U.S. Army Corps of Engineers,
Portland District
(Contract No.W9127N-11-D-0011)
Task Order No. 0003

90% Review

Engineering Documentation Report

The Dalles East Fish Ladder Auxiliary Water Backup System

Columbia River, Oregon-Washington

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A/E IDIQ
W9127N-11-D-0011

The Dalles East Fish Ladder Auxiliary Water Supply Backup Engineering Documentation Report – 90% Review

09 April 2011

HDR

A-E CONTRACTOR STATEMENT OF TECHNICAL REVIEW
COMPLETION OF INDEPENDENT TECHNICAL REVIEW

The A-E Contractor, HDR Engineering, has completed The Dalles East Fish Ladder Auxiliary Water Backup System Engineering Documentation Report**.** Notice is hereby given that an independent technical review, that is appropriate to the level of risk and complexity inherent in the project, has been conducted as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level obtained; and reasonableness of the result, including whether the product meets the customer's needs consistent with law and existing USACE policy. The independent technical review was accomplished by an independent HDR team. All comments resulting from independent technical review have been resolved.

______________________________	________________
Technical Review Team Leader *(Signature)*	Date
______________________________	________________
Project Manager, A-E Contractor *(Signature)*	Date

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW

Significant concerns and the explanation of the resolution are as follows:

(Describe the major technical concerns, possible impact, and resolution)

As noted above, all concerns resulting from independent technical review of the project have been fully resolved.

______________________________	________________
Principal, A-E Contractor *(Signature)*	Date

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Executive Summary

The purpose of *The Dalles East Fish Ladder Auxiliary Water Backup System Engineering Documentation Report (EDR)* is to recommend an alternative for further engineering design that will best 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. To provide a backup supply of water to the AWS in case of a fish unit turbine failure, four alternatives have been evaluated in this EDR.

The alternatives and improvements evaluated in this EDR are capable of providing 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.

The following improvements and alternatives were evaluated in support of the EDR process:

- Improvements to the existing Valve Room,
- Improvements to the existing Fishlock,
- Improvements to the existing Fishway Approach Channel,
- Alternative #1 – Siphon for Additional Water to the Fishlock,
- Alternative #2 – Low Level Intake,
- Alternative #10 – Single Pump/Pumphouse on East Side of Cul-de-sac, and
- Alternative #11 – Upstream Intake Tower with Siphon.

Improvements to the Valve Room would provide about 400 cfs and need to be combined with an alternative to obtain the required 1,400 cfs.

Alternatives Analysis Discussion

This EDR focuses on the evaluation of improvements to the existing infrastructure and 4 alternatives that were ultimately chosen from almost 20 alternatives. These alternatives were formulated during a “USACE/HDR brainstorming team meeting” in December 2011. The alternatives evaluated in this EDR were selected by the USACE and are discussed below.

Alternative #1 – Siphon for Additional Water to the Fishlock. This alternative evaluates the potential of taking water from the forebay through two siphons to an existing fishlock that has been decommissioned. Water from the fishlock would be routed to the existing auxiliary water conduit (AWC).

Alternative #2 – Low Level Intake. This alternative consists of two conduits that pass through one of the concrete monoliths. These pipes would be routed along the base of the concrete non-overflow section of the dam to the existing fishlock. Water from the fishlock would be routed to the existing AWC.

Alternative #10 – Single Pump/Pumphouse on East Side of Cul-de-sac. This alternative considers the use of one single large pump and a pumphouse structure. Water from the tailwater would be pumped into the existing fishway approach channel that has been decommissioned. Water would then be routed to the existing AWC.

Alternative #11 – Upstream Intake Tower with Siphon. This alternative evaluates the use of an intake tower with intake openings at the bottom of the tower to draw water from deep in the forebay. The intake tower is attached to the face of a concrete monolith. Two siphons within the intake tower would route water to the fishlock where it would be routed to the existing AWC.

Final Recommendation

Based on the engineering analysis for this EDR, evaluation criteria for this project, and USACE team input, Alternative #2, Low Level Intake and improvements to the valve room, is being recommended for further evaluation as a potential solution for an emergency backup system for the EFL AWS.

The construction cost with contingency for improvements to the valve room, fishlock, approach channel and Alternative #2, Low level Intake, is estimated to be approximately $10,304,100. The Total Project Cost, without Operations and Maintenance (O&M) is currently estimated to be approximately $16,588,300.

Pertinent 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

Acronyms and Abbreviations

ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers Association
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
AWWA	American Water Works Association
BEP	best efficiency point
CFD	computational fluid dynamic
cfs	Cubic feet per second
CRFI	Continuous Resin Flow Impregnation
CVP	concrete volute pump
DDR	Design Documentation Report
EAWS	Emergency Auxiliary Water Supply
EFL	East Fish Ladder
EM	Engineering Manuals
ER	Engineering Regulations
ETL	Engineering Technical Letters
ETR	Engineering Technical Reports
FCC	fish collection channel
fps	feet per second
FFDRWG	Fish Facility Design and Review Work Group
FHWA	Federal Highway Administration
FTC	fish transportation channel
gpm	gallons per minute
HDC	Hydroelectric Design Center
HI	Hydraulic Institute
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
kV	kilovolt
kVA	kilovolt-ampere

kW	kilowatt
MCASES II	Micro Computer Aided Cost Estimating System Version II
MCC	motor control center
MCE	Maximum credible earthquake
msl	mean sea level
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NHSM	National Seismic Hazard Maps
NMFS	National Marine Fisheries Service
O&M	Operations and Maintenance
OBE	Operational based earthquake
ODOT	Oregon Department of Transportation
OSHA	Occupational Safety and Health Administration
P	pole
pcf	Per cubic foot
PDT	Product Development Team
PH	Phase
psi	Pounds per square inch
PUD	People's Utility District
rpm	revolutions per minute
RTD	resistance temperature detectors
SDBM	Small Diameter Boring Machines
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
V	volt
VFD	variable frequency drive
VPI	Vacuum Pressure Impregnation
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
W	wire

1.0 INTRODUCTION

1.1 General

This report has been developed to aid the USACE in developing cost effective alternatives for providing a backup supply for the auxiliary water system (AWS) for The Dalles Dam EFL. Alternatives presented and discussed in this report were developed during a brainstorming meeting held on December 8, 2010. The brainstorming meeting was attended by USACE staff, regional fish agencies, and HDR product development team (PDT) members. The USACE selected four of the alternatives for further evaluation as part of the scope of work. Additionally, improvements to the existing fishlock valve room and the power house equalizing header system were evaluated.

The Engineering Documentation Report was formulated as follows:

- Evaluate four alternatives to the 60% review level
- Select two alternatives and carry the designs forward to the 90% review level
- Select one alternative from the 90% review level and carry it forward to the final design

Alternatives were ranked and scored based on criteria developed by team participants. Results of this process are presented in this report. Engineering judgment and limited computations were used to support conclusions.

Additional studies and engineering will be required to finalize the selected alternative. This will happen in the next phase of the project. Typically, the USACE will prepare a decision documents report (DDR) for final approval.

1.2 Purpose and Problem Description

Auxiliary water for the EFL is critical to the overall success of adult fish passage at The Dalles Dam. Approximately 80% of the returning adult salmon use the EFL as a passage route to upper parts of the Columbia watershed. The EFL AWS is supplied by two fish unit turbines and reliability of these turbines is critical. The USACE through the Hydroelectric Design Center (HDC) has investigated the reliability of the fish unit turbines. These investigations have been used to develop this report.

The AWS conduit supplies water to the East, West, and South Fish Ladder entrances in order to attract upstream migrating adult fish. Water is currently supplied to the AWS conduit by two fish unit turbines located on the west end of the powerhouse. The AWS normally operates with a total flow of up to 5,000 cfs. If one or both fish unit turbines fail, water supplied to the AWS would be severely limited or eliminated. Four alternatives have been developed to provide a backup supply of water to the AWS in case of a fish unit turbine failure.

The backup water supply system being considered in this report allows for operation of the EFL when the two fish turbines are not operational. The 1,400 cfs design discharge discussed in Alternatives 1, 2, 10, and 11 provides flow to the East entrance of the EFL. The West and South entrances will be closed which will be an integral part of the emergency backup operation. "East Entrances only" operation is only acceptable in the event of an outage of both fish turbine units. The determination of the design flow of 1,400 cfs was thoroughly coordinated and discussed with state and federal fishery agencies. Approximately 80% of the returning adult salmon that approach The Dalles Dam use the EFL as a passage route to upper parts of the Columbia watershed. The EFL AWS is supplied by two fish turbine units and reliability of these turbines is critical. The USACE, through the Hydroelectric Design Center (HDC) has investigated the reliability of the fish turbine units. Investigations by the USACE and other engineering firms have been used to demonstrate the viability of the alternatives presented in this report.

The purpose of this EDR is to document and recommend four alternatives from a brainstorming meeting with the intent of the alternatives being refined and evaluated with other potential solutions for a DDR to be developed in the future. Each alternative has been designed to provide at least 1,000 cfs. Improvements to the existing facilities (valve room and fishway approach channel) will provide an additional 400 cfs for a total discharge of 1,400 cfs.

To ensure equal treatment of each alternative identified in the Brainstorming session, a consistent set of assumptions, constraints, and criteria were developed at the outset of this study. The criteria are presented in Section 2.0 of this report.

1.3 Scope

HDR has prepared this EDR to describe four alternatives that were evaluated to provide a backup water supply for the EFL. Four alternatives were examined to the 60% review level. Two alternatives were then taken to the 90% review level and finally an alternative was selected for final design.

1.4 Authorization

The 1995 Energy and Water Development Appropriation Bill directed the USACE to use additional appropriations to aggressively improve effectiveness and efficiency of the bypass systems, reduce mortality by predators, and enhance passage conditions.

1.5 Existing Fishway Facilities

1.5.1 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 for the EFL is provided by two fish turbine units 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 operational. Fish enter the South and West fish ladders and travel through the transportation and collection channels, respectively, to the EFL (Figure 1 through Figure 3).

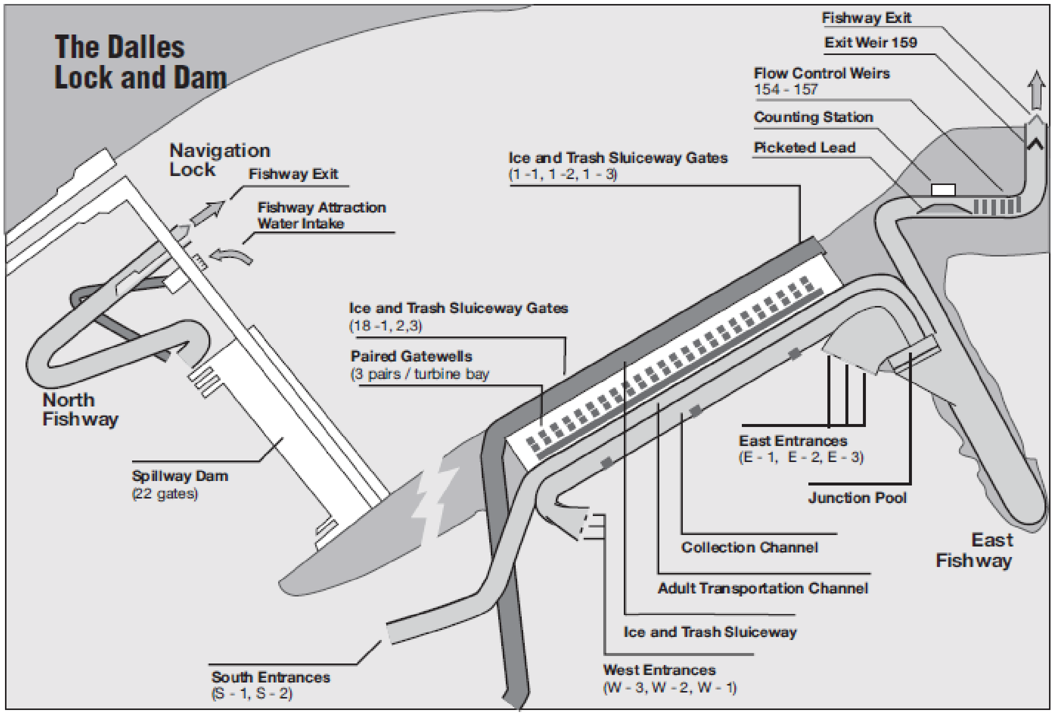

Figure 1. The Dalles Dam Fish Ladder System
(Illustration from the 2008 Fish Passage Plan, USACE)

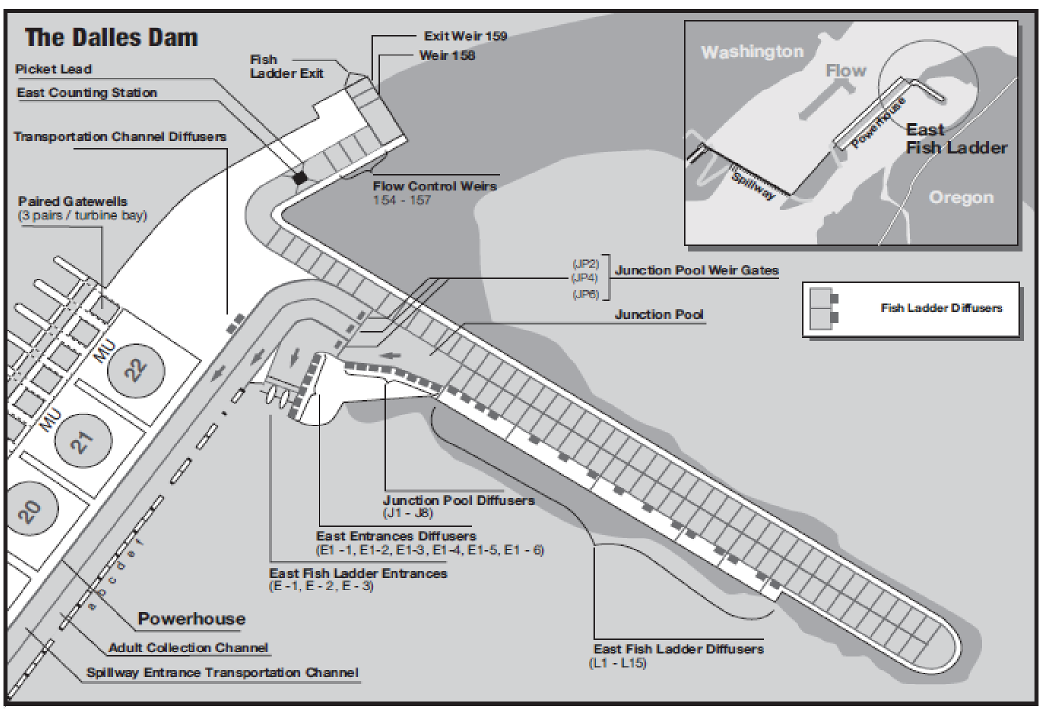

Figure 2. The Dalles Dam East Fish Ladder
(Illustration from the 2008 Fish Passage Plan, USACE)

