the deeper soils, soil moistures graded from slightly moist to saturated as the water table was approached and penetrated. Groundwater depths varied with the elevation of the boring above the Catherine Creek. In the vicinity of the project site, groundwater levels are controlled in large part by the stage and flow of Catherine Creek. Maximum groundwater elevations likely occur during late spring to early summer runoff season. Furthermore, according to Oregon Department of Water Resources well log data within approximately ½-mile of the project site, groundwater was measured as shallow as 7 feet bgs.

Based on evidence of this investigation and background knowledge of the area, Atlas estimates groundwater depths to remain greater than approximately 6 feet bgs throughout the year. However, as the site is heavily influenced by Catherine Creek, flooding or near flooding conditions will result in temporarily higher groundwater elevations. This depth can be confirmed through long-term groundwater monitoring.

## 5.2 Soil Infiltration Rates

Soil permeability, which is a measure of the ability of a soil to transmit a fluid, was not tested in the field. Given the absence of direct measurements, for this report an estimation of infiltration is presented using generally recognized values for each soil type and gradation. Of soils comprising the generalized soil profile for this study, fat clay, lean clay, sandy lean clay, and silt soils generally offer little permeability, with typical hydraulic infiltration rates of less than 2 inches per hour. Silty sand sediments usually display rates of 4 to 8 inches per hour. However, the presence of groundwater will significantly reduce these estimated rates.

## 6. LATERAL EARTH PRESSURES

Retaining, below-grade, or basement walls will be subject to lateral earth pressures. The magnitude of earth pressure is a function of both type and compaction of backfill behind walls within the “active” zone, and allowable rotation of the top of the wall. The active zone is defined as the wedge of soil between the surface of the wall and a plane inclined 31 degrees from vertical passing through the base of the wall. All clay soils must be completely removed from within the active zone. The following recommendations should be used when dealing with lateral earth pressures on a gravity block: 1) a sliding frictional coefficient of 0.35 is appropriate considering native silt with sand soils, and 2) a sliding frictional coefficient of 0.45 is appropriate considering granular structural fill under typical conditions.

A state of plastic equilibrium is when the subject material is considered to be 1) homogeneous and unbounded and 2) at the point of incipient instability. This state is evaluated on the basis of unit weight, mechanical properties, and the definition of instability. For the purpose of this report, it is assumed that native relatively free draining soils and imported granular fill material will be the materials of concern regarding lateral earth pressures. If other materials are considered for use, Atlas must be contacted to provide alternate lateral earth pressure information. Furthermore, changes in natural soil moisture, such as can be imposed by site stormwater systems, can change the values listed below.

Below-grade restrained walls should be designed based on at-rest pressures. Active pressures are appropriate under conditions where the wall moves or rotates away from the soil mass at failure. Passive pressures are used for conditions where the wall moves toward the soil mass at failure. Rotation, or lateral movement, of the top of the wall equal to 0.002 times the height of the wall will be necessary for on-site soil backfill to achieve an “active” loading condition. Lateral movement of the top of the wall equal to 0.001 times the height of the wall will be necessary for the “active” pressure condition for imported granular structural backfill.

## 6.1 Retaining Wall Backfill Materials: Un-drained Conditions

For lateral earth pressure analysis, Atlas anticipates that the soils of interest will be the onsite native silt with sand soils. Clay soils are not suitable for use as backfill on the soil side of walls. Seismic lateral earth pressures have also been provided in the following tables, and were calculated per the Whitman method. For silt soils, the following values are applicable under non-surcharged, un-drained conditions.

**Table 2 – Lateral Earth Pressure Values for Native Soil**

Soil Type: Silt			
Internal Friction Angle:	28 °	Dry Unit Weight:	105 pcf
Cohesion:	100 psf	Bouyant Unit Weight:	68 pcf
Natural Void Ratio:	0.7	Natural Moisture:	17 %
Ground Acceleration <sup>2</sup> :	0.228	Backfill Slope:	0 °
At rest lateral earth pressure:	99 pcf <sup>1</sup>		K <sub>0</sub> = 0.53
Active lateral earth pressure:	87 pcf <sup>1</sup>		K <sub>a</sub> = 0.36
Passive lateral earth pressure:	252 pcf <sup>1</sup>		K <sub>p</sub> = 2.77
Seismic active lateral earth pressure:	99 pcf <sup>1</sup>		K <sub>ae</sub> = 0.53
Seismic passive lateral earth pressure:	208 pcf <sup>1</sup>		K <sub>pe</sub> = 2.14

<sup>1</sup>Lateral earth pressure values are in pounds per square foot, per foot of wall (psf/ft). Alternately, the values presented may also be considered as equivalent fluid with units of pounds per cubic foot (pcf).

<sup>2</sup>Ground acceleration obtained from the USGS Seismic Design Maps.

Imported, compacted, structural material, which is used to backfill the soil side of walls, must demonstrate the following characteristics:

**Table 3 – Lateral Earth Pressure Values for Fill Materials**

Soil Type: Compacted Sandy Gravel Fill			
Internal Friction Angle:	35 °	Dry Unit Weight:	128 pcf
Cohesion:	N/A	Bouyant Unit Weight:	83 pcf
Natural Void Ratio:	0.4	Natural Moisture:	5 %
Ground Acceleration <sup>2</sup> :	0.228	Backfill Slope:	0 °
At rest lateral earth pressure:	98 pcf <sup>1</sup>		K <sub>0</sub> = 0.43
Active lateral earth pressure:	85 pcf <sup>1</sup>		K <sub>a</sub> = 0.27
Passive lateral earth pressure:	370 pcf <sup>1</sup>		K <sub>p</sub> = 3.69
Seismic active lateral earth pressure:	99 pcf <sup>1</sup>		K <sub>ae</sub> = 0.44
Seismic passive lateral earth pressure:	300 pcf <sup>1</sup>		K <sub>pe</sub> = 2.85

<sup>1</sup>Lateral earth pressure values are in pounds per square foot, per foot of wall (psf/ft). Alternately, the values presented may also be considered as equivalent fluid with units of pounds per cubic foot (pcf).

<sup>2</sup>Ground acceleration obtained from the USGS Seismic Design Maps.

## 6.2 Retaining Wall Backfill Materials: Drained Conditions

For lateral earth pressure analysis, Atlas anticipates that the soils of interest will be the onsite native silt with sand soils. Clay soils are not suitable for use as backfill on the soil side of walls. Seismic lateral earth pressures have also been provided in the following tables, and were calculated per the Whitman method. For silt soils, the following values are applicable under non-surcharged, drained conditions.

**Table 4 – Lateral Earth Pressure Values for Native Soil**

Soil Type: Silt			
Internal Friction Angle:	28 °	Dry Unit Weight:	105 pcf
Cohesion:	100 psf	Bouyant Unit Weight:	68 pcf
Natural Void Ratio:	0.7	Natural Moisture:	17 %
Ground Acceleration <sup>2</sup> :	0.228	Backfill Slope:	0 °
At rest lateral earth pressure:	65 pcf <sup>1</sup>		K <sub>0</sub> = 0.53
Active lateral earth pressure:	44 pcf <sup>1</sup>		K <sub>a</sub> = 0.36
Passive lateral earth pressure:	340 pcf <sup>1</sup>		K <sub>p</sub> = 2.77
Seismic active lateral earth pressure:	65 pcf <sup>1</sup>		K <sub>ae</sub> = 0.53
Seismic passive lateral earth pressure:	263 pcf <sup>1</sup>		K <sub>pe</sub> = 2.14

<sup>1</sup>Lateral earth pressure values are in pounds per square foot, per foot of wall (psf/ft). Alternately, the values presented may also be considered as equivalent fluid with units of pounds per cubic foot (pcf).

<sup>2</sup>Ground acceleration obtained from the USGS Seismic Design Maps.

Imported, compacted, structural material, which is used to backfill the soil side of walls, must demonstrate the following characteristics:

**Table 5 – Lateral Earth Pressure Values for Fill Materials**

Soil Type: Compacted Sandy Gravel Fill			
Internal Friction Angle:	35 °	Dry Unit Weight:	128 pcf
Cohesion:	N/A	Bouyant Unit Weight:	83 pcf
Natural Void Ratio:	0.4	Natural Moisture:	5 %
Ground Acceleration <sup>2</sup> :	0.228	Backfill Slope:	0 °
At rest lateral earth pressure:	57 pcf <sup>1</sup>		K <sub>0</sub> = 0.43
Active lateral earth pressure:	36 pcf <sup>1</sup>		K <sub>a</sub> = 0.27
Passive lateral earth pressure:	496 pcf <sup>1</sup>		K <sub>p</sub> = 3.69
Seismic active lateral earth pressure:	59 pcf <sup>1</sup>		K <sub>ae</sub> = 0.44
Seismic passive lateral earth pressure:	383 pcf <sup>1</sup>		K <sub>pe</sub> = 2.85

<sup>1</sup>Lateral earth pressure values are in pounds per square foot, per foot of wall (psf/ft). Alternately, the values presented may also be considered as equivalent fluid with units of pounds per cubic foot (pcf).

<sup>2</sup>Ground acceleration obtained from the USGS Seismic Design Maps.

Please note that the values for seismic lateral earth pressures are calculated using both the static and seismic coefficients. The effect of seismic conditions alone is the difference between the static and seismic lateral earth pressures presented above. Also, the expected pressure diagram is considered to be an inverted triangular force, with the maximum force at the ground surface.

In the case that another material is used for backfill, Atlas should be consulted for alternate lateral earth pressure values. Granular structural fill should consist of 4-inch-minus select, clean, granular soil with no more than 30 percent oversize (greater than  $\frac{3}{4}$ -inch) material and no more than 5 percent non-plastic fines (passing the No. 200 sieve). Retaining wall and basement backfill must be placed in accordance with recommendations in the **Structural Fill** section of this report and must be properly compacted and tested.

Lateral earth pressure values do not incorporate specific factors of safety, and are only applicable for non-surcharged, drained conditions. Factors of safety, if applicable, should be integrated into the structural design of the wall. The preceding values are presented for idealized conditions relating to simple shallow structures. For complex structures, deep structures, or structures with significant perimeter landscaping, a soils engineer should be retained as part of the design team in developing appropriate project design parameters and construction specifications.

### 6.3 Retaining Wall Drainage

Atlas recommends that a drainage system be incorporated into the retained soil mass. This can be accomplished by installing wall and toe drains as a part of each soil-supporting wall system. In areas where there is potential for significantly high soil moistures within the supported soil mass, installation of drains within the soil mass is recommended. Particular consideration of roof drain effluent and irrigation water must be made. Further, these drainage systems must be separate from other retaining wall/foundation systems. If the granular structural fill option to reduce lateral pressures is used, a compacted low permeability soil cap is recommended within the upper 2 feet of the surface to limit surface water infiltration behind the walls.

## 7. FOUNDATION AND SLAB DISCUSSION AND RECOMMENDATIONS

Various foundation types have been considered for support of the proposed structures. Two requirements must be met in the design of foundations. First, the applied bearing stress must be less than the ultimate bearing capacity of foundation soils to maintain stability. Second, total and differential settlement must not exceed an amount that will produce an adverse behavior of the superstructure. Allowable settlement is usually exceeded before bearing capacity considerations become important; thus, allowable bearing pressure is normally controlled by settlement considerations.

Considering subsurface conditions and the proposed construction, it is recommended that the structure be founded upon conventional spread footings and raft/mat slabs. Total settlements should not exceed 1 inch if the following design and construction recommendations are observed. Atlas was informed by Mr. Chris Boyed with River Structures Consulting, Inc that the planned bottom of the structures will be as follows:

- Pump Intake and Wet Wells: 20 feet bgs with raft/mat slab
- Inlet/Fish Screens: 10 to 14 feet bgs with raft/mat slab
- Fish Ladder Footings: 5 to 6 feet bgs with conventional spread footings

## 7.1 Foundation Design Recommendations

Based on data obtained from the site and test results from various laboratory tests performed, Atlas recommends the following guidelines for the net allowable soil bearing capacity:

**Table 6 – Fish Ladder - Shallow Spread Footings**

Footing Depth	ASTM D1557 Subgrade Compaction	Net Allowable Soil Bearing Capacity
<p>It is anticipated that the bottom of footings for the proposed structures will be approximately 5 to 6 feet below existing ground surface. <u>If foundation depths change, Atlas should be contacted to review settlement calculations.</u> Footings must bear on competent, undisturbed, native silt soils, lean clay soils, or compacted structural fill. Existing fill materials (if encountered) must be completely removed from below foundation elements.<sup>1, 2</sup> <u>These foundation recommendations are only applicable for a maximum foundation width of 5 feet. If a wider foundation is utilized, settlement may exceed 1 inch.</u></p>	<p>Not Required for Native Soil  95% for Structural Fill</p>	<p>1,500 lbs/ft<sup>2</sup>  A 1/3 increase is allowable for short-term loading, which is defined by seismic events or designed wind speeds.</p>

<sup>1</sup>It will be required for Atlas personnel to verify the bearing soil suitability for each structure at the time of construction.

<sup>2</sup>Depending on the time of year construction takes place, the subgrade soils may be unstable because of high moisture contents. If unstable conditions are encountered, over-excavation and replacement with granular structural fill and/or use of geotextiles may be required.

**Table 7 – Pump Station and Inlet Screen – Raft or Mat Slab**

Footing Depth	ASTM D1557 Subgrade Compaction	Net Allowable Soil Bearing Capacity
<p>It is anticipated that pump station foundations will reside approximately 20 feet bgs and inlet screen foundations will reside 10 to 14 feet bgs. The raft or mat slab must bear on at least 12 inches of compacted structural fill. Structural fill should bear on compacted, lean clay soils, or silty sand sediments<sup>1, 2</sup></p>	<p>95% for Native Soils and Structural Fill</p>	<p>1,000 lbs/ft<sup>2</sup></p>

<sup>1</sup>It will be required for Atlas personnel to verify the bearing soil suitability for each structure at the time of construction.

<sup>2</sup>Depending on the time of year construction takes place, the subgrade soils may be unstable because of high moisture contents. If unstable conditions are encountered, over-excavation and replacement with granular structural fill and/or use of geotextiles may be required.

For raft or mat slabs bearing on native fat clay soils, lean clay soils, or silty sand sediments, a modulus of subgrade reaction, k value, of 100 pounds per cubic inch (pci) may be used for the slab design based on correlation to values typically resulting from a 1 foot by 1 foot plate load test. Additionally, for raft or mat slabs bearing on at least 12 inches of compacted structural fill material, a k value of 200 pci may be used. However, depending on how the slab load is applied, the value will need to be geometrically modified. The values should be adjusted for larger areas using the following expression:

$$\text{Modulus of Subgrade Reaction: } k_s = k \left( \frac{B+1}{2B} \right)^2$$

where:  $k_s$  = coefficient of vertical subgrade reaction for loaded area,

$k$  = coefficient of vertical subgrade reaction for a 1 square foot area, and

$B$  = effective width of area loaded, in feet.

$$\text{Modulus of Subgrade Reaction for Rectangular Mat Slabs: } k' = \frac{k_s(1+0.5(\frac{B}{L}))}{1.5}$$

where:  $k'$  = coefficient of vertical subgrade reaction for the loaded rectangular area,

$k_s$  = coefficient of vertical subgrade reaction for loaded square area,

$B$  = effective width of area loaded, in feet,

$L$  = effective length of area loaded, in feet.

Footings should be proportioned to meet either the stated soil bearing capacity or the 2019 OSSC minimum requirements. Total settlement should be limited to approximately 1 inch, and differential settlement should be limited to approximately ½ inch. Objectionable soil types encountered at the bottom of footing excavations should be removed and replaced with structural fill. Excessively loose or soft areas that are encountered in the footings subgrade will require over-excavation and backfilling with structural fill. To minimize the effects of slight differential movement that may occur because of variations in the character of supporting soils and seasonal moisture content, Atlas recommends continuous footings be suitably reinforced to make them as rigid as possible. For frost protection, the bottom of external footings should be 30 inches below finished grade.

## 7.2 General Foundation Recommendations

Based on the proposed depth of foundations, it is highly likely that dewatering will be needed during excavation of foundations. Atlas is available to provide additional recommendations for dewatering if needed. Unstable soils should be expected at foundation depths. Atlas recommends that armoring of the subgrade soils be conducted at subgrade elevations. Atlas has provided additional solutions to soft and unstable soils in the **Soft Subgrade Soils** section of the report. If additional recommendations are required, Atlas may be contacted to provide additional recommendations.

## 7.3 Shallow Floor Slab-on-Grade

Uncontrolled fill was encountered in the vicinity of boring 4. Atlas recommends that these fill materials be removed to a depth of at least 1½ feet below existing grade. If fill materials remain after excavation, the exposed subgrade must be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. The excavated fill materials can be replaced in accordance with the **Structural Fill** section provided that all organic material and/or debris is completely removed. Once final grades have been determined, Atlas is available to provide additional recommendations.

Native clay soils are moderately plastic and will be susceptible to shrink/swell movements associated with moisture changes. The clay soils, if exposed, should be scarified to a depth of 6 inches and compacted between 92 to 98 percent of the maximum dry density as determined by ASTM D698. The moisture content should be within 2 percent of optimum. Structural fill should be placed as soon as possible after compaction of clay soils in order to limit moisture loss within the upper clays. Ground surfaces should be sloped away from structures at a minimum of 5 percent for a distance of 10 feet to provide positive drainage of surface water away from buildings. Grading must be provided and maintained following construction.

Organic, loose, or obviously compressive materials must be removed prior to placement of concrete floors or floor-supporting fill. In addition, the remaining subgrade should be treated in accordance with guidelines presented in the **Earthwork** section. Areas of excessive yielding should be excavated and backfilled with structural fill. Fill used to increase the elevation of the floor slab should meet requirements detailed in the **Structural Fill** section. Fill materials must be compacted to a minimum 95 percent of the maximum dry density as determined by ASTM D1557.

A free-draining granular mat should be provided below slabs-on-grade to provide drainage and a uniform and stable bearing surface. This should be a minimum of 4 inches in thickness and properly compacted. The mat should consist of a sand and gravel mixture, complying with Oregon Department of Transportation (ODOT) specifications for ¾-inch crushed aggregate. The granular mat should be compacted to no less than 95 percent of the maximum dry density as determined by ASTM D1557. A moisture-retarder should be placed beneath floor slabs to minimize potential ground moisture effects on moisture-sensitive floor coverings. The moisture-retarder should be at least 15-mil in thickness and have a permeance of less than 0.01 US perms as determined by ASTM E96. Placement of the moisture-retarder will require special consideration with regard to effects on the slab-on-grade and should adhere to recommendations outlined in the ACI 302.1R and ASTM E1745 publications. Upon request, Atlas can provide further consultation regarding installation.

## 8. CONSTRUCTION CONSIDERATIONS

Recommendations in this report are based upon structural elements of the project being founded on competent, native lean clay soils, fat clay soils, silty sand sediments, silt soils, or compacted structural fill. Structural areas should be stripped to an elevation that exposes these soil types.

### 8.1 Earthwork

Excessively organic soils, deleterious materials, or disturbed soils generally undergo high volume changes when subjected to loads, which is detrimental to subgrade behavior in the area of pavements, floor slabs, structural fills, and foundations. Brush, agricultural crops, and thick grasses with associated root systems were noted at the time of our investigation. It is recommended that organic or disturbed soils, if encountered, be removed to depths of 1 foot (minimum), and wasted or stockpiled for later use. Stripping depths should be adjusted in the field to assure that the entire root zone or disturbed zone or topsoil are removed prior to placement and compaction of structural fill materials. Exact removal depths should be determined during grading operations by Atlas personnel, and should be based upon subgrade soil type, composition, and firmness or soil stability. If underground storage tanks, underground utilities, wells, or septic systems are discovered during construction activities, they must be decommissioned then removed or abandoned in accordance with governing Federal, State, and local agencies. Excavations developed as the result of such removal must be backfilled with structural fill materials as defined in the **Structural Fill** section.

Atlas should oversee subgrade conditions (i.e., moisture content) as well as placement and compaction of new fill (if required) after native soils are excavated to design grade. Recommendations for structural fill presented in this report can be used to minimize volume changes and differential settlements that are detrimental to the behavior of footings, pavements, and floor slabs. Sufficient density tests should be performed to properly monitor compaction. For structural fill beneath building structures, one in-place density test per lift for every 5,000 square feet is recommended. In parking and driveway areas, this can be decreased to one test per lift for every 10,000 square feet.

## 8.2 Dry Weather

If construction is to be conducted during dry seasonal conditions, many problems associated with soft soils may be avoided. However, some rutting of subgrade soils may be induced by shallow groundwater conditions related to springtime runoff or irrigation activities during late summer through early fall. Solutions to problems associated with soft subgrade soils are outlined in the **Soft Subgrade Soils** section. Problems may also arise because of lack of moisture in native and fill soils at time of placement. This will require the addition of water to achieve near-optimum moisture levels. Low-cohesion soils exposed in excavations may become friable, increasing chances of sloughing or caving. Measures to control excessive dust should be considered as part of the overall health and safety management plan.

## 8.3 Wet Weather

If construction is to be conducted during wet seasonal conditions (commonly from mid-November through May), problems associated with soft soils must be considered as part of the construction plan. During this time of year, fine-grained soils such as silts and clays will become unstable with increased moisture content, and eventually deform or rut. Additionally, constant low temperatures reduce the possibility of drying soils to near optimum conditions.

## 8.4 Soft Subgrade Soils

Shallow fine-grained subgrade soils that are high in moisture content should be expected to pump and rut under construction traffic. During periods of wet weather, construction may become very difficult if not impossible. The following recommendations and options have been included for dealing with soft subgrade conditions:

- Track-mounted vehicles should be used to strip the subgrade of root matter and other deleterious debris. Heavy rubber-tired equipment should be prohibited from operating directly on the native subgrade and areas in which structural fill materials have been placed. Construction traffic should be restricted to designated roadways that do not cross, or cross on a limited basis, proposed roadway or parking areas.
- Soft areas can be over-excavated and replaced with granular structural fill.
- Construction roadways on soft subgrade soils should consist of a minimum 2-foot thickness of large cobbles of 4 to 6 inches in diameter with sufficient sand and fines to fill voids. Construction entrances should consist of a 6-inch thickness of clean, 2-inch minimum, angular drain-rock and must be a minimum of 10 feet wide and 30 to 50 feet long. During the construction process, top dressing of the entrance may be required for maintenance.
- Scarification and aeration of subgrade soils can be employed to reduce the moisture content of wet subgrade soils. After stripping is complete, the exposed subgrade should be ripped or disked to a depth of 1½ feet and allowed to air dry for 2 to 4 weeks. Further disking should be performed on a weekly basis to aid the aeration process.
- Alternative soil stabilization methods include use of geotextiles, lime, and cement stabilization. Atlas is available to provide recommendations and guidelines at your request.

## 8.5 Frozen Subgrade Soils

Prior to placement of structural fill materials or foundation elements, frozen subgrade soils must either be allowed to thaw or be stripped to depths that expose non-frozen soils and wasted or stockpiled for later use. Stockpiled materials must be allowed to thaw and return to near-optimal conditions prior to use as structural fill.

The onsite, shallow clayey and silty soils are susceptible to frost heave during freezing temperatures. For exterior flatwork and other structural elements, adequate drainage away from subgrades is critical. Compaction and use of structural fill will also help to mitigate the potential for frost heave. Complete removal of frost susceptible soils for the full frost depth, followed by replacement with a non-frost susceptible structural fill, can also be used to mitigate the potential for frost heave. Atlas is available to provide further guidance/assistance upon request.

## 8.6 Structural Fill

Soils recommended for use as structural fill are those classified as GW, GP, SW, and SP in accordance with the Unified Soil Classification System (USCS) (ASTM D2487). Use of silty soils (USCS designation of GM, SM, and ML) as structural fill may be acceptable. However, use of silty soils (GM, SM, and ML) as structural fill below footings is prohibited. These materials require very high moisture contents for compaction and require a long time to dry out if natural moisture contents are too high and may also be susceptible to frost heave under certain conditions. Therefore, these materials can be quite difficult to work with as moisture content, lift thickness, and compactive effort becomes difficult to control. If silty soil is used for structural fill, lift thicknesses should not exceed 6 inches (loose), and fill material moisture must be closely monitored at both the working elevation and the elevations of materials already placed. Following placement, silty soils must be protected from degradation resulting from construction traffic or subsequent construction.

