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Documentation Design Report

The Dalles East Fish Ladder Auxiliary Water Backup System

Columbia River, Oregon-Washington

Prepared by:
U.S. Army Corps of Engineers
Walla Walla District
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EXECUTIVE SUMMARY

The purpose of The Dalles East Fish Ladder Auxiliary Water Backup System Design Documentation Report (DDR) is to develop a design to provide an emergency backup supply of water to the auxiliary water system (AWS). Water is currently supplied to the AWS by two fish unit turbines located on the west end of the powerhouse. If one or both fish unit turbines fail, water supplied to the AWS would be severely limited or eliminated. The AWS supplies water to the east, west, and south fish ladder entrances in order to attract upstream migrating adult fish. An alternative to provide a backup supply of water to the AWS in case both fish unit turbines fail is evaluated in this DDR.

The alternative evaluated in this DDR provides a flow of 1,400 cubic feet per second (cfs). With a discharge of 1,400 cfs, the west and south fish entrances are closed and two of the three weirs at the east fish ladder (EFL) will be operational. This emergency operating condition was developed by the U.S. Army Corps of Engineers (USACE) and regional fishery agencies. The fish passage system would be operational, but under less than ideal flow conditions.

This DDR evaluates an alternative that was ultimately chosen from almost 20 alternatives. These alternatives were formulated during a brainstorming team meeting between USACE and contractor HDR Engineering, Inc. (HDR). This discussion is documented in *The Dalles East Fish Ladder Auxiliary Water System Emergency Operation Backup System Alternatives – Brainstorm Meeting Report* (February 2011). Several alternatives were then selected for further evaluation in the 2012 Engineering Documentation Report (EDR) by HDR, *The Dalles East Fish Ladder Auxiliary Water Backup System*. The recommendation from the EDR was twofold, and includes improvements to the fishlock water supply valve room and Alternative #2 – Low Level Intake.

Based on the engineering analysis for this DDR, evaluation criteria for this project, and USACE team input, a single 10-foot conduit will convey the entire 1,400 cfs by routing flow through monolith 17 into the existing fishlock approach channel. Flow is released into a modified fishlock approach channel and into the existing AWC via two 6-foot conduits and an 8-foot diffuser culvert. The recommend alternative reduces the required borings and associated setups compared to the proposed EDR alternative. The recommended design also utilizes a buried conduit to eliminate structural supports while providing simplified thrust restraint and reduced impact to project access. A single conduit reduces the number of valves required and the complexity of operation. Replacing the four sleeve valves which incorporate orifice plates with a single ring jet valve will reduce potential for debris clogging. The utilization of the existing fishlock approach channel for energy dissipation closely approximates standard design guidance. Two additional 6-foot conduits were required to provide 1,400 cfs to the auxiliary water supply chamber (AWSC) due to revised water surface elevations. The recommendation also eliminates the cost to alter the fishlock valve room.

The construction cost with contingency for this design is estimated to be approximately $TBD. The Total Fully Funded Project Cost, without Operations and Maintenance, (O&M) is currently estimated to be approximately $TBD.

PERTINENT PROJECT DATA

PERTINENT PROJECT DATA THE DALLES LOCK AND DAM - LAKE CELILO		
GENERAL		
Location	Columbia River, Oregon and Washington, River Mile 192	
Drainage area	Square miles	237,000
RESERVOIR – LAKE CELILO (elevations referenced to 1929 datum 1947 adjustment)		
Normal minimum pool elevation	Feet, msl	155
Normal maximum pool elevation	Feet, msl	160
Maximum pool elevation (PMF regulated, 2009)	Feet, msl	178.4
Minimum tailwater elevation	Feet, msl	76.4
Maximum tailwater elevation (PMF regulated, 2009)	Feet, msl	127.2
Reservoir length (to John Day Dam)	Miles	23.5
Reservoir surface area – normal maximum power pool (EL 160.0)	Acres	9,400
Storage capacity (EL. 160.0)	Acre-feet	332,500
Power drawdown pool (EL. 155)	Acre-feet	53,500
Length of shoreline at full pool (EL. 160.0)	Miles	55
FLOOD CONDITIONS		
Probable maximum flood (unregulated)	- feet^3/s	2,660,000
Probable maximum flood (regulated)	- feet^3/s	2,060,000
Standard project flood (unregulated)	- feet^3/s	1,580,000
Standard project flood (regulated)	- feet^3/s	840,000
100-year flood event (regulated)	- feet^3/s	680,000
SPILLWAY		
Type	Gate-controlled Gravity Overflow	
Length	Feet	1,447
Elevation of crest	Feet, msl	121
Number of gates		23
Height (apron to spillway deck)	Feet	130
NAVIGATION LOCK		
Type	Single Lift	
Lift – normal	Feet	87.5
Lift – maximum	Feet	90
Net clear length	Feet	650
Net clear width	Feet	86
Normal depth over upper sill	Feet	20
Minimum depth over upstream sill	Feet	15
Minimum depth over downstream sill	Feet	15

PERTINENT PROJECT DATA **THE DALLES LOCK AND DAM - LAKE CELILO**		
POWER PLANT		
Powerhouse type	Conventional (indoor)	
Powerhouse width	Feet	239
Powerhouse length	Feet	2,089
Number of Main Generating Units		***22***
Installed power capacity	Kilowatts	1,806,800
Peak generating efficiency flow	- feet^3/s	260,000
Maximum flow capacity	- feet^3/s	320,000
Fishway Units (Not Included Above)		***2***
Installed power capacity	Kilowatts	28,000
Peak generating efficiency flow	- feet^3/s	2,500
Maximum flow capacity	- feet^3/s	2,500
Station Service Units (Not Included Above)		***2***
Installed power capacity	Kilowatts	6,000
Peak generating efficiency flow	- feet^3/s	300
Maximum flow capacity	- feet^3/s	300
FISH FACILITIES		
Adult ladders		2
Ladder designations		North and East
North ladder width	Feet	24
East ladder width	Feet	30
Ladder slope (typical)		1v:16h
Ladder elevation change (typical)	Feet	84
NORTHERN WASCO PEOPLE'S UTILITY DISTRICT POWER PLANT (OPERATING AT THE NORTH FISH LADDER AWS)		
Powerhouse type	Conventional (indoor)	
Powerhouse width	Feet	44
Powerhouse length	Feet	48
Intake Structure width	Feet	25
Intake Structure length	Feet	125
Number of Main Generating Units		***1***
Installed power capacity	Kilowatts	5,000
Peak generating efficiency flow	- feet^3/s	800
Maximum flow capacity	- feet^3/s	800

PREVIOUS MEMORANDUMS

ABBREVIATIONS AND ACRONYMS

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWC	auxiliary water conduit
AWS	auxiliary water supply
AWSC	auxiliary water supply chamber
AWWA	American Water Works Association
cfs	cubic feet per second
CWA	Clean Water Act
DDR	Design Documentation Report
EA	Environmental Assessment
EAWS	Emergency Auxiliary Water Supply
EDR	Engineering Documentation Report
EFL	east fish ladder
EIS	Environmental Impact Statement
EM	Engineering Manual
ER	Engineering Regulation
ESA	Endangered Species Act
ETL	Engineering Technical Letter
ETR	Engineering Technical Report
FAC	fishlock approach channel
FCC	fish collection channel
fps	feet per second
FFDRWG	Fish Facility Design and Review Work Group
FONSI	Finding of No Significant Impact
fps	feet per second
ft	feet
ft^2	square feet
FTC	fish transportation channel
gpm	gallons per minute
HDR	HDR Engineering, Inc.
HDC	Hydroelectric Design Center
hp	horsepower
HSS	Hollow Structural Sections
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
ISA	International Society of Automation
JBS	juvenile bypass system
kips	kilo pounds
kV	kilovolt

kVA	kilovolt-ampere
kW	kilowatt
m	meter
MCASES II	Micro Computer Aided Cost Estimating System Version II
MCC	motor control center
MCE	Maximum Credible Earthquake
MDE	Maximum Design Earthquake
msl	mean sea level
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NHSM	National Seismic Hazard Maps
NMFS	National Marine Fisheries Service
NWP	USACE, Portland District
NWW	USACE, Walla Walla District
O&M	Operations and Maintenance
OBE	Operational Based Earthquake
ODOT	Oregon Department of Transportation
OSHA	Occupational Safety and Health Administration
PGA	peak ground acceleration
PH	phase
PSHA	Probabilistic Seismic Hazard Analysis
ppm	parts per million
psi	pounds per square inch
PUD	People’s Utility District
RCC	Reservoir Control Center
SEI	Structural Engineering Institute
TDH	total discharge head
TEFC	totally enclosed, fan-cooled
TEWAC	totally enclosed, water-to-air cooled
UL	Underwriters Laboratories
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
V	volt
VFD	variable frequency drive
VPI	Vacuum Pressure Impregnation
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
W	wire

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CHAPTER 1 – PURPOSE AND INTRODUCTION

1.1 PURPOSE

Providing backup auxiliary water for the east fish ladder (EFL) is critical to the overall success of adult fish passage at The Dalles Dam.

The issue of providing backup auxiliary water has been studied during the 1990s in several alternative reports. Early concepts in the 1990s revolved around the juvenile bypass system (JBS) dewatering to provide the backup water. But, in the early 2000s, the JBS concept at The Dalles Dam was abandoned. Therefore, a backup auxiliary water supply (AWS) was never implemented at The Dalles Dam.

1.2 REFERENCES

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1.3 BACKGROUND

In 2008, the U.S. Army Corps of Engineers’ (USACE) Hydroelectric Design Center (HDC) conducted a risk failure analysis and report on the fish turbines units (USACE 2008). HDC concluded that there is a 25 percent probability that at least one of the two fish water units will experience a significant failure in the next 10 years. Furthermore, the probability of failure of both units at the same time is 1.4 percent in the next 10 years.

Subsequently, HDR Engineering, Inc. (HDR), under contract to USACE, completed a letter report (HDR 2009), that investigated in further detail the concept of utilizing the draft tube of a main turbine unit to provide full flow backup water supply of 5,000 cubic feet per second (cfs) for the AWS. The estimated cost of the recommended alternative from the HDR report was much greater than expected. Due to the high cost and risk of draft tube modifications, this alternative was no longer considered.

Recognizing that providing a full flow backup AWS is cost prohibitive, USACE and representatives from fisheries agencies discussed operational options that would require less flow and still provide good fish passage during an “emergency operation.” The group agreed that in the event both fish units failed, the duration of the “emergency operation” is 1 year. It was also agreed the east fish ladder entrance was the priority, and two of the three weirs would remain operational. The south and west entrances would be closed. Based on the east entrance only scenario, USACE estimated 1,400 cfs is needed. With 1,400 cfs established as the minimum hydraulic AWS needs, it was recommended that a brainstorming session be conducted to further develop concepts for this scenario.

In late 2010, USACE contracted with HDR to facilitate a brainstorming meeting (HDR 2011) to help identify other sources of water that focused on a collective set of processes to pull water from various sources and volumes, in concert with perhaps a smaller, cost effective alternative feature that could help meet the hydraulic need for the “emergency operation.”

A Fish Facility Design Review Work Group (FFDRWG) meeting with regional fisheries agencies and tribes was held in May 2011, with the goal to discuss the brainstorm report and to decide which alternatives from the report should be considered in an Engineering Documentation Report (EDR). It was agreed that several be kept for further investigation. Each alternative was considered to be a stand-alone feature. USACE contracted with HDR to produce an EDR to further develop the chosen alternatives to provide backup AWS (HDR 2012). The preferred alternative selected from the EDR is Alternative #2 – Low Level Intake.