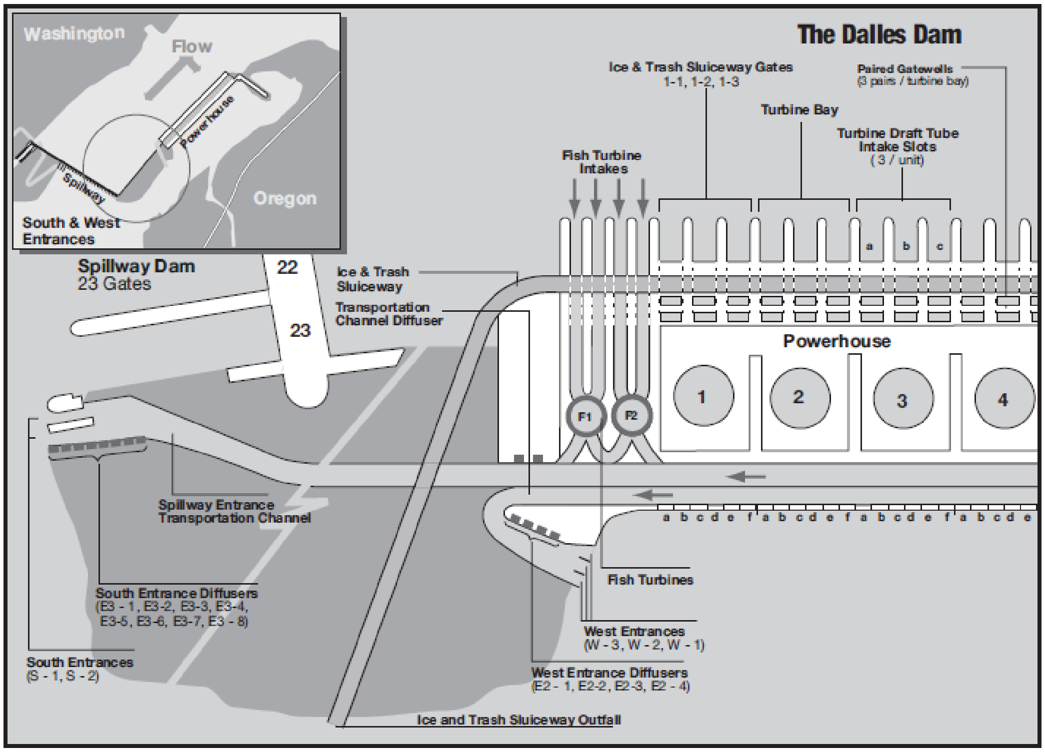

Figure 3. The Dalles Dam West and South Fish Ladders
(Illustration from the 2008 Fish Passage Plan, USACE)

1.5.2 Fish Turbine Units

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 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 spaced 1 inch apart are installed in the fish turbine unit intakes.

1.5.3 Auxiliary Water System

As shown on Figure 1 through Figure 3, the AWS consists of a large 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 unit. This system is complex to operate, but an integral part of the overall operation of the EFL system. Based on a numerical model developed by the USACE, CENWP-EC-HD, the hydraulic head within the AWS conduit is approximately 9 feet greater than the tailrace water surface elevation. This information is referenced on page 12 of the Inca 1997 report, the original model was developed by Northwest Hydraulics, Inc. for the 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.

2.0 DESIGN CRITERIA

2.1 Purpose

This section of the report sets forth a detailed list of criteria used in the development of the EDR. The criteria are used to design system components, subjectively evaluate the four alternatives, and recommend the best alternative for further development by the USACE.

2.2 Background

The purpose of *The Dalles East Fish Ladder Auxiliary Water Backup System Engineering Documentation Report* is to recommend the alternative that will best provide a backup supply of water to the AWS. The AWS conduit supplies water to the East, West, and South Fish Ladder entrances in order to enhance attraction of upstream migrating adult fish. Water is currently supplied to the AWS conduit by two fish turbine units located on the west end of the powerhouse. The AWS normally operates with a total flow of up to 5,000 cfs. If one or both fish turbine units fail, water supplied to the AWS would be severely limited. Four (4) alternatives that could provide a backup supply of water to the AWS in case of a fish turbine unit failure have been selected for evaluation. The alternatives are as follows:

- Alternative #1, Siphon for Additional Water to the Fishlock,
- Alternative #2, Low Level Intake (formerly River Wet Tap),
- Alternative #10, Single Pump/Pump house on East Side of Cul-de-sac, and
- Alternative #11, Intake Tower with Siphon to Fishlock.

These 4 alternatives were selected by the USACE for further analysis from 15 alternatives/concepts formulated during a "brainstorming" session that was conducted in December 2010. Other improvements to the existing infrastructure (fishlock and piping improvements) also will be examined during development of the EDR as potential sources of water for the AWS. The USACE and other agencies in the Fish Facility Design and Review Work Group (FFDRWG) have agreed on a total flow requirement of 1,400 cfs for the AWS backup system.

To ensure an equal treatment of each alternative in the EDR, a consistent set of assumptions, constraints, and design parameters are required to establish design criteria to be used in the alternative evaluation. The design criteria are separated into specific disciplines including: biological, geotechnical, hydraulic, mechanical, structural, and electrical. Also considered in the evaluation of each alternative are system flexibility, ease of operation, construction cost, constructability, and safety criteria. Pertinent Data for The Dalles Dam is included at the front of this report.

2.3 Design Life

The alternatives considered in this project would have an estimated design life of 50 years.

2.4 Hydraulic Criteria

2.4.1 General

The hydraulic criteria list the discharges, water surface elevations, head differentials, and velocities used as the constraints in developing the concept designs for each alternative. Discharge and water surface elevation levels are divided into two types: maximum design and normal operating limits. The maximum design values are those used in designing the alternative and assessing the stability and forces acting upon it. The operating values are those for which the alternative is designed to operate and perform its intended purpose. The operating values may include both minimum and maximum values.

The selected alternative must be able to function under varied flow conditions. Flow requirements for optimal fish passage operations vary due to the fluctuation of forebay and tailwater conditions. The normal forebay elevation ranges from 155 to 160 feet (feet), mean sea level (msl).

Due to the constant fluctuations in the forebay and tailwater elevations, operation of the turbine units and fishway entrance weirs is controlled automatically. As the tailwater and forebay elevations fluctuate, the turbine unit discharge and entrance weir elevations change to maintain a constant head differential at the fishway entrances. The following components are impacted by forebay and tailwater elevation fluctuations:

- Entrance weir elevations will fluctuate as the tailwater changes to meet the entrance head differential criterion.
- West and South fish entrance weirs will be closed, when both fish turbine units are inoperable/off line.
- The East fish entrance will operate with two weirs; the third weir will be closed.
- Entrance weir elevation changes result in water surface elevation changes throughout the fishway channel system.
- Fish turbine operations change in response to forebay and fishway channel elevation fluctuations.

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 one or two fish unit failure, the proposed backup AWS design discharge is 1,400 cfs. Improvements to the Valve Room and Fishway Approach channel should provide 400 cfs and each alternative is designed to provide 1,000 cfs, for a total discharge of 1,400 cfs. USACE determined the design flow requirement of 1,400 cfs. This flow requirement has been documented in a USACE-CENWP-EC-HD memo which is included in Appendix A of this report.

Table 1 provides a summary of the design discharges for the existing fish turbine units and the emergency backup system at The Dalles Dam.

Table 1. Design Discharges for Existing Fish Turbine Units and Emergency Backup System at The Dalles Dam.

Fish Turbine Unit Discharge	
Maximum:	2,500 cfs per unit
Operating:	2,500 cfs (peak generating efficiency flow per unit)
Total Discharge:	5,000 cfs (combined two units)
Emergency AWS Discharge Requirements	
Design Discharge:	1,400 cfs
Operating:	1,400 cfs
Valve Room Improvements to provide	400 cfs
Alternative to provide	1,000 cfs

Sketches, calculations, and other hydraulic support information can be found in Appendix B.

2.4.2 Water Surface Elevations

The normal operating and design water surface elevations for forebay and tailwater are shown in Table 2. These values were provided by the USACE and developed for Design Document Report #34, The Dalles Lock and Dam, Juvenile Behavioral Guidance System, May 2006. The exact water surface elevations used for the design of each alternative are described in the appropriate sections of this memorandum.

Table 2. Water Surface Elevations for Hydraulic Design

	Normal Operating Elevations (feet, msl)	Design Elevations (feet, msl)
Maximum Forebay	160.0	160.0
Minimum Forebay	155.0	155.0
Maximum Tailwater	84.2	86.0
Minimum Tailwater	76.4	76.4

2.4.3 Head Differentials and Velocities for Fish Ladders

The following criteria, detailed in the 2011 Fish Passage Plan, are used for guidance in developing the AWS backup alternatives and for evaluation of the alternatives. The 2011 Fish Passage Plan was written by the USACE and adopted by regional agencies. It documents the operational procedures for ensuring fish passage (juvenile and adult) at USACE projects on the Columbia and Snake Rivers.

- Water depth over fish ladder weirs: 1.0 foot +/- 0.1 foot. During the shad passage season: 1.3 feet +/- 0.1 foot.
- Head on all entrance weirs: 1 to 2 feet (1.5 feet optimum).

- Fishway transport velocities: Maintain water velocities of 1.5 to 4 feet per second (fps; 2 fps optimum) for the full length of the powerhouse collection channel, entrance channels, and the fish ladder pools that are submerged by the tailwater.
- Main entrance weir depths: Weir crest 8 feet or more below tailwater.
- Diffuser velocities: Less than 1 fps for horizontal diffusers, less than 0.5 fps for horizontal diffusers.

2.4.4 Auxiliary Water Conduit

The one-dimensional hydraulic numerical model of The Dalles fish facilities may be used by USACE Portland District staff to determine if the alternatives under consideration for the backup water supply would adversely impact the operation of the EFL. The model output will provide velocities and water surface elevations throughout the AWC and fish channels. The model output will be reviewed to determine if the flow distribution through the AWS and fishway system are acceptable. Although there is no criterion for AWC velocities, a maximum velocity of 10 fps will be applied to the conduits to minimize energy dissipation issues.

2.4.5 Siphon Criteria

Two of the alternatives include a siphon to discharge flow from the forebay to the fishlock. The main issues with a siphon include pressures in the system and priming issues. The following siphon design criteria were developed to minimize these issues.

- Limit negative pressures in the design to 20 feet.
- Provide adequate siphon priming such as a mechanical system to remove air from the siphon or a pumping system to fill the siphon with water to remove the air.
- Provide adequate inlet submergence on the pipe. The minimum inlet submergence will be one siphon pipe diameter.
- “Fill time” to prime siphons will be 2 hours.

2.4.6 Fishlock Channel Criteria

The fishlock channel will be evaluated as an option to discharge flow into the AWC from the forebay. The fishlock channel was originally designed to transport fish to the lock, and was previously utilized as an open channel system until the fishlock was abandoned as a passage option. Due to the location of the channel, the walls extend up to 105 feet, msl; Hydraulic analyses are required to determine if the fishlock could be operated with a high open channel water surface elevation (much higher than the design water surface elevation) or if it would need to be covered allowing for pressurization.

Structural analyses will be required to determine the load restrictions of the channel walls for both an open channel water surface elevation with a minimum of 1 foot of freeboard and a condition where the channel is pressurized.

2.4.7 Operational Criteria for Overall Fish Ladder System

The ease of operation and maintenance was considered with each alternative. If an alternative was easier to operate compared to the other alternatives it was given a higher score compared to the others.

2.4.8 Trashracks

Trashracks will be provided for all alternatives. A ¾-inch opening will be the maximum spacing for all bars. The assumption of a ¾-inch opening is based on team member discussions and team meetings. Woody debris larger than ¾ inch could damage components of the AWS. Trashracks for the two existing fish turbines are sized for 2-inch openings.

Trashracks were sized with an approach velocity of 3 fps and a flow of 1,000 cfs. This velocity criteria was determined to be a reasonable value based on discussions among and experience of the USACE/HDR team. USACE guidance is not directly available for this type of a backup system.

2.5 Geotechnical Criteria

2.5.1 Surface and Subsurface Assumptions

- Subsurface assumptions are based on material presented by the USACE in Part IV, Closure and Non-overflow Dams, of Foundation Report of The Dalles Dam, May 1964.
- Bedrock under the non-overflow dams and closure structure are shown to be Basalts of Columbia River Basalt Group. No other rock units are identified. Overburden depths under the East Non-overflow structure were shallow and all overburden was removed from beneath the structure during construction.
- The closure dam was built in two phases. Stage I placed Rock Fill in-water to approximately Elevation 25 feet, msl. A zoned embankment was placed above this material which consisted of a downstream quarry run rock fill, with three zones (spalls, gravel, and blanket material) of material placed on the upstream face to create a zone of minimal permeability.
- The rock fill zones are constructed of hard, durable Basalt with unit weights of 170 to 180 pounds per cubic foot (pcf), with a maximum stone weight to 300 pounds.
- Rock spalls are reasonably well graded 6-inch minus quarry run rock.
- Gravel fill is a skip-graded sandy gravel from an upstream gravel bar area.
- Upstream blanket is a sandy gravel, or gravely sand pit run gravel.

2.5.2 Geotechnical Assumptions

- Bedrock materials will be sufficiently strong to support relatively heavy structures.
- The unconfined compressive strengths of the Basalt range from 2,000 pounds per square inch (psi) to 37,000 psi and may be very difficult to bore. Rock quality designation (RQD) for the Basalt is 100%, and the rock mass rating (RMR) will vary by rock unit from Class I to Class II.

- The final structures will be designed for no damage during the operational based earthquake (OBE), with a no collapse criteria for the maximum credible earthquake (MCE). Table 3 provides the seismic design criteria for The Dalles Dam.
- Concrete in the east non-overflow section is assumed to be 3,000 psi concrete containing aggregates to 6 inches in size. Unconfined compressive strengths for some of the aggregates exceed 10,000 psi, and will be difficult to mechanically mine if the contractor is not using appropriate equipment.

Table 3: Seismic Hazard for USACE Performance Levels

Performance Level	Return Period	PGA (g)*
Operating Basis Earthquake (OBE)	144-year	0.10
Maximum Design Earthquake (MDE) (noncritical structures)	975-year	0.13
Maximum Credible Earthquake (MCE) (based on deterministic seismic hazard analysis [DSHA])	2,475-year	0.19

**PGA from U.S. Geological Survey (USGS) National Seismic Hazard Maps (NHSM), 2008*

2.5.3 Geotechnical Construction Assumptions

- The ability to use Small Diameter Boring Machines (SDBM) will be determined by the rock properties which vary from good to difficult. The SDBM are normally only able to excavate rock with unconfined compressive strengths up 25,000 psi and then only if the rock is sufficiently fractured. Some of the more massive units at The Dalles Dam have strengths in excess of 25,000 psi.
- In-water rock excavation or use of SDBM should be avoided due to the high cost associated with this type of work.
- Borings up to about 72 inches in diameter can be made in the concrete with SDBM without excessive difficulty. Openings for the 72-inch pipes can also be mined without excessive difficulty.