Recommended granular structural fill materials, those classified as GW, GP, SW, and SP, should consist of a 6-inch minus select, clean, granular soil with no more than 50 percent oversize (greater than ¾-inch) material and no more than 12 percent fines (passing No. 200 sieve). These fill materials should be placed in layers not to exceed 12 inches in loose thickness. Prior to placement of structural fill materials, surfaces must be prepared as outlined in the **Construction Considerations** section. Structural fill material should be moisture-conditioned to achieve optimum moisture content prior to compaction. For structural fill below footings, areas of compacted backfill must extend outside the perimeter of the footings for a distance equal to the thickness of fill between the bottom of foundation and underlying soils, or 5 feet, whichever is less. All fill materials must be monitored during placement and tested to confirm compaction requirements, outlined below, have been achieved.

Each layer of structural fill must be compacted, as outlined below:

- Below Structures and Rigid Pavements: A minimum of 95 percent of the maximum dry density as determined by ASTM D1557.
- Below Flexible Pavements: A minimum of 92 percent of the maximum dry density as determined by ASTM D1557 or 95 percent of the maximum dry density as determined by ASTM D698.

The ASTM D1557 test method must be used for samples containing up to 40 percent oversize (greater than  $\frac{3}{4}$ -inch) particles. If material contains more than 40 percent but less than 50 percent oversize particles, compaction of fill must be confirmed by proof rolling each lift with a 10-ton vibratory roller (or equivalent) until the maximum density has been achieved. Density testing must be performed after each proof rolling pass until the in-place density test results indicate a drop (or no increase) in the dry density, defined as maximum density or “break over” point. The number of required passes should be used as the requirements on the remainder of fill placement. Material should contain sufficient fines to fill void spaces, and must not contain more than 50 percent oversize particles.

## 8.7 Backfill of Walls

Backfill materials must conform to the requirements of structural fill, as defined in this report. For wall heights greater than 2.5 feet, the maximum material size should not exceed 4 inches in diameter. Placing oversized material against rigid surfaces interferes with proper compaction, and can induce excessive point loads on walls. Backfill shall not commence until the wall has gained sufficient strength to resist placement and compaction forces. Further, retaining walls above 2.5 feet in height shall be backfilled in a manner that will limit the potential for damage from compaction methods and/or equipment. It is recommended that only small hand-operated compaction equipment be used for compaction of backfill within a horizontal distance equal to the height of the wall, measured from the back face of the wall.

Backfill should be compacted in accordance with the specifications for structural fill, except in those areas where it is determined that future settlement is not a concern, such as planter areas. In nonstructural areas, backfill must be compacted to a firm and unyielding condition.

## 8.8 Excavations

Shallow excavations that do not exceed 4 feet in depth may be constructed with side slopes approaching vertical. Below this depth, it is recommended that slopes be constructed in accordance with Occupational Safety and Health Administration (OSHA) regulations, Section 1926, Subpart P. Based on these regulations, on-site soils are classified as type “C” soil, and as such, excavations within these soils should be constructed at a maximum slope of 1½ feet horizontal to 1 foot vertical (1½:1) for excavations up to 20 feet in height. Excavations in excess of 20 feet will require additional analysis. Note that these slope angles are considered stable for short-term conditions only, and will not be stable for long-term conditions.

During the subsurface exploration, boring sidewalls generally exhibited little indication of collapse; however, sloughing of native granular sediments from boring sidewalls was observed, particularly after penetration of the water table. For deep excavations, native granular sediments cannot be expected to remain in position. These materials are prone to failure and may collapse, thereby undermining upper soil layers. This is especially true when excavations approach depths near the water table. Care must be taken to ensure that excavations are properly backfilled in accordance with procedures outlined in this report.

## 8.9 Groundwater Control

Groundwater was encountered during the investigation and may be higher than the depth of some construction. Excavations below the water table will require a dewatering program. Dewatering will be required prior to placement of fill materials. Placement of concrete can be accomplished through water by the use of a tremie. It may be possible to discharge dewatering effluent to remote portions of the site, to a sump, or to a pit. This will essentially recycle effluent, thus eliminating the need to enter into agreements with local drainage authorities. Should the scope of the proposed project change, Atlas should be contacted to provide more detailed groundwater control measures.

Special precautions may be required for control of surface runoff and subsurface seepage. It is recommended that runoff be directed away from open excavations. Silty and clayey soils may become soft and pump if subjected to excessive traffic during time of surface runoff. Pondered water in construction areas should be drained through methods such as trenching, sloping, crowning grades, nightly smooth drum rolling, or installing a French drain system. Additionally, temporary or permanent driveway sections should be constructed if extended wet weather is forecasted.

## 9. GENERAL COMMENTS

Based on the subsurface conditions encountered during this investigation and available information regarding the proposed structures, the site is adequate for the planned construction. When plans and specifications are complete, and if significant changes are made in the character or location of the proposed structures, consultation with Atlas must be arranged as supplementary recommendations may be required. Suitability of subgrade soils and compaction of structural fill materials must be verified by Atlas personnel prior to placement of structural elements. Additionally, monitoring and testing should be performed to verify that suitable materials are used for structural fill and that proper placement and compaction techniques are utilized.

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## Appendix I      WARRANTY AND LIMITING CONDITIONS

Atlas warrants that findings and conclusions contained herein have been formulated in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics, and engineering geology only for the site and project described in this report. These engineering methods have been developed to provide the client with information regarding apparent or potential engineering conditions relating to the site within the scope cited above and are necessarily limited to conditions observed at the time of the site visit and research. Field observations and research reported herein are considered sufficient in detail and scope to form a reasonable basis for the purposes cited above.

### **Exclusive Use**

**This report was prepared for exclusive use of the property owner(s), at the time of the report, and their retained design consultants (“Client”).** Conclusions and recommendations presented in this report are based on the agreed-upon scope of work outlined in this report together with the Contract for Professional Services between the Client and Materials Testing and Inspection (“Consultant”). Use or misuse of this report, or reliance upon findings hereof, by parties other than the Client is at their own risk. Neither Client nor Consultant make representation of warranty to such other parties as to accuracy or completeness of this report or suitability of its use by such other parties for purposes whatsoever, known or unknown, to Client or Consultant. Neither Client nor Consultant shall have liability to indemnify or hold harmless third parties for losses incurred by actual or purported use or misuse of this report. No other warranties are implied or expressed.

### **Report Recommendations are Limited and Subject to Misinterpretation**

There is a distinct possibility that conditions may exist that could not be identified within the scope of the investigation or that were not apparent during our site investigation. Findings of this report are limited to data collected from noted explorations advanced and do not account for unidentified fill zones, unsuitable soil types or conditions, and variability in soil moisture and groundwater conditions. To avoid possible misinterpretations of findings, conclusions, and implications of this report, Atlas should be retained to explain the report contents to other design professionals as well as construction professionals.

Since actual subsurface conditions on the site can only be verified by earthwork, note that construction recommendations are based on general assumptions from selective observations and selective field exploratory sampling. Upon commencement of construction, such conditions may be identified that require corrective actions, and these required corrective actions may impact the project budget. Therefore, construction recommendations in this report should be considered preliminary, and Atlas should be retained to observe actual subsurface conditions during earthwork construction activities to provide additional construction recommendations as needed.

Since geotechnical reports are subject to misinterpretation, **do not** separate the soil logs from the report. Rather, provide a copy of, or authorize for their use, the complete report to other design



professionals or contractors. Locations of exploratory sites referenced within this report should be considered approximate locations only. For more accurate locations, services of a professional land surveyor are recommended.

This report is also limited to information available at the time it was prepared. In the event additional information is provided to Atlas following publication of our report, it will be forwarded to the client for evaluation in the form received.

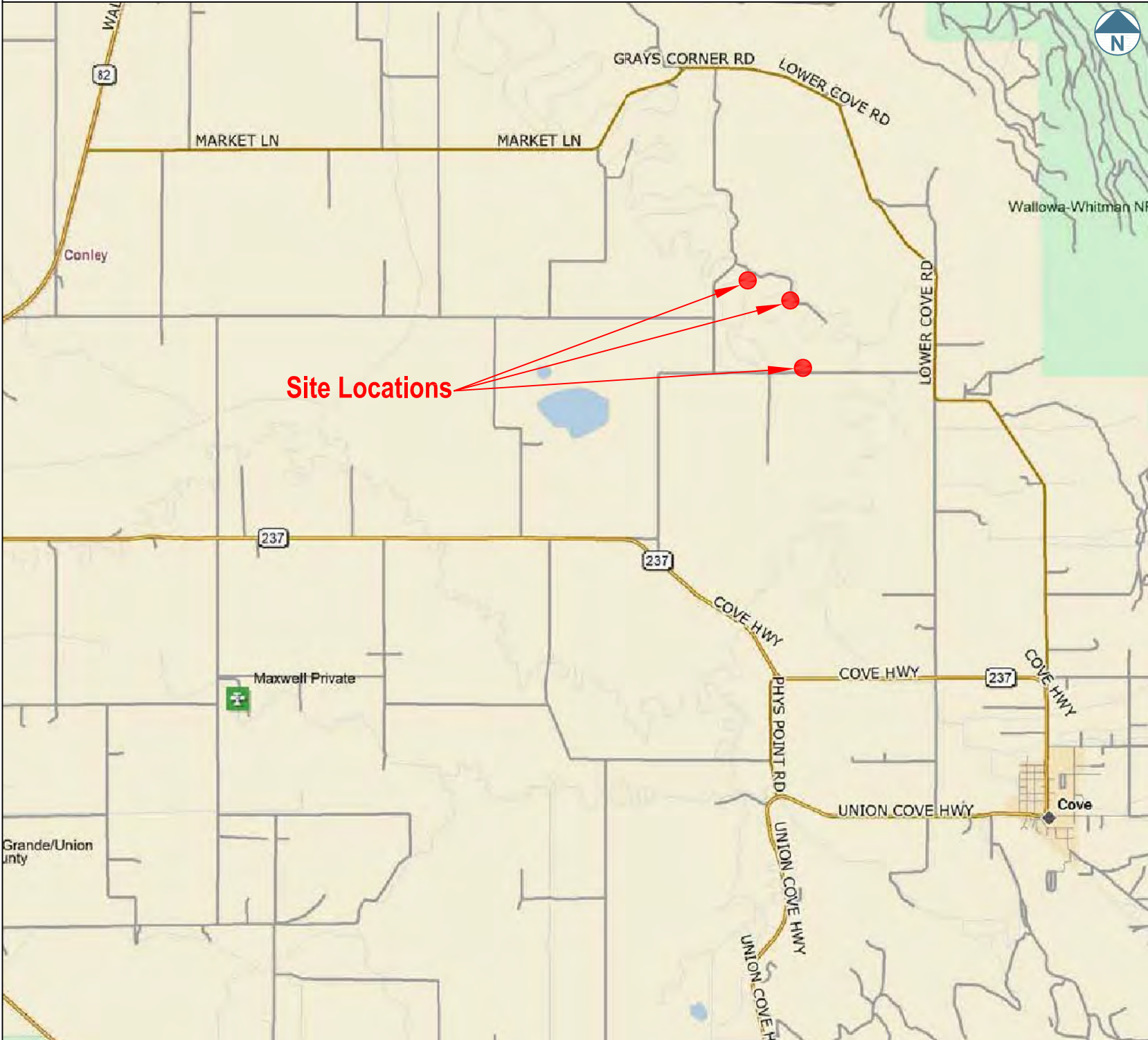
### **Environmental Concerns**

Comments in this report concerning either onsite conditions or observations, including soil appearances and odors, are provided as general information. These comments are not intended to describe, quantify, or evaluate environmental concerns or situations. Since personnel, skills, procedures, standards, and equipment differ, a geotechnical investigation report is not intended to substitute for a geoenvironmental investigation or a Phase II/III Environmental Site Assessment. If environmental services are needed, Atlas can provide, via a separate contract, those personnel who are trained to investigate and delineate soil and water contamination.



# Vicinity Map

# Figure 1



### MAP NOTES:

- Delorme Street Atlas
- Not to Scale

### LEGEND

- Approximate Site Location ●

**Site Locations**

### Elmer Dam Renovations

Booth Lane  
La Grande, OR

Modified from DeLorme by: JBS  
March 2, 2021  
Drawing: B210090g





**NOTES:**

- Not to Scale

**LEGEND**

Approximate Atlas Boring Location

**Elmer Dam Renovations**

Booth Lane  
La Grande, OR

Modified by: JBS  
May 3, 2021  
Drawing: B210090g

**ATLAS**

2791 S. Victory View Way Phone: (208) 376-4748  
Boise, ID 83709 Fax: (208) 322-6515  
Web: oneatlas.com



# FIELD BORING LOG

**BORING NO.:** B-1  
**TOTAL DEPTH:** 21.5'

## PROJECT INFORMATION

**PROJECT:** Elmer Dam Renovations  
**LOCATION:** Elmer Dam  
 La Grande, OR  
**JOB NO.:** B210090g  
**LOGGED BY:** Brian Ronan, EI

## DRILLING INFORMATION

**DRILLING CO.:** Haztech Drilling, Inc.  
**METHOD OF DRILLING:** 6" Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon  
**DATES DRILLED:** April 12, 2021  
**LATITUDE/LONGITUDE:** 45.368107, -117.863251

Water level during drilling    
 Standard Split Spoon    
 Auger Sample    
 California Sampler

DEPTH	SOIL TYPE	DESCRIPTION	MOISTURE (%)	LL/PI	% < #4	% < #200	SAMPLE	BLOWS	BLOWS PER FOOT (N)
0		<b>EG 2689 +- SILT WITH SAND (ML):</b> Brown to light brown, dry to slightly moist, stiff, with fine-grained sand.						4,6,5	
5		<b>LEAN CLAY WITH SAND (CL):</b> Brown, dry to saturated, soft to stiff, with fine-grained sand.						4,5,5	
9.3		Groundwater encountered at 9.3 feet bgs.						1,2,1	
10		<b>FAT CLAY WITH SAND (CH):</b> Brown to light brown, saturated, soft to medium stiff, with fine to medium-grained sand.						0,1,3	
15								1,1,4	
20		<b>LEAN CLAY (CL):</b> Dark gray to dark brown, saturated, very stiff, with fine-grained sand.						5,9,10	



# FIELD BORING LOG

**BORING NO.:** B-2  
**TOTAL DEPTH:** 36.5'

## PROJECT INFORMATION

**PROJECT:** Elmer Dam Renovations  
**LOCATION:** Elmer Dam  
 La Grande, OR  
**JOB NO.:** B210090g  
**LOGGED BY:** Brian Ronan, EI

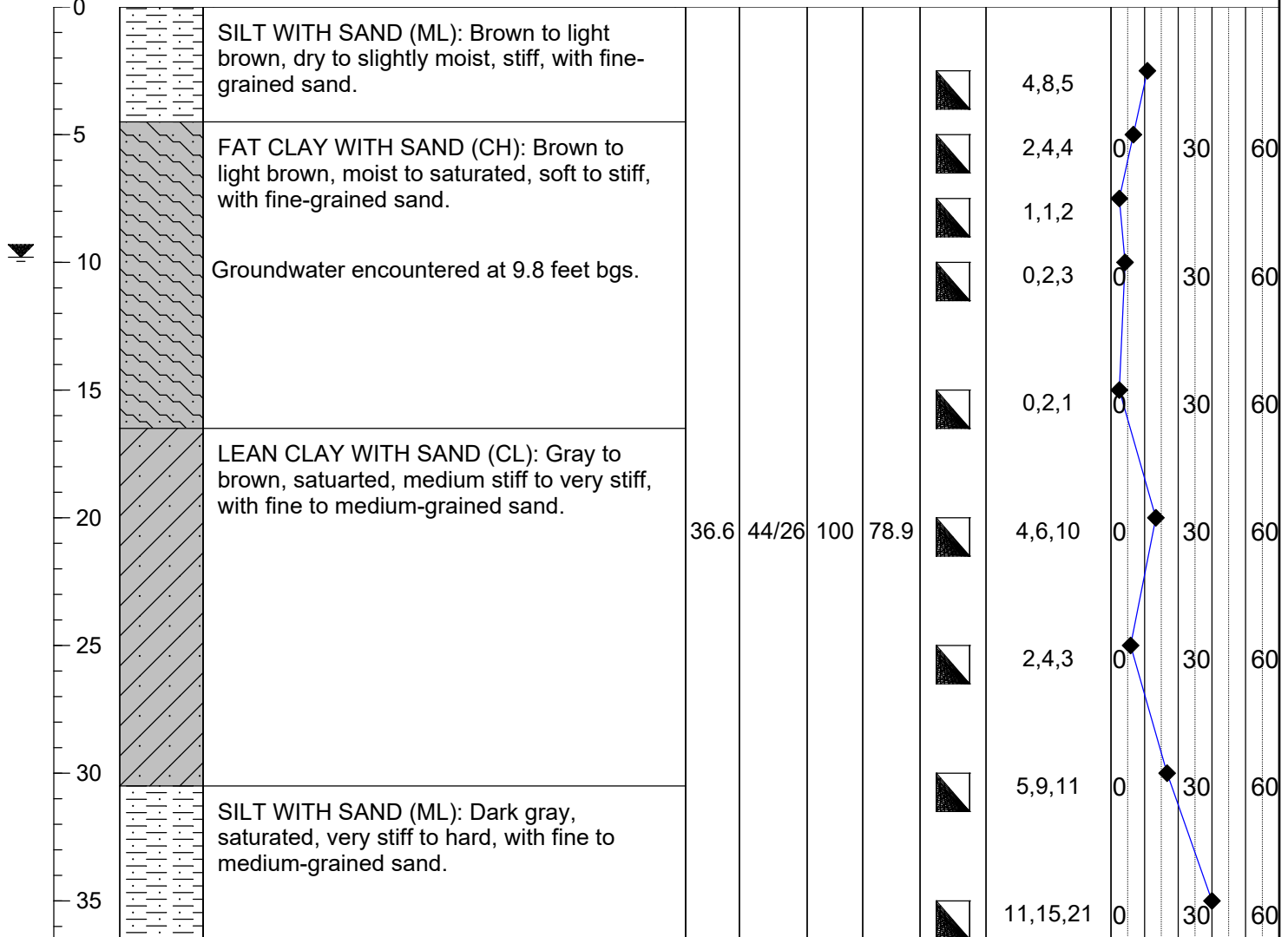
## DRILLING INFORMATION

**DRILLING CO.:** Haztech Drilling, Inc.  
**METHOD OF DRILLING:** 6" Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon  
**DATES DRILLED:** April 12, 2021  
**LATITUDE/LONGITUDE:** 45.368038, -117.863106

Water level during drilling    
 Standard Split Spoon    
 Auger Sample    
 California Sampler

DEPTH	SOIL TYPE	DESCRIPTION	MOISTURE (%)	LL/PI	% < #4	% < #200	SAMPLE	BLOWS	BLOWS PER FOOT (N)
0									
0 - 5	SILT WITH SAND (ML)	Brown to light brown, dry to slightly moist, stiff, with fine-grained sand.						4,8,5	
5 - 16	FAT CLAY WITH SAND (CH)	Brown to light brown, moist to saturated, soft to stiff, with fine-grained sand.						2,4,4	
9.8		Groundwater encountered at 9.8 feet bgs.						1,1,2	
16 - 20								0,2,3	
20 - 30	LEAN CLAY WITH SAND (CL)	Gray to brown, saturated, medium stiff to very stiff, with fine to medium-grained sand.	36.6	44/26	100	78.9		0,2,1	
30 - 33								4,6,10	
33 - 35	SILT WITH SAND (ML)	Dark gray, saturated, very stiff to hard, with fine to medium-grained sand.						2,4,3	
35 - 36.5								5,9,11	
36.5								11,15,21	

EG 2689 +/-





# FIELD BORING LOG

**BORING NO.:** B-3  
**TOTAL DEPTH:** 21.5'

## PROJECT INFORMATION

**PROJECT:** Elmer Dam Renovations  
**LOCATION:** Elmer Dam  
 La Grande, OR  
**JOB NO.:** B210090g  
**LOGGED BY:** Brian Ronan, EI

## DRILLING INFORMATION

**DRILLING CO.:** Haztech Drilling, Inc.  
**METHOD OF DRILLING:** 6" Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon  
**DATES DRILLED:** April 12, 2021  
**LATITUDE/LONGITUDE:** 45.364460, -117.855110

Water level during drilling    
 Standard Split Spoon    
 Auger Sample    
 California Sampler

DEPTH	SOIL TYPE	DESCRIPTION	MOISTURE (%)	LL/PI	% < #4	% < #200	SAMPLE	BLOWS	BLOWS PER FOOT (N)		
0	SILT (ML): Brown to light brown, dry to moist, soft to stiff, with fine-grained sand.							2,3,4			
5								4,5,4	0	30	60
10								5,6,5			
10								5,3,1	0	30	60
15	FAT CLAY WITH SAND (CH): Brown to dark gray, moist to saturated, soft to medium stiff, with fine to medium-grained sand.		47.8	54/26	100	74.0		0,0,2	0	30	60
18.8							Groundwater encountered at 18.8 feet bgs.				
20								0,1,3	0	30	60



# FIELD BORING LOG

**BORING NO.:** B-4  
**TOTAL DEPTH:** 36.5'

## PROJECT INFORMATION

**PROJECT:** Elmer Dam Renovations  
**LOCATION:** Elmer Dam  
 La Grande, OR  
**JOB NO.:** B210090g  
**LOGGED BY:** Brian Ronan, EI

## DRILLING INFORMATION

**DRILLING CO.:** Haztech Drilling, Inc.  
**METHOD OF DRILLING:** 6" Hollow Stem Auger  
**SAMPLING METHODS:** Split Spoon  
**DATES DRILLED:** April 12, 2021  
**LATITUDE/LONGITUDE:** 45.355030, -117.844627

Water level during drilling    
 Standard Split Spoon    
 Auger Sample    
 California Sampler

DEPTH	SOIL TYPE	DESCRIPTION	MOISTURE (%)	LL/PI	% < #4	% < #200	SAMPLE	BLOWS	BLOWS PER FOOT (N)
0 - 2.5	SP-FILL	POORLY GRADED SAND WITH GRAVEL FILL (SP-FILL): Light brown, dry to slightly moist, medium dense to dense, with fine to coarse-grained sand and fine to coarse gravel.					1,2,5	0	0
2.5 - 6.5	CL	LEAN CLAY (CL): Brown, dry to slightly moist, medium stiff, with fine-grained sand.					11,8,5	0	30
6.5 - 10.5	ML	SILT WITH SAND (ML): Brown to light brown, slightly moist to moist, medium stiff to stiff, with fine-grained sand.					0,1,2	0	30
10.5 - 15.5	CH	FAT CLAY WITH SAND (CH): Brown, slightly moist to moist, soft to stiff, with fine-grained sand.					1,1,3	0	30
15.5 - 21.5	CH	FAT CLAY WITH SAND (CH): Brown, slightly moist to moist, soft to stiff, with fine-grained sand.					2,3,4	0	30
21.5 - 24.4	SM	SILTY SAND (SM): Dark reddish brown, moist to saturated, loose to medium dense, with fine to medium-grained sand.					2,3,5	0	30
24.4 - 35.5	CL	SANDY LEAN CLAY (CL): Dark gray to dark brown, saturated, hard, with fine-grained sand.					2,9,14	0	30
35.5 - 36.5	CL	SANDY LEAN CLAY (CL): Dark gray to dark brown, saturated, hard, with fine-grained sand.					0,1,7	0	30
36.5	CL	SANDY LEAN CLAY (CL): Dark gray to dark brown, saturated, hard, with fine-grained sand.					6,20,30	0	60



## Appendix V GEOTECHNICAL GENERAL NOTES

Unified Soil Classification System			
Major Divisions		Symbol	Soil Descriptions
Coarse-Grained Soils < 50% passes No.200 sieve	Gravel & Gravelly Soils < 50% coarse	GW	Well-graded gravels; gravel/sand mixtures with little or no fines
		GP	Poorly-graded gravels; gravel/sand mixtures with little or no fines
		GM	Silty gravels; poorly-graded gravel/sand/silt mixtures
		GC	Clayey gravels; poorly-graded gravel/sand/clay mixtures
	Sand & Sandy Soils > 50% coarse fraction	SW	Well-graded sands; gravelly sands with little or no fines
		SP	Poorly-graded sands; gravelly sands with little or no fines
		SM	Silty sands; poorly-graded sand/gravel/silt mixtures
Fine-Grained Soils > 50% passes No.200 sieve	Sils & Clays LL < 50	SC	Clayey sands; poorly-graded sand/gravel/clay mixtures
		ML	Inorganic silts; sandy, gravelly or clayey silts
		CL	Lean clays; inorganic, gravelly, sandy, or silty, low to medium-plasticity clays
	Sils & Clays LL > 50	OL	Organic, low-plasticity clays and silts
		MH	Inorganic, elastic silts; sandy, gravelly or clayey elastic silts
		CH	Fat clays; high-plasticity, inorganic clays
Highly Organic Soils		OH	Organic, medium to high-plasticity clays and silts
		PT	Peat, humus, hydric soils with high organic content