1.4 SCOPE

The scope of this Design Documentation Report (DDR) involves developing a detailed design of a variation of Alternative #2 – Low Level Intake, as described in the EDR. This DDR will include structural, mechanical, electrical, geotechnical, biological, environmental, cost engineering, constructability, and operations and maintenance considerations. Engineering and analysis will be sufficient to develop a complete project schedule and baseline cost estimate with reasonable contingency factors. Reports will be written at 30 percent, 60 percent, 90 percent, and final 100 percent design levels. The report will contain text, photos, charts, diagrams, calculations, assumptions, costs, discussion of constructability and drawings as required fully documenting the design and basis for decisions. USACE Portland District (NWP) and agency review comments will be provided throughout the development for Walla Walla

District (NWW) consideration and inclusion, as appropriate. Site visits to the project will be necessary.

1.5 AUTHORIZATION

The 1995 Energy and Water Development Appropriations Act (Public Law 104-46) directed USACE to use additional appropriations to evaluate the effectiveness and efficiency of the bypass systems, reduce mortality by predators, and enhance passage conditions.

1.6 EXISTING FISHWAY FACILITIES

1.6.1 East Fish Ladder

The adult fish passage facilities at The Dalles Dam consist of the north fish ladder and the EFL. This report focuses on the EFL. Attraction and transportation flow for the south, west, and east entrances of the EFL is provided by two fish turbine units (F1 and F2) located on the west end of the powerhouse. Water discharged (5,000 cfs) from the fish turbines enters the auxiliary water conduit (AWC) and is released into the system through diffusers. Water enters the fishway at the junction pool, east entrance, south entrance, west entrance, and transportation channel after passing through diffusers. It can enter the collection channel, but these diffusers were closed because fish entrances along the collection channel are not currently operational. Fish enter the south and west fish ladders and travel through the transportation and collection channels, respectively, to the EFL (see figures 1-1, 1-2, and 1-3).

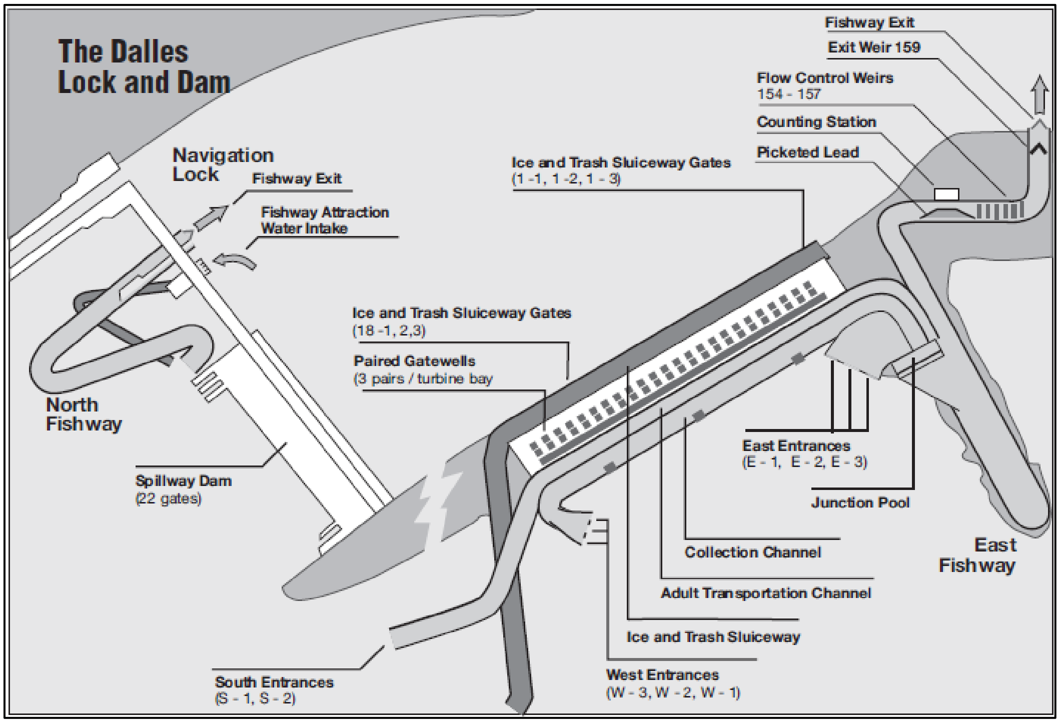

Figure 1-1. The Dalles Dam Fish Ladder System (USACE 2008)

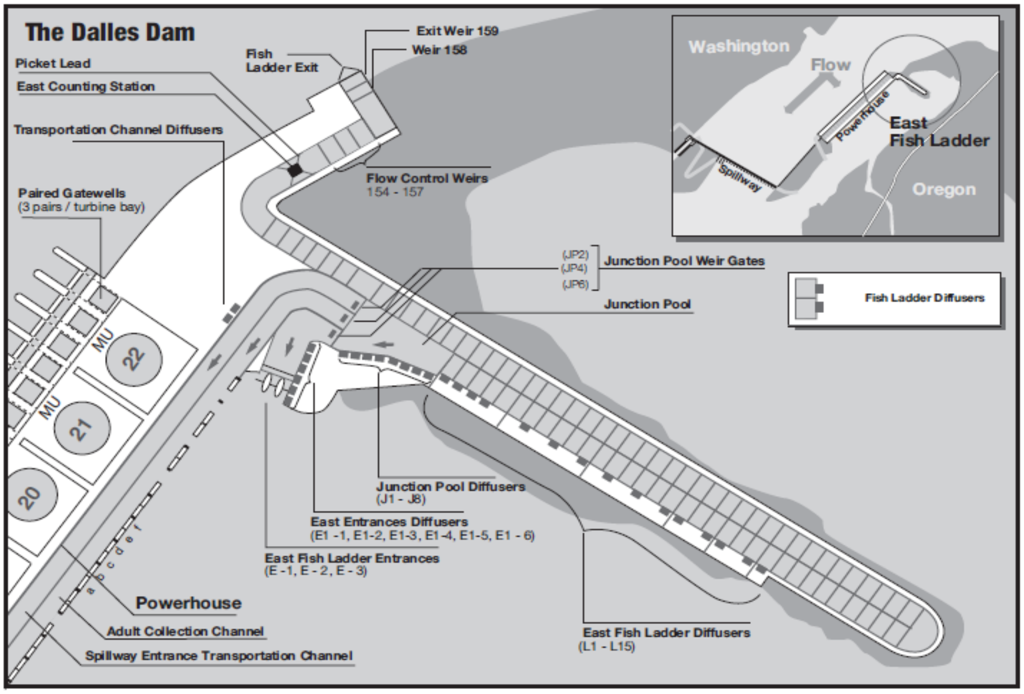

Figure 1-2. The Dalles Dam East Fish Ladder (USACE 2008)

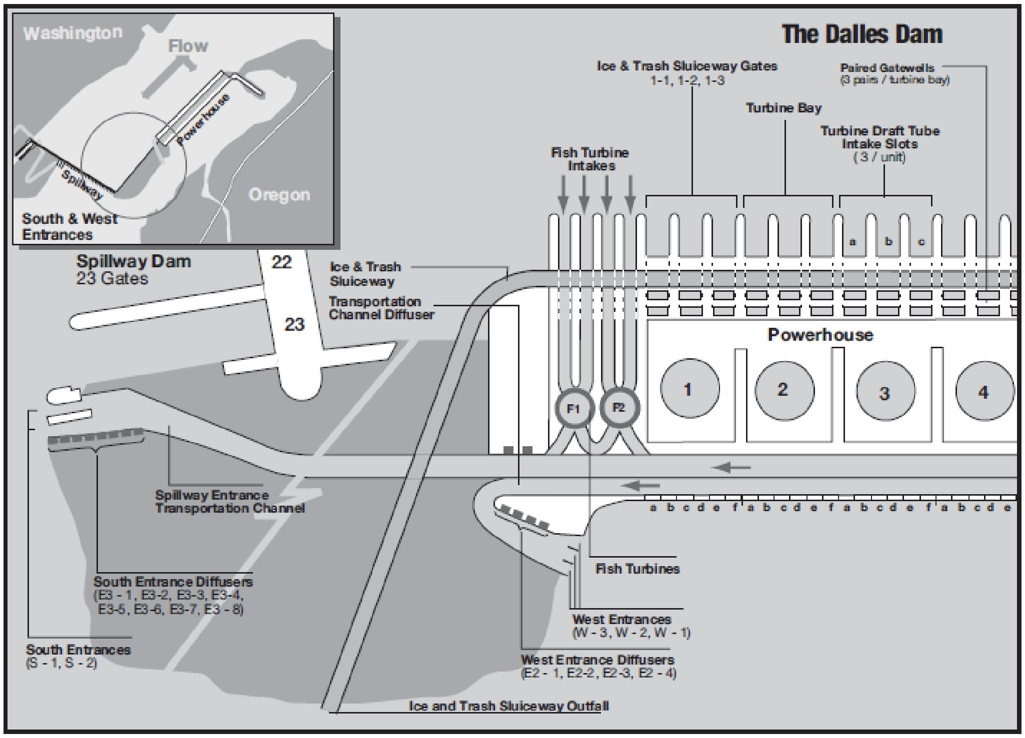

Figure 1-3. The Dalles Dam West and South Fish Ladders (USACE 2008)

1.6.2 Fish Turbine Units

The two fish turbine units, F1 and F2, are located at the west end of the powerhouse. The turbine units have a combined power capacity of 28,000 kilowatts (kW) and a maximum flow capacity of 2,500 cfs each. Water (5,000 cfs) is discharged from the fish turbine units into the AWC. Trashracks with 1-inch spacing are installed in the fish turbine unit intakes.

1.6.3 Auxiliary Water System

As shown on figures 1-3, the AWS consists of an AWC, a fish transport channel, fish collection channel, junction pool, weir gates, and a series of diffusers along the AWC that convey water to the south, west, and east fish ladder entrances. Water is supplied to the AWC from the two fish turbine units. This system is complex to operate, but is an integral part of the overall operation of the EFL system. Based on a numerical model provided by USACE, CENWP-EC-HD, the hydraulic head within the AWS conduit near the east entrance is approximately 5 feet greater than the pool elevation. This is consistent with a rough estimate based on the field data differentials to tailwater obtained at similar ladders (John Day, Little Goose, and Lower Granite). The original model was developed by Northwest Hydraulics, Inc. for USACE.

Prior to flowing through the EFL entrance, water is sent through a series of diffusers in the junction pool. The junction pool provides water to the fish transportation channel (FTC), which supplies the south fish entrance, and the fish collection channel (FCC), which supplies the west fish entrance. The AWS normally operates with a total flow of up to 5,000 cfs, but should be able to be operated with a minimum discharge of 1,400 cfs with the south and west entrances closed.

1.7 AGENCY COORDINATION

This report was fully coordinated with the regional fisheries agencies and tribes through FFDRWG.

CHAPTER 2 – BIOLOGICAL DESIGN CONSIDERATIONS AND CRITERIA

2.1 GENERAL

Anadromous salmonid and lamprey passage criteria are described in this section, as these are the primary taxa of concern with respect to operation of the EFL. The primary source of general criteria for adult and juvenile salmon passage is taken from the *Anadromous Salmonid Passage Facility Design* Report (NMFS 2011). Passage criteria specific to the EFL is provided in the 2011 Fish Passage Plan (USACE 2011). Lamprey criteria are under development by the scientific community concerned about lamprey passage.

The Dalles Dam has two primary fish ladders: the north and east fish ladders. The EFL has east, south, and west entrances for upstream migrating fish. The east entrance leads directly to the EFL. The south and west entrances direct fish into channels that pass along the downstream side of the powerhouse and join the EFL upstream of the east entrance at a junction pool.