2.5.4 Applicable USACE and FHWA Design Documents

Applicable Engineering Manuals (EM) and Engineering Regulation (ER) design documents include:

- EM 1110-1-2907, Rock Reinforcement, 15 Feb 1980
- EM 1110-1-2908, Rock Foundations, 30 Nov 1994
- EM 1110-2-2200, Gravity Dam Design, 30 June 1995
- ER 1110-2-1806, Earthquake Design and Evaluation of Civil Works Projects, 31 July 1995.
- FHWA-SA-97-070, Micropile Design and Construction Guidelines – Implementation Manual June 2000.
- FHWA-NHI-05-039, Micropile Design and Construction Reference Manual 2005.

- Figures supporting geotechnical information can be found in Appendix C.

2.6 Biological Criteria

2.6.1 General

This section discusses biological and behavioral characteristics of both adult and juvenile fish species that migrate through The Dalles Dam fish passage facilities. Although this report is focused on facilities for the fish ladders that are designed to convey adult salmonids upstream, other species and downstream migrants are also discussed as they are a consideration for potential entrainment or other impact in the design of the water intake structures. The information below addresses passage seasons and project operational criteria.

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, Coho, and sockeye salmon, steelhead, Pacific lamprey, white sturgeon, and American shad. Bull trout 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. It is likely that downstream migrating larval and juvenile Pacific lamprey are present during the winter, but no information has been collected to verify this.

2.6.2 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 4).

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 4).

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.

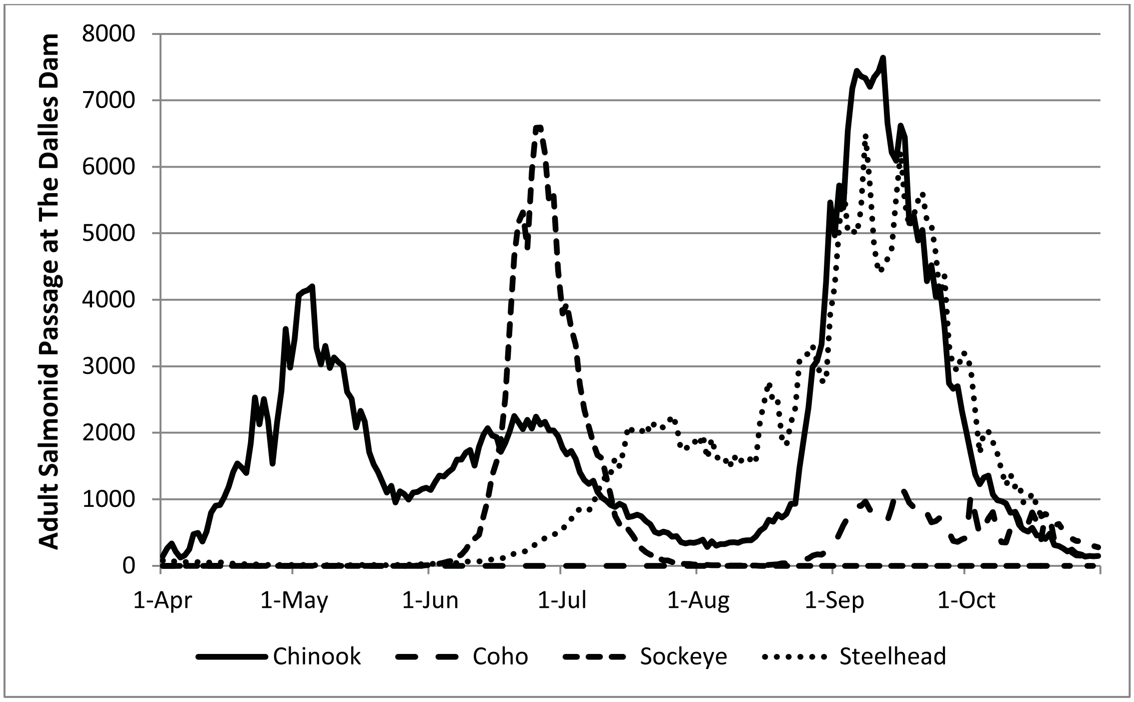

Figure 4. Ten-Year Average (2002-2011) of Adult Salmonid Counts at The Dalles Dam (Fish Passage Center 2011).

Table 4. 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

2.6.3 Adult Passage Criteria

Adequate water depths and flows through the fishways are required to facilitate fish moving upstream through the ladders. The complete operating criteria for adult salmonid passage through the facilities are provided in the 2011 Fish Passage Plan for The Dalles Dam (USACE 2011). During the fish passage season, water depths over fish ladder weirs must be maintained at 1 foot (+/- 0.1 foot) for salmon passage, and 1.3 feet (+/- 0.1 foot) during peak shad passage. The fish ladder entrances must maintain a 1- to 2-foot head (optimum = 1.5 feet), and water velocities in the collection channels and lower ends of the fish ladders must be between 1.5 and 4 fps, with 2 fps being optimum.

2.6.4 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% 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 5 (USACE 2011) and add approximately one day to the dates for each species to estimate the juvenile salmonid arrival dates at The Dalles Dam.

Relatively little is known about downstream-migrating lamprey in the Columbia River. Juvenile lamprey are thought to migrate lower in the water column than juvenile salmonids; therefore, collection rates at most dams are lower than those for juvenile salmonids. Despite this, some juvenile lamprey are collected at dams. 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.

2.6.5 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.

Table 5. Juvenile Salmonid Migration Dates for John Day Dam (USACE 2011).

	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

2.6.6 Fish Screening

The four alternatives being considered for the AWS would be used temporarily during emergency situations, and therefore potential fish entrainment would be a temporary risk. Trashracks with ¾-inch spacing will be included with each alternative to keep debris from entering. These trashracks will also preclude adult fish, even Pacific lamprey, from being entrained (Moser et al. 2007).

Some juvenile fish may be vulnerable to entrainment; however, because of the temporary and emergency nature of operations, and because the turbines at The Dalles Dam are not screened, the USACE and National Marine Fisheries Service (NMFS) have indicated that screens will not be necessary for most alternatives. Screens have been considered as a possible requirement for alternative 10 because of the possibility of entraining juvenile salmonids that have already migrated past the dam.

2.7 Structural Criteria

2.7.1 General

For conceptual design of structures considered in the study, structural analysis and general structural computations are required. One or more of the four (4) alternatives may involve penetrations through existing reinforced concrete sections. These penetrations must be analyzed to determine their effect on the structural integrity (and stability) of the facility. Sketches, calculations, and other structural support information can be found in Appendix D.

2.7.2 Design Code References

The following design code references, USACE EMs, Engineering Technical Letters (ETL), and Engineering Technical Reports (ETR) will apply:

- American Concrete Institute (ACI) 318-08 - Building Code Requirements for Structural Concrete
- American Institute of Steel Construction (AISC) Steel Construction Manual, 13th Edition
- AISC/American National Standards Institute (ANSI) 360-05 – Specifications for Structural Steel Buildings
- American Society for Civil Engineers (ASCE) ASCE/SEI 7-05 Minimum Design Loads for Buildings and Other Structures
- EM 1110-2-2100 - Stability Analysis of Concrete Structures
- EM 1110-2-2104 - Strength Design for Reinforced-Concrete Hydraulic Structures
- EM 1110-2-2400 - Structural Design and Evaluation of Outlet Works
- EM 1110-2-2902 - Conduits Pipes and Culverts
- EM 1110-2-3104 - Structural and Architectural Design of Pumping Stations

- EM 1110-2-6053 - Earthquake Design and Evaluation of Concrete Hydraulic Structures
- ETL 1110-2-568 - Seismic Evaluation Procedures for Existing Civil Works Powerhouses
- ETR INP-SL-1 - Assessment of Underwater Concrete Technologies for In-the-Wet Construction of Navigation Structures, September 1999
- International Building Code (IBC), 2009
- PCI Design Handbook, Precast and Prestressed Concrete, 6th Ed, Precast Concrete Institute
- Post-tensioning Manual, PTI, 6th Ed., Post-tensioning Institute
- Recommendations for Prestressed Rock and Soil Anchors, PTI,

2.7.3 Structural Materials

The following structural design requirements and USACE ETLs will apply:

- Existing concrete 28-day compressive strength: f'c = 3,000 psi based on Appendix D evaluation procedures found in ETL 1110-2-568
- New concrete 28-day compressive strength: f'c = 4,000 psi
- Precast concrete 28-day compressive strength: f'c = 6,000 psi
- Existing reinforcing steel: Grade 40 fy = 40,000 psi based on Appendix D evaluation procedures found in ETL 1110-2-568
- New reinforcing steel: American Society for Testing and Materials (ASTM) A615, Grade 60 fy = 60,000 psi
- Existing structural steel: ASTM A36, fy = 36,000 psi or ASTM A572, fy = 50,000 psi
- New structural steel:
    - W shapes: ASTM A992, fy = 50,000 psi
    - M, S, C, MC, and L shapes: ASTM A36, fy = 36,000 psi
    - Hollow Structural Sections (HSS):
        - Round – ASTM A500 Grade B, fy = 42,000 psi
        - Rectangular and Square – ASTM A500 Grade B, fy = 46,000 psi
    - Pipe: ASTM A53 Grade B, fy = 35,000 psi
    - HP shapes: ASTM A572 Grade 50, fy = 50,000 psi
    - Plates and Bars: ASTM A36, fy = 36,000 psi
    - Conventional Structural Bolts: ASTM A325
        - Nuts: ASTM A563
        - Washers: ASTM F436

- Anchor Rods: ASTM F1554 Grade 36, fy = 36,000 psi, Grade 55, fy = 55,000 psi
- All-Thread Bar: ASTM A722 fy = 150,000 psi
- All-Thread Bar Couplings: ASTM A29, Grade C1045

2.7.4 Design Loads and Operating Conditions

The alternatives will be evaluated to determine the effect and limitations of normal operating conditions of the main powerhouse unit and the EFL AWS. This evaluation will include complete and partial dewatering of the AWC, diffuser chambers, and draft tubes. Structural components will be evaluated for the range of anticipated operating pressures for the preferred alternative.

The following elevations will apply to all alternatives unless otherwise noted.

- Maximum pool elevation: 160.0 feet, msl
- Minimum pool elevation: 155.0 feet, msl
- Maximum tailwater elevation: 86.0 feet, msl
- Minimum tailwater elevation: 76.4 feet, msl

For extreme flood events, the maximum pool elevation will be at 178.4 feet, msl and maximum tailwater elevation will be at 127.2 feet, msl.

Additionally, a 2000 report by CH2M Hill/Montgomery Watson indicated that the AWC cannot be fully dewatered unless the elevation of the tailwater remains below elevation 70 feet, msl for the duration of the dewatering. In order to dewater the AWC a bracing system would need to be deployed to help carry the loads. In a previous report prepared by HDR for the USACE, it was determined that a bracing system was feasible.

2.8 Electrical Criteria

2.8.1 Station Service Power

The existing station service power system does not have available capacity allocated for any large additional loads that are not associated with the powerhouse. A new 13.8-kilovolt (kV) or 4,160-volt tap with transformer and switchgear and/or motor control centers shall be included to provide power to large motor loads.

2.8.2 Induction Motors, 600 Volt and Less

Non-submersible motors would be in locations that are easily accessible for operation and maintenance. Enclosures for motors are to be totally enclosed, fan-cooled (TEFC) type. Service factors would be 1.15. Motor insulation would be Class F with the rise limited to Class B. Bearings are to be rated 100,000-hour Anti-Friction Bearing Manufacturers Association (AFBMA) B-10 life. Motor voltages would be 460-volt, 3-phase for motors 0.5 horsepower (hp) up to 200 hp, and 120-volt, single-phase for motors less than 0.5 hp. All 3-phase motors of 50 hp or less may be operated from combination motor starters with overload protection and 120-volt control transformers located in the motor control centers. All motors would have local disconnect switches at the equipment. The use of soft-start reduced-voltage starters or variable frequency drives (VFDs) may be required for pump starting with motors greater than 50 hp.

Depending on the cooling requirements for the pump motor, the use of totally enclosed, water-to-air cooled (TEWAC) motors may be required.

2.8.3 Induction Motor, Greater than 600 Volt

Enclosures for motors are to be cast iron-type WP-1 or WP-II. Service factors would be 1.15. Motor windings shall be form wound. Insulation shall be Vacuum Pressure Impregnation (VPI) or Continuous Resin Flow Impregnation (CRFI). Bearing resistance temperature detectors (RTDs) and vibration monitors shall be included. Motors will be synchronous-type operating from 4,160 or 6,600-volt, 3-phase power. Motors would be operated from medium-voltage full voltage non-reversing starters, VFDs, or soft starters. These motors will not include local disconnects at the equipment as they are not practical for loads of this size.

2.8.4 Motor Operated Valve and Gate Actuators

The motor operated valve and gate actuators would be served with power from a new motor control center and unit substation. It is assumed the valves and gates would include motors in the range of 1 to 2 hp.

The control circuits for any remotely controlled valve or gate operators would be routed back to the main control room, located at the powerhouse. Valves and gates would include a local control station with LOCAL/OFF/AUTO selector switch and push-buttons for OPEN, CLOSE, and STOP operation.

2.8.5 Design Code References

The alternative designs would conform to the latest edition of the following applicable standards and codes:

- National Electrical Code (NEC-2011 edition)
- Life Safety Code (National Fire Protection Association [NFPA]-101 2009 edition)
- National Electric Safety Code (ANSI C2 2012 edition)
- Standard for Electrical Safety in the Workplace (NFPA 70E)
- American National Standards Association (ANSI)
- Illuminating Engineering Society (IES)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)

- Occupational Safety and Health Administration (OSHA)
- Underwriters Laboratories (UL)
- InterNational Electrical Testing Association (NETA)

Sketches, calculations, and other electrical support information can be found in Appendix E.

2.9 Mechanical Criteria

2.9.1 Pump Stations & Pipelines

Listed below are the design criteria for the pump station and pipelines:

- Maximum hydraulic velocity for all piping systems: 16 fps
- Target hydraulic velocity for pump suction and discharge pipes: 5 to 8 fps
- Maximum velocity for pump suction pipes: 8 fps
- Two generic types of pumping units are available: vertical axial or mixed flow pumps and concrete volute pump (CVP). Since HDR is only scoped to evaluate one pump station option, vertical pumps were assumed as they provide the most flexibility with respect to construction methods for the pump station structure.
- The pump station will incorporate all of the support utilities necessary for the pumping units to be evaluated.
- For conceptual design, the pump efficiency will be assumed to be 85% at the best efficiency point (BEP).
- For pricing, the use of bronze fitted impellers will be assumed.
- The pump driver will consist of an appropriately-sized electric motor operating at 900 revolutions per minute (rpm) close coupled to a parallel shaft gear reduction unit.
- For pump station layout, it is assumed that pump and motor removal will be accomplished using a barge-mounted crane.
- The design water surface elevations for the suction side of the pump station alternative will be per Section 2.4.2.
- Electrical and mechanical equipment and controls will be placed at an elevation of 93.0 feet, msl. (this elevation matches existing electrical equipment)

2.9.2 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)

2.9.2.1 Water Control Gates

- Conform to AWWA 561, Standard for Fabricated Stainless Steel Slide 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.