Relative Density and Consistency Classification	
Coarse-Grained Soils	SPT Blow Counts (N)
Very Loose:	< 4
Loose:	4-10
Medium Dense:	10-30
Dense:	30-50
Very Dense:	> 50
Fine-Grained Soils	
SPT Blow Counts (N)	
Very Soft:	< 2
Soft:	2-4
Medium Stiff:	4-8
Stiff:	8-15
Very Stiff:	15-30
Hard:	> 30

Moisture Content and Cementation Classification	
Description	Field Test
Dry	Absence of moisture, dry to touch
Slightly Moist	Damp, but no visible moisture
Moist	Visible moisture
Wet	Visible free water
Saturated	Soil is usually below water table
Description	
Field Test	
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Particle Size	
Boulders:	> 12 in.
Cobbles:	12 to 3 in.
Gravel:	3 in. to 5 mm
Coarse-Grained Sand:	5 to 0.6 mm
Medium-Grained Sand:	0.6 to 0.2 mm
Fine-Grained Sand:	0.2 to 0.075 mm
Silts:	0.075 to 0.005 mm
Clays:	< 0.005 mm

Acronym List	
GS	grab sample
LL	Liquid Limit
M	moisture content
NP	non-plastic
PI	Plasticity Index
Q <sub>p</sub>	penetrometer value, unconfined compressive strength, tsf
V	vane value, ultimate shearing strength, tsf

# Important Information about This

# Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

**The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.**

## Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

## Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

## Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

## You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

### Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

### This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

### This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

### Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

*conspicuously that you’ve included the material for information purposes only.* To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

### Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

### Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

### Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* **Confront the risk of moisture infiltration** by including building-envelope or mold specialists on the design team. **Geotechnical engineers are not building-envelope or mold specialists.**



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**Appendix 7.5**  
**Spillway Seepage and Stability Analysis**



**River Structures**  
CONSULTING

www.riverstructures.com

PROJECT ELMER DAM

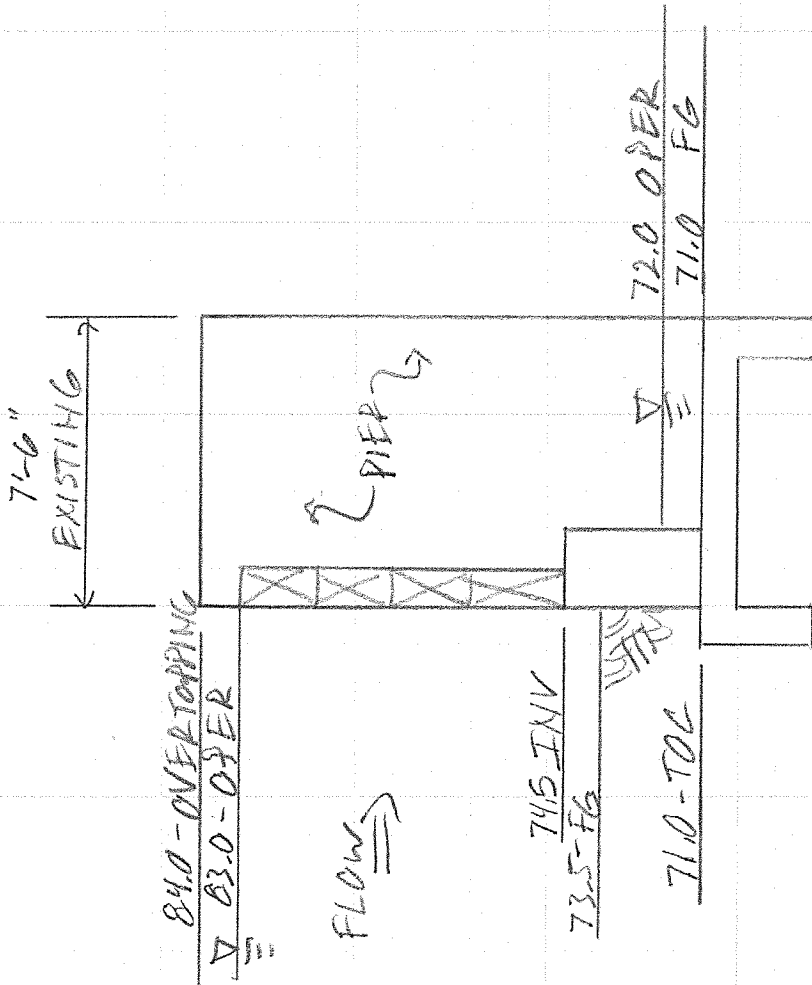
DESCRIPTION STABILITY ANALYSIS

PREPARED BY C. BOYD

DATE 8/27/21

CHECKED \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_



ASSUMPTIONS:

- SUBMERGED SOIL,  $\gamma_o = 101$  PCF,  $\gamma_p = 296$  PCF
- SEEPAGE CREEP RATIO,  $C_w = \frac{L_w}{H_w T_w} \geq 4.0$

- ESTIMATE UPLIFT PRESSURES PER CREEP THEORY



**METHODOLOGY:** For the construction improvements, a portion of the dam between the existing spillway and the existing fishway will be removed, in addition to the fishway. A new 6-ft wide auxiliary spillway will be installed adjacent to the existing spillway pier. A new fishway will be installed to the left of the new auxiliary spillway. It is assumed that the new fishway will provide ample mass to prevent sliding and overturning on the left side of the new spillway (to be confirmed), but the pier between the spillway needs to be check.

For the design assumptions below, the 'x' distance is measured from the downstream toe of the footing.

$$\gamma_c := 150 \text{ pcf}$$

$$\gamma_w := 62.4 \text{ pcf}$$

Assumed Soil Properties

$$\gamma_{soil} := 125 \text{ pcf}$$

$$G_{soil} := 2.65$$

Density of Water

$$\gamma_w := 62.4 \text{ pcf}$$

$$G_{water} := 1.0$$

Buoyancy Weight of Soil

$$\gamma_{buoy} := \frac{G_{soil} - G_{water}}{G_{soil}} \cdot \gamma_{soil} = 78 \text{ pcf}$$

At Rest Soil:

$$K_o := 0.5$$

$$\gamma_{sat\_o} := \gamma_w + K_o \cdot \gamma_{buoy} = 101 \text{ pcf}$$

Passive Soil:

$$K_p := 3.0$$

$$\gamma_{sat\_p} := \gamma_w + K_p \cdot \gamma_{buoy} = 296 \text{ pcf}$$

### Water and Soil Pressure - Normal Operating Condition

Forebay Water Surface Elevation

$$wsel_{op} := 83 \text{ ft}$$

Tailrace Water Surface Elevation

$$wsel_{tr} := 72 \text{ ft}$$

Forebay Soil Elevation

$$soil_{fb} := 73.5 \text{ ft}$$

Tailrace Soil Elevation

$$soil_{tr} := 71 \text{ ft}$$

### Dam Properties

Top of Footing Elevation

$$el_{tof} := 71 \text{ ft}$$

Top of Dam Elevation

$$el_{tod} := 84 \text{ ft}$$

Existing Spillway Width

$$B_{es} := 20 \text{ ft}$$

Existing Pier

$$B_{ep} := 9 \text{ in}$$

$$L_{ep} := 7.5 \text{ ft}$$

$$H_{ep} := el_{tod} - el_{tof} = 13 \text{ ft}$$

New Spillway Width

$$B_{ns} := 6 \text{ ft}$$

New Pier

$$B_{np} := 9 \text{ in}$$

$$L_{np} := 7.5 \text{ ft}$$

$$H_{np} := el_{tod} - el_{tof} = 13 \text{ ft}$$



Sill Dimensions

$$L_{sill} := 12 \text{ in}$$

$$B_{sill} := B_{ns} = 6 \text{ ft}$$

$$el_{tos} := 74.5 \text{ ft}$$

Footing Dimensions

$$L_{heel} := 5 \text{ ft}$$

$$L_{toe} := 9 \text{ ft}$$

$$H_{ftg} := 18 \text{ in}$$

$$L_{ftg} := L_{heel} + L_{sill} + L_{toe} = 15 \text{ ft}$$

$$B_{ftg} := \frac{B_{es}}{2} + B_{ep} + B_{np} + \frac{B_{ns}}{2} = 14.5 \text{ ft}$$

Keyway Dimensions

Heel

$$L_{hk} := 0.5 \text{ in}$$

$$H_{hk} := 20 \text{ ft}$$

Toe

$$L_{tk} := 24 \text{ in}$$

$$H_{tk} := 3 \text{ ft}$$

Toe Keyway

$$W_{tk} := L_{tk} \cdot (H_{tk} - H_{ftg}) \cdot B_{ftg} \cdot \gamma_c = 6.53 \text{ kip}$$

$$x_{tk} := 0.5 L_{tk} = 1 \text{ ft}$$

$$M_{tk} := W_{tk} \cdot x_{tk} = 6.53 \text{ kip} \cdot \text{ft}$$

Heel Keyway - Assume Vinyl Sheet Pile

$$\gamma_{hk} := 1.43 \cdot \gamma_w = 89.23 \text{ pcf}$$

$$W_{hk} := L_{hk} \cdot (H_{hk} - H_{ftg}) \cdot B_{ftg} \cdot \gamma_{hk} = 1 \text{ kip}$$

$$x_{hk} := L_{ftg} - 0.5 L_{hk} = 14.98 \text{ ft}$$

$$M_{hk} := W_{hk} \cdot x_{hk} = 14.94 \text{ kip} \cdot \text{ft}$$

Footing

$$W_{ftg} := L_{ftg} \cdot H_{ftg} \cdot B_{ftg} \cdot \gamma_c = 48.94 \text{ kip}$$

$$x_{ftg} := \frac{B_{ftg}}{2} = 7.25 \text{ ft}$$

$$M_{ftg} := W_{ftg} \cdot x_{ftg} = 354.8 \text{ kip} \cdot \text{ft}$$

Existing Pier

$$W_{ep} := L_{ep} \cdot H_{ep} \cdot B_{ep} \cdot \gamma_c = 10.97 \text{ kip}$$

$$x_{ep} := L_{ftg} - L_{heel} - \frac{L_{ep}}{2} = 6.25 \text{ ft}$$

$$M_{ep} := W_{ep} \cdot x_{ep} = 68.55 \text{ kip} \cdot \text{ft}$$

New Pier

$$W_{np} := L_{np} \cdot H_{np} \cdot B_{np} \cdot \gamma_c = 10.97 \text{ kip}$$

$$x_{np} := L_{ftg} - L_{heel} - \frac{L_{np}}{2} = 6.25 \text{ ft}$$

$$M_{np} := W_{np} \cdot x_{np} = 68.55 \text{ kip} \cdot \text{ft}$$

New Sill

$$W_{sill} := L_{sill} \cdot (el_{tos} - el_{tof}) \cdot B_{sill} \cdot \gamma_c = 3.15 \text{ kip}$$

$$x_{sill} := L_{ftg} - L_{heel} - \frac{L_{sill}}{2} = 9.5 \text{ ft}$$

$$M_{sill} := W_{sill} \cdot x_{sill} = 29.93 \text{ kip} \cdot \text{ft}$$



Spillway Access Platform (steel framing)  $w_{pltfm} := 20 \text{ plf}$   $W_{pltfm} := w_{pltfm} \cdot B_{ftg} = 0.29 \text{ kip}$

$$x_{pltfm} := L_{ftg} - L_{heel} - 1.5 \text{ ft} = 8.5 \text{ ft} \quad M_{pltfm} := W_{pltfm} \cdot x_{pltfm} = 2.47 \text{ kip} \cdot \text{ft}$$

Spillway Gate and Operator  $W_{gate} := 1000 \text{ lbf}$

$$x_{gate} := L_{ftg} - L_{heel} - \frac{L_{sill}}{2} = 9.5 \text{ ft} \quad M_{gate} := W_{gate} \cdot x_{gate} = 9.5 \text{ kip} \cdot \text{ft}$$

### Uplift Pressures - Based on Creep Theory

Relative Seepage Coefficients  $k_v := 1$   $k_h := 3$

Weighted Creep Length  $L_w := \left( \frac{k_v}{k_h} \right) \cdot L_{ftg} + H_{hk} + H_{tk} + (H_{hk} - H_{ftg}) + (H_{tk} - H_{ftg}) = 48 \text{ ft}$

Upstream Cutoff - US Bottom  $HP_1 := e_{lof} - H_{hk} = 51 \text{ ft}$   $LP_{w1} := H_{hk} = 20 \text{ ft}$

Seepage Potential  $SP_1 := (w_{sel_{op}} - w_{sel_{tr}}) \cdot \left( \frac{L_w - LP_{w1}}{L_w} \right) = 6.42 \text{ ft}$

Position Potential  $PP_1 := w_{sel_{tr}} - HP_1 = 21 \text{ ft}$

Pressure  $p_1 := \gamma_w \cdot (SP_1 + PP_1) = 1710.8 \text{ psf}$

Upstream Cutoff - DS Bottom  $HP_2 := e_{lof} - H_{hk} = 51 \text{ ft}$   $LP_{w2} := \frac{k_v}{k_h} \cdot L_{hk} + H_{hk} = 20.01 \text{ ft}$

Seepage Potential  $SP_2 := (w_{sel_{op}} - w_{sel_{tr}}) \cdot \left( \frac{L_w - LP_{w2}}{L_w} \right) = 6.41 \text{ ft}$

Position Potential  $PP_2 := w_{sel_{tr}} - HP_2 = 21 \text{ ft}$

Pressure  $p_2 := \gamma_w \cdot (SP_2 + PP_2) = 1710.6 \text{ psf}$

Footing - US Cutoff  $HP_3 := e_{lof} - H_{ftg} = 69.5 \text{ ft}$   $LP_{w3} := \frac{k_v}{k_h} \cdot L_{hk} + H_{hk} + (H_{hk} - H_{ftg}) = 38.51 \text{ ft}$

Seepage Potential  $SP_3 := (w_{sel_{op}} - w_{sel_{tr}}) \cdot \left( \frac{L_w - LP_{w3}}{L_w} \right) = 2.17 \text{ ft}$

Position Potential  $PP_3 := w_{sel_{tr}} - HP_3 = 2.5 \text{ ft}$

Pressure  $p_3 := \gamma_w \cdot (SP_3 + PP_3) = 291.65 \text{ psf}$



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PROJECT ELMER DAM

DATE 8/27/21

DESCRIPTION STABILITY ANALYSIS

CHECKED \_\_\_\_\_

PREPARED BY C. BOYD

PAGE \_\_\_\_\_ OF \_\_\_\_\_

SEEPAGE ANALYSIS - CREEP ANALYSIS FROM MATHCAD  
(ALL PRESSURES IN PSF)

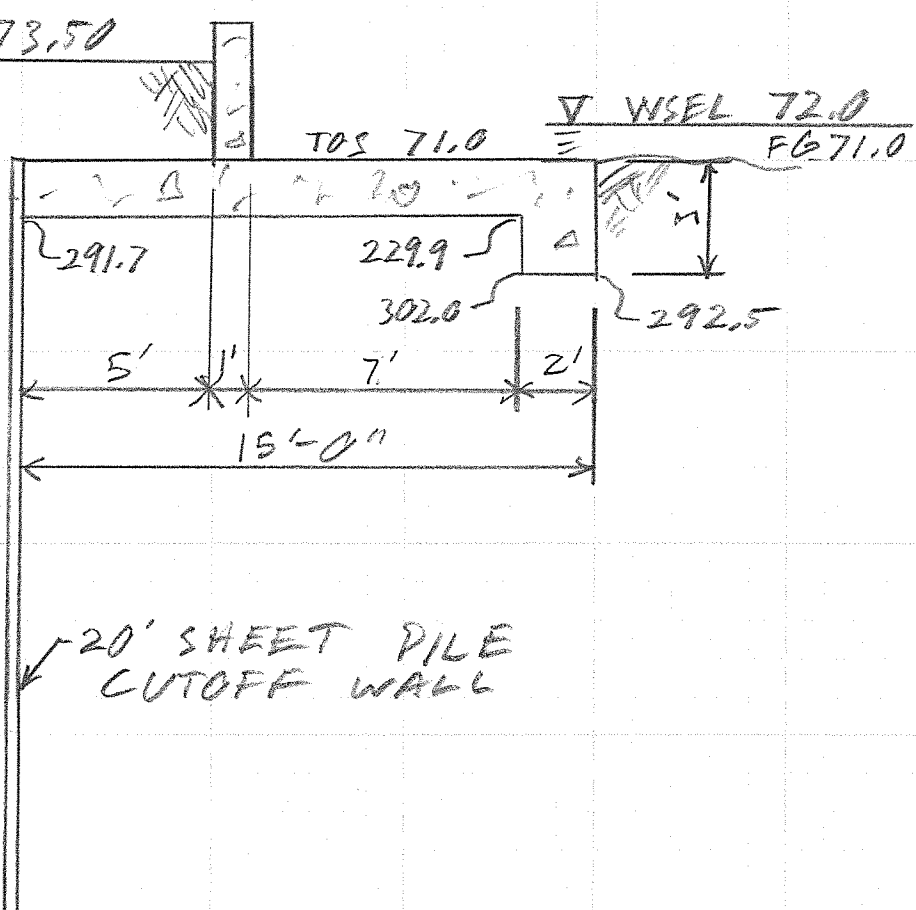
$\nabla$  WSEL 83.0

FG 73.50

TOS 71.0

$\nabla$  WSEL 72.0

FG 71.0



HYDROSTATIC PRESSURE, TYP  $\rightarrow$  1710.6  $\leftarrow$  1710.6

WEIGHTED CREEP LENGTH = 48 - FT

WEIGHTED CREEP RATIO =  $\frac{48}{83 - 72} = 4.36 = C_w$

- COMMON THRESHOLDS

- SOFT CLAY  $3.0 < 4.36$  OK
- MEDIUM CLAY  $2.0 < 4.36$  OK
- SAND, SILT & > 15% CLAY  $4.0 < 4.36$  OK



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DATE 8/27/21

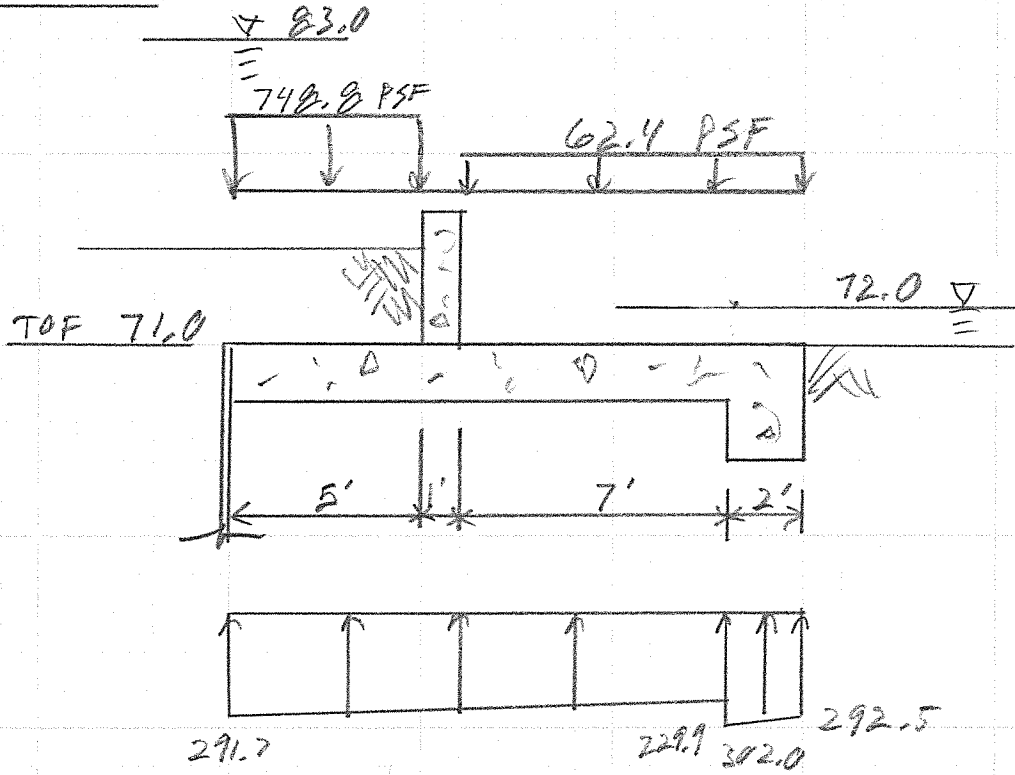
DESCRIPTION STABILITY ANALYSIS

CHECKED \_\_\_\_\_

PREPARED BY C. BOYD

PAGE \_\_\_\_\_ OF \_\_\_\_\_

HYDRO PRESSURES:





Footing - DS Cutoff

$$HP_4 := e_{l_{tof}} - H_{ftg} = 69.5 \text{ ft}$$

$$LP_{w4} := \frac{k_v}{k_h} \cdot (L_{hk} + (L_{ftg} - L_{hk} - L_{tk})) + H_{hk} + (H_{hk} - H_{ftg}) = 42.83 \text{ ft}$$

Seepage Potential

$$SP_4 := (wsel_{op} - wsel_{tr}) \cdot \left( \frac{L_w - LP_{w4}}{L_w} \right) = 1.18 \text{ ft}$$

Position Potential

$$PP_4 := wsel_{tr} - HP_4 = 2.5 \text{ ft}$$

Pressure

$$p_4 := \gamma_w \cdot (SP_4 + PP_4) = 229.88 \text{ psf}$$

Downstream Cutoff - US Bottom

$$HP_5 := e_{l_{tof}} - H_{tk} = 68 \text{ ft}$$

$$LP_{w5} := \frac{k_v}{k_h} \cdot (L_{hk} + (L_{ftg} - L_{hk} - L_{tk})) + H_{hk} + (H_{hk} - H_{ftg}) + (H_{tk} - H_{ftg}) = 44.33 \text{ ft}$$

Seepage Potential

$$SP_5 := (wsel_{op} - wsel_{tr}) \cdot \left( \frac{L_w - LP_{w5}}{L_w} \right) = 0.84 \text{ ft}$$

Position Potential

$$PP_5 := wsel_{tr} - HP_5 = 4 \text{ ft}$$

Pressure

$$p_5 := \gamma_w \cdot (SP_5 + PP_5) = 302.03 \text{ psf}$$

Downstream Cutoff - DS Bottom

$$HP_6 := e_{l_{tof}} - H_{tk} = 68 \text{ ft}$$

$$LP_{w6} := \frac{k_v}{k_h} \cdot (L_{hk} + (L_{ftg} - L_{hk} - L_{tk}) + L_{tk}) + H_{hk} + (H_{hk} - H_{ftg}) + (H_{tk} - H_{ftg}) = 45 \text{ ft}$$

Seepage Potential

$$SP_6 := (wsel_{op} - wsel_{tr}) \cdot \left( \frac{L_w - LP_{w6}}{L_w} \right) = 0.69 \text{ ft}$$

Position Potential

$$PP_6 := wsel_{tr} - HP_6 = 4 \text{ ft}$$

Pressure

$$p_6 := \gamma_w \cdot (SP_6 + PP_6) = 292.5 \text{ psf}$$

### Uplift Forces

Upstream Cutoff

$$U_{uc} := \frac{p_1 + p_2}{2} \cdot L_{hk} \cdot B_{ftg} = 1.03 \text{ kip}$$

$$x_{uc} := L_{ftg} - \frac{L_{hk}}{2} = 14.98 \text{ ft}$$

$$M_{uc} := U_{uc} \cdot x_{uc} = 15.48 \text{ kip} \cdot \text{ft}$$



Center Footing 
$$U_{ftg} := \frac{p_3 + p_4}{2} \cdot (L_{ftg} - L_{hk} - L_{tk}) \cdot B_{ftg} = 49 \text{ kip}$$

$$x_{uftg} := L_{tk} + \frac{L_{ftg} - L_{hk} - L_{tk}}{2} = 8.48 \text{ ft} \quad M_{uftg} := U_{ftg} \cdot x_{uftg} = 415.45 \text{ kip} \cdot \text{ft}$$