Species of fish migrating past The Dalles Dam include Chinook (*Oncorhynchus tshawytscha*), Coho (*Oncorhynchus kisutch*), and sockeye (*Oncorhynchus nerka*) salmon, steelhead (*Oncorhynchus mykiss*), Pacific lamprey (*Entosphenus tridentatus*), white sturgeon (*Acipenser transmontanus*), and American shad (*Alosa sapidissima*). Bull trout (*Salvelinus confluentus*) have also been observed occasionally in the fish ladders. Upstream migrants are present at the dam year-round, whereas downstream migrating juvenile salmonids and shad are present primarily from April through November. No information has been collected to verify this, but it is likely that downstream migrating larval and juvenile Pacific lamprey are present during the winter.

2.2 REFERENCES

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2.3 ADULT PASSAGE PERIOD

Upstream migrating adult salmonids are present at The Dalles Dam throughout the year and adult passage facilities are operated year-round. Adult salmon, steelhead, lamprey, and shad are normally counted from April 1 through October 31. Counts are visual, and occur from 0500 to 2100 Pacific Daylight Time. Peak numbers of upstream migrating salmon and steelhead occur from April through October (figure 2-1). Adult Pacific lamprey also migrate past The Dalles Dam. Counts have ranged from almost 29,000 to less than 2,000 since 2002, with numbers generally decreasing in recent years. Count data can only serve as a relative index of adult passage because most adult lamprey pass at night when counting is not conducted, and numerous routes are available for lamprey to pass dams without being detected (Moser and Close 2003; Robinson and Bayer 2005). River discharge and temperature play important roles in migration timing, but in most years, passage occurs primarily between late June and early September (table 2-1).

Although numbers are far less than those of adult salmon or Pacific lamprey, limited upstream movement of white sturgeon occurs at The Dalles Dam. Upstream passage is generally highest during July and August. Sturgeon use the EFL almost exclusively for upstream passage (Parsley et al. 2007), although they may reside for periods of time in both the east and north fish ladders.

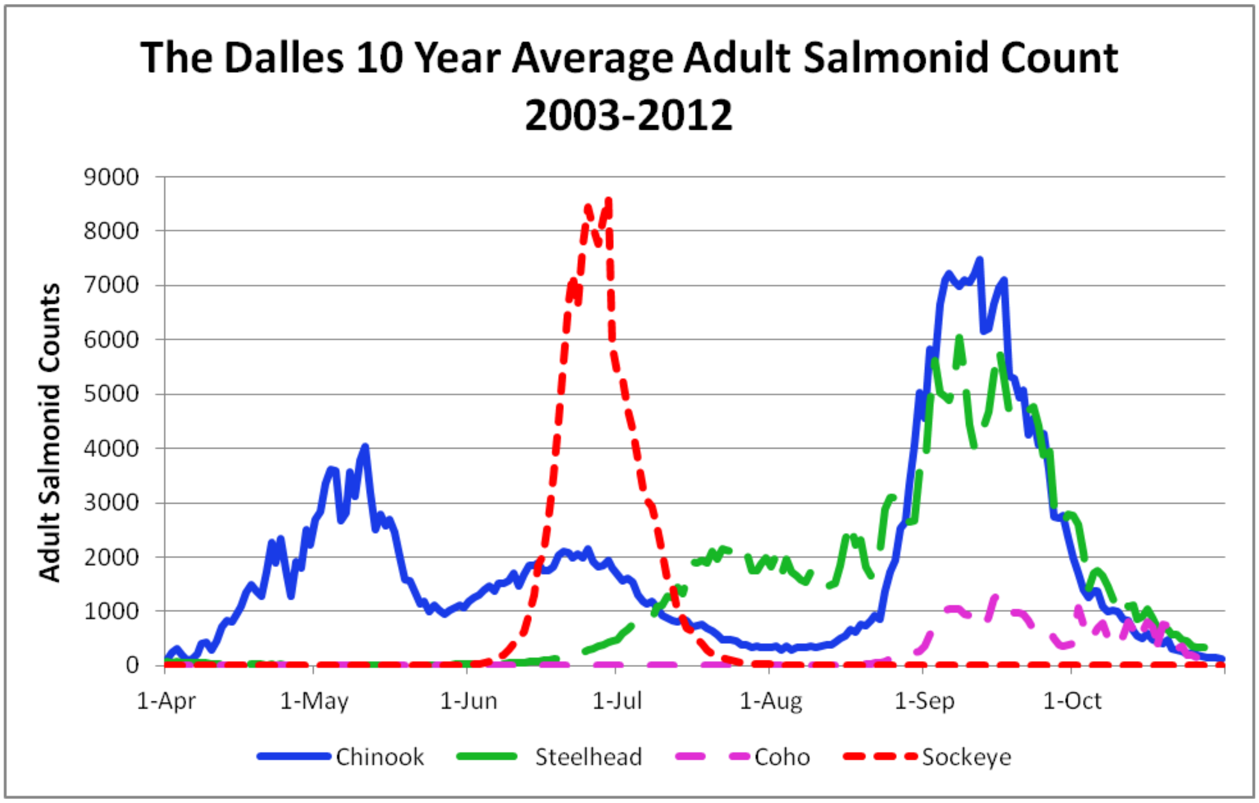
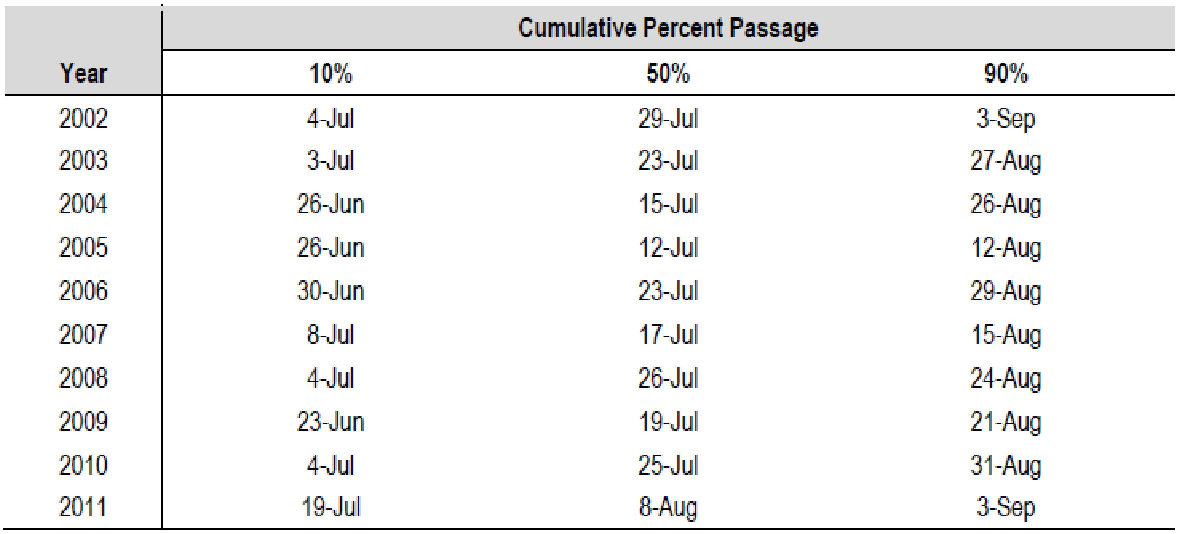


Figure 2-1. 10 Year Average (2003-2012) of Adult Migrating Salmonids at The Dalles Dam (Data Access in Real Time [DART] 2013)

Table 2-1. Adult Pacific Lamprey Migration Dates for The Dalles Dam



Year	Cumulative Percent Passage		
	10%	50%	90%
2002	4-Jul	29-Jul	3-Sep
2003	3-Jul	23-Jul	27-Aug
2004	26-Jun	15-Jul	26-Aug
2005	26-Jun	12-Jul	12-Aug
2006	30-Jun	23-Jul	29-Aug
2007	8-Jul	17-Jul	15-Aug
2008	4-Jul	26-Jul	24-Aug
2009	23-Jun	19-Jul	21-Aug
2010	4-Jul	25-Jul	31-Aug
2011	19-Jul	8-Aug	3-Sep

2.4 ADULT SALMONID PASSAGE CRITERIA

The AWS backup system considered in this report allows for operation of the EFL in the event that the two fish turbine units are not operational. Per consultation with regional fish managers, the backup system considered will provide a design flow of 1,400 cfs, the discharge required to meet adult fish passage criteria for the east entrances of the EFL (HDR 2012, Appendix A). In the event of a double outage of the fish turbine units, the west and south entrances would be closed and the proposed backup system operated. USACE and regional fish managers have already developed an emergency operation plan in the event of the loss of a *single* fish turbine unit (USACE 2011). The backup systems and proposed operations considered in this report are *not* intended to supplant the emergency operation plan for the loss of a single unit.

2.4.1 Fish Passage Plan Criteria for Adult Fishways at The Dalles Dam

The adult fishway criteria discussed below should assume operation of the east entrances of the EFL only (in addition to normal operation of the north fish ladder). Per the 2012 *Fish Passage Plan* (USACE 2012), relevant criteria include:

- Depth over fish ladder weirs: 1.0 foot (± 0.1 foot). During the shad passage season (> 5,000 shad/count station/day at Bonneville Dam): 1.3 feet (± 0.1 foot). The 2012 *Fish Passage Plan* includes exceptions to these criteria:
    - East powerhouse entrance (east entrances): Operate entrance weirs E2 and E3 to maintain gate crest > 8 feet below tailwater, currently operated at 13 feet below tailwater. Weir E1 to be closed at 81 feet mean sea level (msl), but will remain operational. At lower range of tailwater elevation, weir E1 may be operated manually at any depth to meet entrance differential criteria.

    - Operate EFL junction pool weir JP6 at the following minimum depths in relation to east entrances tailwater surface elevation: > 7 feet.

- Head on all entrances: 1 to 2 feet (1.5 feet optimum).

- Entrance weir depths: 8 feet or greater below tailwater. Maintain tailwater elevation greater than 70 feet msl to remain in entrance weir criteria operating range, which is regulated by Reservoir Control Center (RCC).

- A water velocity of 1.5 to 4 fps (2 fps optimum) shall be maintained for the full length of the powerhouse collection channel and lower ends of the fish ladders that are below the tailwater. ***Note:*** *For the purposes of this report, it is assumed that these criteria will not apply to the powerhouse collection channel, as the west and south entrances will be closed. The water velocity criteria here will only apply to the lower ladder/junction pool area immediately upstream of the east entrances.*

- Diffuser velocities: AWS diffuser velocity must be less 1.0 fps for vertical diffusers and 0.5 fps for horizontal diffusers, based on total diffuser panel area. Diffuser velocities should be nearly uniform. Energy dissipation on the upstream side of the diffuser screens will be provided, if needed, to meet this criterion.

- Remove debris as required to maintain head below 0.5 feet on attraction water intakes and trashracks at all ladder exits. Debris shall be removed when significant amounts accumulate.

Discharge from the two operating fish units will be adjusted to maintain criteria at all associated fishway entrances. Discharge volume will be dependent on criteria levels at entrances. ***Note:*** *The AWS system design in this report should provide discharge volume sufficient to maintain entrance criteria at the east entrances only.*

2.4.2 Adult Salmonid Passage Facility Design Criteria

Relevant criteria specified in the *Anadromous Salmonid Passage Facility Design* report (NMFS 2011) that is not already specified above from the 2012 *Fish Passage Plan*:

<u>AWS Diffusers</u>

- Velocity and Orientation: The maximum AWS diffuser velocity must be less 1.0 fps for vertical diffusers and 0.5 fps for horizontal diffusers, based on total diffuser panel area. Vertical diffusers should only be used in appropriate orientation to assist in guiding fish within the fishway. Diffuser velocities should be nearly uniform.

- Debris Removal: The AWS design must include access for debris for each diffuser, unless the AWS intake is equipped with a juvenile fish screen, as described in Section 11 (NMFS 2011) or if required by Section 4.3.4 (NMFS 2011).