2.9.2.2 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

2.9.2.3 Valves

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

2.9.2.4 Pumps

Pump hydraulics and design will comply with the following requirements:

- Hydraulic Institute Standards.
- EM 1110-2-3105 Mechanical and Electrical Design of Pumping Stations

Sketches, calculations, and other mechanical support information can be found in Appendix F.

2.10 Construction Considerations

The ease of construction was considered with each alternative. If cost and schedule are similar the alternative that is more easily constructible is preferable when determining the final recommended alternative.

2.11 Operational Criteria

The ease of operation and maintenance was considered with each alternative. If an alternative was easier to operate compared to the other alternatives it was given a higher score compared to the others. Some annual maintenance will be required for all alternatives including periodically exercising of the valves, gates, and trash cleaning devices. Alternative #10, the large pump alternative, will require significantly more effort and cost to maintain the pump in operational condition including periodically starting the pump.

2.12 Cost

A conceptual level Construction Cost estimate for each investigated alternative was prepared at the 60% level (Appendix G). Costs presented were effective price levels as of March 2012. Cost data was based on estimates from vendors, fabricators, contractors, the Oregon Department of Transportation (ODOT) construction cost database, previously prepared cost estimates at The Dalles Lock and Dam Spillway, and other projects in the Pacific Northwest. The estimates contain contractor markups and contingencies. Contingency amounts were established based on an Abbreviated Risk Analysis (see guidance at www.nww.usace.army/mil/html/OFFICES/ED/C/default.asp). Cost estimates for the alternatives selected for the 90% and final reports are provided in Micro Computer Aided Cost Estimating System (MCACES) MII estimate. Contingencies will be established based on an Abbreviated Risk Cost estimates will conform to USACE publications ER 1110-2-1150, Engineering and Design for Civil Works Projects; ER 1110-2-1302, Civil Works Cost Engineering; and ETL1110-2-573 Engineering and Design: Construction Cost Estimating Guide for Civil Works. Information on the abbreviated risk analysis is contained in Appendix G.

2.13 Safety Criteria

Safety was an important consideration when evaluating each alternative. If the construction or operation of an alternative put human life or existing structures at risk, the alternative was not considered. All regulatory safety standards were considered during the development of each alternative. The safety of construction and operation and maintenance personnel would be essential for each alternative.

3.0 ALTERNATIVES TAKEN TO 60% DESIGN LEVEL AND OTHER IMPROVEMENTS

3.1 General Discussion

This section of the report will provide information about each alternative that has been evaluated and designed to the 60% level. Four major alternatives and hydraulic improvements to existing facility will be discussed. Each sub-section will contain the following:

- General Description of the Alternative
- Biological Considerations
- Geotechnical Evaluation
- Hydraulic Design
- Mechanical Design
- Structural Design
- Electrical Design
- Cost Information
- Constructability
- Summary discussion

Each alternative has been designed to provide 1,000 cfs. Improvements to the existing piping systems in the valve room will provide 400 cfs. The combined flow of 1,000 and 400 cfs will match the total design flow requirement of 1,400 cfs. Sheets 1-20, prepared for the 60% EDR submittal, have been revised based on review comments received. Minor revisions have been made for the 90% submittal.

Sheet 1 provides the locations of each of the following alternatives.

3.2 Alternative #1—Siphon for Additional Water to the Fishlock

3.2.1 Description of Alternative

This alternative proposes the use of two 72-inch steel siphon pipes that will convey water from the forebay to the existing fishlock. The fishlock will then discharge into the fishway approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. Sheet 2 displays the general plan for this alternative.

The siphon pipes will be sized for approximately 1,000 cfs. Improvements to the existing piping systems in the valve room will provide an additional flow of about 400 cfs, for a combined flow of 1,400 cfs. Figure 3 displays the piping layout in section views for this alternative and its relationship to the existing dam facilities. The control building on top of the fishlock may need to be demolished, but this depends on its importance to future operations. It may also need to be demolished because of placement of siphon pipes.

The siphons will be primed by pumps prior to beginning operation. An upstream gate valve at elevation 150.0 feet, msl will be provided for priming purposes. A downstream combination valve will be used for priming and flow control as needed. The two valves are located at elevation 120.0 feet, msl near the end of the pipe.

The invert elevation of the intake for each siphon pipe is at 134.0 feet, msl; the crest invert elevation is at 161.0 feet, msl; and the invert of the discharge outlet pipes are at elevation 120.0 feet, msl. This proposed alternative is designed to function over the range of the normal operating pool limits of 160.0 feet, msl to 155.0 feet, msl.

Inspection hatch covers will be added in the final design phase. This will allow for inspection access and minor maintenance if needed.

Six trashrack panels with ¾-inch spacing will be provided at the upstream trashrack structure. An air blast-type cleaning system will be used to remove debris.

3.2.2 Biological Considerations

3.2.2.1 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% 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. A relatively shallow intake would likely have more impact on juvenile salmonids than a deeper intake. Information on distribution of juvenile lamprey is scarce; however, the collection of some larval (ammocoete) and juvenile (macrophthalmia) lamprey in salmonid bypass systems at other mainstem dams illustrates the potential vulnerability of young lamprey as well.

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 proportion is likely to be low.

3.2.2.2 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 - 1.4%) than for those using the north fish ladder (1.8% - 5.0%). Similarly, fallback of adult Pacific lamprey was lower for those using the EFL (2.6%) than the north fish ladder (11.8%; 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.

3.2.3 Geotechnical Evaluation

The siphon pipes and trashrack located upstream of the concrete non-overflow dam would rest on the wraparound section of the embankment dam. The embankment dam was designed with an upstream zone, which was designated the "upstream blanket material," and was intended to reduce permeability and limit the flow through the dam. This material is described as well graded fine sandy gravel or course gravely sand. Between 35% and 75% of the material is smaller than ¼-inch. It contains sufficient gravel material sizes up to 8 inches to reduce the potential for surface erosion except from high velocities. Much of the material was placed under water and should be considered loose. The bearing capacity of the material is not known. The blanket material is only protected above about elevation 145 feet, msl with a 2-foot layer of revetment rock. It is intended that the blanket material zone would not be disturbed by construction of the siphon or its trashrack. Sheet 16 provides an upstream profile of embankment materials.

3.2.4 Hydraulic Design

The hydraulic analysis of the siphon alternative assumes that 1,000 cfs will be supplied to the fishlock by the proposed new siphon connection to the forebay, and 400 cfs will be supplied by the existing valve room piping with some minor modifications. Section 3.6.4 provides a summary of the valve room hydraulics. As a result, two separate hydraulic analyses were conducted to evaluate the two supply sources including the siphon pipe and valve room pipe systems.

3.2.4.1 Siphon Hydraulic Evaluation

The hydraulic analysis of the siphon alternative included estimating a pipe diameter that would provide the required discharge while also meeting the project hydraulic criteria. Both the negative pressure and velocity criteria were used in the hydraulic analysis of the siphons. At the crest of the siphon, the negative pressures were limited to -20 feet of pressure head. The velocities in the siphon were originally limited to 16 fps; however, that criterion was based on velocity limits for valves. To allow for higher velocities (and smaller pipes), the pipe size will be expanded at the valve sections to meet the 16 fps criterion; therefore, velocities in the main siphon pipes were allowed to exceed 16 fps.

The available head for this alternative is the forebay elevation minus the pressure grade elevation at the pipe outlet. An energy loss equation from the reservoir to the fishlock was utilized to estimate the discharge for various pipe diameters and is shown below:

$$H = \left(K + f \cdot \frac{L}{d}\right)\frac{V^2}{2 \cdot g}$$

Where,

H = Head between reservoir and fishlock, feet
K = Sum of minor loss coefficients
f = Pipe friction factor
L = Length of pipe, feet
d = Diameter, feet
V = velocity, fps
g = gravitational constant, feet/s^2

The minor losses included trashrack, entrance, bend, valve, and exit. Several references were used for the minor loss coefficients including "Internal Flow Systems", D.S. Miller; USACE EM110-2-1602 "Hydraulic Design of Reservoir Outlet Structures"; "Handbook of Hydraulics", Brater and King; and "Mechanics of Fluids", Potter and Wiggert. The friction loss in the pipes was also estimated by these sources, and a sensitivity analysis was conducted on the friction values. A Darcy-Weisbach roughness value (e) of 0.2 millifeet was used for the siphon pipes, which results in a friction factor of approximately 0.0115. To facilitate the design process, the numerical model EPANET was used to evaluate the various pipes and flow scenarios. EPANET simulates the hydraulics within pressurized pipe networks. The EPANET 'network' extended from the forebay to the siphon exit in the fishlock. The EPANET results provided the pressure grade line throughout the length of the pipe.

The inlet to the siphon is located at an invert elevation of 134.0 feet, msl. This elevation provides 26 feet and 21 feet of submergence on the entrance centerline when the forebay is at elevation 160 feet, msl and 155 feet, msl, respectively. EM 1110-2-1602 was used for a preliminary review of potential vortex activity. For a 72-inch pipe and a discharge of 500 cfs, the submergence is in a region that should not produce vortex activity; however, the lower forebay scenario is barely in the non-vortex region. Although vortices could be minor surface swirls or surface dimples, stronger vortices that could pull trash or full air core vortices that would break the siphon action would be more problematic and would need to be eliminated. The trashrack located in front of the intake could help break up vortices that may form. The entrance elevation selected was considered adequate for this level of detail; however, potential vortex activity should be considered and addressed in more detail as the design progresses.

There are three sharp bends in the vertical alignment of the siphon. The radii of the bends need to be sufficiently large to prevent separation that would increase the head losses and create undesirable pressure fluctuations through the bend. To address these issues, the radius should be at least, and preferably larger than, 1.5 times the pipe diameter. Due to the high discharge and velocities, the thrust on the bends is also a significant issue that must be accounted for in the design. Preliminary calculations estimate a thrust on the order of 50 to 60 kips (1,000 pounds – force) would exist on the 90-degree bend located where the pipe enters the fishlock. Supports along the full length of the pipe are needed to restrain the pipe and minimize undesirable vibration. In addition, the pipes extend 40 feet vertically down into the fishlock and would need to be rigidly supported along that length to restrain the pipe and minimize undesirable vibration. Loading on and support of the control valve at the pipes exit also present a significant design challenge.

The jets exiting the pipes at elevation 120 feet, msl are in a vertical direction into the fishlock pool and are located about 10 feet above the water surface elevation in the fishlock. This configuration will create complex hydraulic conditions within the fishlock. The close proximity of the two discharge jets and the turbulence the jets create within the fishlock chamber will need further evaluation. Physical and computational fluid dynamic (CFD) numerical models would be required in subsequent design phases to address the complex hydraulics associated with the turbulence and jet interaction.

The two system valves include a closure valve upstream of the siphon crest and a control valve at the downstream end of the system. Depending on the type of control valve selected, a positive full closure valve upstream of the control valve may be required for siphon priming operations. In addition, appropriate venting will be provided at the siphon crest to release and provide air during filling and emptying, respectively. The control valve would be used to control the discharge to ensure a constant inflow to the AWS system, which is required to minimize fluctuations in the fishway open channel system. For the siphon hydraulics presented in this report, a sleeve valve was used for pipe sizing purposes as it was the type of valve originally considered for this application. Since sleeve valves result in a higher loss coefficient when fully open compared to other types of valves, this was considered to be a conservative approach to sizing the pipes. As the design progresses, the valve manufacturer for the selected valve type will be able to provide detailed loss coefficient information. The loss coefficient for a fully open sleeve valve was obtained from U.S. Bureau of Reclamation model studies entitled 'Hydraulic Tests and Developments of Multijet Sleeve Valves' (USBR, 1977). The loss coefficients for other various types of valves vary significantly; therefore, other energy dissipation valves were also considered and used in sensitivity analyses. To be conservative, an exit loss was included in the calculations; however, if the valves are located at the end of the siphon pipes, the exit loss would be included in the valve loss.

Based on the preliminary hydraulic analysis for this alternative, two 72-inch diameter pipes would have the capacity to provide the required discharge of 1,000 cfs. The capacity of the pipes is on the order of 600 cfs to 650 cfs depending on the forebay elevation. Although the preliminary analysis shows that the pipes provide the required 500 cfs per pipe, as the design progresses the capacity of the pipes should be reevaluated as the minor losses will change, which could impact the capacity. As noted, the type of valve and loss associated with the valve will impact the discharge capacity of the system. As the design is refined and additional valve information is obtained, the size of the pipes should be reevaluated. The minimum pressures along the siphon crest are approximately negative 15 feet and negative 18 feet for forebay elevations of 160 feet, msl and 155 feet, msl, respectively. With a pipe size diameter of 72 inches and a discharge controlled to 500 cfs, the velocities would be approximately 18 fps.

Another siphon concept option that could be considered would include lowering the invert of the siphon crest to about elevation 154 feet, msl so that the pipe would automatically fill or 'self prime', which would eliminate the need for a pump fill system. The discharge capacity of the system would be about the same as the presented design alternative since most of the losses would be similar.

A less complicated design alternative that would completely eliminate the priming and low pressure issues associated with a siphon concept is a high level outlet (invert elevation to be determined based on submergence and geotechnical considerations) with the 6-foot diameter pipes extending directly from the reservoir, through the dam without a siphon, and into the fishlock at elevation 120.0 feet, msl. This concept would have the same, or somewhat greater capacity due to fewer minor losses, than the siphon alternative as the hydraulic head available for both concepts would be identical.

3.2.5 Mechanical Design

The siphon pipe will be primed using a small centrifugal pump that will fill each siphon line in approximately 2 hours. The capacity of the pump is 300 gpm at an estimated total discharge head (TDH) of 40 feet, which requires a 5-hp motor. Two pumps will be provided, one duty pump and one standby pump.

The siphon pipe will be provided with an isolation valve on the inlet side. To minimize head losses in the siphon, a full port resilient seated gate valve is assumed. On the downstream side, a jet flow gate valve will be used for both isolation of the pipeline for siphon priming, and as an energy dissipation valve to control the flow through the pipe during siphon operation. Both valves will be hydraulically actuated.

An air release valve will be provided at the invert of the siphon to evacuate air during priming of the pipeline.

3.2.6 Structural Design

A preliminary structural design was performed for this siphon alternative. The two, 72-inch diameter steel siphon pipes will be placed through monolith number 7 of the non-overflow section of the dam. It is assumed that the method of concrete removal will be coring or mining. The construction contractor will select one of these options. For both methods, the steel pipes will be fully grouted in place. Both siphon pipes will enter the fishlock at approximately 110-degrees to the axis of the dam (and the parallel centerline of the fishlock) to minimize the length of steel pipe to reach the trashrack structure at an elevation of 132.0 feet, msl. This optimized angle also keeps the pipes within 2 feet of the existing fishway channel exit. The approximate length of the pipes from the upstream face of the dam monolith to the back of the trashrack structure is 95 feet. The steel trashrack structure (without trashrack panels) will be shop welded and built in sections that can be bolted together. This will facilitate dipping into galvanization tanks in the Portland area. Sheet 2 shows the plan view and Sheet 3 shows the sections. Sheet 4 shows sizes and details of the trashracks and for the steel sections and pipe support brackets.