Downstream Cutoff 
$$U_{dc} := \frac{p_5 + p_6}{2} \cdot L_{tk} \cdot B_{ftg} = 8.62 \text{ kip}$$

$$x_{dc} := \frac{L_{tk}}{2} = 1 \text{ ft}$$

$$M_{dc} := U_{dc} \cdot x_{dc} = 8.62 \text{ kip} \cdot \text{ft}$$

### Downward Forces on Footing (Neglect Soils)

Tributary Loading Width 
$$B_{trib} := \frac{B_{es}}{2} + B_{ep} + B_{np} + \frac{B_{ns}}{2} = 14.5 \text{ ft}$$

Forebay Heel Forces 
$$V_{fbh} := \gamma_w \cdot (wsel_{op} - el_{tof}) \cdot L_{heel} \cdot B_{trib} = 54.29 \text{ kip}$$

$$x_{fbh} := L_{ftg} - \frac{L_{heel}}{2} = 12.5 \text{ ft} \quad M_{fbh} := V_{fbh} \cdot x_{fbh} = 678.6 \text{ kip} \cdot \text{ft}$$

Tailrace Toe Forces 
$$V_{trt} := \gamma_w \cdot (wsel_{tr} - el_{tof}) \cdot L_{toe} \cdot B_{trib} = 8.14 \text{ kip}$$

$$x_{trt} := \frac{L_{toe}}{2} = 4.5 \text{ ft} \quad M_{trt} := V_{trt} \cdot x_{trt} = 36.64 \text{ kip} \cdot \text{ft}$$

### Horizontal Overturning Forces

Saturated Soil in Forebay 
$$el_{boc} := el_{tof} - H_{ftg} = 69.5 \text{ ft}$$

Neglect soil on flexible sheet pile

Hydrostatic Above Forebay Ground Line 
$$wsel_{op} = 83 \text{ ft} \quad soil_{fb} = 73.5 \text{ ft}$$

$$p_{wfb} := \gamma_w \cdot (wsel_{op} - soil_{fb}) = 592.8 \text{ psf} \quad H_{wfb} := \frac{\gamma_w \cdot B_{trib} \cdot (wsel_{op} - soil_{fb})^2}{2} = 40.83 \text{ kip}$$

$$y_{wfb} := \frac{wsel_{op} - soil_{fb}}{3} + (soil_{fb} - el_{boc}) = 7.17 \text{ ft} \quad M_{wfb} := H_{wfb} \cdot y_{wfb} = 292.61 \text{ kip} \cdot \text{ft}$$



Saturated Soil in Forebay  $e_{l_{boc}} = 69.5 \text{ ft}$

$$p_{sfb} := p_{wfb} + \gamma_{sat_o} \cdot (soil_{fb} - e_{l_{boc}}) = 998.06 \text{ psf} \quad H_{sfb} := \frac{p_{wfb} + p_{sfb}}{2} \cdot (soil_{fb} - e_{l_{boc}}) \cdot B_{trib} = 46.13 \text{ kip}$$

$$y_{sfb} := \frac{p_{wfb} \cdot \left(\frac{soil_{fb} - e_{l_{boc}}}{2}\right) + \left(\frac{p_{sfb} + p_{wfb}}{2} - p_{wfb}\right) \cdot \left(\frac{soil_{fb} - e_{l_{boc}}}{3}\right)}{\frac{p_{wfb} + p_{sfb}}{2}} = 1.83 \text{ ft}$$

$$M_{sfb} := H_{sfb} \cdot y_{sfb} = 84.43 \text{ kip} \cdot \text{ft}$$

Hydrostatic Tailrace Pressure  $wsel_{tr} = 72 \text{ ft}$   $e_{l_{boc}} = 69.5 \text{ ft}$

$$p_{wtr} := \gamma_w \cdot (wsel_{tr} - e_{l_{boc}}) = 156 \text{ psf} \quad H_{wtr} := \frac{\gamma_w \cdot B_{trib} \cdot (wsel_{tr} - e_{l_{boc}})^2}{2} = 2.83 \text{ kip}$$

$$y_{wtr} := \frac{wsel_{tr} - e_{l_{boc}}}{3} = 0.83 \text{ ft}$$

$$M_{wtr} := H_{wtr} \cdot y_{wtr} = 2.36 \text{ kip} \cdot \text{ft}$$

Passive Resistance on Downstream Cutoff

Neglect soil on flexible sheet pile

$$p_{pcut} := 0 \text{ psf}$$

$$H_{pcut} := 0 \text{ kip}$$

$$y_{pcut} := 0 \text{ ft}$$

$$M_{pcut} := H_{pcut} \cdot y_{pcut} = 0 \text{ kip} \cdot \text{ft}$$

Passive Resistance on Downstream Cutoff - Neglect resistance due to scour potential



### Load Summary

#### Gravity Forces

Toe Keyway	$W_{tk} = 6.53 \text{ kip}$	$M_{tk} = 6.53 \text{ kip} \cdot \text{ft}$
Heel Keyway	$W_{hk} = 1 \text{ kip}$	$M_{hk} = 14.94 \text{ kip} \cdot \text{ft}$
Footing	$W_{ftg} = 48.94 \text{ kip}$	$M_{ftg} = 354.8 \text{ kip} \cdot \text{ft}$
Existing Pier	$W_{ep} = 10.97 \text{ kip}$	$M_{ep} = 68.55 \text{ kip} \cdot \text{ft}$
New Pier	$W_{np} = 10.97 \text{ kip}$	$M_{np} = 68.55 \text{ kip} \cdot \text{ft}$
Spillway Sill	$W_{sill} = 3.15 \text{ kip}$	$M_{sill} = 29.93 \text{ kip} \cdot \text{ft}$
Spillway Access Platform	$W_{pltfm} = 0.29 \text{ kip}$	$M_{pltfm} = 2.47 \text{ kip} \cdot \text{ft}$
Spillway Gate and Operator	$W_{gate} = 1 \text{ kip}$	$M_{gate} = 9.5 \text{ kip} \cdot \text{ft}$
Forebay Heel Forces	$V_{fbh} = 54.29 \text{ kip}$	$M_{fbh} = 678.6 \text{ kip} \cdot \text{ft}$
Tailrace Toe Forces	$V_{trt} = 8.14 \text{ kip}$	$M_{trt} = 36.64 \text{ kip} \cdot \text{ft}$

#### Uplift Forces

Upstream Cutoff	$U_{uc} = 1.03 \text{ kip}$	$M_{uc} = 15.48 \text{ kip} \cdot \text{ft}$
Center Footing	$U_{ftg} = 49 \text{ kip}$	$M_{uftg} = 415.45 \text{ kip} \cdot \text{ft}$
Downstream Cutoff	$U_{dc} = 8.62 \text{ kip}$	$M_{dc} = 8.62 \text{ kip} \cdot \text{ft}$

#### Horizontal Overturning Forces

Hydrostatic Above Forebay Ground	$H_{wfb} = 40.83 \text{ kip}$	$M_{wfb} = 292.61 \text{ kip} \cdot \text{ft}$
Saturated Soil in Forebay	$H_{sfb} = 46.13 \text{ kip}$	$M_{sfb} = 84.43 \text{ kip} \cdot \text{ft}$

#### Horizontal Stabilizing Forces

Tailrace Hydrostatic	$H_{wtr} = 2.83 \text{ kip}$	$M_{wtr} = 2.36 \text{ kip} \cdot \text{ft}$
Passive Resistance on Cutoff	$H_{pcut} = 0 \text{ kip}$	$M_{pcut} = 0 \text{ kip} \cdot \text{ft}$

Passive Resistance on Downstream Cutoff - Neglect resistance due to scour potential



**Overturning Stability Analysis**

Vertical Stabilizing Force

$$V_{stab} := W_{tk} + W_{hk} + W_{ftg} + W_{ep} + W_{np} + W_{sill} + W_{pltfm} + W_{gate} + V_{fbh} + V_{trt} = 145.27 \text{ kip}$$

$$M_{vstab} := M_{tk} + M_{hk} + M_{ftg} + M_{ep} + M_{np} + M_{sill} + M_{pltfm} + M_{gate} + M_{fbh} + M_{trt} = 1270.51 \text{ kip} \cdot \text{ft}$$

Vertical Overturning Force

$$V_{ot} := U_{uc} + U_{ftg} + U_{dc} = 58.65 \text{ kip}$$

$$M_{vot} := M_{uc} + M_{uftg} + M_{dc} = 439.56 \text{ kip} \cdot \text{ft}$$

Horizontal Stabilizing Force

$$H_{stab} := H_{wtr} + H_{pcut} = 2.83 \text{ kip}$$

$$M_{hstab} := M_{wtr} + M_{pcut} = 2.36 \text{ kip} \cdot \text{ft}$$

Horizontal Overturning Force

$$H_{ot} := H_{wfb} + H_{sfb} = 86.96 \text{ kip}$$

$$M_{hot} := M_{wfb} + M_{sfb} = 377.04 \text{ kip} \cdot \text{ft}$$

Vertical Resultant

$$V_r := V_{stab} - V_{ot} = 86.62 \text{ kip}$$

Overturning Resultant

$$M_r := M_{vstab} + M_{hstab} - M_{vot} - M_{hot} = 456.26 \text{ kip} \cdot \text{ft}$$

Eccentricity

$$x_r := \frac{M_r}{V_r} = 5.27 \text{ ft} \quad e := \frac{L_{ftg}}{2} - x_r = 2.23 \text{ ft} \quad e = 2.23 \text{ ft} \quad \frac{L_{ftg}}{6} = 2.5 \text{ ft}$$

Check Resultant in the Middle 1/3

$$Check\_e := \text{if} \left( e \leq \frac{L_{ftg}}{6}, \text{"OK"}, \text{"REDESIGN"} \right) = \text{"OK"}$$

Allowable Bearing Pressure From Geotech

$$Q_s := 1000 \text{ psf}$$

Maximum Bearing Pressure

$$q_{smax1} := \frac{V_r}{L_{ftg} \cdot B_{ftg}} \cdot \left( 1 + \frac{6 \cdot e}{L_{ftg}} \right) = 753.86 \text{ psf}$$

Minimum Bearing Pressure

$$q_{smin1} := \frac{V_r}{L_{ftg} \cdot B_{ftg}} \cdot \left( 1 - \frac{6 \cdot e}{L_{ftg}} \right) = 42.62 \text{ psf}$$

$$q_{max1} := \max(q_{smax1}, q_{smin1}) = 753.86 \text{ psf}$$

$$Check\_Brg := \text{if} (q_{max1} \leq Q_s, \text{"OK"}, \text{"REDESIGN"}) = \text{"OK"}$$



### Sliding Stability Analysis

Horizontal Driving Force  $H_{dr} := H_{wfb} + H_{sfb} = 86.96 \text{ kip}$

Net Vertical Force  $V_{res} := V_{stab} - V_{ot} = 86.62 \text{ kip}$

Sliding Coefficient of Friction  $\mu := 0.35$

Horizontal Resisting Force  $H_{res} := H_{wtr} + H_{pcut} + \mu \cdot V_{res} = 33.14 \text{ kip}$

Assuming that the auxiliary spillway slab acts as a diaphragm to transfer horizontal pier loading to the fishway, determine the shear resistance required by the fishway to meet a sliding factor of safety of 1.5.

$$FS_{sl} := 1.5$$

$$H_{res\_fw} := 1.5 \cdot H_{dr} - H_{res} = 97.3 \text{ kip}$$

Spillway Toe Length  $L_{toe} = 9 \text{ ft}$   $H_{ftg} = 1.5 \text{ ft}$

Apron Shear Stress  $f_{v\_fw} := \frac{H_{res\_fw}}{L_{toe} \cdot H_{ftg}} = 50.05 \text{ psi}$  By inspection, shear strength is adequate.

**Appendix 7.6**  
**Quantities and Engineer's Opinion of Probable Construction**  
**Costs (EOPCC)**

**ELMER DAM FISH PASSAGE IMPROVEMENTS**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST (EOPCC, see Note 1)

Date Revised: 6/29/2022

Item #	Work Item Description (units)	Quantity	Units	Estimated Unit Cost (\$/unit)	Subtotal EOPCC
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**General Sitework**

1	Erosion & Sediment Control	1	LS	\$ 10,000.00	\$ 10,000
2	Construction Survey & Staking	1	LS	\$ 20,000.00	\$ 20,000
<b>Subtotal:</b>					<b>\$ 30,000</b>

**Fishway and Spillway Modifications**

3	Dewatering	1	LS	\$100,000.00	\$ 100,000
4	Clearing and Grubbing	1000	SY	\$ 10.00	\$ 10,000
5	Excavation	1775	CY	\$ 40.00	\$ 71,000
6	Structural Backfill	1315	CY	\$ 50.00	\$ 65,750
7	Angular Rock Riprap	18.5	CY	\$ 75.00	\$ 1,387.50
8	Hydroseeding	5000	SF	\$ 0.10	\$ 500
9	Dam & Fishway Demolition	1	LS	\$ 50,000.00	\$ 50,000
10	Vinyl Sheet Pile Cutoff Wall	1265	SF	\$ 50.00	\$ 63,250
11	Cast-in-Place Concrete	354	CY	\$ 600.00	\$ 212,400
12	Reinforcing Steel (Assumed 100 #/cy)	35400	LB	\$ 2.00	\$ 70,800
13	Structural Framing - Galvanized Steel	3000	LB	\$ 3.00	\$ 9,000
14	Plank Grating - Galvanized Steel	19100	LB	\$ 3.00	\$ 57,300
15	Removable Guardrail - Galvanized Steel	2025	LB	\$ 3.00	\$ 6,075
16	Removable Baffles - Aluminum	80	LB	\$ 25.00	\$ 2,000
17	Fishway Entrance - 18"x36" Upward Opening Gate	2	EA	\$ 25,000.00	\$ 50,000
18	Fishway Exit - 18"x48" Downward Opening Gate	1	EA	\$ 36,875.00	\$ 36,875
19	Fishway Exit - 18"x48" Upward Opening Gate	1	EA	\$ 26,875.00	\$ 26,875
20					\$ -
21	Spillway - 60" Tilting Weir Gate	1	EA	\$ 40,000.00	\$ 40,000
22					
23	Spillway Header Beam	1300	LB	\$ 3.00	\$ 3,900
24	Stanchions	1600	LB	\$ 3.00	\$ 4,800
25	Rollers & Brackets	2	EA	\$ 1,000.00	\$ 2,000
<b>Subtotal:</b>					<b>\$ 883,913</b>

Item #	Work Item Description (units)	Quantity	Units	Estimated Unit Cost (\$/unit)	Subtotal EOPCC
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**Reservoir 4 Pump Station**

26	Dewatering	1	LS	\$ 50,000.00	\$ 50,000.00
27	Clearing and Grubbing	4600	SY	\$ 10.00	\$ 46,000.00
28	Excavation	5100	CY	\$ 40.00	\$ 204,000.00
29	Structural Backfill	30	CY	\$ 50.00	\$ 1,500.00
30	Angular Rock Riprap	100	CY	\$ 75.00	\$ 7,500.00
31	Hydroseeding	41000	SF	\$ 0.10	\$ 4,100.00
32	Pump Intake Structure	1	EA	\$ 50,000.00	\$ 50,000.00
33	Concrete Splitter Box	1	EA	\$ 15,000.00	\$ 15,000.00
34	60" Diameter Concrete Wet Well	1	EA	\$ 15,000.00	\$ 15,000.00
35	48" Dia. Concrete Manhole	2	EA	\$ 5,000.00	\$ 10,000.00
36	Concrete Pad at Wet Well	150	SF	\$ 10.00	\$ 1,500.00
37	Concrete Gate Support	250	SF	\$ 20.00	\$ 5,000.00
38	36" SS Slide Gate	2	EA	\$ 4,500.00	\$ 9,000.00
39	24" SS Slide Gate	3	EA	\$ 3,500.00	\$ 10,500.00
40	18" SS Slide Gate	1	EA	\$ 3,000.00	\$ 3,000.00
41	24"x54" SS Slide Gate	1	EA	\$ 6,000.00	\$ 6,000.00
42	18"x42" SS Slide Gate	1	EA	\$ 5,000.00	\$ 5,000.00
43	Misc. Steel Grating	1	LS	\$ 25,000.00	\$ 25,000.00
44	Steel Trash Rack	2	EA	\$ 5,000.00	\$ 10,000.00
45	Self Cleaning Intake Screens	2	EA	\$ 4,800.00	\$ 9,600.00
46	24" Dia. Schedule 40 Steel Pipe	30	LF	\$ 250.00	\$ 7,500.00
47	Misc. Steel Fittings	1	LS	\$ 10,000.00	\$ 10,000.00
48	24" Dia. ADS N-12 HDPE Pipe	260	LF	\$ 75.00	\$ 19,500.00
49	18" Dia. ADS N-12 HDPE Pipe	180	LF	\$ 50.00	\$ 9,000.00
50	12" Dia. Class 125 PVC Pipe	160	LF	\$ 45.00	\$ 7,200.00
51	12" Dia. Schedule 40 Steel Pipe	120	LF	\$ 125.00	\$ 15,000.00
52	Misc. 12" Fittings	1	LS	\$ 7,500.00	\$ 7,500.00
53	Pump Station Electrical Disconnect/Misc. Electrical	1	LS	\$ 6,000.00	\$ 6,000.00
54	Relocate and Re-install Vertical Turbine Pump & VFD	1	LS	\$ 5,000.00	\$ 5,000.00
55	3 Phase Overhead Power Extension	1	LS	\$ 50,000.00	\$ 50,000.00
56	Decommission Existing Pump Station Electrical Service	1	LS	\$ 1,000.00	\$ 1,000.00

**Subtotal: \$ 625,400**

**Booth Lane Pump Station**

57	Dewatering	1	LS	\$ 20,000.00	\$ 20,000.00
58	Clearing and Grubbing	270	SY	\$ 10.00	\$ 2,700.00
59	Excavation	400	CY	\$ 40.00	\$ 16,000.00
60	Structural Backfill	20	CY	\$ 50.00	\$ 1,000.00
61	Hydroseeding	7200	SF	\$ 0.10	\$ 720.00
62	Pump Intake Structure	1	EA	\$ 45,000.00	\$ 45,000.00
63	60" Diameter Concrete Wet Well	1	EA	\$ 15,000.00	\$ 15,000.00
64	36" SS Slide Gate	2	EA	\$ 4,500.00	\$ 9,000.00
65	Misc. Steel Grating	1	LS	\$ 12,000.00	\$ 12,000.00
66	Self Cleaning Intake Screens	2	EA	\$ 4,800.00	\$ 9,600.00
67	24" Dia. Schedule 40 Steel Pipe	30	LF	\$ 250.00	\$ 7,500.00
68	Relocate and Re-install Vertical Turbine Pump	1	LS	\$ 5,000.00	\$ 5,000.00
69	Reconnect Pump to Existing 10" PVC Mainline	1	LS	\$ 3,000.00	\$ 3,000.00
70	Reconnect Pump Station Electrical	1	LS	\$ 2,500.00	\$ 2,500.00

**Subtotal: \$ 149,020**

Item #	Work Item Description (units)	Quantity	Units	Estimated Unit Cost (\$/unit)	Subtotal EOPCC
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**Reservoir 2 Intake**

71	Dewatering	1	LS	\$ 20,000.00	\$ 20,000.00
72	Clearing and Grubbing	175	SY	\$ 10.00	\$ 1,750.00
73	Excavation	450	CY	\$ 40.00	\$ 18,000.00
74	Structural Backfill	20	CY	\$ 50.00	\$ 1,000.00
75	Hydroseeding	1500	SF	\$ 0.10	\$ 150.00
76	Intake Structure	1	EA	\$ 45,000.00	\$ 45,000.00
77	Concrete Irrigation Box	1	EA	\$ 10,000.00	\$ 10,000.00
78	Concrete Headwall	1	EA	\$ 15,000.00	\$ 15,000.00
79	Misc. Steel Grating	1	LS	\$ 10,000.00	\$ 10,000.00
80	Steel Trash Rack	1	EA	\$ 5,000.00	\$ 5,000.00
81	Self Cleaning Intake Screens	2	EA	\$ 4,800.00	\$ 9,600.00
82	18" Dia. Schedule 40 Steel Pipe	13	LF	\$ 200.00	\$ 2,600.00
83	18" Dia. ADS N-12 HDPE Pipe	30	LF	\$ 50.00	\$ 1,500.00
84	Screen Backwash Submersible Pump	1	EA	\$ 2,000.00	\$ 2,000.00
85	Backwash Pump Electrical	1	LS	\$ 15,000.00	\$ 15,000.00
<b>Subtotal:</b>					<b>\$ 156,600</b>

**Reservoir Pipeline Connections**

86	Dewatering	1	LS	\$ 15,000.00	\$ 15,000.00
87	Clearing & Grubbing	1700	SY	\$ 10.00	\$ 17,000.00
88	Hydroseeding	2500	SF	\$ 0.10	\$ 250.00
89	Concrete Headwall	4	EA	\$ 15,000.00	\$ 60,000.00
90	Steel Trash Rack	4	EA	\$ 5,000.00	\$ 20,000.00
91	24" SS Slide Gate	4	EA	\$ 3,500.00	\$ 14,000.00
92	24" Dia. ADS N-12 HDPE Pipe (Reservoir 1-2)	850	LF	\$ 75.00	\$ 63,750.00
93	24" Dia. ADS N-12 HDPE Pipe (Reservoir 2-3)	650	LF	\$ 75.00	\$ 48,750.00
94	Misc. Appurtanances	1	LS	\$ 3,000.00	\$ 3,000.00
95	48" Dia. Concrete Manhole	2	EA	\$ 5,000.00	\$ 10,000.00
<b>Subtotal:</b>					<b>\$ 251,750</b>

**Raw Construction Cost (RCC) Estimate (in Yr 2022 \$)**

**\$ 2,097,000**

	(% of RCC)	
State of OREGON Sales Tax on Equipment & Mtls (Assume 50% Mtls)	0%	\$0
Contractor's Mob. & Demob. Costs to Project Site (4% of RCC)	4%	\$84,000
Contractor's Bonding and Insurance Costs (1% of RCC)	1%	\$21,000
Contractor's Additional Div 01 Requirements (PM, Safety, Security, Office Exp, etc.)	4%	\$84,000
Contractor's Overhead and Profit (12%)	12%	\$252,000
Remoteness of Materials & Equipment to Project Site	0%	\$0
Work Scheduling Inefficiencies due to Construction Access Constraints (See Above)	0%	\$0
Permitting Requirements (Note 2)	2%	\$42,000
Estimating Contingency	25%	\$524,000

**Estimated Opinion of Probable Construction Cost (in Yr 2022 \$)**

**\$ 2,580,000**

**Upper Level Estimate of Construction Cost (in Yr 2022 \$)**

**\$ 3,100,000**

(1) The final construction and project costs will depend upon actual labor and material costs, actual site conditions, competitive market and bidding conditions, final project scope and schedule, and other variable factors. As a result, the final project costs will vary from the cost opinion presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final project budgets.

(2) Cost Opinion does not include possible land acquisition or easement costs, permitting fees, or any applicable local or federal taxes.