- Edges: All flat bar diffuser edges and surfaces exposed to fish shall be rounded or grounded smooth to the touch, with all edges aligning in a single smooth plane to reduce potential for contact injury.

AWS Fine Trashracks

A fine trashrack must be provided at the AWS intake with clear space between the vertical flat bars 7/8 inch or less, and the maximum velocity shall not exceed 1 fps, as calculated by the maximum flow divided by the entire fine trashrack area. The support structure for the fine trashrack must not interfere with cleaning requirements and must provide access for debris raking and removal. Fine trashracks must be installed at a 1:5 (horizontal:vertical) slope (or flatter) for ease of cleaning. ***Note:*** *The new AWS system design may include a new trashrack grating criteria of 0.75 inch openings (0.625 inch between bars) to prevent debris from accumulating in the AWS diffuser system and exclude lamprey from the AWS.*

- Staff gages must be installed to indicate head differential across the AWS fine trashrack, and must be located to facilitate observation and in-season cleaning. Head difference across the AWS intake must not exceed 0.3 feet. ***Note****: Due to the potential depth of the AWS intake design, the staff gage criterion may have to be reconsidered or changed, in consultation with regional fish managers.*

- Structural Integrity: The AWS intake fine trashracks must be of sufficient structural integrity to avoid permanent deformation associated with maximum occlusion.

Transport Channels:

- Dimensions: Transport channels should be a minimum of 5 feet deep.

- A water velocity of 1.5 to 4 fps (2 fps optimum) shall be maintained in all channels and at the lower ends of the fish ladder that are below tailwater (already stated as 2012 *Fish Passage Plan* criteria).

Ladder Pools:

- Hydraulic drop: The maximum hydraulic drop between fishway pools is 1 foot or less.

- Pool dimensions: Pool dimensions should be a minimum of 5 feet deep.

- Pool volume: The fishway pools shall have a minimum water volume of:

$$V = \frac{\gamma Q i H o}{\left(4 \cdot \frac{ft}{s} \cdot \frac{lbs}{ft^3}\right)}$$

where:
V = Pool volume = depth x width x length (feet^3)
γ = Unit weight of water = 62.4 lbs/feet^3
Qi = Total inflow to pool (cfs)
Ho = Energy head of pool to pool flow (feet)

This pool volume must be provided under all expected design flow conditions, with the entire pool having active flow and contributing to energy dissipation.

2.5 ADULT PACIFIC LAMPREY CRITERIA

Most passage criteria developed for adult Pacific lamprey are not directly relevant to development of AWS backup system alternatives, as they generally address structural design (shape) of fish ladder features, such as overflow weirs. For the purposes of this report, it is assumed that maintaining the adult fish passage criteria described in the 2012 *Fish Passage Plan* and by NMFS (2011) will provide the hydraulic targets for the EFL in the event of the loss of both fish turbine units.

The primary concern relative to adult Pacific lamprey is infiltration of AWS backup system intakes, particularly those that are in close proximity to entrances (tailwater) or exits (forebay) of the EFL:

- Clear openings on AWS backup system intake trashracks shall be no greater than 0.75 inch to prevent lamprey infiltration.

2.5.1 Anadromous Fish Passage Structure Materials

Zinc is a known fish toxin that can induce avoidance behavior. In recent diffuser grating replacement discussions at The Dalles Dam, regional fish managers agreed to allow installation of galvanized steel grating on the condition that the zinc concentration fell below the perception threshold of salmonids, which is assumed to be 0.026 parts per million (ppm) (Svecevicius 1999).

- Galvanized steel materials used in fishways or fishway water supply structures may be used only if the associated zinc concentration remains below the 0.026 ppm threshold (roughly 40 square feet of galvanized material per each cfs of flow).

Galvanized steel material may be used if it is coated with an inert material (powder-coated), as this is known to slow the leaching rate of zinc.

2.6 JUVENILE PASSAGE PERIOD

Turbine units at The Dalles Dam are not screened. Juvenile fish passage facilities consist of the spillway, the ice and trash sluiceway, and one 6-inch orifice in each gatewell. Gatewell orifices allow flow into the sluiceway, providing a potential means of passing fish from the gatewells into the sluiceway. When any of the sluiceway gates (located in the forebay side of the sluiceway) are opened, water and juvenile migrants are skimmed from the forebay into the sluiceway and deposited in the tailrace downstream of the dam. Approximately 80 percent of juvenile salmonids pass over the spillway (Johnson et al. 2007). Many others pass through the ice and trash sluiceway, with the remainder passing through turbines.

The primary juvenile salmonid passage period is April through November. Because juvenile monitoring is not performed at The Dalles Dam, refer to table 2-2 (USACE 2011) and add approximately 1 day to the dates for each species to estimate the juvenile salmonid arrival dates at The Dalles Dam.

Migration depth of juvenile salmonids can vary by species, race, time of day, and location. Faber et al. (2005) found that 80 percent of spring migrants (primarily yearlings) were in the upper 5.6 meters (m) of the water column (4.7 m at night), and 80 percent of summer migrants were in the upper 4.7 m of the water column. Smolt-sized fish were distributed deeper in the water column in the center of channel than near the edges, such as near the dam.

Distribution and migration depth information for juvenile lamprey is scarce; however, studies at various dams found that >70 percent of larval (ammocoete) and juvenile (macrophthalmia) lamprey passed below turbine intake screens of juvenile bypass systems (BioAnalysts Inc. 2000; Moursund et al. 2003; Monk et al. 2004; Moursund and Bleich 2006).

Table 2-2. Juvenile Salmonid Migration Dates for John Day Dam

	Yearling Chinook		
Year	10%	50%	90%
2001	6-May	27-May	20-Jun
2002	1-May	17-May	1-Jun
2003	3-May	19-May	2-Jun
2004	28-Apr	16-May	30-May
2005	25-Apr	12-May	22-May
2006	25-Apr	11-May	24-May
2007	2-May	13-May	25-May
2008	4-May	22-May	1-Jun
2009	27-Apr	17-May	1-Jun
2010	1-May	18-May	6-Jun

	Subyearling Chinook		
Year	10%	50%	90%
2001	27-Jun	30-Jul	22-Aug
2002	20-Jun	30-Jun	20-Jul
2003	6-Jun	27-Jun	30-Jul
2004	14-Jun	28-Jun	23-Jul
2005	19-Jun	5-Jul	27-Jul
2006	14-Jun	3-Jul	18-Jul
2007	25-Jun	8-Jul	17-Jul
2008	24-Jun	9-Jul	5-Aug
2009	17-Jun	1-Jul	17-Jul
2010	14-Jun	1-Jul	20-Jul

	Unclipped Steelhead		
Year	10%	50%	90%
2001	28-Apr	5-May	30-May
2002	19-Apr	19-May	8-Jun
2003	30-Apr	28-May	4-Jun
2004	30-Apr	23-May	2-Jun
2005	1-May	14-May	24-May
2006	24-Apr	13-May	29-May
2007	29-Apr	13-May	28-May
2008	6-May	21-May	1-Jun
2009	26-Apr	11-May	28-May
2010	27-Apr	12-May	8-Jun

	Clipped Steelhead		
Year	10%	50%	90%
2001	2-May	17-May	10-Jun
2002	24-Apr	14-May	6-Jun
2003	2-May	29-May	4-Jun
2004	7-May	20-Jun	29-May
2005	4-May	19-May	26-May
2006	28-Apr	10-May	29-May
2007	4-May	12-May	26-May
2008	7-May	16-May	30-May
2009	29-Apr	10-May	27-May
2010	3-May	11-May	9-Jun

	Coho		
Year	10%	50%	90%
2001	17-May	1-Jun	14-Aug
2002	7-May	1-Jun	12-Jun
2003	9-May	30-May	8-Jun
2004	12-May	27-May	12-Jun
2005	5-May	16-May	3-Jun
2006	10-May	26-May	12-Jun
2007	5-May	16-May	4-Jun
2008	11-May	25-May	6-Jun
2009	16-May	29-May	13-Jun
2010	9-May	3-Jun	16-Jun

	Sockeye		
Year	10%	50%	90%
2001	1-Jun	14-Jun	27-Jun
2002	9-May	21-May	2-Jun
2003	10-May	19-May	2-Jun
2004	20-May	1-Jun	12-Jun
2005	16-May	21-May	31-May
2006	7-May	20-May	30-May
2007	9-May	25-May	7-Jun
2008	22-May	29-May	6-Jun
2009	10-May	25-May	7-Jun
2010	11-May	29-May	9-Jun

Although no sampling is conducted at The Dalles Dam, data from John Day Dam indicates that most juvenile lamprey are collected between early April and late June, with some fish collected into September (Fish Passage Center 2011). Many fish likely pass during winter when counting does not take place.

2.6.1 Juvenile Fish Passage Criteria

The existing AWS is supplied by two hydroelectric turbine units (F1 and F2). These units are unscreened, but are equipped with 2-inch trashracks to prevent larger debris from entering the AWS. Although NOAA Fisheries typically requires screening on new intake structures, juvenile fish screening is not required for *forebay* intakes of alternatives described in this report due to the emergency-use only nature of the project, the limited duration of operation (up to 1 year), and the anticipated construction, operation, and maintenance costs of juvenile fish screening (HDR 2012, Appendix J and Appendix K).

The primary concern for juvenile salmon and juvenile lamprey with respect to the AWS backup system design discussed in this report is entrainment in the system via the forebay intake. For the purposes of this report, juvenile fish impacts for this design will be compared with the *existing* system based on the following assumptions:

- It is assumed that 100 percent of fish entering the AWS backup system will die as a result. This is a reasonable assumption for the existing system, given the structural design and hydraulic conditions associated with the existing AWS.

- It is also assumed that the AWS backup system will be operated for up to 1 year, and outmigrating juvenile salmonids and lamprey will be exposed to the backup system for that period.

- Entrainment risk is influenced by a number of factors, including location, design discharge, and depth.

2.6.1.1 Juvenile Salmon and Steelhead

- Forebay Intake Location: Intakes should be located in areas that minimize risk of entrainment. ***Assumptions:*** *Intake Location will be appropriate to reduce the probability of juvenile salmonid entrainment as they approach the powerhouse.*

- Horizontal Distribution in Forebay: Data on first detections within 100 m of the dam indicate that acoustic-tagged juvenile salmon and steelhead often approach from the east (upstream) end of the powerhouse, but turbine and sluiceway passage is skewed to the west end of the powerhouse (including F1 and F2) for yearling Chinook salmon and steelhead. Subyearling Chinook salmon horizontal passage distribution, in contrast, is typically more evenly distributed across the powerhouse (Johnson et al. 2007, 2011). ***Assumptions:*** *Locating AWS backup system forebay intakes at the east end of the powerhouse (rather than the west end) will reduce risk of entrainment of juvenile Chinook and steelhead relative to* *the existing system. It is assumed that horizontal location will have a neutral effect on subyearling Chinook entrainment risk.*

- Design Discharge: Relative route use by outmigrating juvenile salmonids is influenced by the amount of water passing via various routes. This design will deliver 1,400 cfs which was determined to be appropriate flow to maintain fishway entrance criteria (HDR 2012). This discharge is much less than the 5,000 cfs supplied to the AWS via F1 and F2. ***Assumptions:*** *Design discharge will have a neutral effect on assessing juvenile salmonid entrainment risk, as the target discharge (1,400 cfs) is less than the volume passing via F1 and F2.*