There are six trashrack panels which are supported on the bottom concrete pad and on the sides by the steel HSS sections and ¾-inch thick plate. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spaces between the bars. All panels are 10 feet 7 inches wide by 14 feet tall. The vertical bars are welded to three horizontal members that are welded to vertical HSS members on each side that are stabilized by a steel plate. All members are welded. The trashrack panels are bolted to the steel structure and can be removed. The 1-inch vertical bars were designed for a 5-foot head differential per EM 1110-2-3104. A vibrational analysis of the vertical members was not completed for this level of preliminary design. The trashrack panels are placed optimally at a 5 to 1 slope.

The 3-foot thick by 33.5 feet square concrete bearing pad will be placed on existing embankment material and the pipes will be bedded from the upstream face of the dam at elevation 148.8 feet, msl to approximately elevation 132.0 feet, msl without any excavation of existing material. Additional bedding material may be used to provide a level support grade.

3.2.7 Electrical Design

3.2.7.1 Electrical Loads

Alternative #1 includes the electrical loads identified in Table 6. The total connected electrical load is estimated to be 59 kVA.

Two siphon priming pumps are to be provided. One siphon pipe will be filled at a time using one pump; the second pump is a standby pump for backup. Three hydraulically actuated valves are to be provided on the discharge pipe of the pumps to control the flow of the water from the pumps to the siphon pipes. Additionally, two, 72-inch, hydraulically actuated valves will be installed on each siphon pipe to allow the siphon to be filled for siphon priming. A single hydraulic power unit is to be used for these four valves.

An electrically-operated debris cleaning system is to be installed on the trashrack at the upstream intake.

A lighting panelboard is included to provide new lighting and convenience receptacles at the new facilities, as required.

Two new motor actuated valves are to be installed in the Fish Ladder Valve Room to replace existing valves.

Table 6. Alternative #1 Electrical Loads

Description	Estimated Connected Load	Voltage
Siphon Priming Pump 1	5 hp	460 volt, 3-phase
Siphon Priming Pump 2	5 hp	460 volt, 3-phase
Hydraulic Power Unit	5 hp	460 volt, 3-phase
Trashrack Debris Cleaning System	25 hp	460 volt, 3-phase
Fishlock Valve Room 42-inch Valve	2 hp	460 volt, 3-phase
Fishlock Valve Room 36-inch Valve	2 hp	460 volt, 3-phase
Lighting Panelboard	15 kVA	460 volt, 3-phase

3.2.7.2 Electrical Power Source

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. Therefore, a new Unit Substation and 480-volt motor control center is to be installed. Sheet 18 displays an electrical one-line diagram. This equipment is to be located in a nearby pipe gallery.

The unit substation shall receive 4,160-volt, 3-phase power from the existing station service switchgear. Kirk-key interlocked, load break switches are included in the Unit Substation to allow selection of primary power from one of two 4,160-volt buses.

3.2.7.3 Control Requirements

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

Siphon Priming Pump Controls

The pumps will include local control stations located near each valve. Because these pumps 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:

- START push button (momentary contact)
- STOP push button (momentary contact)
- RUNNING indicator light
- STOPPED indicator light

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

- RUNNING

Valve 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

Debris Cleaning System

A manufacturer supplied control panel will be located near the trashrack equipment. This panel will include the motor controls as required to operate the system. In automatic mode the cleaning system will be controlled by timers located in the manufacturer supplied control panel. 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

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

3.2.8 Cost Evaluation

Construction of Alternative #1 will require construction of a work platform in the fishlock, mining or drilling for two, 72-inch steel pipes through the east non-overflow structure, and fabrication of the upstream siphon pipes and trashracks performed in the wet using barges, barge mounted cranes, and divers. This alternative also will require construction of an underwater concrete pad for the trashrack. The estimated construction cost for Alternative #1 is $4,771,000. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and the source of the estimate are shown on the backup data provided in Appendix G.

3.2.9 Constructability

The Siphon will be excavated from the inside of the fishlock and will pass through the fishlock and monolith 7 at an invert elevation of 161.0 feet, msl. Normal maximum pool level is elevation 160.0 feet, msl so a cofferdam will not be required for construction of the openings for the two, 72-inch pipes. It is assumed that construction will be performed from a secured platform inside of the fishlock. Demolition or support of the fishlock control building will be required. Mining for the siphon pipes will be performed in the dry with out the need for a floating plant in the lake. The siphon pipe will extend down the face of the dam to about elevation 149.0 feet, msl where they will rest on the surface of the embankment dam. The pipe will extend downward along the embankment until the invert is at an elevation of about 134.0 feet, msl where it will tie into the trashrack structure. The trashrack will be founded on a concrete pad placed on the embankment dam slope. The concrete pad that will support the ends of the pipes and the trashrack structure and panels will be built using the tremie method of placing concrete underwater. Once the pad is in place, the trashrack structure can be assembled and lowered from a work barge with a crane and bolted to the embedded anchors. Most of the work to place the pipe and trashrack panels will be completed by divers.

3.3 Alternative #2 – Low Level Intake

3.3.1 Description of Alternative

This alternative proposes the use of two, 72-inch pipes that will convey water from the forebay to the existing fishlock. The fishlock will then discharge into the approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. The pipes will be sized for approximately 1,000 cfs. Improvements to the existing piping systems in the valve room will provide an additional flow of about 400 cfs, for a combined flow of 1,400 cfs. Sheet 5 displays the plan layout of the alternative and its major features.

The preliminary design of each pipe shows a discharge capacity of about 760 cfs, for total combined capacity of about 1,520 cfs. A downstream flow control valve on each pipe would be used to limit the discharge into the fishlock. Further engineering will be required in the next phase of the study if this alternative is selected.

Downstream valves will be used for flow control as needed. The locations of these valves are displayed in Sheet 5.

Inspection hatch covers will be added in the final design phase. This will allow for inspection access and minor maintenance if needed.

The invert elevation of the intake trashrack is 104.0 feet, msl, the invert elevation for each pipe is at 111.5 feet, msl, and the invert of the discharge outlet pipes at the fishlock are at elevation 110.5 feet, msl.

Trashracks with ¾-inch spacing will be provided at the upstream intake. A debris cleaning system will also be included. Bulkheads will be attached to the upstream face of the dam at the entrance to each pipe to keep the system in a "dewatered" mode when not in operation. A crane will be needed to lower and raise the bulkheads. It is assumed that the trashrack enclosure will be attached by divers.

3.3.2 Biological Considerations

3.3.2.1 White Sturgeon and Lamprey

Position of the intake could impact benthic fish such as young sturgeon and larval lamprey. Young sturgeon rear in deep water in reservoirs (Parsley and Beckman 1994), preferring deep (29 - 125 feet), low velocity areas, where substrate particle sizes are small (e.g., sand; Parsley et al. 1993). 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 and bottom roughness (Hatten and Parsley 2009). Boyson and Hoover (2009) found that small (about 4 inches in length) age-0 white sturgeon had escape speeds of about 1.3 to 1.5 fps. Overall, benthic station-holding behaviors were least frequent in the smallest fish.

In general, lamprey ammocoete habitat occurs in low velocity, low gradient areas containing soft substrate and organic materials (Pirtle et al. 2003; Graham and Brun 2006). Ammocoetes will remain burrowed in soft substrates for up to 7 years (Close et al. 1995). Sutphin and Hueth (2010) found that the burst swimming speeds of Pacific lamprey ammocoetes increased with length, and ranged from about 1.1 to 2.5 fps. Moursund et al. (2003) found that juvenile lamprey had a maximum burst speed of 0.9 to 3.3 fps, increasing with length from about 5 to 7 inches. Most fish became impinged within one minute when exposed to velocities of 1.5 fps.

Although much remains unknown about the downstream migration of larval and juvenile lamprey in the Columbia River, in general, lampreys utilize a greater proportion of the water column than out-migrating juvenile salmonids. This is evident by the collection of some larval and juvenile lamprey in salmonid bypass systems at mainstem dams, and the affinity of ammocoetes for the substrate. Although blind and sedentary while burrowed, evidence suggests that ammocoetes from a given cohort can colonize the stream network from where they emerge down to the Lower Columbia River (Jolley et al. 2010).

Summary of potential impacts:

Depending on substrate composition, construction could displace rearing lamprey and white sturgeon. Lamprey will likely not be abundant in areas where the bottom is bedrock or consists mostly of sand. However, age-0 white sturgeon may be found over sand substrate.

Operation could entrain age-0 white sturgeon and larval and juvenile lamprey. White sturgeon may grow to as long as 10 inches by age 1 (Chapman and Kern 2005); therefore, only very young fish should be vulnerable to entrainment. Approach velocities greater than 1.1 to 1.3 fps could entrain sturgeon and lamprey if they are in the area.

3.3.2.2 Juvenile Salmonids

This alternative also has the possibility of entraining juvenile salmonids. Juvenile salmonids may be located throughout the water column, however, the overwhelming majority are usually found in the upper portions of the water column (Faber et al. 2005). Therefore, levels of entrainment of juvenile salmonids will likely be very low.

Summary of potential impacts:

Juvenile salmonids may be entrained; however, location of the intake near the bottom would likely minimize this impact.

3.3.3 Geotechnical Evaluation

The low level intake will be mined through the east non-overflow dam with the trashrack connected to the upstream face of the east non-overflow dam. On the downstream side of the non-overflow dam the pipes will be placed on the existing elevation 111.5-foot bench. The surface of this bench is paved surface. Stability of the concrete dam is not considered an issue. The paved surface of the 111.5-foot bench appears to have been designed for significant loads and the pipe should not cause settlement issues.

3.3.4 Hydraulic Design

The hydraulic analysis of the low level lake tap option included estimating a pipe size that would provide the required discharge while also meeting the project hydraulic criteria. The available head for this alternative is the forebay elevation (155-160 feet, msl) minus the fishlock water surface elevation (110 feet, msl). An energy loss equation from the reservoir to the fishlock was utilized to estimate the discharge for various pipe size diameters. Section 3.2.4.1 provides the energy loss equation used in the analysis. As described in Section 3.2.4.1, the minor losses included trashrack, entrance, bend, valve, and exit losses. The friction loss in the pipes was also estimated by these sources, and a sensitivity analysis was conducted on the friction values. A Darcy-Weisbach roughness coefficient (e) of 0.2 millifeet was used for the low level pipes.

Similar to the siphon alternatives, control valves would be located on the downstream end to control the discharge and to dissipate energy. For this alternative, the valves would discharge just above the water surface elevation in a horizontal direction. An emergency closure gate would be required at the entrance of the low level outlet system.

For the hydraulic analysis of the low level outlet alternative, a sleeve valve was used for the loss coefficients as discussed in Section 3.2.4.1. A sensitivity analysis was conducted to evaluate other types of valves. As the design progresses and additional valve information is available, the capacity of the pipes should be reevaluated. Other control options considered included slide gates; however, due to the high velocity and discharge, the energy dissipation associated with a sleeve-type valve was considered to be desirable. The impact of the jets on the walls of the fishlock and turbulence issues will need to be evaluated in future design phases. Other design considerations including thrust blocks and bend radius to pipe diameter ratios were discussed in Section 3.2.4.1.

Since several different low level outlet options were evaluated, the EPANET numerical model was used to evaluate the various options. The EPANET ‘network’ extended from the forebay to the fishlock water surface elevation. The model was also used to conduct sensitivity analyses on the minor losses and friction losses. Two, 72-inch diameter low level pipes would provide the 1,000 cfs requirement. The discharge capacity of each pipe exceeds 500 cfs, and the control valves would be used to maintain total discharge of 1,000 cfs through this system. The discharge capacity of the low level outlets is greater than that of the siphons as the head is 10 feet greater than the siphon head due to the siphon pipes horizontal exit invert elevation being 10 feet above the fishlock water elevation. Similar to the 72-inch diameter siphon pipes, the velocity in the pipes would be approximately 18 fps with 500 cfs passing through each pipe.

3.3.5 Mechanical Design

A jet flow gate valve will be used for energy dissipation in this alternative. The valve will be installed close to the discharge in the existing fishlock, on a valve support pad at the existing grade. To provide adequate safety during valve maintenance activities, it is also recommended that an additional isolation gate valve be provided on the upstream side of the jet flow gate valve to provide a backup means of isolation in addition to the bulkhead gates. The valves will be hydraulically actuated.

3.3.6 Structural Design

The two, 72-inch diameter steel siphon pipes will be placed through monolith number 5 of the non-overflow section of the dam. It is assumed that for the method of coring or mining through the concrete dam, contractor will select one of these options. For both methods, the steel pipes will be fully grouted in place. The invert elevation of the pipe is at 111.5 feet, msl and the pipes will run horizontal to the fishlock. The pipes will be either supported on the ground or on concrete pipe saddles (Sheet 5 and Sheet 6).

There are two trashrack steel enclosures that are bolted to the upstream wall, one for each of the proposed low level inlet pipes. These enclosures will hold three trashrack panels each for a total of six panels. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spacing between the bars. All panels are 10 feet 7 inches wide by 15 feet 4 inches tall. The vertical bars are welded to three horizontal members that are welded to vertical HSS members on each side and stabilized by steel plates. All members are welded. The trashrack panels are bolted to the steel structure and can be removed if needed. The 1-inch vertical bars were designed for a 5-foot head differential per EM 1110-2-3104. A vibrational analysis of the vertical members was not completed for this level of preliminary design. The trashrack panels are placed at a 5 to 1 slope. Inside the trashrack enclosures are two steel bulkheads to be utilized when the system is not in operation. The bulkheads for each outlet slide down into the enclosures on guide rails. When the system is in operation, the bulkheads are lowered out of the way and stored in the enclosures. When the Emergency Auxiliary Water Supply (EAWS) is not in operation, the bulkheads are pulled up and pinned into place. The steel enclosure will be bolted to the upstream face of the dam using 1-inch diameter stainless steel undercut anchors embedded 2 feet into the concrete. The invert elevation of the trashracks is 104.0 feet, msl.

3.3.7 Electrical Evaluation

3.3.7.1 Electrical Loads

Alternative #2 includes the electrical loads identified in Table 7. The total connected electrical load is estimated to be 59 kVA.

One 72-inch, hydraulically actuated valve will be installed at the downstream end of each pipe. A hydraulically actuated emergency closure gate is also provided for each pipe. A single hydraulic power unit is to be used for these two valves and two gates.

An electrically operated debris cleaning system will be installed on the trashrack at the upstream intake.

A lighting panelboard is included to provide new lighting and convenience receptacles as required at the new facilities.