**Appendix 7.7**  
**HIP Review Comments and Responses**



## HIP Project Review Comment Tracking

### Project Information:

**Project Name:** Elmer Dam Fish Passage  
**BPA Project #:** 1992-026-01  
**Contract #:**  
**Sponsor:** Levi Old – Trout Unlimited  
**Designer:** Chris Boyd - River Structures Consulting  
**Area Lead:** Sean Welch  
**COR/PM:** Tracy Hauser  
**HIP Program Lead:** Daniel A. Gambetta, ECF

### HIP Review Team:

**BPA EC Lead:** Lindsey Arotin  
**BPA Technical Lead:** Sean P. Welch, P.E., EWL  
**NMFS Branch Chief:** Bill Lind, NMFS, Southern Snake Branch Chief  
**NMFS Biologist:** Sarah Fesenmyer and Jim Morrow  
**NMFS Engineer:** Aaron Beavers, NOAA Fisheries, West Coast Region  
**USFWS Field Office:** Marisa Meyers, USFWS La Grande Field Office  
**USFWS Reviewer:** John Stephenson

### Documents Reviewed:

Elmer Dam Fish Passage 15 Percent Design and Alternatives Analysis Report, August 2020  
 Elmer Dam Fish Passage 30 Percent Basis of Design Report, October 2020  
 Elmer Dam Fish Passage 60 Percent Basis of Design Report, August 2021  
 Elmer Dam Fish Passage 80 Percent Basis of Design Report, September 2021

### Activity Categories:

1e - Provide Fish Passage at an Existing Facility  
**Overall Project Risk**

### Risk Level:

Medium  
**Medium**

### Review Timeline:

### Date Completed

- Conceptual Review (typically 15%)
  - Site visit, if needed NA
  - Sponsor to submit conceptual design to EC Lead and COR 8/9/2020
  - EC Lead to submit concept to HIP Review Team to initiate review 8/9/2020
  - EC Lead to send design package to appropriate HIP Review members 8/9/2020
  - EC Lead to compile comments and forward to Sponsor 9/10/2020
  - Sponsor to provide responses to EC Lead 9/21/2020
  - HIP Review Team and Sponsor to resolve “open” comments Not Started
  - EC Lead to notify Sponsor to proceed to preliminary design Not Started
- Preliminary Design or Alternatives Analysis Review ( 30%)
  - Sponsor to submit preliminary design to EC Lead and COR 12/8/2020
  - EC Lead to submit design package to HIP Review Team 12/8/2020
  - EC Lead to submit design to NMFS Engineer if applicable Submitted by Sponsor
  - NMFS Engineer approves project, if applicable Pending
  - EC Lead to compile comments and forward to Sponsor 12/13/2020
  - Sponsor to provide responses to EC Lead 12/23/2020
  - HIP Review Team and Sponsor to resolve “open” comments 12/19/2020
  - EC Lead to notify Sponsor to proceed with design 1/19/2021
- Permit Level Design Review (60% to 80%)
  - Sponsor to submit design package to EC lead and COR 9/20/2021
  - EC Lead to submit design package to HIP Review Team 9/20/2021
  - EC Lead to compile comments and forward to Sponsor 10/18/2021
  - Sponsor to provide responses to EC Lead 3/31/2022
  - HIP Review Team and Sponsor to resolve “open” comments 3/31/2022
  - EC Lead to notify Sponsor to proceed to final design 3/31/2022
- Final Design Package (100%)
  - Sponsor to submit final designs to EC Lead and COR Not Started
  - EC Lead and BPA Technical Lead to verify no critical changes Not Started



## HIP Project Review Comment Tracking

**Comments:**

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
1	S. Welch (BPA)	9/8/2020	Elmer Dam Fish Passage 15% Design & Alternatives Analysis Report	General	The reviewer understands the primary objective of this project being the improvement of the fish passage at the existing Elmer Dam. Following review comments will be directed at that component of the project.	C. Boyd (RSC)	9/21/20	As discussed in the Report, we recommend that modifications to the intakes, adjacent oxbows, and the dam itself could provide additional benefits to downstream passage and overall stream health. We would appreciate BPA's consideration of all the recommended alternatives as described in the report.	Open (Requirement)
2	S. Welch (BPA) L. Arotin	9/8/2020	Elmer Dam Fish Passage 15% Design & Alternatives Analysis Report	General	Please provide documentation of ODFW Fish Passage and NMFS fish passage review, comments and approvals. <b>Updated 10/04/2021:</b> Jeff Brown approved fishway with the condition that it constructed within standard dimensions.	C. Boyd (RSC)	9/21/20	The Report has been distributed to ODFW, NMFS, and USFWS as well. We have provided the 15% Design & Alternatives Analysis Report as a courtesy copy asking if there are any major concerns, then the 30% Design & BoD will be distributed for formal review and comment.	For Information Only
3	S. Welch (BPA)	9/8/2020	Elmer Dam Fish Passage 15% Basis of Design Report	General	Please include in future submittals the substantiating hydraulic analysis that demonstrate the passage hydraulics for the proposed ladder and compliance with OAR Div 412 and NOAA Passage Criteria.	C. Boyd (RSC)	9/21/20	The fishway configuration and geometry will be provided with the 30% Design and will be based on OAR Div 412 and NOAA Passage Criteria. The preliminary and final design will include the specific hydraulic analysis for the fishway.	Open (Requirement)
4	S. Welch (BPA)	9/8/2020	Elmer Dam Fish Passage 15% Basis of Design Report	General	Please provide the operations and maintenance agreement for the proposed fish ladder and identification of the proposed party whom will hold responsibility for maintenance and operational requirements (including debris removal, maintenance, flash board operation etc.).	L. Old (TU) J. Webster (USWCD)	9/21/20	<b>Update 12/22/21:</b> The project team will work with the landowners to decide upon operation and maintenance responsibilities when the project moves from 80-100%	Open (Requirement)



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
5	S. Welch (BPA)	9/8/2020	Elmer Dam Fish Passage 15% Basis of Design Report	General	Please demonstrate how the proposed technical fishway will meet the volitional passage objectives with minimal operational manipulation or constraint. Specifically, how will forebay intake flow and stage vary with water withdrawal scenarios relative to species and lifestage migratory periods? As a component of this assessment please demonstrate any risks to functional passage as a result of operational characteristics of the system. It is expected that the appropriate hydraulic analysis will be provided to substantiate this assessment.	C. Boyd (RSC)	9/21/20	<p>Given the established water rights and operation of the dam, the fishway may not be in compliance with OAR/NOAA over all flow regimes (ie, all possible forebay and tailrace elevations).</p> <p>The fishway will be designed to meet criteria for flows expected during the key adult migratory periods. These criteria will be presented in the 30% Design &amp; BoD Report for review and concurrence.</p> <p>Multiple fishway entrance slots and exit orifices will be evaluated during the design to determine the maximum practical range of flow regimes (ie, hydraulic differential) that can be accommodated while ensuring passage during the key biological time periods.</p> <p><b>Updated 11/19/21:</b> The hydraulic design submitted with the 80% Basis of Design Report addressed the operation over the varying forebay and tailrace conditions.</p> <p><b>Updated 6/29/22:</b> The final hydraulic design results are submitted with the final Basis of Design Report.</p>	Open (Requirement)



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
6	T. Kessler (BPA)  L. Arotin	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Please show any access roads as well as staging, storage, and stockpile areas that would be used for equipment and construction materials. Keep these areas 150 feet or more from natural waterbodies (Catherine Creek) and wetlands or on an adjacent established road area in a location and manner that will preclude erosion into, or contamination of, the stream or floodplain. Staging areas may be closer than 150 feet if the area is above (elevation) the 100-yr floodplain and spill prevention measures are approved by BPA.</p> <p><b>Updated (12/10/20):</b> Please make drawings easier to read. It appears that the proposed staging and access areas are within 150 feet from Catherine Creek. Can you please show the 100-year floodplain boundary so that we can confirm the staging and access areas are above the 100 year floodplain elevation?</p> <p><b>Updated 10/04/2021:</b> It does not appear changes have been made.</p>	C. Boyd (RSC)	9/21/20	<p>Staging, access, and work areas will be identified in the 30% Design submittal, including the HIP IV conservation measures.</p> <p>At this time only preliminary survey and hydraulic modelling information is available, but this data will be further refined during the final design.</p> <p><b>Response 11/19/21:</b> The entire project, and majority of the surrounding roadways and agricultural land, is within the 100-year inundation extents per FEMA FIRM #410260305B dated May 15, 1980. For this reason, it is not practical to move staging and access areas outside of the 100-year floodplain. This was discussed with previous BPA reviewers, and as such has been noted on the plans, including sheets G02 and C02.</p>	Request Additional Information



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
7	T. Kessler (BPA)  L. Arotin	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Please ensure the Ordinary High Water (OHW) line and FEMA 100-year floodplain boundary are included on all plan sheets.</p> <p><b>Updated (12/10/20):</b> Please clearly show OHW and the 100-year floodplain boundary on all sheets.</p> <p><b>Updated 10/04/2021:</b> It does not appear changes have been made.</p>	C. Boyd (RSC)	9/21/20	<p>The OHW line will be included on the 30% drawings to the extent that it's available from the survey and hydraulic modelling.</p> <p>The FEMA 100-year floodplain boundary will be included on the 30% drawings.</p> <p><b>Response 11/19/21:</b> The entire project, and majority of the surrounding roadways and agricultural land, is within the 100-year inundation extents per FEMA FIRM #410260305B dated May 15, 1980. For this reason, it is not practical to move staging and access areas outside of the 100-year floodplain. This was discussed with previous BPA reviewers, and as such has been noted on the plans, including sheets G02 and C02.</p>	Request Additional Information
8	T. Kessler (BPA)	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Please include erosion control best management practices that will be utilized for the project to limit sediments from entering Catherine Creek and adjacent wetlands.</p> <p><b>BPA Response (12/10/20):</b> <b>Comment addressed.</b></p>	C. Boyd (RSC)	9/21/20	Erosion control BMPs will be included in the 30% Design submittal.	Closed
9	T. Kessler (BPA)	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Please add the general conservation measures from the HIP IV into the first several pages of the design set.</p> <p><b>BPA Response (12/10/20):</b> <b>Comment addressed.</b></p>	C. Boyd (RSC)	9/21/20	HIP IV general conservation measures will be included in the 30% Design submittal.	Closed



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
10	T. Kessler (BPA)  L. Arotin	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Please include all areas where ground disturbing activities, temporary access roads, equipment and vehicle storage, and stockpiling will occur within the APE. If any areas of the project occur outside of these areas after BPA consults on the original APE, they will have to be re-consulted on. Encompassing the entire project area within the APE the first time around will greatly reduce any back and forth with the contractor archaeologist and BPA.</p> <p><b>BPA Response (12/10/20):</b> Please make drawings easier to read.</p> <p><b>Updated 10/04/2021:</b> It does not appear changes have been made. Access roads and staging areas are still undefined.</p>	C. Boyd (RSC)	9/21/20	Areas of disturbance will be included in the 30% Design submittal.	Closed
11	T. Kessler (BPA)  L. Arotin	9/10/20	Elmer Dam Fish Passage 15% Basis of Design Report	General	<p>Has the APE had a wetland delineation completed recently? If not, what is the wetland delineation schedule? Please consult with the USACE project manager early in the process to determine whether or not a delineation is necessary for the site. What is the status of the RGP-6?</p> <p><b>BPA Response (12/10/20):</b> Acknowledged.</p> <p><b>Updated 10/04/2021:</b> What was determined in regard to the necessity of a wetland delineation?</p>	C. Boyd (RSC) L. Old (TU) J. Webster (USWCD)	9/21/20	A wetland delineation has not been completed. The wetland delineation will be completed (if necessary) after the 30% Design & BoD has been approved. TU and USWCD will work together with OR DSL and USACE to determine the need for a wetland delineation.	Closed



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
12	S. Welch (BPA)	12/10/20	Elmer Dam Fish Passage 30% Basis of Design Report	General	At the 30% design completion level, existing condition hydraulic analysis should be provided that evaluate the flow interactions with the project reach under existing conditions. The existing condition hydraulic analysis shall demonstrate water surface and velocity profiles. The modeling results should describe the hydraulic interactions of the dam, fish way, diversions, pumps, head gates and other appurtenances within the project reach. These outputs should be provided for all critical hydrologic events including the appropriate recurrence interval flows and regulatory fish passage requirements.	C. Boyd (RSC) L. Old (TU) J. Webster (USWCD)	12/22/20	RSC Update (12/22/20) – Per the discussion during the 30% design review meeting, the hydrology, hydraulic and fishway designs will be submitted for review at 60%.	Closed
13	S. Welch (BPA)	12/10/20	Elmer Dam Fish Passage 30% Basis of Design Report	General	Results of the preceding hydraulic assessment should be used in the assessment of the current project reach condition and interpretation and decision making that shape the proposed alternative. This analyses will be used to support the “with and without” project analyses and demonstrate how the proposed project will ultimately improve hydraulic conditions for volitional passage, irrigation requirements.	C. Boyd (RSC) L. Old (TU) J. Webster (USWCD)	12/22/20	Per the discussion during the 30% design review meeting, the hydrology, hydraulic and fishway designs will be submitted for review at 60%.	Closed



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
14	S. Welch (BPA)	12/10/20	Elmer Dam Fish Passage 30% Basis of Design Report	General	All design features shall be developed with sustainability, operability, and minimization to impacts to riverine processes (flow, sediment, debris, etc.). For example, any instream infrastructure (such as pump intakes) shall be placed as close to the bank line as possible or located in an off bank vault. Lateral projection of pump intakes into Catherine Creek will be allowed only if they can be removed after irrigation season.	C. Boyd (RSC) L. Old (TU) J. Webster (USWCD)	12/22/20	Per the discussion during the 30% design review meeting, the irrigation designs will be submitted for review at 60%.	Closed
15	S. Welch (BPA)	12/10/20	Elmer Dam Fish Passage 30% Basis of Design Report	General	Per the HIP Handbook, <b>Initial Review of Plans and BDR (typically 30%)</b> : Preliminary drawings, specifications, a draft Basis of Design Report, and other supporting documentation (profiles, details, cross sections, quantities, technical analyses/appendixes, etc.) for the preferred project alternative will be submitted for review. It is expected that the hydraulic and hydrologic analyses described above, foundation conditions and geotechnical analyses and stability evaluations of existing infrastructure that will be impacted by this project.	C. Boyd (RSC) L. Old (TU) J. Webster (USWCD)	12/22/20	Per the discussion during the 30% design review meeting, the hydrology, hydraulic and fishway designs will be submitted for review at 60%.	Closed



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
16	S. Welch (BPA)	10/15/2021	Elmer Dam Fish Passage 80% Basis of Design Report	3	<p><i>"Fishway operation will require the installation or removal of check boards or bulkheads in the vertical slots to maintain reservoir storage during the irrigation season while maintaining compliance with Oregon Administrative Rules and NMFS 2011 requirements."</i></p> <p>Regulatory approval on the final design and operations and maintenance manual are required submittals to BPA as a component of this project. Approval documentation from ODFW, NMFS and USFWS shall be provided by the project sponsor to BPA before a final funding decision is made on this project. Please see the addendum information for agency O&amp;M requirements.</p>	C. Boyd (RSC), L. Old (TU), J. Webster (USWCD)	12/20/21	<p>NMFS has indicated their approval provided that the fishway design is constructed in accordance with standard geometric recommendations. The design team is working with ODFW to address temporary fish passage concerns during construction.</p> <p><b>Update 12/11/21:</b> The project team will work with the landowners to develop an operation and maintenance manual prior to implementation.</p>	For Information Only
17	J Brown (NOAA)	3/4/2022	Elmer Dam Fish Passage 80% Basis of Design Report		From email dated 3/4/22 – "I've reviewed the temporary passage plans for the Elmer Dam construction project, as well as the rest of the final designs (previously) and have no objections or comments to offer."				For Information Only
18	G. Apkey (ODFW)	3/10/22	Elmer Dam Temporary Fish Passage Plan		<p>From email dated 3/10/22:</p> <p>G. Apkey - The design of the trap water supply should plan for the need to remove debris. Are the trap pickets easily accessible for cleaning or should there be a temporary trash rack?</p>	C. Boyd	3/25/22	The trap pickets will be easily accessible and we feel that a temporary trash rack on the upstream side of the cofferdam will cause more headaches than it'll solve for the short period (a couple of weeks) that the trap will be operated.	Closed



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
19	G. Apkey (OFDW)	3/10/22	Elmer Dam Temporary Fish Passage Plan		From email dated 3/10/22:  G. Apkey - The spillway design, by the contractor, should be reviewed by the regulatory agencies prior to implementation.	C. Boyd	3/25/22	Agreed, that will be a included as a requirement for the work.	For Information Only
20	G. Apkey (OFDW)	3/10/22	Elmer Dam Temporary Fish Passage Plan		From email dated 3/10/22:  G. Apkey - Will the entire bypass system be lined as shown on detail "G" on sheet G05? The super sack coffer dam system will likely leak water without a comprehensive plan to seal the system.	C. Boyd	3/25/22	Temporary fish passage plans currently require the contractor to maintain minimum channel and weir depths during operation. Requirements will be added to seal the bypass channel to minimize leakage and maximize channel flow for downstream fish passage.	To be Addressed at Next Review



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
21	G. Apkey and J. Watts (ODFW)	3/14/2022	Elmer Dam Temporary Fish Passage Plan		<p>From email dated 3/14/22:</p> <p>G. Apkey - The trap water supply will be designed to accommodate 10 cfs, but the pool volumes within the ladder and the trap don't appear to provide enough energy dissipation for that much water. Will there be adequate attraction flow to be effective?</p> <p>C. Boyd - This is how the currently operate the ladder – up to 10 cfs. Our proposal is to operate the ladder as it is currently configured for the short period until we can replace it.</p> <p>J. Watts - Current operations of the ladder obviously allow the fish to exit volitionally upstream. If their upstream progress is blocked by the trapping operation, will the water within the trap pool be too turbulent to allow the fish an adequate resting/holding area? On other projects, we have seen fish become too exhausted to maintain their position in the trap and wind up entrained against the downstream finger weir. Obviously we are not expecting a large number of fish, but it may be prudent to make sure we have the provisions to “make” some quiet water within the trap pool.</p>	C. Boyd	3/25/22	Temporary fish passage plans and specifications will specify that the trap flow shall be adjusted in the field with feedback from the Engineer, ODFW Regional Biologist, and CTUIR staff who will be operating the trap to maximize attraction flow and trapping potential while limiting velocities to ensure they are not detrimental to any trapped fish.	



## HIP Project Review Comment Tracking

#	Reviewer (Org.)	Date	Document	Page/Section	Comment	Response by (Org.)	Date	Comment	Status (BPA to Update)
22	G. Apkey and J. Watts (ODFW)	3/14/2022	Elmer Dam Temporary Fish Passage Plan		<p>From email dated 3/14/22:</p> <p>G. Apkey - How will the super sacks seal against the sheet pile coffer dam? Will there be a welded on flat plate perpendicular to the sheet pile to seal the super sacks to? We presume the exact details will be left to the contractor, but provisions should be considered.</p> <p>C. Boyd - If it was me I'd wrap the plastic around the corner between the sheet pile and super sacks and strategically place gravel backs to keep it in place, but as you've noted the specifics will be left to the contract.</p> <p>J. Watts - We would recommend that this is a required submittal by the contractor. Advanced planning by the contractor can eliminate some of the commonly overlooked issues.</p>	C. Boyd	3/25/22	Temporary fish passage plans currently require the contractor to maintain minimum channel and weir depths during operation. Requirements will be added to seal the bypass channel against the cofferdam to minimize leakage and maximize channel flow for downstream fish passage.	
23	J. Lemanski (ODFW)	3/15/22	Elmer Dam Temporary Fish Passage Plan		From email dated 3/15/22 – "At this time, I don't have any lingering questions."				
24									
25									
26									

**Appendix 7.8**  
**Temporary Fish Passage Plan**

**Trout Unlimited and Union Soil  
and Water Conservation  
District**

**Elmer Dam Fish Passage and  
Flow Improvements Project**

**Temporary Fish Passage Plan**



## Table of Contents

1.0	Introduction.....	1
1.1	Purpose.....	1
1.2	Project Description.....	1
2.0	Temporary Passage Plan .....	2
2.1	Approach Justification .....	2
2.2	Construction Timeline.....	3
2.3	Phase I Temporary Fish Passage Plan.....	3
2.4	Phase II Temporary Fish Passage Plan .....	4

## Appendices

Appendix A – Temporary Fish Passage Plan Figures

Appendix B – Temporary Fish Passage Plan Drawings

## **1.0 Introduction**

### **1.1 Purpose**

Trout Unlimited (TU) and the Union Soil and Water Conservation District (USWCD) contracted River Structures Consulting (River Structures) to provide engineering and design services for the Elmer Dam Fish Passage and Flow Improvements Project (Project). The purpose of this report is to present the Temporary Fish Passage Plan (Plan) to be implemented during the construction of the Project. The objective of the Plan is to outline the approach to mitigate temporary disruption to the migration of native fish species during construction of the Project. The key objectives of the Plan are to:

1. Provide relevant background information to serve as the basis of the Plan including:
  - a. Project Description
  - b. Hydrology, Irrigation, and Fish Migration
  - c. OAR and NMFS rules and criteria
2. Outline the Temporary Fish Passage Plan Including:
  - a. Proposed Construction Timeline
  - b. Mitigation methods and temporary facilities
  - c. Roles and Responsibilities

The following sections present the relevant background information used as the basis of the Plan.

### **1.2 Project Description**

Elmer Dam is located on Catherine Creek in Union County approximately 14 miles east of La Grande, Oregon. Catherine Creek is a tributary to the Grande Ronde River and is a migratory corridor for Chinook Salmon as well as Steelhead, Bull Trout, Lamprey, and Mountain Whitefish. Elmer Dam is located approximately 30 miles downstream of the Catherine Creek adult trapping facility which serves as a satellite facility to the Lookingglass Fish Hatchery (Hatchery). The satellite facilities are operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) under the Grande Ronde Satellite Facilities Project.

Elmer Dam is a concrete run-of-river dam that provides irrigation storage from April to November. The dam is equipped with a pool and weir type fish ladder and a 20-foot-wide stop log spillway. The reservoir system consists of three oxbow (off-channel) storage reservoirs located off the left bank of Catherine Creek, and the on-channel storage reservoir. Each of the three oxbow reservoirs have individual intake structures that divert water from Catherine Creek (reservoir 4). The existing fish ladder at Elmer Dam does not meet Oregon Department of Fish and Wildlife (ODFW) or National Marine Fisheries Service (NMFS) design criteria for fish passage facilities. Likewise, the intake structures are not equipped with NMFS/ODFW compliant screening systems to prevent fish entrainment into the off-channel reservoirs.

TU and the USWCD, in cooperation with private landowners, seek to address fish passage and flow issues on Catherine Creek associated with Elmer Dam and the reservoir systems for the benefit of native migratory fish species. The primary objectives of the Project are to:

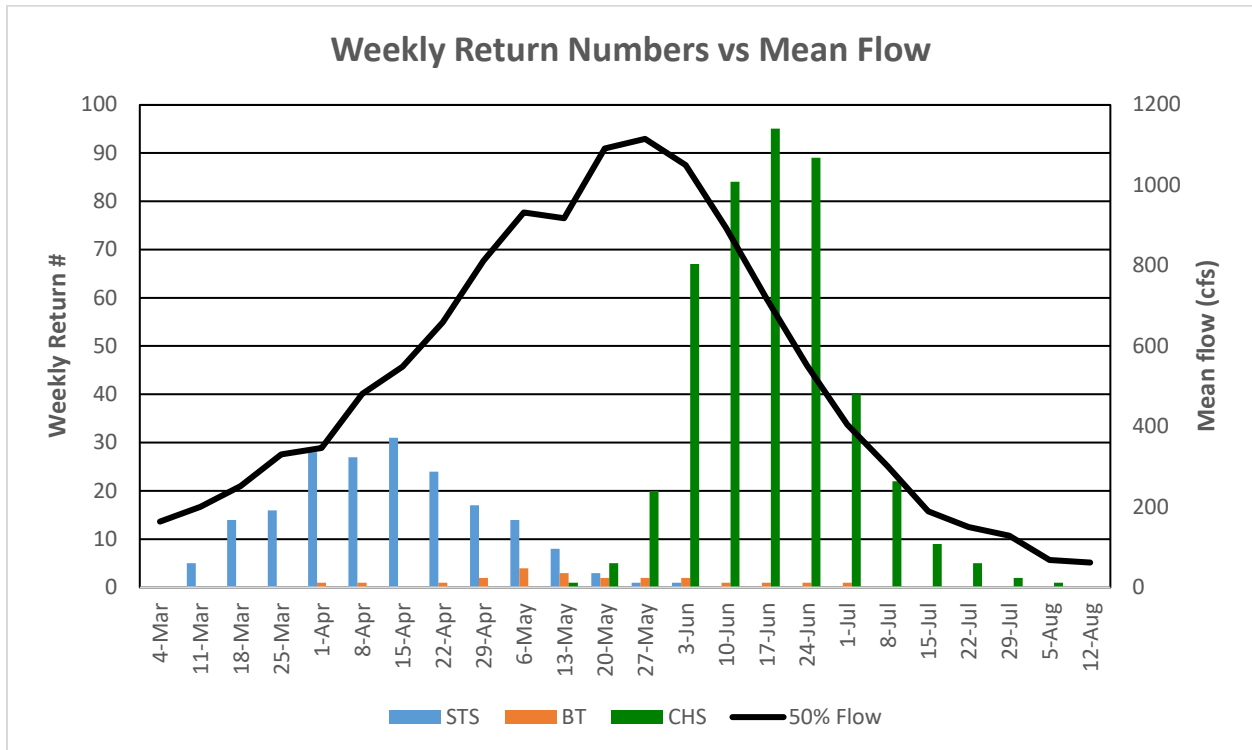
1. Construct a vertical slot fishway to improve fish passage past Elmer Dam. The new fishway will meet current ODFW and NMFS fishway design criteria.