- Forebay Intake Depth: Migration and passage depth varies by species, time of day, location, and structure encountered, but outmigrating juvenile salmonids generally occupy the upper 20 feet of the water column (Faber et al. 2005), and Johnson et al. (2011) found that over 50 percent of juvenile salmonids approached turbine F1 and F2 intakes within the upper 13 feet of the water column. ***Assumptions:*** *Locating the intake centerline at 116 feet msl will submerge the structure approximately 43 feet (13 m) below low forebay elevation at 155 feet msl. This will reduce the probability of juvenile salmonid entrainment as they approach the powerhouse.*

2.6.1.2 Juvenile Pacific Lamprey

- Horizontal Distribution: Unknown for juvenile lamprey. Subyearling Chinook salmon can be used as surrogates for horizontal distribution, because both juvenile Pacific lamprey and subyearling Chinook salmon are relatively weak swimmers compared to larger yearling salmonids. ***Assumptions:*** *AWS backup system forebay intake location (horizontal) will have a neutral effect on juvenile lamprey entrainment risk.*

- Design Discharge: Relative route use by outmigrating juvenile lamprey is influenced by the amount of water passing via various routes. This design will deliver 1,400 cfs, which is much less than the 5,000 cfs supplied to the AWS via F1 and F2. ***Assumptions:*** *Design discharge will have a neutral effect on assessing juvenile lamprey entrainment risk, as the target discharge (1,000 cfs) is common to all alternatives and is less than the volume passing via F1 and F2.*

- Forebay Intake Depth: Migration depth of juvenile lamprey is poorly understood, but studies at various dams found that >70 percent of juvenile lamprey passed below turbine intake screens of juvenile bypass systems (BioAnalysts Inc. 2000; Moursund et al. 2003; Monk et al. 2004; Moursund and Bleich, 2006). ***Assumptions:*** *Deeper intakes may increase risk to juvenile lamprey. The depth (based on normal pool elevation of 160.0 feet) of the top and bottom edges of AWS backup system trashracks will be compared with the depth of the top and bottom edges of the existing trashracks on F1 and F2 to assess relative risk of juvenile lamprey entrainment.*

2.6.2 Predator Habitat

Predation on juvenile salmonids and lamprey by resident fish (northern pikeminnow, smallmouth bass, etc.) is an important concern. The AWS backup system will minimize forebay structures that provide habitat (hydraulic conditions) for piscivorous fish.

2.7 IN-WATER WORK PERIOD

The in-water work period for annual maintenance of fish facilities is scheduled from December 1 through February 28 (or 29). Work during this period minimizes impacts on both upstream and downstream migrating salmonids. During the in-water work period, one fish ladder (north or east fish ladder) is always operational. Coordination with Northern Wasco People's Utility District (PUD) is needed prior to scheduling construction because they conduct routine maintenance each year when the north fish ladder is out of service.

2.8 FISH PASSAGE CONSIDERATIONS

2.8.1 Adult Salmonids and Lamprey

Adult salmonids migrating upriver and exiting the fishways of dams will occasionally pass back downstream via one of many potential routes, an event commonly called fallback. When exiting fishways and confronting the impounded water of a dam forebay, migrants may be attracted to water passing through spillways, sluiceways, and turbine intakes or may orient with the upstream face of the dam and enter these areas. The position of the intake pipes near the exit of the fishway could serve as an attractant to adult salmonids and possibly lamprey. Fallback rates at The Dalles Dam for adult salmonids have been higher than rates at other mainstem dams (Burke et al. 2005); however, fallback was lower for fish using the EFL (1.1 percent to 1.4 percent) than for those using the north fish ladder (1.8 percent to 5.0 percent). Similarly, fallback of adult Pacific lamprey was lower for those using the EFL (2.6 percent) than the north fish ladder (11.8 percent) (Claybough et al. 2011). Trashracks placed over the intake pipes should eliminate the potential for fallback. During tests at Bonneville Dam, no adult lamprey were able to pass through grating with ¾-inch spacing (Moser et al. 2007). Adult salmonids would also be precluded from passing. Adult Pacific lamprey can achieve short-term burst speeds exceeding 12 fps (Moser et al. 2002); therefore, impingement on trashracks should not be a problem.

Summary of potential impacts:

Flow into the intake pipes during operation may serve as an attractant to adult salmonids and Pacific lamprey; however, trashracks should prevent fallback. Fallback through the intake should therefore be less than that of the existing system.

2.8.2 Juvenile Salmonids and Lamprey

Juvenile salmonids and lamprey encounter The Dalles Dam during their downstream migration; therefore flow through the intake pipes could result in some entrainment.

Although approximately 80 percent of juvenile salmonids pass the dam via the spillway (Johnson et al. 2007), fish approaching the dam near the south shore of the Columbia River first pass along the powerhouse, and would therefore be vulnerable to entrainment. Turbine and sluiceway passage of yearling Chinook salmon and steelhead is skewed to the west end of the powerhouse; therefore, location of the intake at the east end of the powerhouse will reduce risk of entrainment relative to the existing system. Horizontal distribution of subyearling Chinook salmon is more evenly distributed; therefore, location of the intake should neither increase nor decrease the risk of entrainment. Horizontal distribution of outmigrating lamprey is unknown; however, they are weak swimmers and most likely distributed similarly to subyearling salmonids. Location of the intake should therefore neither increase nor decrease the risk of entrainment.

Over 80 percent of all juvenile salmonids should be distributed above the ceiling of the intake pipe, which would be at an approximate depth of 38 ft (11.6 m; assuming a 10-foot-diameter intake pipe with a centerline of approximately 43 feet (13 m) deep at maximum operating pool (Faber et al. 2005). Many juvenile salmonids will be well above the intake because it will be located along the edge of the channel, where fish tend to be higher in the water column. Trashrack depth will be similar to that of trashracks at turbine intakes; therefore location of the intake in the water column should neither increase nor decrease the risk of entrainment. Out-migrating lamprey may be located below the intake ceiling; however, location of the intake in the water column should neither increase nor decrease the risk of entrainment.

Summary of potential impacts:

Downstream-migrating juvenile salmonids and lamprey could be entrained into pipes during operation. Estimating the proportion of juvenile salmonids vulnerable to entrainment is not feasible; however, the risk of entrainment relative to the existing system at The Dalles Dam is likely to be neutral for most species and runs, and potentially decreased for yearling salmonids

2.8.3 White Sturgeon

Position and depth of the intake should have a negligible effect on white sturgeon. Adult sturgeon will be precluded from entrainment by the trashracks. Young sturgeon are usually found near the bottom in reservoirs, preferring deep (29-125 feet), low velocity areas, (Parsley et al. 1993; Parsley and Beckman 1994). During non-winter months, age-0 and juvenile white sturgeon tend to select areas of moderate to high depth (70 feet) with steep channel slopes (Hatten and Parsley 2009). The effect of the intake on white sturgeon should be neutral relative to the existing system at The Dalles Dam.

2.9 PREDATION

Structures added to the forebay would be limited to an intake pipe bulkhead and trashrack, which will provide little additional habitat for predators or change in conditions that may provide an advantage to predators. The risk of predation relative to the existing system at The Dalles Dam is likely to be neutral.

CHAPTER 3 – GEOTECHNICAL DESIGN

3.1 GENERAL

This section describes the probable subsurface conditions and geotechnical design parameters and properties for The Dalles fish ladder auxiliary water supply.

3.2 REFERENCES

a. U.S. Army Corps of Engineers (USACE). 1964. The Dalles Dam, Part IV, Foundation Report for the Closure and Non-overflow Dams. May. (not yet available)

b. HDR Engineering, Inc. 2012. The Dalles East Fish Ladder Auxiliary Water Backup System Engineering Documentation Report. December. Report to U.S. Army Corps of Engineers, Portland District.

c. U.S. Geologic Survey Seismic Hazard Curves and Uniform Hazard Response Spectra applet. http://earthquake.usgs.gov/hazards/designmaps/grdmotion.php

d. USACE Engineering Regulation (ER) 1110-2-1806, Earthquake Design and Evaluation for Civil Works Projects.

e. USACE Engineering Manual (EM) 1110-2-6053, Earthquake Design and Evaluation of Concrete Hydraulic Structures.

3.3 SUBSURFACE INFORMATION

3.3.1 Geology

The anticipated dominant subsurface material is a gravelly, sandy, SILT fill. The material was placed during construction of the east fish ladder. At depth, the anticipated material is Columbia River Basalt. The Dalles Dam design memo (USACE 1964) should detail the condition of the basalt (fractured, weathered, etc.). The original overburden is anticipated to have been removed during the original construction.

3.3.2 Geotechnical Design Parameter

Due to the uncertainty of the depth to basalt, the fill design parameters and properties are assumed, based on experience, and presented in table 3-1 below.

Table 3-1. Fill Design Parameters

FILL Assumed Design Properties & Parameters				
Property		Value	Units	
Dry Unit Weight	γ_d	115	pounds per cubic foot	pcf
Moisture	ω	10	percent	%
Friction Angle	ϕ	32	degrees	°
Cohesion	c	100	pounds per square foot	psf

The basalt design parameters and properties are also assumed (HDR 2012) and are presented in table 3-2 below.

Table 3-2. Basalt Design Properties

BASALT Assumed Design Properties & Parameters				
Property		Value	Units	
Unit Weight	γ	140	pounds per cubic foot	pcf
Rock Quality Designation	RQD	>90	percent	%
Compressive Strength	q_u	≈10,000	Pounds per square inch	psi

3.3.3 Groundwater

The river level is anticipated to strongly influence the groundwater elevation. It is possible for groundwater to be perched in the fill, but the quantity of water would be small.

3.3.4 Seismic Parameters

Earthquake ground motions for an event with a 50 percent probability of exceedence during the service life, known as the Operational Basis Earthquake (OBE), and an event with a 10 percent probability of exceedence during the service life, known as the Maximum Design Earthquake (MDE), are estimated to provide an economical design. After an OBE event, the project is expected to function with little or no damage; after the MDE, the project is not expected to experience catastrophic failure. If the structure is considered critical in accordance with ER 1110-2-1806, the Maximum Credible Earthquake (MCE) is determined as the greatest earthquake that can reasonably be expected to be generated and is used as the MDE.

The service life of the project is 100 years, resulting in a return period of 144 years for the OBE, and, for noncritical structures, the MDE return period is 950 years. For MCE events, there is no return period. Therefore, both the OBE and the MDE can be characterized by a probabilistic analysis; the MCE is determined by a deterministic analysis.

The seismic ground motion parameters in table 3-3 should be used in design. The ground motion for the MCE was estimated using a probabilistic analysis and a return period of 2,475 years. Additional work will be necessary to determine the MCE.

Table 3-3. Seismic Ground Motion Parameters

Seismic Ground Motion Parameters (in % g)			
Period		Critical Structure	
	Non Critical Structure		
	MDE	OBE	MCE
Peak Ground Acceleration (PGA)	0.14	0.05	0.20
0.2 sec damping			
1.0 sec damping			

3.3.5 Anticipated Foundations

The new supply conduit will likely be placed on fill material and shallow foundations should be adequate. Depending on the stability of the existing fishlock approach channel (FAC), tie-backs may be required. If insufficient length is available to tie-back the FAC walls, then a dead-man anchorage will be developed, likely consisting of drilled shafts. Thrust blocks to restrain the change of momentum of the water in the new supply conduit will be resisted by passive earth pressures and sliding friction.

CHAPTER 4 –HYDRAULIC DESIGN

4.1 GENERAL

The selected alternative provides 1,400 cfs of flow with a single conduit penetrating Monolith 5 and discharging through an energy dissipation valve into the modified fishlock approach channel (FAC). Flow is then partially conveyed from the FAC to the auxiliary water supply chamber (AWSC) by an existing subsurface culvert, and the remainder of flow is routed through two 6-foot culverts that bridge across the fish ladder into the AWSC.