Two new motor actuated valves are to be installed in the fish ladder valve room to replace existing valves.

Table 7. Alternative #2 Electrical Loads

Description	Estimated Connected Load	Voltage
Bulkhead Crane	10 hp	460 volt, 3-phase
Hydraulic Power Unit	5 hp	460 volt, 3-phase
Trashrack Debris Cleaning System	25 hp	460 volt, 3-phase
Fishlock Valve Room 42-inch Valve	2 hp	460 volt, 3-phase
Fishlock Valve Room 36-inch Valve	2 hp	460 volt, 3-phase
Lighting Panelboard	15 kVA	460 volt, 3-phase

3.3.7.2 Electrical Power Source

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. Therefore, a new Unit substation and 480-volt motor control center will be installed. Sheet 19 displays an electrical one-line diagram. This equipment is to be located in a nearby pipe gallery.

The unit substation shall receive 4,160-volt, 3-phase power from the existing station service switchgear. Kirk-key interlocked, load break switches are included in the Unit Substation to allow selection of primary power from one of two 4,160-volt buses.

3.3.7.3 Control Requirements

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.

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

Debris Cleaning System

A manufacturer supplied control panel will be located near the trashrack equipment. This panel will include the motor controls as required to operate the system. In automatic mode the cleaning system will be controlled by timers located in the manufacturer supplied control panel. 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

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

3.3.8 Cost Evaluation

Construction of the Alternative #2 will require mining or drilling for two, 72-inch steel pipes through the east non-overflow structure, and fabrication of upstream trashracks. This work can be performed from the elevation 111.5-foot, msl downstream bench or from the roadway on top of the dam. A crane and divers will be required to install the cofferdam structure, trashrack, and bulkhead structure. The estimated construction cost for Alternative #2 is $4,152,000. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and the source of the estimate are shown on the backup data provided in Appendix G.

3.3.9 Constructability

The low level intake will require boring or mining openings for two, 72-inch diameter steel pipes through the east non-overflow structure. The borings will be made at an invert elevation of approximately 111.5 feet, msl. The excavation will require some form of cofferdam on the upstream face of the dam. It is assumed that the contractor will use a bolt on structure just large enough to allow the boring to safely penetrate the dam and with enough space to perform any entrance modification that are required to insure a smooth approach of flows into the pipes. See Plan and Elevation on Sheet 7. The cofferdam will be left in-place until the pipes have been grouted into place and the pipe line to the fishlock has been installed along with the downstream control valves. Once the pipe line is completed the cofferdam can be removed and the trashrack bolted to the face of the dam. A bulkhead structure will be fitted to the face of the trashrack structure. It is assumed that all work can be performed from the elevation 111.5 feet, msl bench or from the top of the dam roadway. Installation of the cofferdams and trashracks will require divers working from a dive barge.

3.4 Alternative #10 – Single Pump/Pump House on East Side of Cul-de-sac

3.4.1 Description of Alternative

This alternative proposes the use of a single pump and pump house. The pump house will be located in the east side of the "Cul-de-sac" with access to the pump house from the north, as shown in Sheet 8. Two generic types of pumping units are available: vertical pump and CVP. For the purposes of this evaluation, a vertical axial flow pump was assumed. This type was selected over the CVP because vertical pumps provide more flexibility in terms of possible in-water construction methods for the pump station structure. CVP pumps would require the use of a cofferdam to allow for forming of the concrete volute.

The pump will discharge into a single steel pipe which is 11 feet in diameter and will have an invert elevation of 95.0 feet, msl. The discharge pipe will follow the bank line and then connect to the existing fishway approach channel that was formerly used for the fishlock operations. The approach channel will then discharge into an existing 8 foot by 8 foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. Sheet 8 through Sheet 11 show the layout of this alternative and its major features.

The single pump will be sized for about 1,000 cfs at 52 feet TDH. Improvements to the existing piping systems in the valve room will provide about 400 cfs, for a combined flow of 1,400 cfs. The size and configuration of the pump house wet well was determined using Hydraulic Institute (HI) standards based on the design flow of the pump. Wet well and pump sizing calculations are provided in Appendix F. Based on these calculations, the size of the pump motor will be approximately 7,000 hp and will run at a speed of 900 rpm. A parallel shaft gear reducer will reduce the speed of the pump to approximately 167 rpm.

During normal operation, it is assumed that the water surface elevation in the approach channel is at elevation 109.0 feet, msl, similar to the other alternatives. However, this channel will most likely be empty during pump startup, which could cause cavitation issues in the pump. Typically, this is mitigated by starting the pump against a closed downstream valve that is slowly opened once the pump is up to speed, but the pump manufacturer does not recommend this procedure for the selected pump. To facilitate pump startup, the pump will discharge into a junction tower approximately halfway between the pump station and the approach channel. The junction tower will contain a weir with a set elevation that provides a constant head for pump operation. The water then flows over the weir and to the approach channel by gravity. The size and configuration of the junction tower is shown in Sheet 8.

The pump house wet well is determined from HI standards to provide minimum pump submergence and ideal approach conditions at the design flow. For this alternative, the bottom of the wet well is at elevation 41.0 feet, msl, which results in a pump house that is 52 feet deep. The width of the wet well is 30 feet and the overall inside length if 90 feet. Due to the significant size and backup nature of this facility, it was assumed that dewatering the wet well would not be a frequent occurrence. Thus, the structure as currently designed to determine the project costs does not allow dewatering without the use of temporary bracing inside the wet well. If it is later decided that dewatering the wet well is an essential feature of this pump station, it is estimated that the structure costs would increase by approximately 30%.

For this alternative, it was also assumed that the pump, gear reducer and motor would be removed from the pump house using a barge mounted crane. Since it is unlikely that the pump or motor would ever need to be removed from the pump station, and due to the significant weight and size of the pump components, providing a station mounted bridge crane (along with the necessary structural improvements) is cost prohibitive.

Inspection hatch covers will be added in the final design phase. This will allow for inspection access and minor maintenance if needed.

Trashracks will be provided at the upstream intake including a proprietary debris cleaning system.

3.4.2 Biological Considerations

3.4.2.1 White Sturgeon

Adult white sturgeon aggregate in the cul-de-sac during winter months and disperse downriver as temperatures increase in the spring (Parsley et al. 2007). The deep, still waters of the cul-de-sac likely provide good habitat during periods of reduced metabolic activity during winter. White sturgeon have also been the second most common incidental catch of crews fishing for northern pikeminnow in The Dalles Dam tailrace, including the cul-de-sac, during spring and summer (U.S. Department of Agriculture 2009; Hone et al. 2011).

Habitat suitable for white sturgeon spawning exists in the tailrace of the dam (downstream from the cul-de-sac), especially at flows greater than 150,000 cfs (Parsley and Beckman 1994). Maturing and ripe female white sturgeon have been collected in the cul-de-sac during spring sampling in multiple years (Webb et al. 2005; Webb and Kappenman 2008). Although not specific to the cul-de-sac, age-0 white sturgeon have been collected throughout the Bonneville Reservoir annually (Chapman and Jones 2011). Boyson and Hoover (2009) found that small (about 4 inches in length) age-0 white sturgeon had escape speeds of about 1.3 to 1.5 fps.

Summary of potential impacts

Installation and construction in the cul-de-sac could disrupt adult white sturgeon congregating for the winter. Operation of the pump in winter may also disrupt white sturgeon.

Operation of the pump could possibly entrain age-0 white sturgeon if approach velocities exceed 1.3 to 1.5 fps. White sturgeon may grow to as long as 10 inches by age 1 (Chapman and Kern 2005); therefore, only very young fish should be vulnerable to entrainment.

3.4.2.2 Juvenile Salmonids

Approximately 80% to 90% of juvenile salmonids migrate past The Dalles Dam via the spillway and ice and trash sluiceway (Johnson et al. 2007); however, a small number may reside for a period of time in the cul-de-sac. Although not specific to pumps, the general NMFS criterion for approach velocity at screens to protect juvenile salmonids is 0.4 fps (NMFS 2008).

Summary of potential impacts

Operation of the pump could possibly entrain juvenile salmonids. Even if screened, approach velocities would exceed NMFS criteria. Because most fish pass via the spillway or ice and trash sluiceway, only a small proportion of juvenile salmonids migrating past the dam would be vulnerable to entrainment.

3.4.2.3 Predation

A new structure may provide additional habitat for non-native predators found in the cul-de-sac such as smallmouth bass and walleye. Smallmouth bass in particular have an affinity for structures including pilings and riprap (Pribyl et al. 2005). Smallmouth bass have consistently been the most common incidental catch of crews fishing for northern pikeminnow in The Dalles Dam tailrace, including the cul-de-sac (U.S. Department of Agriculture 2009; Hone et al. 2011). Effects of a single structure are difficult if not impossible to quantify; however, effects of multiple structures are cumulative.

Both smallmouth bass and walleye prey on juvenile salmonids and juvenile white sturgeon. Smallmouth bass also prey on small lamprey, although sculpins are generally the most commonly consumed fish between Bonneville and The Dalles dams (Weaver et al. 2009).

Summary of potential impacts

The new structure may result in some increase in predation on native fishes; however, quantifying this impact would be difficult or impossible. The effect of a single structure is likely minimal.

3.4.3 Geotechnical Evaluation

The pump platform and trashrack structure are located near the contact between the elevation 60-foot, msl bedrock bench and the downstream embankment dam. The pump house and trashrack structure location will be adjusted to insure that it does not straddle this contact. The downstream portion of the embankment dam was constructed of quarry run rock fill consisting of hard, durable Basalt blocks generally weighing between 200 and 300 pounds with the potential for larger stones. Much of the fill material was placed in-the-wet and extends down to an elevation of about 80 feet, msl or lower. Driving of piles into the rock fill is not recommended. Micropiles can be used to tie foundations into this fill area. Drilling into the rock fill will require a cased hole. Piles or piers installed in bedrock will require a rock socket.

3.4.4 Hydraulic Design

Preliminary pump hydraulic calculations are provided in Appendix F. If the pump station alternative is ultimately selected, physical modeling of the pump station and discharge piping is recommended.

3.4.5 Mechanical Design

An isolation sluice gate and a butterfly valve will be provided on the discharge pipe near the fishway approach channel to provide redundant isolation of the pipe for personnel to enter and inspect the pipeline.

The pump gear reducer will require an oil-to-water or oil-to-air heat exchanger to dissipate heat generated by the motor during operation. This system also requires an oil storage tank that is approximately 500 gallons in size. The pump seals will require seal water for flushing, so a potable water line will be needed at the pump station. The motors will be equipped with anti-condensation heaters and vibration monitoring equipment.

The pumps will require monthly and weekly maintenance to ensure they will perform as required. The pump motor control center will be equipped with a jog switch that slightly moves the pump shaft to keep the bearings lubricated. This should be done on a weekly basis. It is also recommended that the pump be operated for a short period of time on a monthly basis. All valves and gates should also be operated monthly.

The pump station trashrack will be equipped with a mechanical trash rake system to remove debris from the trashrack. Cut sheets for this and other mechanical items are provided in Appendix F.

3.4.6 Structural Design

The pump house 2-foot thick concrete platform (and integrated beams) is designed to support a 200-ton, 7,000-HP vertical turbine pump. For this level of effort, the structure was not designed for lateral (seismic) forces or rotational motor torque. The 52-foot walls were not designed for a de-watered condition for pump maintenance.

The concrete wet-well is 30 feet wide by 90 feet long by 52 feet tall. The 2-foot thick walls (and integrated columns) are supported on a 4-foot concrete foundation mat that is supported on ten 6-foot diameter and four 4-foot diameter drilled shafts. The reinforced drilled shafts are embedded into the rock approximately 5 feet. At the entrance to the wet-well, there are four trashrack panels supported on the sloped 5 vertical to 1 horizontal concrete end walls. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spacing between the bars to allow a flow of 1,000 cfs at a velocity of 3 fps. All panels are 14 feet wide by 16 feet 6 inches tall. The vertical bars are welded to three (3) horizontal 2-inch by 6-inch deep members that are welded to vertical HSS members on each side that will be bolted to 8-inch by 8-inch by ½-inch angles welded to embedded plates in the wall. Additional steel members to support the trashracks as required. The 1-inch vertical bars were designed for a 5-foot head differential per EM 1110-2-3104. A vibrational analysis of the vertical members was not completed for this level of preliminary design.

The pump house building is a simple structure using 12-foot by 8-foot- by 16-foot concrete masonry units (CMU) and is approximately 43 feet at the highest point. CMU pilasters may be needed for wind and seismic design. There are two 12 feet wide by 15-foot tall garage doors on each side of the building to allow a small truck to drive through the pump house building and access the rear deck to service the proprietary trash rake system and remove debris. To remove the motor and pump, a removable hatch has been incorporated into the steel roof and it is assumed this would be removed by a barge-mounted crane. There are other options for the roof joists, but a W18 roof beam at 5-foot centers has been used. A metal deck roof spans the beams.

The roadway bridge is 14 feet wide out-to-out and is comprised of three ODOT precast/prestressed slabs side by side. A 3-inch concrete deck overlay will be used and the roadway barriers will be supported on corbel extensions on the outside slabs. There are three 50-foot spans that will be supported on two 4-foot diameter concrete piers supported on a thick concrete mat foundation founded on micropiles. The roadway is sloped at a 10% grade from the downstream dam embankment to the pump house. The bridge is supported on a spread footing-type abutment seat at the downstream embankment and a corbel at the pump house back wall. With more refinement, this slope may be lessened.

The 11-foot diameter steel pipe shares one bridge pier with the roadway and then is supported on a single pier midway between the fishlock approach channel and discharge box/junction structure. The pipe is supported on a concrete pipe saddle at the pump house. A 30-foot diameter steel junction structure is required and is founded on a concrete footing which is also supported on micropiles.

3.4.7 Electrical Evaluation

3.4.7.1 Electrical Loads

Alternative #10 includes the electrical loads identified in Table 8. The total connected electrical load is estimated to be 7,180 kVA.

A single pump is used to deliver water to the fishway approach channel. The motor is a synchronous-type motor and operated with a full voltage non reversing starter. Further analysis will be required if this alternative is selected to move forward in order to investigate the effects of motor inrush current to determine if a reduced voltage autotransformer-type starter is necessary. Vibration and temperature monitoring equipment is to be provided to protect the pump and motor against abnormal conditions.

An electrically operated debris cleaning system is to be installed on the trashrack at the upstream intake.

A lighting panelboard is included to provide new lighting and convenience receptacles at the new facilities, as required.

Table 8. Alternative #10 Electrical Loads

Description	Estimated Connected Load	Voltage
Auxiliary Water Pump	7,000 hp	6,600-volt, 3-phase
Trashrack Debris Cleaning System	50 hp	460-volt, 3-phase
Pump Station Heating and Ventilation	100 kW	460-volt, 3-phase
Lighting Panelboard	30 kVA	460-volt, 3-phase

3.4.7.2 Electrical Power Source

The auxiliary water pump represents a substantial load. It is proposed that a connection to the 13.2 kV power system near the main units (generators) be made to provide power to the pump station as indicated on the electrical one line diagram on Sheet 20. A current limiting reactor is shown on the one-line diagram. Further analysis will be required if this alternative is selected to move forward to determine if the current limiting reactor is required for limiting the available fault current to the new system.