2. Install a 5-foot-wide tilting weir gate on Elmer Dam to provide additional hydraulic capacity and improve regulation of instream flows. It will also eliminate the need to adjust stop logs in the primary spillway throughout the irrigation season.
3. Relocate three existing intake structures to off-channel wet wells with ODFW/NMFS compliant fish screens. The off-channel oxbow reservoirs 1, 2 and 3 will be hydraulically connected to the lower wet wells, adjacent to Elmer Dam and the existing intake structures between each oxbow reservoir and Catherine Creek (reservoir 4) will be decommissioned. These efforts will reduce entrainment of ESA listed steelhead and juvenile Chinook, as well as other resident species, into the oxbow (off-channel) reservoirs while maximizing the storage capacity of the existing reservoir system.

## 2.0 Temporary Passage Plan

### 2.1 Approach Justification

Per ODFW, the in-water work window for Catherine Creek is July 1 – October 15. Figure 1 displays fish return numbers to the CTUIR trap approximately 30 miles upstream. As shown in Figure 1, this period overlaps with the tail end of the in-migration period for Catherine Creek spring Chinook. The in-water work window also overlaps with the irrigation season (typically April 1 – October 31) which requires full storage capacity in Reservoir 4 (Catherine Creek).



**Figure 1. Fish Migration Timing**

Efforts were made to incorporate a volitional upstream passage facility in the Plan. However, it was determined that construction of the temporary facility would require a significant portion of the in-water work window and leave inadequate time for construction of the permanent fishway. Therefore, the Plan

proposes a monitored trap and haul approach during construction of the Elmer Dam modifications and vertical slot fishway. Downstream fish passage will be provided continuously during the construction of the Project. The full Plan is presented in the following sections.

## 2.2 Construction Timeline

Construction will be completed in two phases over a two-year period starting in the late fall/winter. The construction phases are summarized in Table 1.

**Table 1. Construction Phases**

<b>Construction Phase</b>	<b>Phase I</b>	<b>Phase II</b>
Performance Period	November 1 – March 31 (Request in-water work window exemption for the installation of the reservoir intakes)	July 1 – November 30 (Request in-water work window extension)
Design Elements	<ul style="list-style-type: none"> <li>• Decommission existing non-compliant intakes at Reservoirs No. 1, No. 2, and No. 3.</li> <li>• Install screened off-channel wet wells at Elmer Dam (to Reservoir 1) and Booth Lane.</li> <li>• Install screened oxbow intake structure at Reservoir No. 2</li> <li>• Install underground piping from Elmer Dam wet well to Reservoir No. 1.</li> <li>• Install underground piping and between Reservoirs No. 1 to No. 2 and No. 2 to No. 3.</li> <li>• Connect new intakes to the existing distribution system outside of the irrigation season.</li> </ul>	<ul style="list-style-type: none"> <li>• Install temporary trap in the existing fishway.</li> <li>• Install temporary cofferdam and downstream fish bypass.</li> <li>• Demolish existing fishway and left abutment after spring Chinook run is complete.</li> <li>• Install vertical slot fishway at Elmer Dam</li> <li>• Install 5-ft tilting weir gate at Elmer Dam</li> <li>• Install overhead irrigation supply piping across Elmer Dam.</li> </ul>

## 2.3 Phase I Temporary Fish Passage Plan

Phase I consists of installing the new screened intake structures, wet wells, and reservoir connections required for operation of the reservoir system. As noted in Table 1, an in-water work exemption will be requested for the installation of the pump stations and oxbow intakes outside of the irrigation season. This will allow the work to be completed when the reservoir is empty.

In-water work will require installation of temporary cofferdams around each of the proposed intake structures while the existing intakes remain operational. The contractor will coordinate with TU, USWCD, ODFW, and possibly CTUIR fish biologists for the immediate removal of fish from the work area upon installation of the cofferdams. Dewatering and/or construction activities shall not occur within the in-water work area until the fish have been removed. Fish removed from within the cofferdam will be immediately returned to Catherine Creek. Figures presented in Appendix A present the proposed cofferdam and fish exclusion barriers to be installed for Phase I construction. Note that the cofferdams presented in Appendix A are conceptual. Final alignment and design of the coffer dams will be the

responsibility of the contractor and may vary. The proposed winter in-water work will not block or impede upstream or downstream migration in Catherine Creek and no fish passage mitigation measures are proposed for winter work.

Prior to the start of the irrigation season (approximately April 1) the new intakes will be connected to the existing distribution systems. Construction of the Phase I design elements during the non-irrigation season will avoid interruption of irrigation operations.

## **2.4 Phase II Temporary Fish Passage Plan**

Phase II construction consists of installing the new fishway and 5-foot-wide overshot gate at Elmer Dam. The construction period for Phase II is anticipated to extend from July 1<sup>st</sup> - November 15<sup>th</sup> and therefore will require an in-water work window extension. Additional time will be needed due to the extensive dewatering efforts, construction of the temporary fish passage facilities, and complex formwork required for the vertical slot fishway.

From Figure 1, approximately 9% of the Chinook return to the CTUIR Catherine Creek adult trapping facility located approximately 30 miles upstream of Elmer Dam after July 1. Similarly, very few bull trout and no steelhead adults are seen at the upstream CTUIR trapping facility in July. Because the trap data is from an upstream location, it is anticipated that the number of Chinook passing Elmer Dam during this period will occur sooner than exhibited in Figure 1. If a temporary volitional fishway was constructed, it is anticipated that any remaining Chinook will have passed Elmer Dam before it is complete. Therefore, the Phase II fish passage plan proposes an adaptive trap and haul program be employed during the early portion of the in-water work window.

Phase II construction efforts will begin with the installation of a sheet pile coffer dam upstream of Elmer Dam. During the construction of the cofferdam the dam boards and existing fishway will remain in service for both upstream and downstream passage. When it is time to close the cofferdam and dewater the existing dam and ladder (likely the second or third week of July), the flow will be diverted through a downstream bypass structure and the existing fish ladder. Appendix A, Figure 9 and Figure 10 present a plan view of the Phase II temporary bypass plan. Appendix B presents plan, section, and detail drawings of the temporary bypass structures. Note that Appendix A and Appendix B figures and drawings were developed to present the overall construction approach and key design and operational criteria of the temporary bypass facilities. The contractor is responsible for final design, construction, and operation of the temporary bypass facilities (with exception to the temporary fish trap which will be designed, installed, and operated by the CTUIR) and therefore may develop an alternative approach to construction of the temporary bypass facilities, so long as they meet the intent and criteria outlined herein.

Initially a portion of the bypass flow will be routed through the existing fish ladder to attract any remaining upstream migrants. CTUIR will install and operate a temporary fish trap within the existing ladder consisting of a finger weir and picket barrier. Stoplogs will be installed to manage pool depths and drop heights within the ladder during trapping operations. Up to 10 cfs will be diverted to the existing fish ladder for trapping operations. Water will be conveyed from the coffer dam through an 18-inch-diameter pipe to the existing ladder entrance. Flow through the pipe will be controlled with a sluice gate installed on the upstream face of the coffer dam. The contractor will fabricate a water-tight barrier to be installed at the fish ladder exit to prevent backwatering of the work area. The 18-inch pipe will penetrate the barrier and discharge into the first bay of the ladder. The pipe outlet will be submerged within the ladder pool to reduce turbulence within the fish trap and reduce potential for fish to jump at the pipe outlet. The picket

weir, provided by CTUIR, will be located downstream of the pipe outlet and will prevent upstream migrants from exhausting themselves by attempting to swim through the pipe.

When CTUIR is performing fish removal and transfer operations, the sluice gate can be closed and the trap partially drained to crowd fish, if necessary. CTUIR will haul and release fish above the Catherine Creek Acclimation Facility. CTUIR may utilize some of the trapped fish for spawning. Final operational requirements for the trap (i.e., frequency in which the trap is checked by CTUIR, handling and transfer methods, duration of trap operations, etc.) will be negotiated between CTUIR and ODFW and finalized prior to the start of any Phase II dewatering activities. Once trapping operations have completed, all the flow will be diverted to the downstream bypass channel. The cofferdam will be extended downstream of the dam and dewatering of the left bank will commence in preparation for demolition of the existing fishway and installation of the new vertical slot fishway and tilting weir gate. All bypass discharge will be routed through the bypass channel and released into the tail race.

The downstream bypass structure consists of an adjustable weir, a plunge pool, and a cofferdam extending downstream through the existing spillway apron. The adjustable stoplog weir is designed to pass between 3 and 100 cfs. The stoplog weir will be adjusted by the Contractor to maintain a minimum depth of 1 foot over the weir for downstream migrants. The weir discharges into a 12-foot-long by 8-foot-wide by 4-foot-deep (minimum dimensions) plunge pool. The plunge pool is designed to provide adequate depth and energy dissipation for downstream migrating fish. The plunge pool will also be equipped with an adjustable weir at the downstream end of the pool to allow the contractor to maintain pool depth and a minimum 1 foot of depth over the plunge pool weir. Finally, the supersack cofferdam will extend downstream to the spillway apron to contain water to the north side of the channel and spillway. The Contractor may choose an alternative method to construct the temporary downstream bypass structure so long as it meets the criteria outlined above and summarized in Table 2. Supersack construction was presented because it can be used in tandem with visqueen to contain water. In addition, supersacks can be moved relatively easily with an excavator to adjust to changing flow conditions.

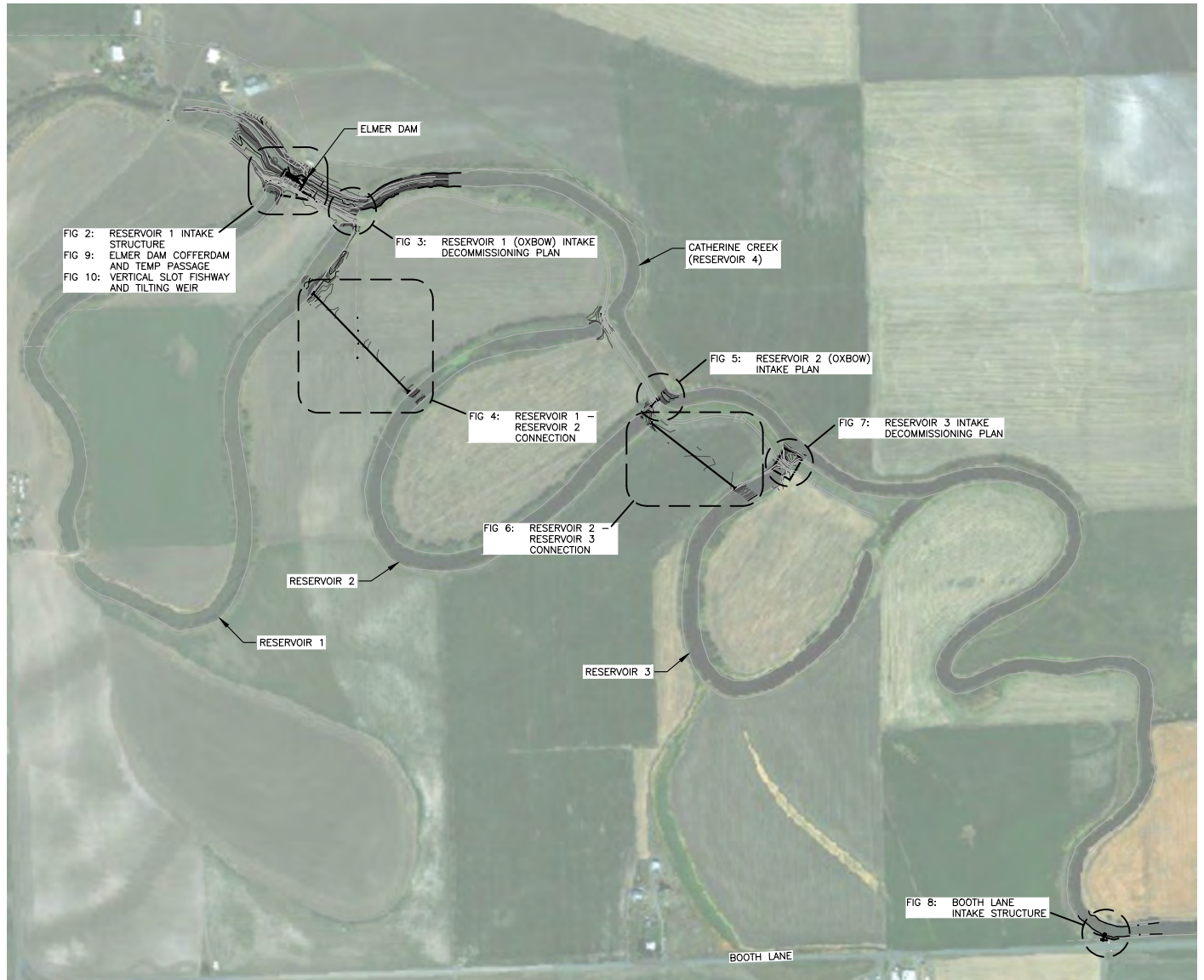
Based on discussions with the local ODFW fisheries biologists, downstream migrants are not anticipated in this reach during the upstream trapping period (early July).

After the construction of the dam and fishway improvements are completed, the cofferdam will be removed, and the dam restored to its winter operating regime with the primary spillway open to allow upstream and downstream passage until the following irrigation season.

**Table 2. Temporary Downstream Bypass and Trap Criteria**

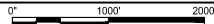
<b>Criteria</b>	<b>Value</b>	<b>Responsible Party</b>	<b>Comments</b>
<b>Temporary Trapping Facility</b>			
Water Supply	10 cfs (max)	Contractor	Water supply shall be adjustable with gate or valve adjustment.
Trapping Period	Early July	CTUIR	Trapping period to begin with installation of the coffer dam. End of operations to be negotiated between CTUIR and ODFW based on fish return timing.
Fish Handling/ Transfer method	TBD	CTUIR	Fish handling to be negotiated between CTUIR and ODFW.
Trap Check Frequency	TBD	CTUIR	Frequency of trap check to be negotiated between CTUIR and ODFW.
<b>Downstream Bypass Channel</b>			
Discharge Capacity	3 – 100 cfs	Contractor	Contractor shall coordinate with the landowners/irrigators on management of the forebay water surface elevation and discharge through the weir.
Weir Operational Range	2683.00 ft – 2676.50 ft	Contractor	Stoplog weir shall be able to regulate flows over 6.5' range of forebay elevations.
Min. Weir Depth	1 ft	Contractor	Minimum depth of flow over downstream bypass weirs and dam apron shall be 1 foot.
Min. Plunge Pool Depth	4 ft	Contractor	Adjust plunge pool sandbag weir to maintain minimum plunge pool depth.
Min. Plunge Pool Dimensions	12ft long x 8 ft wide	Contractor	Dimensions are based on maintaining an energy dissipation factor of less than 60 ft-lbs/s/ft <sup>3</sup> for full range of design flows.

**APPENDIX A**  
**TEMPORARY FISH PASSAGE PLAN FIGURES**



OVERALL SITE KEY PLAN

SCALE: 1" = 1000'



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 TEMPORARY FISH PASSAGE PLAN



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FIGURE:

1

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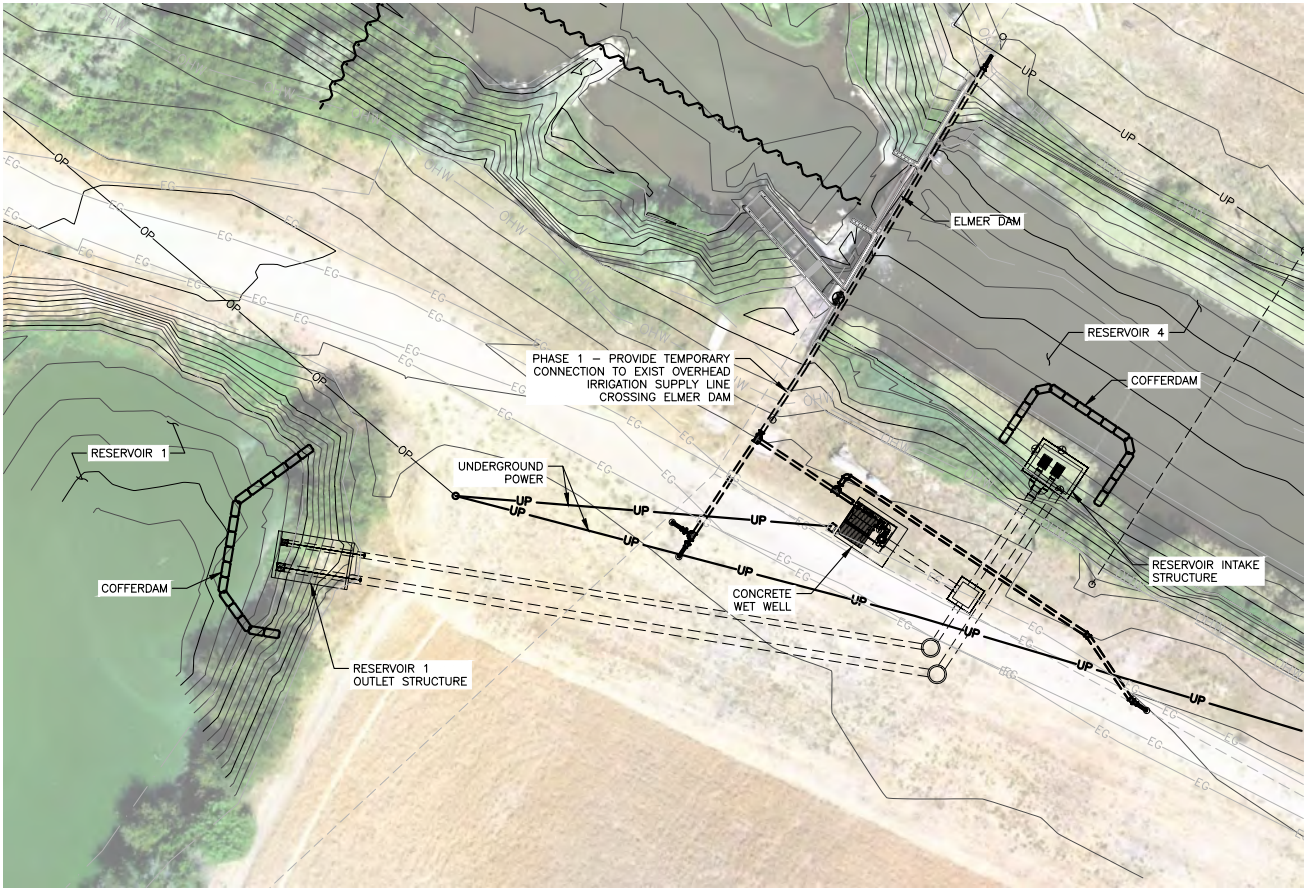
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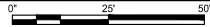
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**RESERVOIR 1 INTAKE STRUCTURE PLAN**

SCALE: 1" = 50'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - INSTALL RESERVOIR INTAKE STRUCTURE.
  - INSTALL RESERVOIR 1 OUTLET STRUCTURE.
  - INSTALL CONCRETE WET WELL WITH PUMPS, VFD, AND CONTROLS.
  - INSTALL UNDERGROUND IRRIGATION SUPPLY PIPING.
  - CONNECT NEW UNDERGROUND IRRIGATION SUPPLY PIPING TO EXIST ABOVE GROUND IRRIGATION LINE ACROSS ELMER DAM.
  - INSTALL UNDERGROUND POWER TO RESERVOIR 1 AND RESERVOIR 2 WET WELLS.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

TITLE:

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TEMPORARY FISH PASSAGE PLAN



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FIGURE:

**2**

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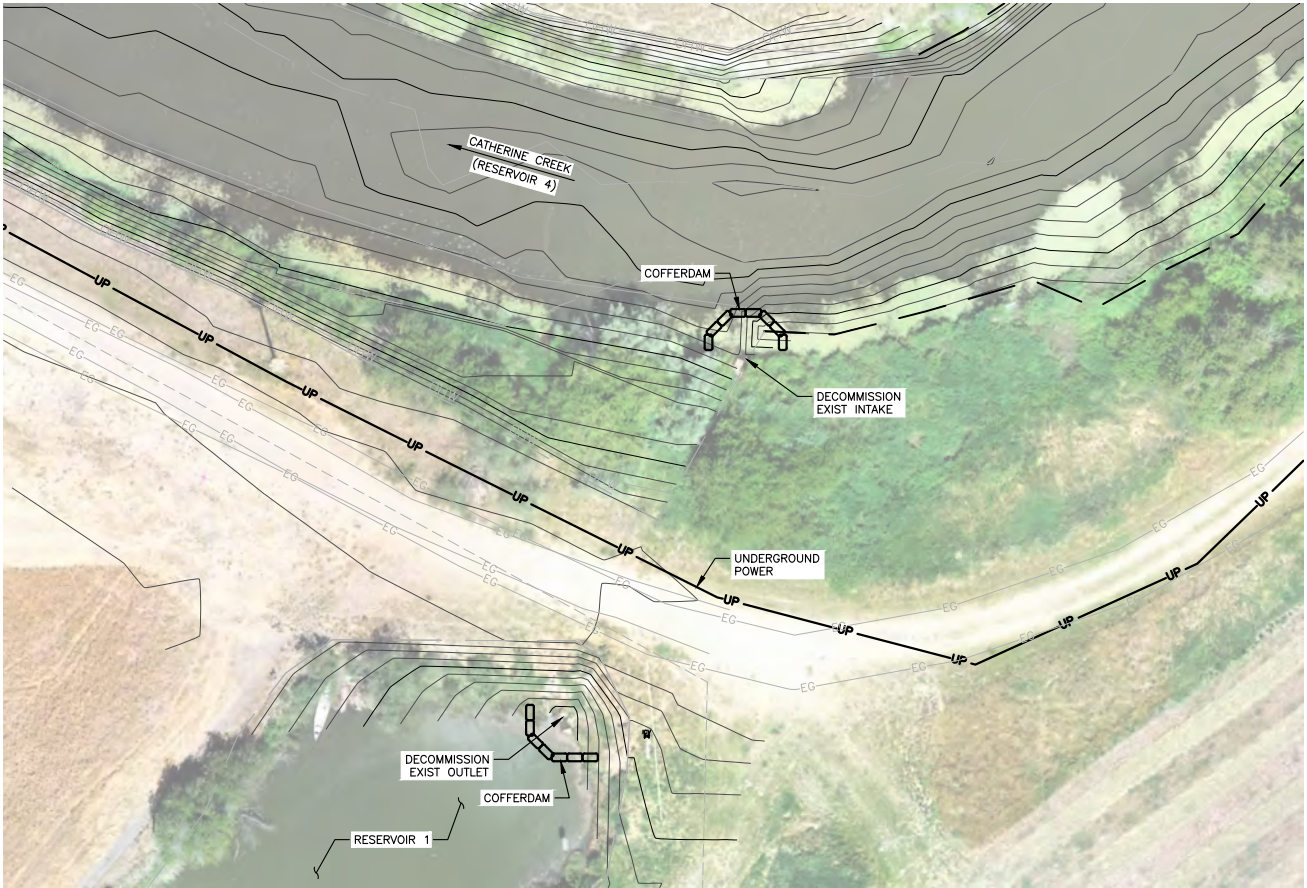
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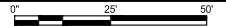
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**RESERVOIR 1 INTAKE DECOMMISSIONING PLAN**

SCALE: 1"= 50'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - DECOMMISSION EXISTING INTAKE AND OUTLET STRUCTURE TO RESERVOIR 1.
  - INSTALL UNDERGROUND POWER TO RESERVOIR 2 INTAKE WET WELL.
  - REGRADE AND RE-VEGETATE DISTURBED AREAS.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