4.2 REFERENCES

a. U.S. Army Corps of Engineers (USACE). Engineering Manual (EM) 1110-2-1602, Hydraulic Design of Reservoir Outlet Works.

b. USACE Coastal & Hydraulics Laboratory. 1987. Hydraulic Design Criteria. http://chl.erdc.usace.army.mil/hdc

c. USACE. 2006. Design Document Report #34, The Dalles Lock and Dam, Juvenile Behavioral Guidance System. May.

d. U.S. Dept. of the Interior Bureau of Reclamation. 1987. Design of Small Dams.

e. Miller, D. S. 1990. Internal Flow Systems, 2nd Ed.

f. King, H. W. and Brater, E. F. 1963. Handbook of Hydraulics, 5th Ed.

g. Justin, J. D. and Creager, W. P. 1950. Hydroelectric Handbook.

h. Swamee, P. K. and Jain, A. K. 1976. Explicit equations for pipe-flow problems. Journal of the Hydraulics Division, American Society of Civil Engineers (ASCE), Vol. 102, No. HY5, pp. 657-664.

i. Beichley, C. L. and Peterka, A. J. 1961. Hydraulic Design of Hollow-Jet Valve Stilling Basins. Journal of the Hydraulics Division, ASCE, No. HY5.

4.3 HYDRAULIC CRITERIA

Under a normal two turbine operating condition, the AWS operates with flows of up to 5,000 cfs. In an emergency operating scenario where there is a two fish turbine unit failure, the proposed backup AWS design discharge is 1,400 cfs (coordinated and approved by USACE and fisheries agencies; see table 4-1). Due to the reduced discharge available, the following operational changes will be made to the system.

- West and south fish entrance weirs will be closed.

- East fish entrance will operate with only two weirs; the third weir will be closed.

Table 4-1. Emergency AWS Discharge Requirements

Emergency AWS Discharge Requirements	
Design Discharge	1,400 cfs
Design Supply Head	90.0 feet

4.3.1 Water Surface Elevations

The design water surface elevations for forebay and tailwater are shown in table 4-2 below. These values were identified in the Juvenile Behavioral Guidance System report (USACE 2006). The AWSC water surface elevations were identified from the design tailwater elevation and the original EFL hydraulic design analysis. The exact water surface elevations used for the design of the alternative components are described in the appropriate sections of this report.

Table 4-2. Design Elevations

Design Elevations	
	Feet, msl
Maximum Forebay	160.0
Minimum Forebay	155.0
Maximum Tailwater	86.0
Minimum Tailwater	74.0
Maximum AWSC	90.0
Minimum AWSC	80.5

4.4 HYDRAULIC DESIGN

4.4.1 Inlet Design

The inlet of the supply conduit selected is 30 feet below minimum forebay water surface elevation and at least 10 feet off the river bottom to avoid entrainment of juvenile salmonids and lamprey during operation. Penetration of the dam on the upstream face occurs at an elevation of 116.5 feet at the centerline of the inlet. This elevation is subject to change based on new bathymetry data as the current alignment requires an angle boring through the dam. The inlet is to be a bell-mouthed circular conduit inlet normal to the dam face.

Trashracks for the intake are sized with a 3 fps approach velocity and a flow of 1,400 cfs. Velocity criterion was determined during the EDR phase of design and based off of EM 1110-2-1602. A through bar velocity of 5 fps is recommended by the Bureau of Reclamation *Design of Small Dams* (1987) publication. An assumed porosity of 75 percent for the trashrack results in a required gross area of 375 square feet; however, in order to meet the approach velocity a required gross area of trashrack is required to be

466 square feet. Resulting force on the trashrack will be developed from the head differential and the momentum pending further design of the inlet structure.

4.4.2 Main Supply Conduit

Conduit size selection and design were based on head loss, velocity constraints, cavitation potential, and alignment constraints.

Friction losses were based the Darcy-Weisbach friction formula (Equation 1) for a welded steel pipe,

$$h_f = f\frac{L}{D}\frac{V^2}{2g} \qquad \text{(Equation 1)}$$

where h_f is the head loss due to friction, f is the friction factor, L is the length of conduit, D is the conduit diameter, V is the fluid velocity in the pipe, and g is the acceleration due to gravity. The friction factor f was developed from the explicit friction factor equation listed below,

$$f = \frac{0.25}{log\left[\frac{k_S}{3.7D}+\frac{5.74}{Re^{0.9}}\right]^2} \qquad \text{(Equation 2)}$$

where k_S is the equivalent sand grain roughness of the pipe, and Re is the Reynolds number for the fluid passing through the conduit. Equation 2 was developed in the ASCE *Journal of Hydraulics Division* article “Explicit equations for pipe-flow problems.”

Minor losses were based off of D.S. Miller’s *Internal Flow Systems* (1990) and consist of an entrance loss, an air relief valve and filling valve tee, an isolation valve, two 90-degree bends, one contraction, a 40-degree bend, and the discharge valve to be discussed in greater detail below.

The main supply conduit was sized to meet velocity limitations defined in the EDR of 18 fps. This resulted in a single conduit selection of 10 feet in diameter for 225 feet, the majority of the alignment, with a maximum velocity of 17.85 fps. Due to constraints of the energy dissipation valve to be later discussed, the conduit transitions to an 8-foot diameter conduit for 45 feet, with a maximum velocity of 27.8 fps. A final transition to 7-foot diameter occurs at the dissipation valve.

The conduit penetrates the dam with the centerline at 116.5 feet and angles downward to 104.5 feet to achieve 2 feet of cover below the roadway and parking lot. It makes a 90-degree turn to parallel the dam toward the fishlock. The conduit enters the FAC in front of the fishlock and makes a second 90-degree turn to continue in line with the fishlock approach channel. The resulting in forces at the first and second 90-degree turns of 420 kips (kilo pound) and 339 kips respectively. The conduit then contracts to an 8-foot diameter; the resulting force from the 10-foot diameter to 8-foot diameter contraction is 112 kips in the direction opposite of flow. The conduit continues in line with the FAC to the bend downstream of the main access bridge over the FAC. It makes a horizontal and vertical composite 40-degree bend here, resulting in a restraint force required of 150 kips. Here a contraction from an 8-foot diameter to the 7-foot diameter valve is installed at the valve support, as shown in appendix B. The resulting force from the contraction is 56 kips in the opposite direction of flow.

The selection of the energy dissipation valve requires a reduction from a 10-foot diameter conduit to a 7-foot-diameter conduit. However, the incipient cavitation parameter for the radius-diameter ratio for the 40-degree bend is too low with a 7-foot diameter pipe, and the conduit must first transition from a 10-foot diameter to an 8-foot diameter conduit in order make the turn without having cavitation issues.

The total head loss through the conduit is 12.25 feet, leaving 40 to 45 feet of head pressure to dissipate.

4.4.3 Energy Dissipation

The EDR identified energy dissipation with the use of ported sleeve valves. Concerns for clogging within the valve or valve seizure due to intermittent use prompted investigation into alternative energy dissipation methods better suited for this use.

Excess energy is dissipated with the combination of a hollow-jet valve and stilling basin in the existing fishlock approach channel. Basin design and selection was developed based on the ASCE Journal of Hydraulics Division Proceeding *Hydraulic Design of Hollow-Jet Valve Stilling Basins* (Beichley and Peterka, 1961). A hollow-jet valve is a type of needle valve that forces water outward into a short containing sleeve to create a jet of water with an air void in the center of flow into which it can expand as it extends past the outlet of the valve.

A ring-jet cone valve was selected from commercially available valves. The ring-jet valve is a variation of the typical hollow-jet valve with a deflecting ring on the end that forces the jet of water to collapse on the air void in the center of the jet. This reduces excess spray and concentrates flow for better containment. Based on available head at the valve and discharge coefficients for the valve, a 7-foot (84-inch) valve was selected with a 0.78 discharge coefficient. See appendix B for additional properties of the proposed ring-jet cone valve.

In order to confine the jet exiting the energy dissipation valve, modifications to the channel to create a stilling basing is necessary. ASCE developed guidance for design of hollow-jet valve stilling basins that was used to identify the modifications necessary for the fishlock approach channel and sizing constraints (Beichley and Peterka, 1961). For the selected hollow-jet valve a flow rate, a 76-foot long by 18-foot wide and 30-foot deep basin was necessary. The FAC is 20 feet wide, 200 feet long, and 45 feet deep, which exceeds the recommended design. Due to the excessive depth and length available within the FAC, the end sill and wing-walls that are developed in the design guidance have been elected to be removed. A deflection ramp located below the jet from the valve will be incorporated into the fishlock approach channel and will extend from the valve support to the floor of the FAC. The design tailwater for the stilling basin design was set at 102.5 feet to allow for 2.5 feet of freeboard at maximum tailrace conditions.

4.4.4 FAC Modifications

The FAC will be modified to contain the flow within the channel and prevent drainage into the cul-de-sac and fish ladder. This requires blocking off the cul-de-sac entrance to an elevation of 105.0 feet. The fish ladder entrance will be blocked off to 105.0 feet, with two culverts penetrating the new wall (see section 4.4.6).

The two upstream diffusers in the FAC from the existing AWS will have the diffuser baffles and the grating removed to increase flow capacity into the AWS culvert. The two downstream diffusers in the FAC from the existing AWS will have the walls and control gates removed to provide a direct flow path to the AWS culvert and additional capacity to route water back to the AWSC.

4.4.5 Existing AWS Subsurface Conduit

The EDR recommends passing all 1,400 cfs through the AWS fishlock conduit; however, further investigation shows that driving head required is insufficient at a high design pool in the AWSC. The EDR identifies the design maximum tailwater at 86.6-foot water surface elevation. Assuming 1 foot of attraction head differential at the junction pool to the EFL entrance, and a maximum of 2.2 feet of head differential from the AWSC to the junction pool through the diffuser from the EFL design calculations, the result water surface elevation required in the AWSC is 89.8 feet. The EDR assumes an AWS chamber water surface elevation of 85 feet in the calculations.

The velocity for the full 1,400 cfs through the 8-foot by 8-foot box culvert resulted in a velocity of 21.9 fps, which raised concerns for local scour/cavitation and complex upwelling in the AWSC.

The water surface elevation in the FAC is designed to 102.5 feet in order to provide adequate energy dissipation. The resulting head differential available between the FAC and the AWSC is 12.5 feet; whereas in the EDR an assumption of raising the FAC walls and associated water surface to 109.0 feet would achieve a head differential of 24 feet.

Further analysis of the AWS culvert and modifications noted in section 4.4.6 determined that the capacity of the AWS culvert was approximately 620 cfs at high tailrace conditions. Velocity through the AWS culvert is 9.7 fps, which will mobilize deposits out of the culvert from non-emergency AWS operations.

Considering these factors, additional conveyance conduit in conjunction with the use of the existing 8-foot by 8-foot box culvert was deemed necessary to route flow from the FAC to the AWS chamber.

4.4.6 New FAC to AWSC Conduit

In order to increase the flow capacity from the FAC to the AWSC, two additional 6-foot circular culverts will span the fish ladder from the fishlock approach channel to the AWS chamber. Each are sized to carry up to 400 cfs each at the design FAC water surface elevation. The invert will be set at an elevation of 90.5 feet on the FAC inlet and discharge freely above the maximum AWS water surface elevation at 90.45 feet. Velocity through the conduits will be 14.2 fps at 400 cfs. Alignment of the conduit will be angled such that the exiting flow does not severely impact the far wall of the AWS chamber. The new conduit will require modifying or abandoning the diffuser gate operators for junction pool D, where the culverts discharge into the AWSC.