A primary unit substation would be located near the existing roadway and the new bridge to the pump station to convert the 13.2-kV power to 6,600-volt power for the motor control equipment. The 6,600-volt motor control equipment is to be located within the pump station.

3.4.7.3 Control Requirements

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.

Auxiliary Water Pump Controls

The pumps will include local control stations located at the pump station. Because these pumps 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:

- START push button (momentary contact)
- STOP push button (momentary contact)
- RUNNING indicator light
- STOPPED indicator light

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

- RUNNING

Debris Cleaning System

A manufacturer supplied control panel will be located near the trashrack equipment. This panel will include the motor controls as required to operate the system. In automatic mode the cleaning system will be controlled by timers located in the manufacture supplied control panel. 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

3.4.8 Cost Evaluation

Construction of the single pump alternative will require construction two bridges and the pump house platform and installation of a large pump. Bridge and pump station construction will use a construction process typical of bridge construction and other forms of in-water work. The portions of the pump station constructed below the water level will be more difficult since dewatering of the structure will not be possible without significant additional structural members being added. Installation of the pump and pump assembly will require a barge mounted crane to lift the pump and motor into place. The electrical connection is expected to have a significant cost. The estimated construction cost for Alternative #10 is $22,208,000. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and the source of the estimate are shown on the backup data provided in Appendix G.

The cost for the pump assumes that no exotic materials are required for the pump bowl or impeller. The cost for the bare pump without the motor and the gear reducer without contingency is approximately $2,500,000. However, if a stainless steel impeller and pump bowl are required, and stringent vibration limitations are specified, the bare pump cost could escalate to approximately $4,000,000.

3.4.9 Constructability

Construction of the pump station and associated bridges will likely be performed from a crane barge or by construction of a temporary trestle. Much of the initial construction will use standard bridge construction technology. Once the drilled piers and base slab are in-place and the perimeter walls constructed, the remainder of the work including bridge decks, pump station deck and interior wall will not be considered in-water. The piers will require a double casing to contain any spillage of cuttings or concrete. The concrete base slab will be placed underwater by tremie method of concrete placement using non-dispersive concrete. Pipe line construction and mining of the fishlock approach channel will be performed in the dry.

3.5 Alternative #11 – Intake Tower with Siphon to Fishlock

3.5.1 Description of Alternative

This alternative requires two, 72-inch siphon pipes that will convey water from an upstream intake tower with low level inlet openings to the existing fishlock. The fishlock will then discharge into the fishway approach channel (no longer in use) which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. Sheet 12 displays the general plan layout and flow path for this alternative.

The siphon pipes will be sized for approximately 1,000 cfs. Proposed Improvements to the existing piping systems in the "valve room" will provide about 400 cfs, for a combined flow of 1,400 cfs. Sheet 13 shows the pipe layout sectional view for this alternative. The piping geometry from elevation 120.0 feet, msl in the fishlock through the dam monolith is the exact same configuration as Alternative #1.

The siphons will be primed by pumps prior to the beginning of operation. An upstream gate valve at elevation 150.00 feet, msl will be provided for priming purposes. Downstream jet flow valves in the fishlock at elevation 120.0 feet, msl will be used for priming and flow control as needed. The locations of these valves are also shown in Figure 13. The design will include a small pump used to fill the siphon pipes that will prime the siphon. The operation of the upstream and downstream valves needs to open and close simultaneously to ensure initiation of the siphon action.

Inspection hatch covers will be added in the final design phase. This will allow for inspection access and minor maintenance if needed.

The invert elevation of the trashrack at the intake tower is at 100.0 feet, msl, the intake invert for the siphon is at elevation 134.0 feet msl, the crest invert elevation for the siphon pipes is at 161.0 feet, msl and the invert elevation of the discharge outlet pipes is at 120.0 feet, msl, which is located in the fishlock. This proposed alternative is designed to function over the range of the normal operating pool limits of 160.0 to 155.0 feet, msl.

The proposed design calls for six trashrack openings at the base of the intake tower. There will four flat rectangular and two curved rectangular trashracks. An air blast-type cleaning system will be used to remove debris from the trashrack faces.

3.5.2 Biological Considerations

3.5.2.1 White Sturgeon and Lamprey

Position of the intake slots could impact benthic fish such as young sturgeon and larval lamprey. Young sturgeon rear in deep water in reservoirs (Parsley and Beckman 1994), preferring deep (29-125 feet), low velocity areas, where substrate particle sizes are small (e.g., sand; Parsley et al. 1993). 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 and bottom roughness (Hatten and

Parsley 2009). Boyson and Hoover (2009) found that small (about 4 inches in length) age-0 white sturgeon had escape speeds of about 1.3 to 1.5 fps. Overall, benthic station-holding behaviors were least frequent in the smallest fish.

In general, lamprey ammocoete habitat occurs in low velocity, low gradient areas containing soft substrate and organic materials (Pirtle et al. 2003; Graham and Brun 2006). Ammocoetes will remain burrowed in soft substrates for up to 7 years (Close et al. 1995). Sutphin and Hueth (2010) found that the burst swimming speeds of Pacific lamprey ammocoetes increased with length, and ranged from about 1.1 to 2.5 fps. Moursund et al. (2003) found that juvenile lamprey had a maximum burst speed of 0.9 to 3.3 fps, increasing with length from about 5 to 7 inches. Most fish became impinged within one minute when exposed to velocities of 1.5 fps.

Although much remains unknown about the downstream migration of larval and juvenile lamprey in the Columbia River, in general, lamprey utilize a greater proportion of the water column than out-migrating juvenile salmonids. This is evident by the collection of some larval and juvenile lamprey in salmonid bypass systems at mainstem dams, and the affinity of ammocoetes for the substrate. Although blind and sedentary while burrowed, evidence suggests that ammocoetes from a given cohort can colonize the stream network from where they emerge down to the Lower Columbia River (Jolley et al. 2010).

Summary of potential impacts:

Depending on substrate composition, construction could displace rearing lamprey and white sturgeon. Lamprey will likely not be abundant in areas where the bottom is bedrock or consists mostly of sand. However, age-0 white sturgeon may be found over sand substrate.

Intake slots on or near the base of the tower could result in entrainment of lamprey and age-0 white sturgeon. This placement should minimize potential impacts on juvenile salmonids.

3.5.2.2 Juvenile Salmonids

This alternative also has the possibility of entraining juvenile salmonids. Juvenile salmonids may be located throughout the water column, however, the overwhelming majority are usually found in the upper portions of the water column (Faber et al. 2005). Therefore, levels of entrainment of juvenile salmonids will likely be very low.

Summary of potential impacts:

Juvenile salmonids may be entrained; however, location of the intake near the bottom would likely minimize this impact.

3.5.2.3 Predation

A new structure may provide additional habitat for non-native predators found in The Dalles Dam forebay, especially smallmouth bass. Smallmouth bass density fluctuates in the forebay, generally increasing from 1990-2006, but decreasing from 2006 to 2009; however, sculpins dominate the diet of smallmouth bass throughout the reservoir. Approximately 70-80% of fish consumed by smallmouth bass in the reservoir are sculpins, 5-6% salmonids, and 0-1% lamprey

(Weaver et al. 2007; 2010). Effects of a single structure are difficult if not impossible to quantify; however, effects of multiple structures are cumulative.

Summary of potential impacts

The new structure may result in some increase in predation on native fishes; however, quantifying this impact would be difficult or impossible. The effect of a single structure is likely minimal.

3.5.3 Geotechnical Evaluation

The intake for this option will be founded on bedrock at about elevation 100 feet, msl. The rock in this area is hard sound Basalt with relatively high unconfined compressive strengths. The structure will be located 35 to 40 feet west of the toe of the embankment dam and should have no impact on the dam.

3.5.4 Hydraulic Design

The hydraulic analysis of the siphon with an intake tower is very similar to the siphon option discussed in Section 3.2.4.1 where the siphon intake is located upstream of the dam in the forebay. The analysis included estimating a siphon pipe size diameter that would provide the required discharge while also meeting the project hydraulic criteria. Similar to the Alternative 1 siphon option, the available head for this alternative is the forebay elevation minus the pressure grade elevation at the exit elevation of the siphon pipe in the fishlock. An energy loss equation from the reservoir to the fishlock was utilized to estimate the discharge for various pipe size diameters. Section 3.2.4.1 provides the energy loss equation used in the analysis. As described in Section 3.2.4.1, the minor losses included trashrack, entrance, bend, valve, and exit losses. The friction loss in the pipes was also estimated by these sources, and a sensitivity analysis was conducted on the friction values. A Darcy-Weisbach roughness coefficient (e) of 0.2 millifeet was used for the low level pipes.

Similar to the Alternative 1 siphon alternative, control valves would be located on the downstream end to control the discharge and dissipate energy. The valves would discharge into the fishlock in a vertical direction at elevation 120 feet, msl. For the hydraulic analysis of this alternative, a sleeve valve was used for the loss coefficients as discussed in Section 3.2.4.1. A sensitivity analysis was conducted to evaluate other types of valves. Section 3.2.4.1 also describes thrust issues at bends (especially at the 90 degree bend into the fishlock), necessary bend radii, pipe and valve support issues, and additional hydraulic analyses required as the design progresses to evaluate the jet impact and potential turbulence issues in the fishlock.

EPANET was used to facilitate the hydraulic analyses, and the EPANET ‘network’ extended from the forebay to the fishlock water surface elevation. The model was also used to conduct sensitivity analyses on the minor losses and friction losses. Based on this preliminary analysis, two, 72-inch diameter siphon pipes would provide the 1,000 cfs requirement. Similar to Alternative 1, the capacity of the pipes is around 600 cfs to 650 cfs depending on the forebay elevation. The discharge is about the same for both siphon alternatives as there are relatively minor differences in the two configurations, and the friction loss associated with the longer pipe length for this alternative was minor. Although the preliminary analysis shows that the pipes provide the required 500 cfs per pipe, the capacity of the pipes should be reevaluated as the design progresses since the minor losses will change and could impact the capacity. Similar to the other alternatives, as the design is refined and additional valve information is obtained, the size of the siphons should be reevaluated. The negative pressures along the siphon crest are approximately negative 15 feet and negative 18 feet for forebay elevations of 160 feet, msl and 155 feet, msl, respectively. With two, 72-inch diameter pipes, the velocity in the pipes would be approximately 18 fps with 500 cfs passing through each pipe.

3.5.5 Mechanical Design

The siphon pipe will be primed using a small centrifugal pump that will fill each siphon line in approximately 2 hours. Due to the longer length of the pipelines for this alternative, the capacity of the pump is 670 gpm at an estimated TDH of 40 feet, which requires a 10-hp motor. Two pumps will be provided, one duty pump and one standby pump.

The siphon pipe will be provided with a isolation valve on the inlet side. To minimize head losses in the siphon, a full port resilient seated gate valve is assumed. On the downstream side, a jet flow gate valve will be used for both isolation of the pipeline for siphon priming, and as an energy dissipation valve to control the flow through the pipe during siphon operation. Both valves will be hydraulically actuated.

An air release valve will be provided at the invert of the siphon to evacuate air during priming of the pipeline.

3.5.6 Structural Design

A preliminary structural design was completed for this second siphon alternative. A semi-circular concrete intake tower is used for siphoning water from elevation 100.0 feet, msl. Two, 72-inch diameter steel siphon pipes will also be placed through monolith number 7 of the non-overflow section of the dam in the same manner as Alternative #1. It is again assumed for the method of coring or mining through the concrete dam, contractor will select one of these options. For both construction methods, the steel pipes will be fully grouted in place. Both siphon pipes will exit the intake tower at elevation 161.0 feet, msl at approximately Station 43+14.13. The pipes will enter the fishlock at approximately 110 degrees to the axis of the dam (and the parallel centerline of the fishlock).The length of the pipes from elevation 134.0 feet, msl to the upstream face of the dam monolith is 165 feet. The pipes are supported at the intake tower (on concrete saddles) at the Fishway Channel piers, and at the upstream face of the dam as they enter through monolith number 7. Sheet 12 shows the piping layout in plan view and Sheet 13 shows the sections. Sheet 14 shows the pipe support at the fishway channel pier and Sheet 15 shows the plan and elevation of the intake tower and basic preliminary dimensions. There are six trashrack panels which are supported on the bottom concrete foundation pad and on the sides by the concrete walls. Four of the panels are rectangular and two of the upstream panels are curved. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spacing between the bars. All panels are 10 feet 7 inches wide by 14 feet tall. The vertical bars are welded to three horizontal members that are welded to vertical HSS members on each side that are stabilized by steel plate. All members are welded. The trashrack panels are bolted to embed plates and can be removed. The 1-inch vertical bars were designed for the case when the trashrack is 50% covered by debris.

A vibrational analysis of the vertical members was not completed for this level of preliminary design. The trashrack panels are placed optimally at a 5 to 1 slope.

The concrete intake tower is 85 feet tall. The walls of the concrete intake tower are 2 feet thick and designed for a differential pressure head of 60 feet. For this EDR, the tower was not designed for hydrodynamic forces. It is also assumed that the tower will not be fully dewatered so there will be no differential pressure to design the lower walls. The tower may be dewatered to elevation 145.0 feet, msl to service the gate valve. The walls are supported on a 3-foot-thick concrete foundation. The lower 14 feet of the tower were designed to support the steel trashrack panels. The walls are attached to the upstream face of the dam using grouted dowels. The top deck of the tower is at elevation 185.0 feet, msl to match the existing top of dam. The top deck has removable metal grating for servicing the valves. Part of the existing concrete railing on the dam is removed and a similar rail is used on the new concrete deck.

3.5.7 Electrical Evaluation

3.5.7.1 Electrical Loads

This alternative includes the electrical loads identified in Table 9. The total additional electrical load is estimated to be 69 kVA.

Two siphon priming pumps are to be provided to deliver water to the siphon pipe for priming. One siphon pipe will be filled at a time using one pump; the second pump is a standby pump for backup. Three hydraulically actuated valves are to be provided on the discharge pipe of the pumps to control the flow of the water from the pumps to the siphon pipes. Additionally, two, 72-inch, hydraulically actuated valves will be installed on each siphon pipe to allow the siphon to be filled for siphon priming. A single hydraulic power unit is to be used for these four valves.

An electrically operated debris cleaning system is to be installed on the trashrack at the upstream intake.

A lighting panelboard is included to provide new lighting and convenience receptacles as required at the new facilities.

Two new motor actuated valves are to be installed in the fish ladder valve room to replace existing valves.