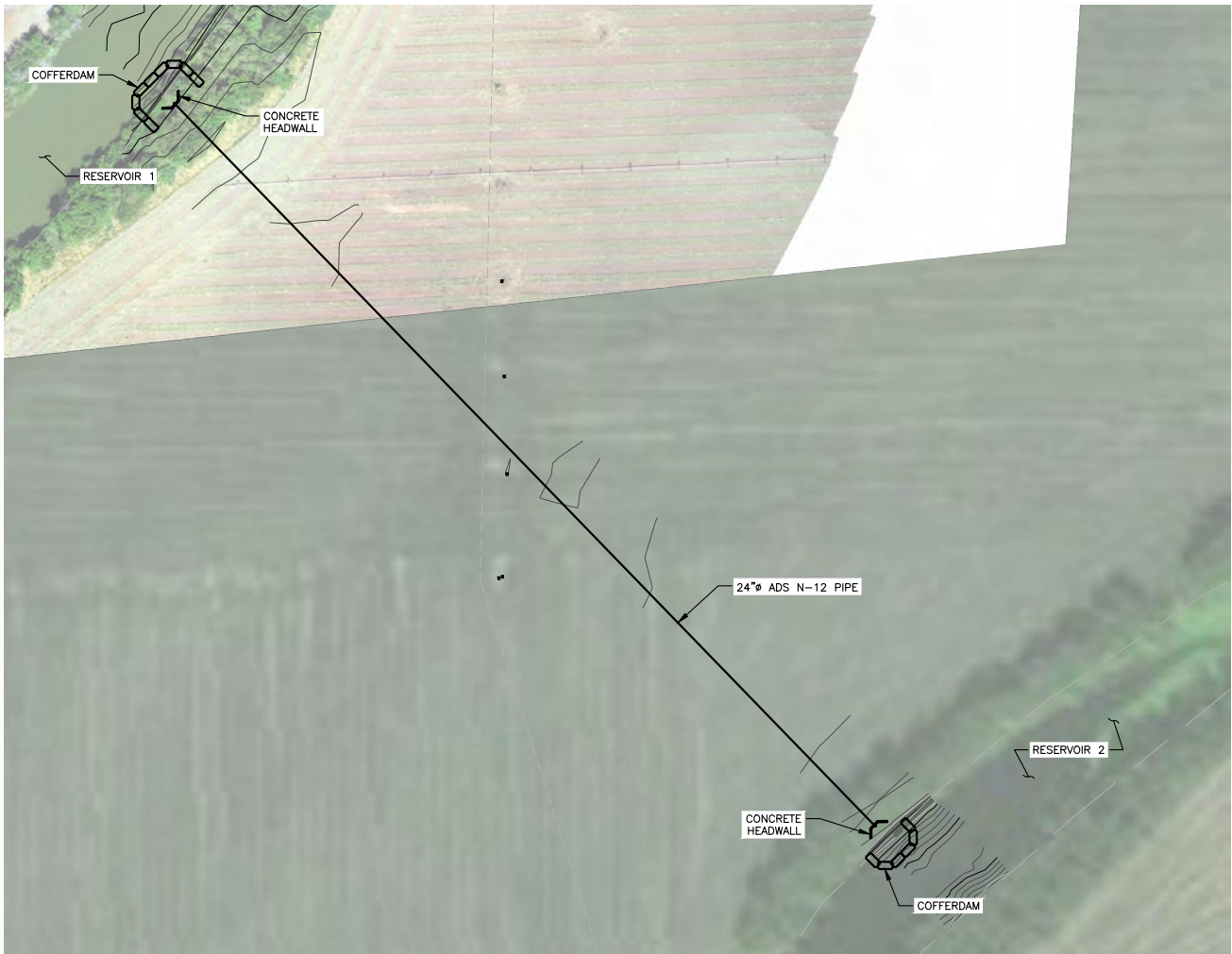
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 TEMPORARY FISH PASSAGE PLAN



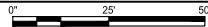
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**RESERVOIR 1 – RESERVOIR 2 CONNECTION PLAN**

SCALE: 1" = 50'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - INSTALL CONCRETE HEADWALLS AND 24"Ø ADS N-12 PIPE TO CREATE HYDRAULIC CONNECTION BETWEEN RESERVOIR 1 AND RESERVOIR 2.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

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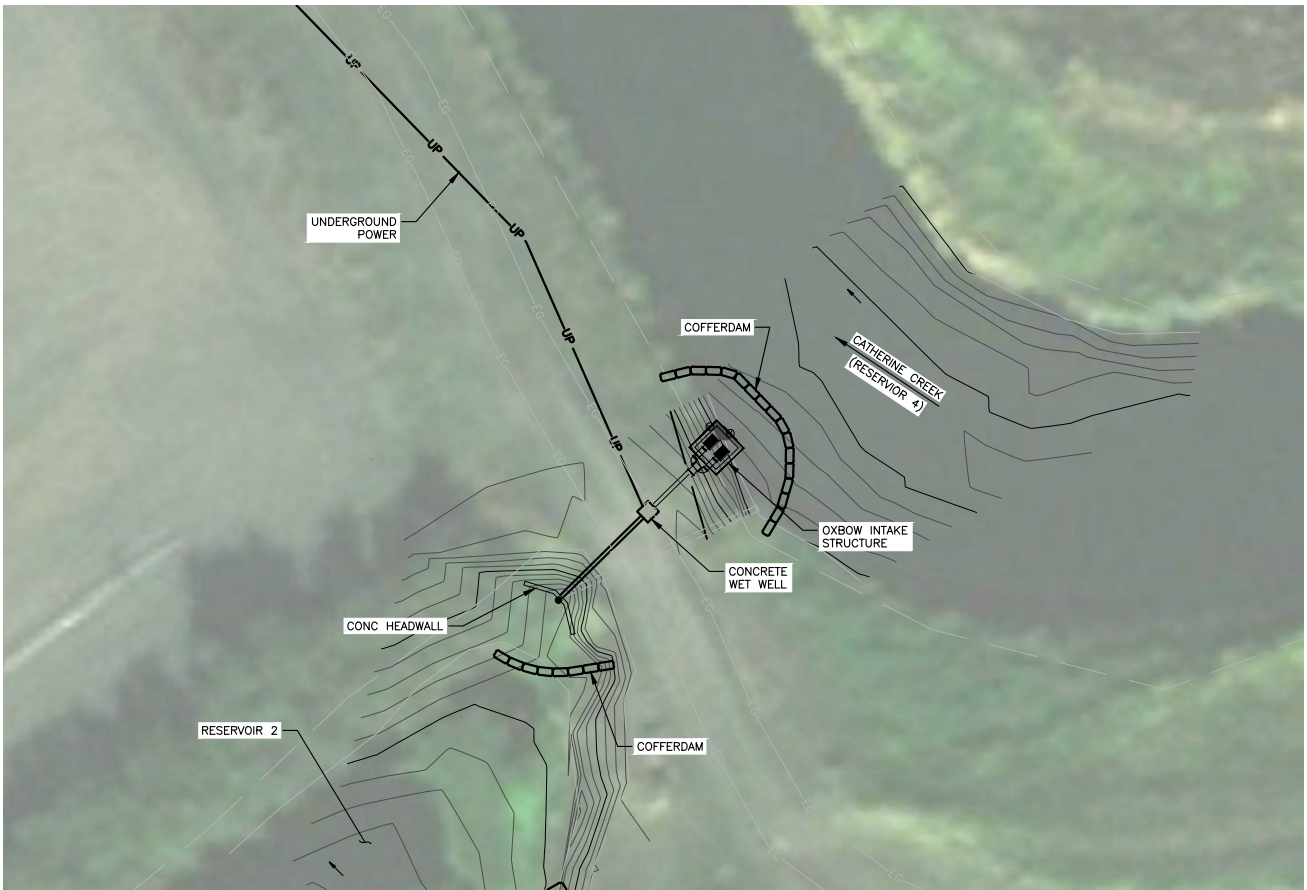


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FIGURE:

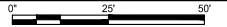
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**RESERVOIR 2 (OXBOW) INTAKE PLAN**

SCALE: 1" = 50'



TEMPORARY PASSAGE PLAN NOTES:

- PHASE 1
- WORK PERIOD: NOVEMBER 1 - DECEMBER 15
- WORK ITEMS:
  - INSTALL OXBOW INTAKE STRUCTURE.
  - INSTALL CONCRETE WET WELL.
  - INSTALL CONCRETE HEADWALL.
  - INSTALL UNDERGROUND POWER TO WET WELL.
  - REGRADE AND RE-VEGETATE DISTURBED AREAS.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

TITLE:  
 TROUT UNLIMITED  
 ELMER DAM  
 TEMPORARY FISH PASSAGE PLAN



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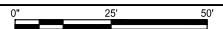
FIGURE:

**5**



**RESERVOIR 2 – RESERVOIR 3 CONNECTION PLAN**

SCALE: 1" = 50'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - INSTALL CONCRETE HEADWALLS AND 24"Ø ADS N-12 PIPE TO CREATE HYDRAULIC CONNECTION BETWEEN RESERVOIR 2 AND RESERVOIR 3.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

TITLE:  
 TROUT UNLIMITED  
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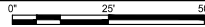
FIGURE:

**6**



**RESERVOIR 3 INTAKE DECOMMISSIONING PLAN**

SCALE: 1" = 50'



TEMPORARY PASSAGE PLAN NOTES:

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - DECOMMISSION EXISTING INTAKE AND OUTLET STRUCTURE TO RESERVOIR 3.
  - REGRADE AND RE-VEGETATE DISTURBED AREAS.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

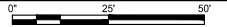
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**BOOTH LANE INTAKE STRUCTURE PLAN**

SCALE: 1" = 50'

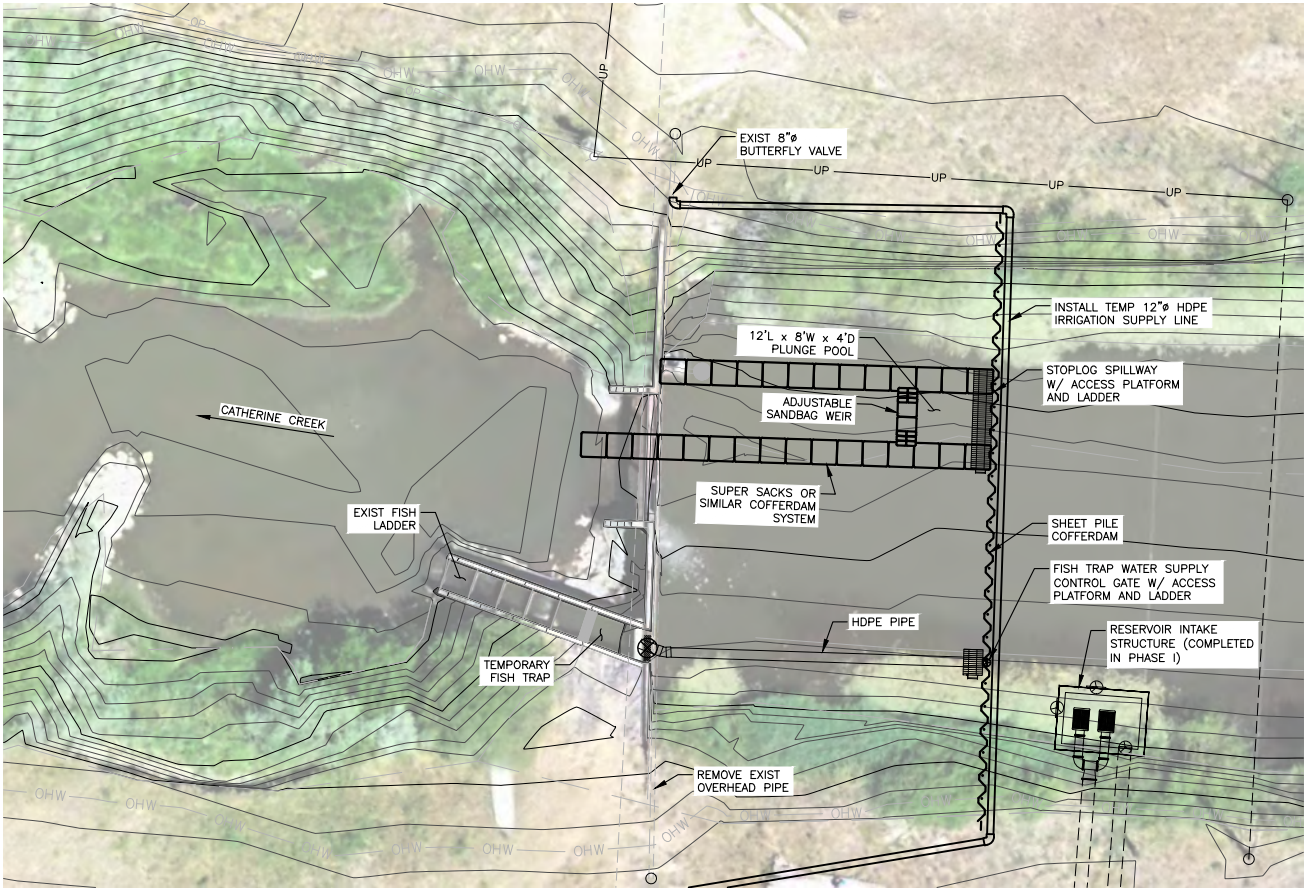


**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 1
- WORK PERIOD: NOVEMBER 1 – DECEMBER 15
- WORK ITEMS:
  - INSTALL RESERVOIR INTAKE STRUCTURE AT BOOTH LANE.
  - INSTALL CONCRETE WET WELL.
  - CONNECT TO EXISTING PIPING AND POWER.
  - REGRADE AND RE-VEGETATE DISTURBED AREAS.
- FISH PASSAGE MEASURES
  - FISH REMOVAL SHALL OCCUR AFTER INSTALLATION OF TEMPORARY COFFERDAMS.
  - CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - COFFERDAM DESIGN AND DEWATERING MEASURES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

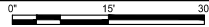
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TITLE:  <p style="text-align: center; font-size: 1.2em;">TROUT UNLIMITED ELMER DAM TEMPORARY FISH PASSAGE PLAN</p>		FIGURE:  <p style="font-size: 2em; text-align: center;">8</p>
DRAWN: J. LAHMEN	CHECKED: J. WOODBURY	DATE: 11/05/21



**ELMER DAM COFFER DAM AND TEMPORARY PASSAGE PLAN**

SCALE: 1" = 30'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 2A
- WORK PERIOD: JULY 1 – NOVEMBER 30
- WORK ITEMS:
  - INSTALL SHEET PILE COFFERDAM.
  - INSTALL ADJUSTABLE STOPLOG WEIRS, PLUNGE POOL, AND BYPASS CHANNEL.
  - INSTALL HDPE WATER SUPPLY PIPE TO EXIST FISH LADDER.
  - INSTALL FISH TRAP IN EXIST FISH LADDER (BY CTUIR).
  - BEGIN EXCAVATION OF LEFT BANK.
  - INSTALL TEMPORARY 12"Ø HDPE IRRIGATION SUPPLY PIPE
  - REMOVE EXIST 8"Ø OVERHEAD IRRIGATION SUPPLY PIPE.
- FISH PASSAGE MEASURES
  - CONTRACTOR SHALL COORDINATE WITH TU, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - THE ADJUSTABLE STOPLOG WEIRS, PLUNGE POOL, AND BYPASS CHANNEL WILL PROVIDE DOWNSTREAM PASSAGE FOR THE DURATION OF THE PHASE 2 WORK PERIOD.
  - CTUIR WILL OPERATE AND INSPECT THE TRAP AS WELL AS HANDLE, TRANSPORT, AND RELEASE UPSTREAM CHINOOK MIGRANTS UPSTREAM OF THE DAM.
  - FISH TRAP AND HAUL OPERATIONS SHALL CONTINUE THROUGH THE MONTH OF JULY OR UNTIL THE TRAP HAS BEEN CLEAR OF FISH FOR A PERIOD OF TIME TO BE AGREED UPON BETWEEN ODFW AND CTUIR PRIOR TO START OF CONSTRUCTION.

TITLE:

TROUT UNLIMITED  
ELMER DAM  
TEMPORARY FISH PASSAGE PLAN



**River Structures**  
CONSULTING

FIGURE:

**9**

DRAWN:

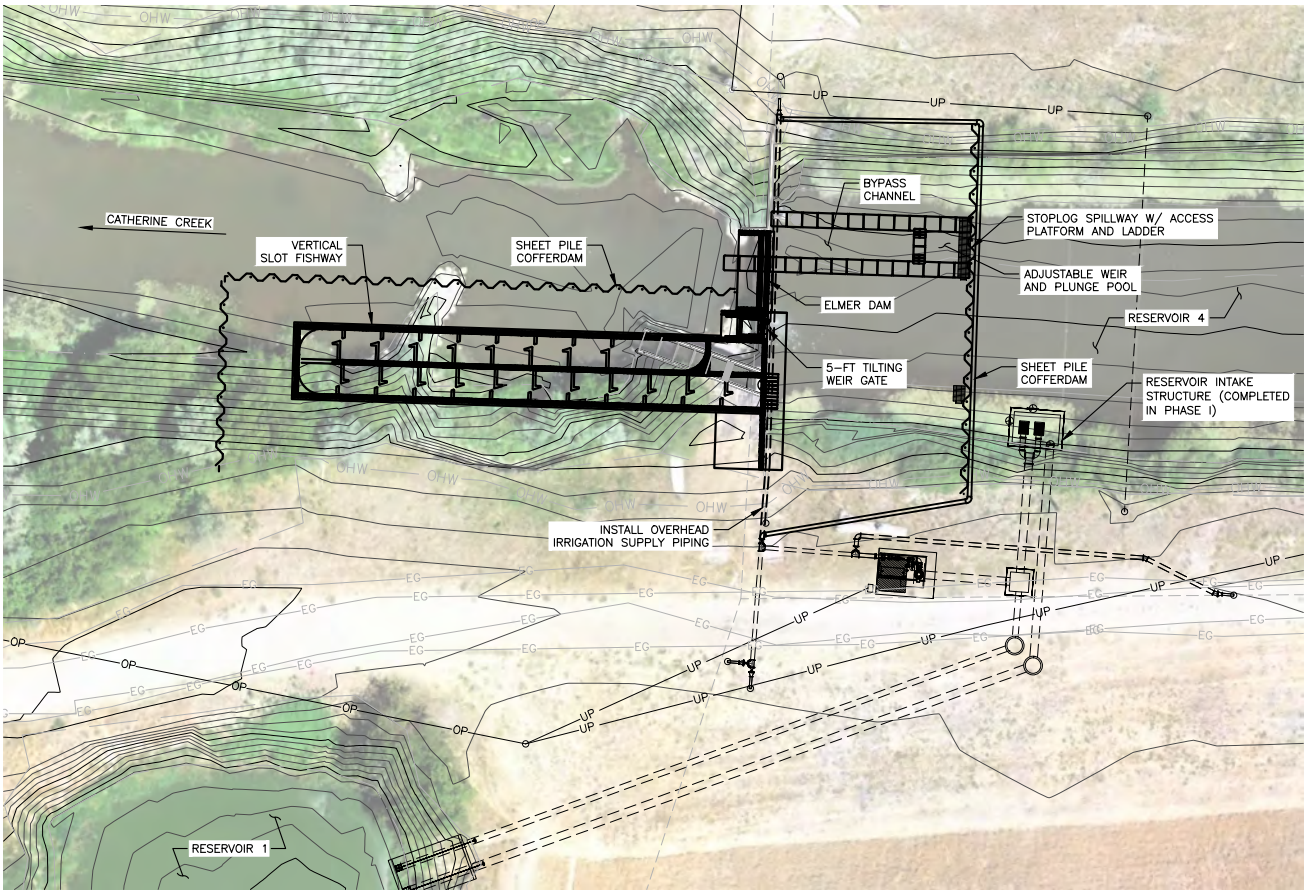
J. LAHMOM

CHECKED:

J. WOODBURY

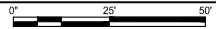
DATE:

11/05/21



**VERTICAL SLOT FISHWAY AND TILTING WEIR PLAN**

SCALE: 1" = 50'



**TEMPORARY PASSAGE PLAN NOTES:**

- PHASE 2B
- WORK PERIOD: JULY 1 – NOVEMBER 30
- WORK ITEMS:
  - INSTALL SHEET PILE COFFERDAM DOWNSTREAM OF ELMER DAM.
  - DEMOLISH EXIST FISH LADDER AND CONCRETE WINGWALL.
  - INSTALL 5-FT TILTING WEIR GATE AT ELMER DAM.
  - INSTALL VERTICAL SLOT FISHWAY AT ELMER DAM.
  - INSTALL NEW OVERHEAD IRRIGATION PIPING ACROSS ELMER DAM.
  - REGRADE AND RE-VEGETATE DISTURBED AREAS.
- FISH PASSAGE MEASURES
  - DOWNSTREAM FISH MIGRATION AND BYPASS FLOWS SHALL BE PROVIDED FOR DURATION OF THE WORK PERIOD THROUGH THE ADJUSTABLE STOPLOG WEIRS, PLUNGE POOL AND BYPASS CHANNEL.
  - CONTRACTOR SHALL COORDINATE WITH TU, USWCD, ODFW AND CTUIR FOR IMMEDIATE REMOVAL OF FISH FROM WORK AREA.
  - CONSTRUCTION ACTIVITIES WITHIN IN-WATER WORK AREA SHALL NOT BEGIN UNTIL FISH REMOVAL HAS OCCURRED.
  - UPON COMPLETION OF THE WORK, ALL TEMPORARY FISH PASSAGE AND COFFERDAM WORKS SHALL BE REMOVED.

TITLE:

TROUT UNLIMITED  
ELMER DAM  
TEMPORARY FISH PASSAGE PLAN



**River Structures**  
CONSULTING

FIGURE:

**10**

DRAWN:

J. LAHMON

CHECKED:

J. WOODBURY

DATE:

11/05/21

**APPENDIX B**  
**TEMPORARY FISH PASSAGE PLAN DRAWINGS**

**NOTES:**

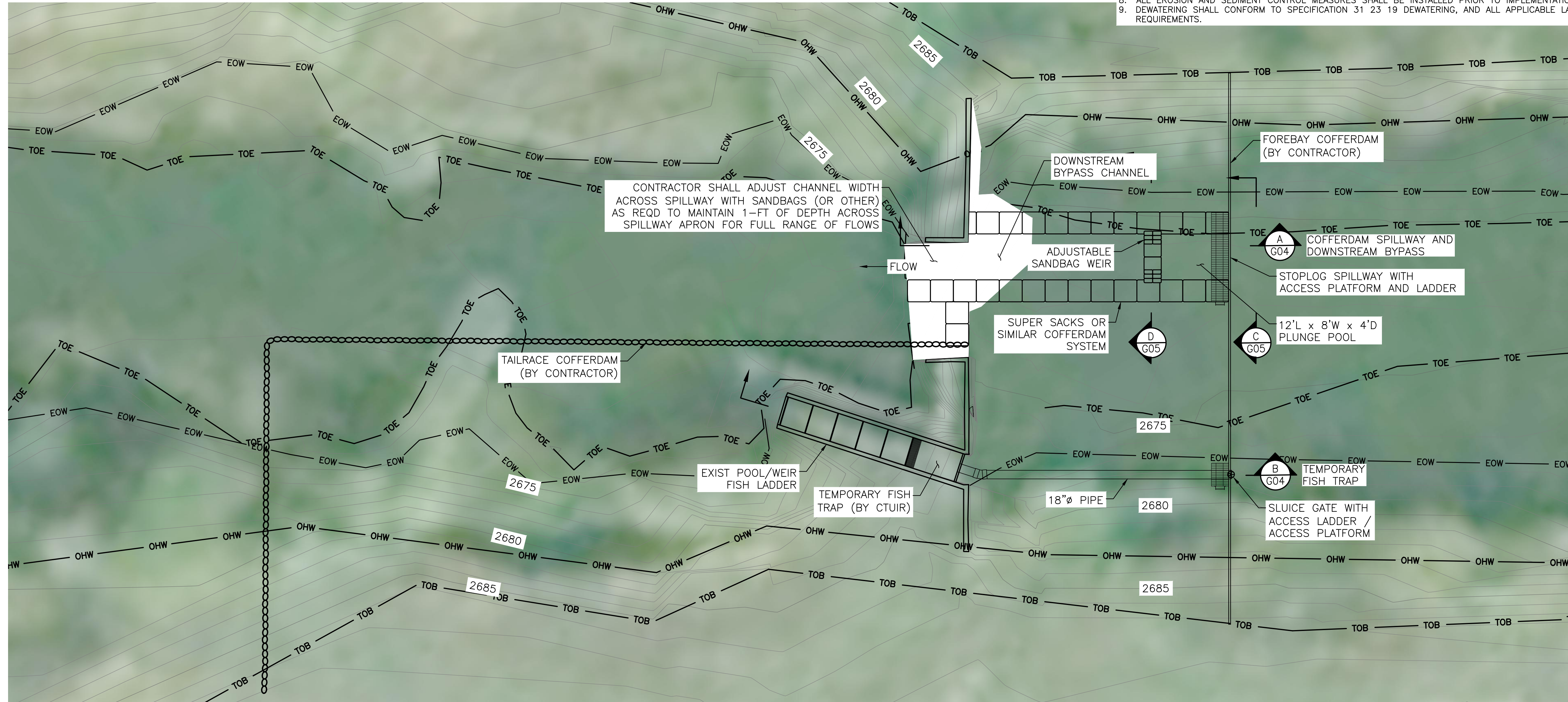
1. THE DAM AND FISHWAY CONCEPTUAL COFFERDAM PLAN PRESENTED ON SHEETS G03, G04, AND G05 ARE FOR REGULATORY APPROVAL AND THE CONTRACTOR'S UNDERSTANDING OF THE DEWATERING AND TEMPORARY FISH PASSAGE AND TRAPPING MEASURES REQUIRED FOR CONSTRUCTION OF ELMER DAM MODIFICATIONS.
2. THE TEMPORARY FACILITIES SHOWN IN THE PLAN SET ARE INFORMATIONAL ONLY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DESIGN, IMPLEMENTATION, OPERATION AND MAINTENANCE AND REMOVAL OF ALL TEMPORARY DEWATERING, DOWNSTREAM FISH PASSAGE AND FISH TRAP WATER SUPPLY MEASURES. THE CONTRACTOR SHALL DESIGN AND IMPLEMENT THE TEMPORARY FACILITIES IN ACCORDANCE WITH THE CRITERIA PRESENTED IN THE DRAWINGS AND THE TEMPORARY FISH PASSAGE PLAN.
3. THE CONTRACTOR'S COFFERDAM STRUCTURAL DESIGN AND INSTALLATION PLANS SHALL BE SEALED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF OREGON.
4. THE CONTRACTOR SHALL SUBMIT THE DESIGN OF THE ABOVE MEASURES AS PART OF THE CONTRACTOR'S DEWATERING PLAN. THE DEWATERING PLAN SHALL BE SUBMITTED FOR APPROVAL BY THE ENGINEER.