CHAPTER 5 – STRUCTURAL DESIGN

5.1 STRUCTURAL DESIGN

Features to be designed:

1. Guide slots for:
    a. Emergency gate.
    b. Trashrack – Investigating making the trash rack slot to be used as the dewatering slot for a temporary bulkhead for construction.
    c. Trashrack cleaning.
2. Emergency gate.
    a. Lifting beam will be designed at a later time, not part of this 30 percent DDR.
3. Trashrack.
4. Thrust block for 10-foot-diameter supply conduit.
5. Penetration into fishlock approach channel (FAC) for 10-foot-diameter supply conduit.
6. Thrust restraint in FAC for 10-foot-diameter supply conduit.
7. Evaluation of removal and sizing of soil anchors for FAC side wall supports.
8. Liner or scour protection in FAC and wall extension.
9. Bulkheads in FAC.
10. Pipe support over existing fish ladder.

5.2 GOVERNING DESIGN CODES

1. Emergency gate and bulkheads – Engineer Manual (EM) 1110-2-2105 – Design of Hydraulic Steel Structures.
2. Steel design – AISC 360-05 Specification for Structural Steel Buildings – Steel Construction Manual 13th Ed.
3. Concrete design:
    a. ACI 318-08 Building code requirements for Structural Concrete.

   b. EM 1110-2-2104 – Strength design for reinforced concrete hydraulic structures- will use load factors from EM, will use ACE 318-08 for design equations.

4. AWS D1.1-2008, American Welding Society, Structural Welding Code – Steel.

5. AWS D1.5-2008, American Welding Society, Bridge Welding Code.

6. ASCE-7-05 American Society for Civil Engineers, Minimum Design Loads for Buildings and Other Structures.

7. Stability Analysis of Concrete Structures, EM 1110-2-2100

5.3 MATERIAL PROPERTIES

1. Existing concrete 28-day compressive strength: f'c = 3,000 psi.

2. New concrete 28-day compressive strength: f'c = 4,000 psi.

3. Precast concrete 28-day compressive strength: f'c = 6,000 psi.

4. Existing reinforcing steel: Grade 40 fy = 40,000 psi.

5. New reinforcing steel: American Society for Testing and Materials (ASTM) A615, Grade 60 fy = 60,000 psi.

6. Existing structural steel: ASTM A36, fy = 36,000 psi or ASTM A572, fy = 50,000 psi.

7. New structural steel:

   a. W shapes: ASTM A992, fy = 50,000 psi.

   b. M, S, C, MC, and L shapes: ASTM A36, fy = 36,000 psi.

   c. Hollow Structural Sections (HSS):

   d. Round – ASTM A500 Grade B, fy = 42,000 psi.

   e. Rectangular and Square – ASTM A500 Grade B, fy = 46,000 psi.

   f. Pipe: ASTM A53 Grade B, fy = 35,000 psi.

   g. HP shapes: ASTM A572 Grade 50, fy = 50,000 psi.

   h. Plates and Bars: ASTM A36, fy = 36,000 psi.

   i. Plates and Bars for HSS: ASTM A 709 Grade 50, fy = 50,000 psi.

j. Conventional Structural Bolts: ASTM A325.

k. Nuts: ASTM A563.

l. Washers: ASTM F436.

m. Anchor Rods: ASTM F1554 Grade 36, fy = 36,000 psi, Grade 55, fy = 55,000 psi.

n. All-Thread Bar: ASTM A722 fy = 150,000 psi.

o. All-Thread Bar Couplings: ASTM A29, Grade C1045.

5.4 REFERENCES

1. Engineering Regulation (ER) 1110-2-8157 – Responsibility of Hydraulic Steel Structures.
2. AISC Manual of Steel Construction: Allowable Stress Design 9th Ed., ASD. 1989.

CHAPTER 6 – MECHANICAL DESIGN

6.1 GENERAL

6.1.1 Trash Rake

The components for the intake structure, from upstream to downstream will be first the trash rake, then the trash rack, then the emergency gate. The trash rake will be designed to clear the trash rack from incidental debris that may accumulate as a result of flow through the pipeline. The trash rake will not be designed to operate while under flow. Rather, the operational procedure will be to suspend flow with the downstream isolation valve, then lower the trash rake to clear debris. It is anticipated that this operation would be very infrequent and require less than one hour to complete. As a result, it is assumed that a no flow type of operation is acceptable.

The trash rake will be designed to push debris downward from the rack surface in order to clear the passageway. The rake will be guided within slots of the intake structure using typical bulkhead type sliding guides. The tines will be spaced at ¾ inches to accommodate the trash rack, with the tines centered between the rack grating. The leading edge of the rake will likely form a ramp away from the rack surface, so that the as the rake encounters debris it will lift debris off the rack surface and force it downward. The rake will typically be dogged off above the water surface. If it is determined that trash has built up on the racks, a mobile crane will be required to lift the rake off the dogs and lower it to clear debris. In order to make the determination that debris has built up on the rakes, an acoustic range finder system will actively monitor the water surface elevation both upstream and downstream of the trash racks. This element of the system will require coordination with electrical design.

6.1.2 Emergency gate

The dam safety criteria for the emergency gate have one requirement in particular that pertains to mechanical design. That requirement is that the gate be deployable under flow. In order to accomplish this, the gate requires two mechanical features. The first is that the gate have roller wheels to minimize the friction that develops as forebay pressure pushes the gate into the guides. The second feature is some means to force the gate into the flow. It is assumed that the structural weight of the gate will not be sufficient to overcome the sliding friction within the gate wheels.

6.1.3 Gate Wheels

The emergency gate is assumed to be 14 foot square in order to cover the 10 foot diameter pipe. The gate is assumed to have eight wheels, four on either side. The wheels will be mounted on spherical, plane, self lubricating bearings.

The assumed wheel dimensions at this point are an outside diameter of approximately 12 inches, with an approximate 6-inch axel. The diameter of the spherical surface will likely be approximately 9 inches. The wheel will be fabricated from 17-4PH stainless steel. There will be two separate self lubricating surfaces. The spherical bearing will rotate about the axel on a self lubricating liner and the spherical surface will have a self lubricating liner. The self lubricating liner will be Kamatics Karon V or equal.

The presence of the spherical surface means that the bearing could also rotate out plane from normal to the gate guides. A rubber centering system will be required to maintain the wheel alignment. In general, the gate wheels will be modeled after the Kamatics self-aligning track roller design used for the John Day and Little Goose TSW closure gates.

6.1.4 Operating Gate Hydraulic Operators

The second mechanical feature derived from the dam safety requirement that the emergency gate be operable under flow, is a means to push the gate into the flow. While the gate wheels serve to minimize the friction between the gate and the guides, there is still a rather sizable friction load that needs to be overcome, likely between 10 to 15 thousand pounds. The structural weight of the gate will likely be in the 5 thousand pound range, leaving 5 to 10 thousand pounds that must be overcome to close the gate. Typically, this is accomplished through the use of hydraulic cylinder pushing downward on the gate. The gate closure system will be designed to keep the hydraulic components above the water surface. This will require a frame to be installed above the gate to transfer the force from the hydraulic cylinders to the gate. The frame could be pin coupled to the gate and act as both a closure device and lifting beam to lift the gate out of the slot. A means would also be required to pin the upper parts of the hydraulic system to the intake structure to react the force applied by the hydraulics.

A portable hydraulic power unit would also be provided to supply pressure to the hydraulic cylinders. This system would be skid mounted so that it could be trucked into place on the rare occasions that gate operation was required. This hydraulic unit would require electrical power, and as such the design would need to be coordinated with electrical design. It is assumed that the time required to deploy this portable system would be acceptable.

6.1.5 Downstream Isolation Valve

A butterfly valve downstream of the dam will be provided to serve as another means to shut off flow. This valve would be located immediately downstream of the dam, and tied into the dam structure by means of anchors and concrete. This would provide a stable isolation point that would move with the dam in case of a seismic event. With this valve in place, it is more likely that damage to the pipeline would occur downstream of the dam in the buried portion of the pipe. If this were to happen, the butterfly valve could be closed to stop flow through the dam.

The butterfly valve would be motor operated, and as such its design would require coordination with electrical design.

6.1.6 Energy Dissipation Valve

The primary means of dissipating energy in the water stream is an 84-inch ring jet cone valve. he function of this valve is described in the hydraulics section of this DDR. This valve would be specified by mechanical design. This valve also requires an electrical actuation system. This valve actuator would be mounted on a platform above the valve. The actuator itself would be a multi-turn valve actuator similar to a limitorque actuator. The actuator would be coupled to the valve via an extension stem. As this presents an electrical load, the design of this system will require coordination with electrical design.

Operationally, this valve would be the first place to start up or shut down the system. For start-up, the valve would initially be opened with the emergency gate in place. This condition leads to a large volume of air in the pipeline in its drained and vented state. In order to remove this air from the system in a controlled manner, the cavity between the emergency gate and the jet valve would need to be back flooded slowly. For this purpose, a smaller (perhaps 6-inch) tap could be taken from the 4- inch line in the valve room and routed to just upstream of the valve. For venting the cavity, the water inlet at the emergency gate is the high point in the system. A 6-inch tap could be placed towards the pipe inlet in the forebay and run up the face of the dam to deck elevation. This tap would terminate at deck elevation with a candy cane style vent. The system would vent air as the pipe cavity was filled. When the pipe cavity was filled, the emergency gate could be raised without forebay pressure acting on it.

For the shut-down case, the butterfly valve could be closed to suspend flow. Then the emergency gate would be closed. Finally, the butterfly valve would be opened to drain the pipeline.

6.1.7 Pipeline

The pipeline itself will be a 10-foot diameter, ½-inch wall, welded steel pipe. Connections to valves and specialty fittings will be done using flanged joints. In order to accommodate relative motion between the ground and structure resulting from seismic conditions, at least two restrained dresser style mechanical couplings will be place in the run of the pipe. These connection would be located, one immediately downstream of the butterfly valve the other just upstream of the penetration through the approach channel wall. The pipe will be epoxy lined and coated to protect it against corrosion.

6.1.8 Expansion Joints

Another dam safety requirement for this system is that the pipeline have expansion joints to accommodate thermal expansion. It is currently unclear whether or not thermal expansion joints are required in a buried pipe system, as temperature fluctuations will likely be small and buried pipe is partially anchored due to soil friction with its bedding. If expansion joints are required, there are a couple of methods that could be used to accommodate this growth. If expansion lengths are short, perhaps ½ inch or less, it may be possible to take up the expansion in the dresser couplings used to provide seismic flexibility. If expansion joints are longer, a dedicated expansion joint may be required in the long run of pipe. In either case, the joints will required some form of vault to allow for inspection, maintenance, and replacement of the joint. As such, the design of this system will require coordination with structural and geotechnical design. This vault would also make a good location for an inspection hatch into the pipeline.

6.1.9 Valve Room

In this design, the entirety of the attraction flow will come from the 10-foot-diameter pipe through the dam. As a result of this, the valve room will be left alone, with the exception of a small tap that will back fill the void between the emergency gate and the isolation valve. This tap will be controlled via a gate valve in the valve room.

6.1.10 Demolition of Approach Channel Gates

There are currently several gates in the approach channel, and most of these have hoist works above them. The new system will provide for the demolition of these gates and the hoist works that support them. In place of the gates, the channel will be confined by new concreted permanent bulkheads.

6.2 DESIGN CODE REFERENCES

The designs of alternatives would conform to the following pertinent mechanical criteria and applicable standards and codes:

- American Water Works Association (AWWA).

6.2.1 Water Control Gates

- Maximum effort on crank or handwheel: 40 pounds.
- Centerline height of crank or handwheel: 36 inches.
- Stem covers: Clear butyrate plastic with Mylar open/close indicator. Maximum allowable leakage rate: 0.1 gpm per foot of seat perimeter.

6.2.2 Piping

- AWWA C200, Standard for Steel Water Pipe: 6 inches (150 mm) and larger.
- AWWA C206, Standard for Field Welding of Steel Water Pipe.
- AWWA C207, Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4-inch through 144-inch.
- AWWA C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
- AWWA C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

- AWWA M11, Steel Water Pipe: A Guide for Design and Installation.