**FISH TRAPPING NOTES:**

1. THE CONSTRUCTION WINDOW OVERLAPS WITH THE IN-MIGRATION WINDOW FOR CATHERINE CREEK SPRING CHINOOK.
2. THE CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION (CTUIR) SHALL BE RESPONSIBLE FOR IMPLEMENTATION AND OPERATION OF A TEMPORARY FISH TRAP WITHIN THE EXISTING FISHWAY, IN ACCORDANCE WITH THE TEMPORARY FISH PASSAGE PLAN, TO MITIGATE FOR DISRUPTION OF SPRING CHINOOK MIGRATION DUE TO CONSTRUCTION OF ELMER DAM MODIFICATIONS.
3. THE CONTRACTOR SHALL DESIGN AND IMPLEMENT A WATER SUPPLY SYSTEM BETWEEN THE FOREBAY COFFERDAM AND THE FISH TRAP. THE WATER SUPPLY SYSTEM SHALL BE EQUIPPED WITH FLOW CONTROLS (SLUICE GATE) AND BE ABLE TO DELIVER UP TO 10 CFS TO THE FISH TRAP.
4. ONLY QUALIFIED CTUIR STAFF SHALL BE INVOLVED WITH FISH TRAPPING OPERATIONS.
5. CTUIR SHALL BE RESPONSIBLE FOR FIELD ADJUSTING THE FISH TRAP WATER SUPPLY RATES AND STOPLOG HEIGHTS BASED ON THE NEEDS OF TRAPPING OPERATIONS AS WELL AS TAILWATER LEVELS IN CATHERINE CREEK. THE WATER SUPPLY SHALL BE THROTTLED AS NEEDED TO MINIMIZE TURBULENCE WITHIN THE TRAP TO PREVENT FISH EXHAUSTION.

**DEWATERING NOTES:**

1. CONSTRUCTION OF THE ELMER DAM MODIFICATIONS REQUIRES DEWATERING OF THE FOREBAY AND LEFT BANK OF THE TAILRACE. THE PRIMARY FOREBAY DEWATERING MEASURES SHALL INCLUDE THE FOREBAY COFFERDAM, DOWNSTREAM BYPASS, FISH TRAP WATER SUPPLY AND DEWATERING PUMPS.
2. THE FOREBAY COFFERDAM SHALL HAVE A MINIMUM TOP OF WALL ELEVATION OF 2884' AND PROVIDE A MAXIMUM FOREBAY ELEVATION OF 2883'. THE FOREBAY COFFERDAM SHALL BE EQUIPPED WITH AN ADJUSTABLE STOPLOG SPILLWAY AND WATER SUPPLY INTAKE GATE FOR THE FISH TRAP. THE STOPLOG SPILLWAY SHALL HAVE A MAX DISCHARGE CAPACITY OF 100 CFS. THE TEMPORARY TRAP WATER SUPPLY SHALL PROVIDE A MAX DISCHARGE OF 10 CFS. SEE SHEETS G04 AND G05 FOR ADDITIONAL CRITERIA AND DETAILS.
3. A DOWNSTREAM BYPASS CHANNEL SHALL BE CONSTRUCTED TO TRANSPORT RIVER FLOWS AND DOWNSTREAM MIGRATING FISH BETWEEN COFFERDAM SPILLWAY AND ELMER DAM. THE DOWNSTREAM BYPASS CHANNEL SHALL MAINTAIN A MINIMUM DEPTH OF 4' IN THE PLUNGE POOL AND 1' ACROSS THE SPILLWAY WEIR, PLUNGE POOL WEIR AND ELMER DAM SPILLWAY. THE CONTRACTOR SHALL PROVIDE DOWNSTREAM FISH PASSAGE IN ACCORDANCE WITH ODFW AND NMFS FISH PASSAGE CRITERIA FOR THE DURATION OF THE WORK.
4. INSTALLATION OF THE TAILRACE COFFERDAM SHALL PROCEED UPON COMPLETION OF THE TEMPORARY FISH TRAPPING OPERATIONS. THE CONTRACTOR MUST RECEIVE WRITTEN APPROVAL FROM ODFW IN ACCORDANCE WITH THE TEMPORARY FISH PASSAGE PLAN TO PROCEED WITH THE TAILRACE COFFERDAM INSTALLATION.
5. THE TAILRACE COFFERDAM HEIGHT AND STYLE SHALL BE DETERMINED BY THE CONTRACTOR. BOTH FOREBAY AND TAILRACE COFFERDAM STRUCTURAL DESIGN CALCULATIONS AND PLANS SHALL BE SEALED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF OREGON AND SUBMITTED FOR APPROVAL BY THE ENGINEER.
6. THE CONTRACTOR SHALL COORDINATE WITH TROUT UNLIMITED, UNION SOIL AND WATER CONSERVATION DISTRICT (USWCD) AND ODFW ON FISH REMOVAL PRIOR TO DEWATERING THE FOREBAY OR TAILRACE.
7. THE CONTRACTOR'S DEWATERING PLAN SHALL ADDRESS TURBIDITY TREATMENT AND EROSION CONTROL MEASURES FOR SEEPAGE WATER REMOVAL FROM THE DEWATERED AREAS. ALL DISCHARGE FROM THE WORK AREA SHALL MEET LOCAL, STATE AND FEDERAL DISCHARGE REQUIREMENTS.
8. ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED PRIOR TO IMPLEMENTATION OF DEWATERING WORK.
9. DEWATERING SHALL CONFORM TO SPECIFICATION 31 23 19 DEWATERING, AND ALL APPLICABLE LAWS, REGULATIONS AND REQUIREMENTS.



CONTRACTOR SHALL ADJUST CHANNEL WIDTH ACROSS SPILLWAY WITH SANDBAGS (OR OTHER) AS REQD TO MAINTAIN 1-FT OF DEPTH ACROSS SPILLWAY APRON FOR FULL RANGE OF FLOWS

PLAN  
SCALE: 1"=10'-0"

REV	DATE	BY	DESCRIPTION
0	06/17/22	CCB	ISSUED FOR CONSTRUCTION

WARNING

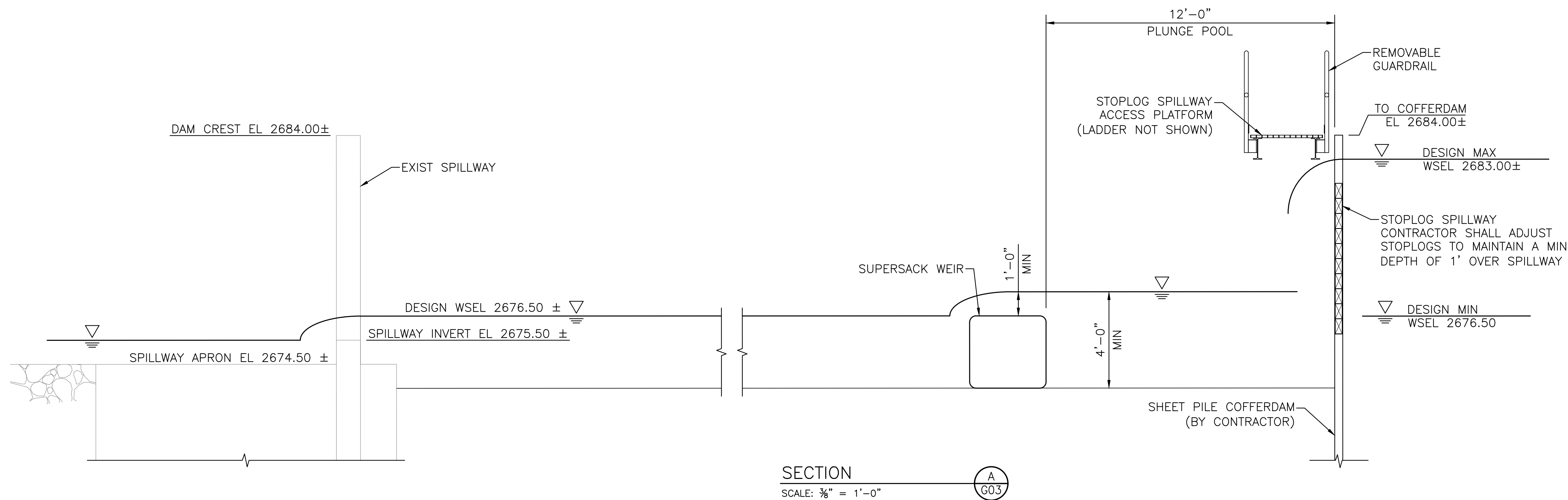
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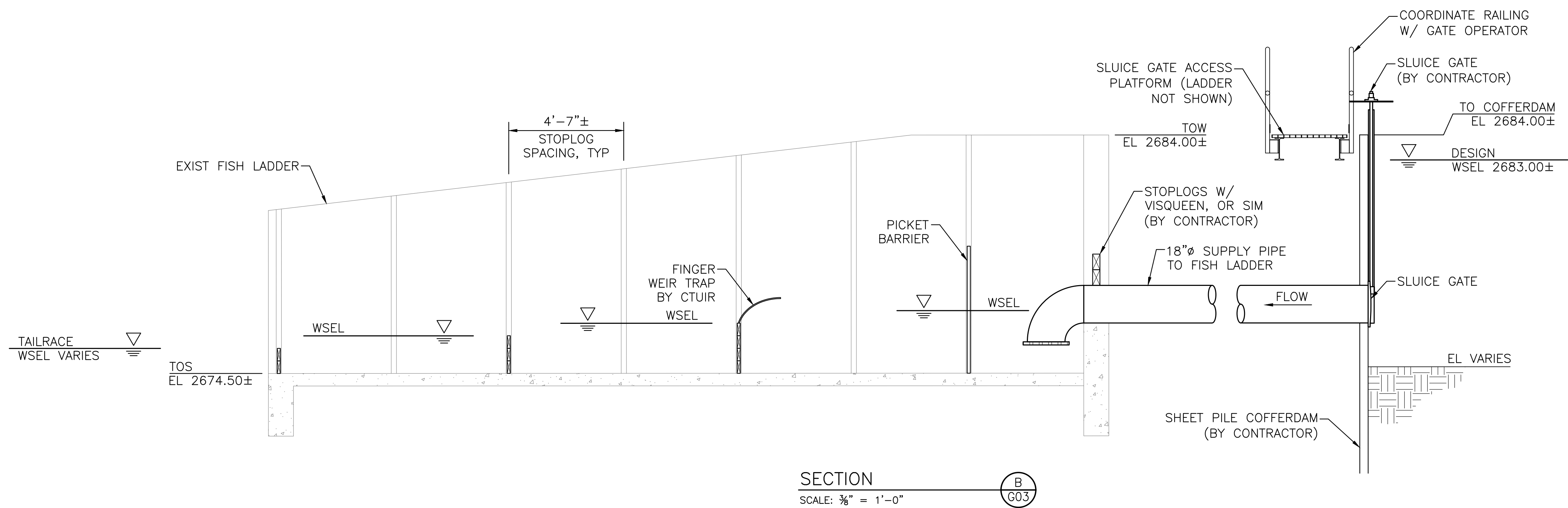
TU/USWCD
ELMER DAM MODIFICATIONS
DAM & FISHWAY CONCEPTUAL COFFERDAM PLAN

DESIGNED <u>J. WOODBURY</u>	DRAWING <b>G03</b>
DRAWN <u>J. LAHMEN</u>	
CHECKED <u>C. BOYD</u>	
ISSUED DATE <u>06/17/22</u>	
SCALE: AS NOTED	



**NOTES:**

1. INSTREAM FLOWS SHALL BE PROVIDED THROUGH A COMBINATION OF PIPED FLOW THROUGH THE EXIST FISH LADDER AND BYPASS SPILLWAY FLOW.
2. THE CONTRACTOR SHALL COORDINATE WITH LAND OWNERS/IRRIGATORS ON FOREBAY WATER LEVEL MANAGEMENT.
3. THE CONTRACTOR SHALL ADJUST STOPLOG HEIGHTS TO MAINTAIN 1 FT OF DEPTH OVER THE WEIR FOR RANGE OF BYPASS FLOWS, TYP 20-30 CFS (TOTAL).
4. THE BYPASS SPILLWAY SHALL BE CAPABLE OF PASSING FLOWS UP TO 100 CFS.
5. CONTRACTOR SHALL ADJUST SANDBAG PLACEMENT AT THE PLUNGE POOL WEIR AND EXIST SPILLWAY APRON TO MAINTAIN A MINIMUM OF 1 FT OF DEPTH.



**TRAP NOTES:**

1. CONTRACTOR SHALL PROVIDE AND INSTALL ALL COMPONENTS (SLUICE GATE, PIPE, WATER TIGHT CONNECTION TO LADDER, ETC) FOR UP TO 10 CFS WATER SUPPLY TO FISH LADDER.
2. CONTRACTOR SHALL INSTALL A PICKET BARRIER W/ 1" MAX OPENING OR SIM TO PREVENT FISH MIGRATION UPSTREAM THROUGH PIPE.
3. CTUIR SHALL INSTALL AND OPERATE FISH TRAP TO FIT IN EXIST FISH LADDER IN ACCORDANCE WITH THE TEMPORARY FISH PASSAGE PLAN.
4. CTUIR STAFF SHALL REGULATE THE FLOW TO THE FISH TRAP BY ADJUSTING THE SLUICE GATE. FLOWS SHALL BE REGULATED SUCH THAT VELOCITIES AND TURBULENCE WITHIN THE TRAP ARE SUITABLE FOR SUSTAINED SWIM SPEEDS TO PREVENT FISH EXHAUSTION.
5. CTUIR SHALL ADJUST STOPLOG HEIGHTS WITHIN THE FISH LADDER TO ACHIEVE OPTIMAL FLOW DEPTHS AND DROP HEIGHTS ACROSS THE LADDER AS TAILWATER ELEVATION VARIES.
6. THE SLUICE GATE MAY BE PARTIALLY OR FULLY CLOSED TO ASSIST WITH CROWDING AND NETTING OF FISH.
7. CTUIR STAFF SHALL BE RESPONSIBLE FOR ALL HANDLING AND TRANSPORT OF FISH. FISH SHALL BE RELEASED ABOVE CTUIR'S CATHERINE CREEK ADULT TRAPPING FACILITY AT RIVER MILE 42.5.

REV	DATE	BY	DESCRIPTION
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WARNING

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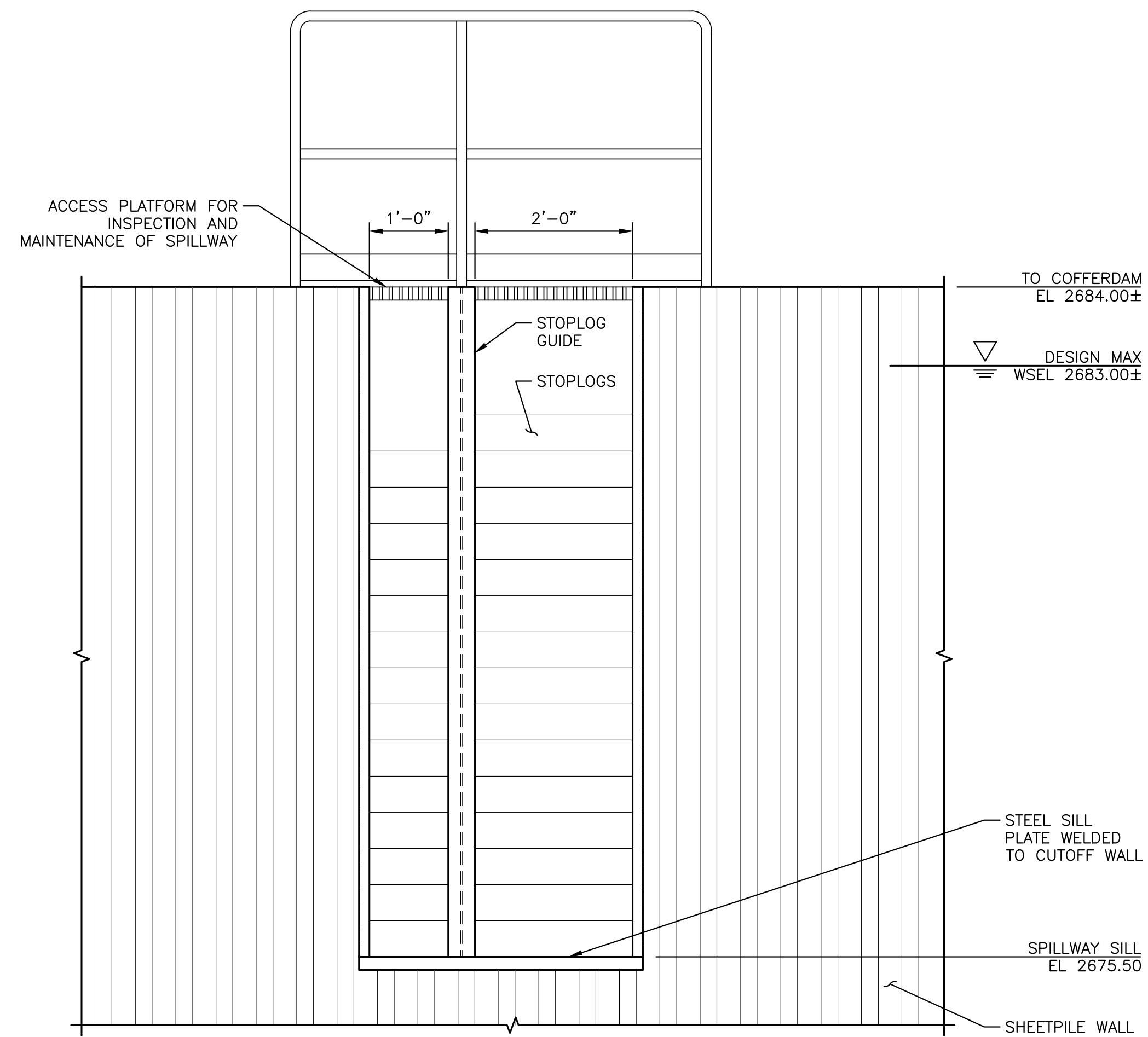


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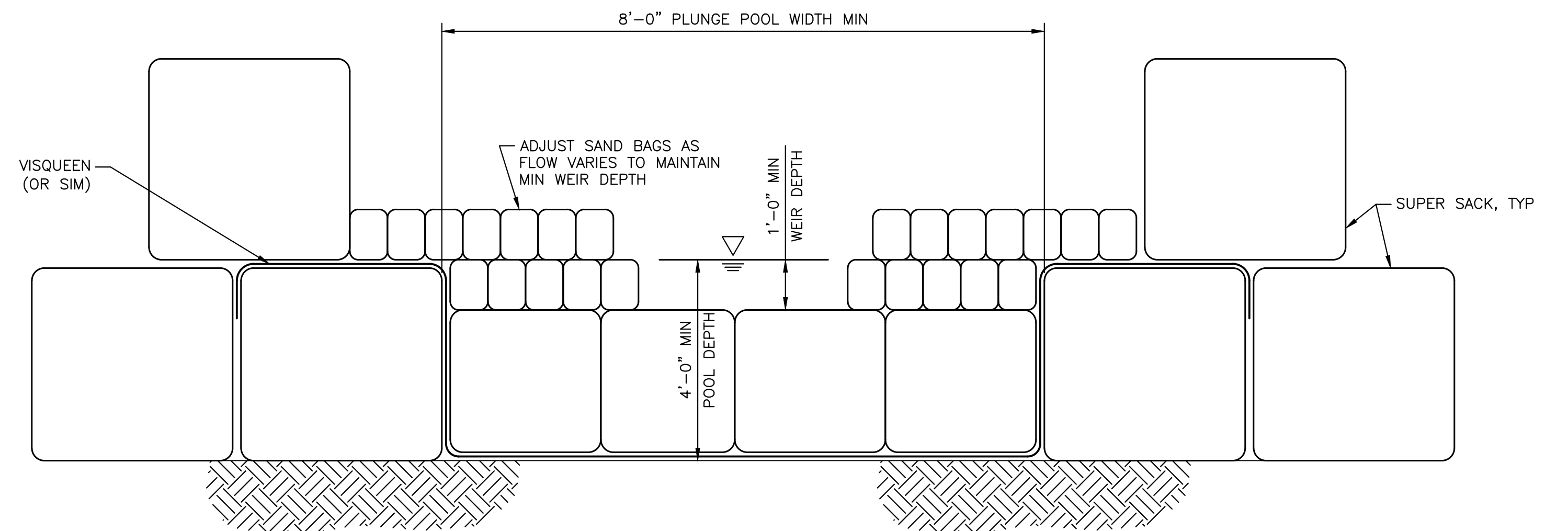
TU/USWCD  
ELMER DAM MODIFICATIONS  
DAM & FISHWAY  
CONCEPTUAL COFFERDAM SECTIONS 1

DESIGNED <u>J. WOODBURY</u>
DRAWN <u>J. LAHMEN</u>
CHECKED <u>C. BOYD</u>
ISSUED DATE <u>06/17/22</u>

DRAWING  
**G04**  
SCALE: AS NOTED



SPILLWAY SECTION C  
SCALE: 3/4" = 1'-0" (G03)



SAND BAG WEIR SECTION D  
SCALE: 1/2" = 1'-0" (G03)

- NOTES:
1. COFFERDAM SPILLWAY SHALL BE DESIGNED, INSTALLED AND MAINTAINED BY CONTRACTOR.
  2. SPILLWAY SHALL PASS FLOWS UP TO 100 CFS.
  3. CONTRACTOR SHALL ADJUST SPILLWAY AS REQD TO MAINTAIN A MIN DEPTH OF 1' OVER SPILLWAY WEIR FOR DOWNSTREAM MIGRANTS.
  4. PLUNGE POOL SHALL BE CENTERED BELOW THE COFFERDAM WEIR TO PREVENT FISH FROM IMPACTING PLUNGE POOL WALLS.
  5. WEIR AND STOPLOGS SHALL BE FREE OF ANY SHARP PROTRUSIONS OR JAGGED CORNERS WHICH MAY HARM FISH.

REV	DATE	BY	DESCRIPTION
0	06/17/22	CCB	ISSUED FOR CONSTRUCTION

WARNING

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TU/USWCD  
ELMER DAM MODIFICATIONS  
DAM & FISHWAY  
CONCEPTUAL COFFERDAM SECTIONS 2

DESIGNED J. WOODBURY  
DRAWN J. LAHMON  
CHECKED C. BOYD  
ISSUED DATE 06/17/22

DRAWING  
**G05**  
SCALE: AS NOTED