6.2.3 Valves

- AWWA C515, Standards for Reduced-Wall, Resilient-Seated Gate Valves for Water.

6.2.4 Supply Service

- AWWA C504, Rubber Seated Butterfly Valves.
- AWWA C540, Standard for Power-Actuating Devices for Valves and Slide Gates.
- AWWA C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

CHAPTER 7 – ELECTRICAL DESIGN

7.1 GENERAL

7.1.1 Electrical Power

There is no reserved electrical power capacity at any of the existing motor control centers to provide power to the new equipment as part of this alternative. New connected loads, abandoned valve room loads, and demolished gate actuators need to be evaluated to determine the size of the new separately fed motor control center.

- The total connected electrical load is estimated to be 50 kilovolt-ampere (kVA).
- The largest expected load is the portable hydraulic power unit (forebay emergency gate).
- The valve actuators with associated (motor) controllers.
- Instrumentation for alarm annunciation.
- Adding local maintenance lighting and receptacles.
- Motor voltages would be 460-volt (V), 3-phase (PH) for motors 0.5 horsepower (hp) up to 200 hp, and 120V, single-phase for motors less than 0.5 hp.
- Evaluate the loads of abandoned valve room valve actuators and demolished approached channel gates and fishlock entrance gate circuits for use by new valve actuators.

7.1.2 Control

There are no automatic or remote controls associated with the operation of this equipment. When this system is required, the equipment will be manually controlled as required to be placed into service.

- Primarily reversible motor control of the electric valve actuators, manually switched.

7.1.3 Instrumentation and Annunciation

- Instrumentation for announcing alarm conditions should be considered.

7.1.4 Relocate Existing Conduit, Devices, and Equipment

- Survey existing drawings and locate existing conduit, devices, and equipment impacted by construction.

- Determine electrical items needing relocation.
- Develop plan for relocating electrical items located in the construction area.

7.1.5 Demolish Electrical Equipment

- Disconnect and remove gate valve actuators.
- Determine electrical circuit to be reused and protect from damage.

7.2 OPERATING GATE HYDRAULIC OPERATORS

The emergency gate needs to be operable under flow, as a means to push the gate into the flow. Typically, this is accomplished through the use of hydraulic cylinder pushing downward on the gate.

A portable hydraulic power unit would also be provided to supply pressure to the hydraulic cylinders. This system would be skid mounted so that it could be trucked into place on the rare occasions that gate operation was required. This hydraulic unit would require electrical power and as such the design would need to be coordinated with electrical design.

Electrical design work is needed to initially determine if the portable hydraulic power unit is fed from an existing 480V/3PH weld receptacle and extension cord or a dedicated power circuit designed and installed.

7.2.1 Portable Hydraulic Power Unit

A manufacturer supplied control panel will be located near the hydraulic power unit. This panel will include the motor controls as required to operate the system. In automatic mode, the unit will be controlled by pressure switches or transmitters located on the hydraulic power unit. The panel will include the following operator control devices:

- HAND/OFF/AUTO selector switch.
- EMERGENCY STOP push button (maintained contact).
- RUNNING indicator light.
- FAULT indicator light.

7.3 ELECTRIC VALVE ACTUATORS

The mechanical valves will be positioned with electric valve actuators. The valve actuators include an electric motor, gear box, adjustable limit switches, manual lock, and (possibly) electric break. Each valve actuator requires an electrical power circuit and (reversible) motor controller. The valve actuators will be controlled by hand switches on or near the valve (motor) controller cabinet close to the valves. It is assumed the valves and gates would include motors in the range of 1 to 5 HP. Valves and gates would include a local control station with LOCAL/OFF selector switch and push-buttons for OPEN, CLOSE, and STOP operation.

7.3.1 Downstream Isolation Valve

- A butterfly valve downstream of the dam will be provided to serve as the primary water shutoff point.
- The butterfly valve will require an electric valve actuator and associated motor controller.

7.3.2 Energy Dissipation Valve

- The primary means of dissipating energy in the water stream is a 76 inch ring jet cone valve. This valve will require an electric valve actuator and associated motor controller.

7.4 INSTRUMENTATION AND ANNUNCIATION

Discussion is needed to determine if instrumentation is required. As an example, additional or relocated water level sensors should be considered to annunciate the channel overflowing. Instrumentation in concert with annunciation should be considered to alarm dangerous conditions.

7.5 CONTROL

In general, most electrical control will be local hand switch control operating NEMA 3 motor controllers. NO REMOTE OR AUTOMATIC CONTROL IS EXPECTED.

7.5.1 Valve and Gate Controls

The valves will include local control stations located near each valve. Because these valves are to be rarely operated, the local operator controls (push buttons) are to be installed in a secured enclosure. The local control station will include the following operator control devices:

- OPEN push button (momentary contact).
- STOP push button (momentary contact).
- CLOSE push button (momentary contact).
- FULLY OPEN indicator light.
- FULLY CLOSED indicator light.

The local controls for the valves will provide dry, relay contact to allow remote monitoring of the following status points:

- FULLY OPEN.
- FULLY CLOSED.

7.6 MAINTENANCE LIGHTING AND RECEPTACLES

Design work should include maintenance lighting and receptacles. This would involve providing a lighting panel and circuit.

7.7 VALVE ROOM

In this design, the all of the attraction flow will come from the 10-foot-diameter pipe through the dam. As a result of this, the valve room will be left alone, with the exception of a small tap that will back fill the void between the emergency gate and the isolation valve. This tap will be controlled via a gate valve in the valve room. This gate valve will require an electric valve actuator and associated valve (motor) controller.

7.8 DEMOLITION OF APPROACH CHANNEL GATES

There are currently several gates in the approach channel most of these have hoist works above them. The new system will provide for the demolition of these gates and the hoist works that support them. These hoists will need their electric power and controllers disconnected and removed.

There is existing electrical equipment and electrical conduits near the fishlock (see figure D-1 in appendix D) that will need to be relocated. This equipment is in the proposed path of the new low level intake pipes. This equipment includes a control panel associated with security and a disconnect switch for the vehicle gate operator.

The electrical equipment for the fishlock approach channel gate may be disconnected and removed (see figure D-2 in appendix D).

The electrical equipment for the fishlock entrance gate may be disconnected and removed (see figure D-3 in appendix D).

7.9 DESIGN CODE REFERENCES

The designs of alternatives would conform to the following pertinent electrical criteria and applicable standards and codes:

<u>National Codes</u>

NFPA 70	National Electrical Code
NFPA 79	Electrical Standard for Industrial Control

ANSI C2 2012	National Electric Safety Code

U.S. Army Corp of Engineers

UFC 3-501-01	Electrical Engineering

Valve Actuators, Electrical

ISA-96.02.01-2007	Guidelines for the Specification of Electric Valve Actuators

CHAPTER 8 – ENVIRONMENTAL AND CULTURAL RESOURCES

8.1 GENERAL

This section outlines the environmental and cultural resources and permitting requirements as they may apply to providing a backup auxiliary water system for The Dalles EFL. During development of the DDR, the recommended alternative will be further refined with additional development of the major facility components. The design refinement will continue throughout the development of the plans and specifications. Typically, it is during this phase that environmental clearance documents are prepared to satisfy the various environmental laws and regulations that USACE must comply with prior to constructing the facilities or modifying operations to improve the adult fish facilities operation. USACE is required to comply with numerous Federal laws, rules, and regulations as well as potential additional requirements under State and/or local jurisdictions.

All Federal actions that are funded, constructed, or permitted must comply with the National Environmental Policy Act (NEPA). The District Commander is the USACE NEPA official responsible for compliance with NEPA for actions within District boundaries. Typically, under NEPA, the District will prepare a Categorical Exclusion for O&M activities, or an Environmental Assessment (EA) for larger construction projects. An EA is a brief document that provides sufficient information to the District Commander on potential environmental effects of the proposed action, if appropriate, and its alternatives. The EA review also determines whether an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) needs to be prepared. In the case where project impacts are known to be major, USACE may decide to proceed to an EIS without conducting the EA/FONSI.

Consultation with appropriate Federal, State, and tribal agencies regarding potential environmental effects is coordinated by CENWP-PM-E. Compliance and consultation includes all permitting activities associated with the Clean Water Act (CWA) including Sections 401, 402, 404, and 408. Under Section 401 of the CWA, water quality certification would be requested from the State of Oregon. Cultural resource clearance would be required for construction sites, other areas disturbed to facilitate construction (access roads, staging areas, etc.), or otherwise affected by operational changes. Endangered Species Act (ESA) compliance would include interagency consultation with the NMFS and U.S. Fish and Wildlife Service (USFWS) on all threatened, endangered, and proposed species and/or designated critical habitat, including terrestrial and aquatic plants and animals.

The consultation process may also encompass sections of the Fish and Wildlife Coordination Act; Magnuson-Stevens Act (Essential Fish Habitat); Bald and Golden Eagle Protection Act; several cultural resource laws including the National Historic Preservation Act; Archaeological Resources Protection Act; Native American Grave Protection and Repatriation Act; Antiquities Act; Archaeological and Historic Preservation Act; Executive Order 11988, Flood Plain Management; Executive Order 11990, Protection of Wetlands; Executive Order 13514, Federal Leadership in

Environmental, Energy, and Economic Performance; Comprehensive Environmental Response, Compensation, and Liability Act; Resource Conservation and Recovery Act; Toxic Substances Control Act; Federal Insecticide, Fungicide, and Rodenticide Act; and Migratory Bird Treaty Act.

CHAPTER 9 – CONSTRUCTION

9.1 CONSTRUCTABILITY

The recommended low level intake through The Dalles Dam will require boring or mining for one 120-inch-diameter steel pipe through the east non-overflow structure. The boring will be angled such that the forebay inlet will meet design elevation and will exit low enough to allow for a minimum of 2 feet of ground cover. The mining through the dam will require some form of cofferdam on the forebay face of the dam to allow access to the pipe inlet. The cofferdam will be left in place throughout the entire construction process. This will eliminate the need for divers throughout the construction process and alleviate in-water work window restrictions. Following completion of the inlet, bulkhead, and trashrack, the cofferdam can be filled with water and removed. Installation and removal of the cofferdam will require the use of divers, a barge, and a crane from the surface deck of the dam.

9.2 CONSTRUCTION SEQUENCE AND SCHEDULE

Construction sequencing and schedule is estimated as follows:

1. Mobilization to the site – 1 week.
2. Excavation and setup of launch pad for mining – 2-3 weeks.
3. Boring operations – 4 weeks.
4. Fabrication and installation of cofferdam – 3-4 weeks.

a. Performed concurrently with work items 2 and 3.

5. Excavation from boring to channel – 2 weeks.
6. Installation of bulkhead and trashrack – 1-2 weeks.
7. Modification of fishlock approach channel (FAC) – 5 weeks.
8. Fabrication and installation of 10-foot-diameter supply conduit – 4-6 weeks.
9. Installation of two 72-inch-diameter pipes to auxiliary water supply chamber (AWSC) – 2 weeks.
10. Punch list and testing – 1-2 weeks.
11. Removal of cofferdam – 1 week.
12. Demobilization – 1 week.

Total Duration: 20 to 29 weeks onsite

CHAPTER 10 – OPERATIONS AND MAINTENANCE

To be developed.

CHAPTER 11 – COST ESTIMATES

11.1 COST EVALUATION

Construction of the recommended alternative will require mining or boring of up to a 144-inch-diameter hole to accommodate a 120-inch-diameter pipe, and fabrication and installation of a cofferdam, bulkhead, and trash rack system. Following installation of the cofferdam, it is assumed divers will not be needed until the cofferdam needs to be removed. Total cost estimate to be determined at a later date.