Table 9. Alternative #11 Electrical Loads

Description	Estimated Load	Voltage
Siphon Priming Pump 1	10 hp	460-volt, 3-phase
Siphon Priming Pump 2	10 hp	460-volt, 3-phase
Hydraulic Power Unit	5 hp	460-volt, 3-phase
Trashrack Debris Cleaning System	25 hp	460-volt, 3-phase
Fishlock Valve Room 42-inch Valve	2 hp	460-volt, 3-phase
Fishlock Valve Room 36-inch Valve	2 hp	460-volt, 3-phase
Lighting Panelboard	15 kVA	460-volt, 3-phase

3.5.7.2 Electrical Power Source

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. Therefore, a new unit substation and 480-volt motor control center is to be installed. Sheet 18 displays an electrical one-line diagram. This equipment is to be located in a nearby pipe gallery.

The unit substation shall receive 4,160-volt, 3-phase power from the existing station service switchgear. Kirk-key interlocked, load break switches are included in the unit substation to allow selection of primary power from one of two 4,160-volt buses.

3.5.7.3 Control Requirements

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.

Siphon Priming Pump Controls

The pumps will include local control stations located near each valve. Because these pumps 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:

- START push button (momentary contact)
- STOP push button (momentary contact)
- RUNNING indicator light
- STOPPED indicator light

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

- RUNNING

Valve 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

Debris Cleaning System

A manufacturer supplied control panel will be located near the trashrack equipment. This panel will include the motor controls as required to operate the system. In automatic mode, the cleaning system will be controlled by timers located in the manufacturer supplied control panel. 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

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

3.5.8 Cost Evaluation

Construction of Alternative #11 will require construction of a work platform in the fishlock, mining or drilling for two, 72-inch steel pipes through the east non-overflow structure, fabrication of the upstream siphon pipes, and construction of a precast intake structure with trashracks attached to the face of the dam. This alternative will require construction of an underwater concrete pad for the intake structure. All upstream work can be performed without any floating plant except as required by the divers. The estimated construction cost for Alternative #11 is $3,826,000. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and the source of the estimate are shown on the backup data provided in Appendix G.

3.5.9 Constructability

The siphon with an intake tower will be constructed in the same manner as the siphon alternative from the fishlock to the upstream face of the dam. Unlike the siphon option, the siphon pipes will be hung from the upstream face of the non-overflow structure to the location of the intake structure. The foundation base for the intake tower will be cast in-the-wet using tremied non-dispersive concrete. The base will have cast-in-place threaded rod for attaching precast (and possibly prestressed) tower wall sections. The tower walls are assumed to be cast at a precast plant and shipped in sections that meet ODOT requirements. This is up to the contractor, as the sections can be cast at the plant or cast on top of the dam. The precast sections will be lowered by crane on top of the foundation and post-tensioned to the foundation base. This procedure will require the use of divers. The pipes and valves will be installed in the dry. A floating barge mounted crane should not be required with all lifting being performed from the roadway of the concrete dam. Once the intake tower is completed, the pipes and valves will be installed and the structure watered up.

3.6 Improvements to Fishlock, Valve Room, and Approach Channel

3.6.1 Description of Improvements to Existing Fishlock, Valve Room, and Approach Channel

During the brainstorming meeting, several improvements to the existing project features were identified. These are as follows:

- Improvements to the existing valve room
- Improvements to the fishlock approach channel
- Improvements to the equalizing headers and pipe system.

This section of the report will discuss the above proposed improvements.

3.6.2 Biological Considerations

Potential effects of providing a backup supply for the AWS were described for each of the four alternatives, under the assumption that fish entrained into the system through any of the alternatives would be severely injured or killed. Therefore, a detailed description of biological considerations is not provided here. It is possible however, that removal of the diffusers could lessen the impact of entrainment on fish. Impacts of diffuser removal would be the same for each design alternative.

3.6.3 Geotechnical Evaluation N/A

The Geotechnical Evaluation is not applicable.

3.6.4 Hydraulic Evaluation

3.6.4.1 Valve Room Pipe Hydraulic Evaluation

The fishlock system includes an existing piping system that was designed and originally used for the fishlock fill supply, holding pool discharge, and approach channel attraction flow. The discharge from this existing pipe system (400 cfs) would be used in addition to the siphon alternative (1,000 cfs capacity) to provide the total required 1,400 cfs for the AWS. The existing fill system includes a 42-inch diameter and 36-inch diameter pipe extending from the forebay to the valve room where the pipes connect to various components of the system.

The 42-inch diameter pipe connects the forebay to the fishlock and was originally used for filling the fishlock. The 36-inch diameter pipe divides into three 18-inch diameter pipes that were used to provide flows to the fishlock approach channel (open channel) downstream of the fishlock itself. Two of the 18-inch diameter pipes supply discharge to the holding pond just downstream of the fishlock. The other 18-inch diameter pipe supplies water to the diffuser located between the fishlock approach channel and AWS diffusers 77 and 78. This analysis assumed that the diffuser screens and bubbler diffuser beams would be removed. Similar to the siphon pipe analysis, the EPANET numerical model was used to estimate the discharge capacity of the pipes.

The valve room pipe system includes a substantial number of losses due to the intricate design of the system. For the 42-inch diameter pipe, the minor losses included entrance, sudden valve contraction (entrance conduit to 42-inch diameter pipe), bends, diffuser chimney expansion section, and an exit loss. For the 36-inch diameter pipe, the minor losses include those listed for the 42-inch diameter pipe as well as losses associated with the 36-inch diameter pipe branching into three 18-inch diameter pipes. The discharge capacities of the 36-inch diameter and 42-inch diameter pipes were originally estimated for two different fishlock and channel water surface elevations. If the existing fishlock approach channel is covered with a 'lid' to create a pressurized system, the flow through the 36-inch diameter and 42-inch diameter pipes will be reduced due to the reduction in available head on the pipes. Subsequent analyses provided an alternative solution to pressurizing the fishlock channel; therefore, the open channel downstream condition (resulting in a higher head for the valve room piping system) was used for the results presented in this report.

The capacities of the two systems for forebay elevations of 155.0 and 160.0 feet, msl are shown in Table 10 with and without the 16 fps velocity criterion. The 16 fps pipe velocity criterion is based on the velocity through the existing valves. As shown in Table 10, the total capacity of the existing pipe system as limited by the existing valves is less than the required 400 cfs, whereas the maximum capacity without the valve velocity limitation is significantly greater than 400 cfs. Replacing the existing valves with newer larger valves that could accommodate higher velocities would allow the 16 fps velocity criterion to be exceeded in the pipes themselves.

Table 10. Valve Room Piping Discharge Capacities

Pipe System	Forebay (feet, msl)	Discharge Capacity (cfs)	Velocity for Discharge Capacity (fps)	Discharge with 16 fps velocity criterion (cfs)
42-inch diameter	160	375	39	155
42-inch diameter	155	350	36	155
36-inch diameter	160	180	25	85
36-inch diameter	155	170	25	85

As shown in Table 10, the capacity of this system is capable of exceeding 400 cfs. The velocities in the system could be reduced to less than 25 fps by controlling the discharge with the valves to 400 cfs. One modification that was considered included connecting the 36-inch diameter pipe to discharge directly into the fishlock drain, thus bypassing the 18-inch diameter pipes that currently restrict the capacity of the 36-inch diameter pipe. In this scenario, the fishlock drain pipe would be modified to discharge into the fishlock approach channel immediately downstream of the fishlock. Based on an initial review, this modification could increase the capacity of the 36-inch diameter pipe system by 30%; however, a discharge of 400 cfs is met with the existing system, would not require any major modifications, and would limit the velocities in the pipes to a reasonable value. As a result, all of the alternatives are required to pass 1,000 cfs with the remaining 400 cfs being supplied by the valve room piping system.

3.6.4.2 Fishlock Approach Channel

The hydraulic evaluation of the fishlock approach channel was required to determine the maximum discharge capacity of the connection between the fishlock approach channel and the AWS. Discharge would essentially flow in the reverse direction when compared to the original design. There are four diffuser systems connecting the fishlock approach channel to the AWS. The analysis of the existing system assumed that the diffusers and bubbler beams underneath the diffusers would be removed. Additional analyses were conducted to determine options that would increase the discharge capacity of the connection.

For the existing system, an EPANET numerical model was developed from the fishlock approach channel upstream of the four diffusers to the main AWS conduit. EPANET was developed for pressure systems with round pipes; therefore, the program requires an input diameter for the size of the pipe. Since the AWS system includes rectangular conduits, the equivalent hydraulic diameter of the various rectangular conduits was used in the model. Use of the hydraulic diameter instead of actual conduit area results in smaller areas than exist in the rectangular conduit and is appropriate in a pipe system where friction losses dominate. For this application, minor losses are not the dominant losses; however, using the hydraulic diameter in the computations results in higher velocities than actually exist in the rectangular conduits; and, therefore, provides the most conservative estimate of capacity. There are other limitations with a one-dimensional model applied to this type of analysis; however, other types of models were considered beyond the scope for this preliminary analysis.

To obtain the maximum discharge possible through the existing system, a water surface elevation of 109 feet, msl was used in the fishlock approach channel. This assumes that the fishlock approach channel water surface has 1 foot of freeboard from the top of the channel wall; and, it assumes a water surface elevation of approximately 110 feet, msl in the fishlock. The opening between the fishlock and approach channel has an area of approximately 350 $feet^2$, and the head loss associated with the constriction is minor. Along the fishlock approach channel, the head loss was considered to be negligible due to the large cross-section area of the fishlock approach channel and low velocities (less than 2 fps). At the downstream end of the fishlock approach channel (downstream for this operation versus original design), the fishlock approach diffuser system and the main AWS conduit are connected by an 8-foot by 8-foot AWS concrete ‘culvert’. Each of the four diffusers includes two constrictions that restrict the discharge capacity of this system. There is a typical diffuser chimney section that includes a 4-foot by 4-foot gate opening constriction as well as a 2-foot by 14-foot opening between the diffuser chamber and the diffuser chimney.

The minor losses included contractions, expansions, bends, combining flow, exit, and others. The AWS conduit systems include components that require the application of minor loss coefficient estimates based on standard and well documented components found in water distribution systems. Several references were used for the minor loss coefficients including 'Internal Flow Systems', D.S. Miller; USACE EM110-2-1602; 'Handbook of Hydraulics', Brater and King; and 'Mechanics of Fluids', Potter and Wiggert. A Darcy-Weisbach roughness coefficient (e) of 1 millifeet (0.001 feet) was used for the concrete conduits. The upstream node of the EPANET model represented the fishlock approach channel. The system includes four branches to represent the four diffuser connections. The branches merge in the manifold conduit upstream of the 8-foot by 8-foot AWS concrete ‘culvert’. The model extended to the main AWS conduit that was represented by a reservoir with a water surface elevation 5 feet above the tailwater elevation.

The 8-foot by 8-foot culvert discharges into the AWS at a location where the cross-sectional area is 600 $feet^2$ with around 30 feet of water depth. In future analyses, potential issues with turbulence and surging in this chamber should be evaluated; however, 3-dimensional modeling would be required to adequately evaluate this area. Sensitivity analyses were conducted to evaluate the impact of additional losses associated with baffles or other type of energy dissipation structure.

Due to the original design purpose of the fishlock approach channel/AWS connection, the existing system includes multiple constrictions and losses. As a result, the overall discharge capacity is estimated to be approximately 1,000 cfs for a fishlock approach channel water surface elevation of 109 feet, msl. Sensitivity analyses were conducted on the minor loss and friction values; however, the total discharge capacity was still well below the 1,400 cfs requirement. An 8-foot by 8-foot conduit directly connecting the AWS and fishlock approach channel would have a maximum discharge capacity of about 2,500 cfs based on an upstream water surface elevation of 109 feet, msl and a downstream pressure grade line of 85 feet. Therefore, the culvert is not a restriction in the system. Other constrictions were also evaluated to determine if improvements could be made to increase the discharge capacity of the system.

Since the 1,400 cfs discharge requirement would not be met with the existing fishlock approach channel, modifications to the system were evaluated in an attempt to provide a higher discharge. The two modifications considered included the following:

1. Pressurize the fishlock approach channel.
2. Remove the diffuser chimney constrictions (Sheet 17).

3.6.4.3 Pressurize Fishlock

For this option, a trial and error approach was used to determine the pressure grade line that would provide the required head to discharge 1,400 cfs through the fishlock channel/AWS connection. For this evaluation, a pressure grade line upstream approximately 128 feet was required to pass 1,400 cfs through the system. Such a high pressure elevation would decrease the capacity of proposed Alternatives 1, 2, and 11 to supply the fishlock

3.6.4.4 Remove Diffuser Chimney Constrictions

This option included removing the four diffuser chimney constrictions. The EPANET model was modified to represent an option where the diffuser chimneys are completely removed. Due to the one-dimensional nature of EPANET and the difficulty in estimating losses associated with AWS systems where the types of losses encountered are not readily available in references, there is some uncertainty associated with estimating an exact discharge; however, based on this preliminary analysis, a discharge on the order of 1,400 cfs appears to be possible. Future analyses would require CFD modeling since the one-dimensional EPANET model and loss estimates are only approximations, and this type of modification would be a major structural change to the system that requires evaluation in a detailed hydraulic model prior to detailed design.

3.6.5 Mechanical Design

Mechanical Design is not applicable.

3.6.6 Structural Design

Structurally, portions of the four gates, frames, and shaft walls will be removed to accommodate the additional water to the 8-foot by 8-foot concrete conduit. No additional structural modifications will be required.

3.6.7 Electrical Evaluation

Electrical Evaluation is not applicable.

3.6.8 Cost Evaluation

Improvements to the fishlock, valve room, and approach channel will require concrete demolition and some reconstruction, and replacement and some demolition in the valve room. The estimated construction cost for the fishlock, valve room, and approach channel options is $817,000. The cost estimate has attempted to take in to account all cost associated with this type of work when selecting appropriate unit costs. The cost per unit and source of the estimate are shown on the backup data provided in Appendix G.

3.6.9 Constructability

The fishlock approach channel can be de-watered and the demolition of the concrete for the gates and frames can be completed in the dry.

3.7 Equalizing Headers and Pipe System Improvements

3.7.1 Description of Improvements Existing Equalizing Headers and Pipe System

3.7.2 Hydraulic Evaluation

3.7.2.1 System Description

The improvements to the equalizing headers and pipe system would utilize the scroll case fill lines as a water supply source to the AWS. The scroll case fill line is used during the start-up of a unit that has been drained to equalize head on the bulkheads before the unit is placed back into operation. The scroll case fill line connects to a 24-inch diameter steel equalizer header pipe that runs in a gallery along a section of units of the powerhouse. The equalizer header system is split into three sections including Units 1-8, Units 9-14, and Units 15-22. For Units 1-14, this system was also designed to operate as an AWS and fish ladder fill line to provide additional filling capacity when the AWS and fish ladder have been drained for maintenance. As a result, the possibility of utilizing this existing system to supplement the Emergency Auxiliary Water Supply (EAWS) water is under consideration by the USACE. By utilizing this AWS fill line source from the scroll case, essentially the full reservoir head would be available to drive flow into the AWS through a series of existing pipes. For Units 15-22, blind flanges were included in several locations; however, the fish ladder drain and fill system was never installed. Therefore, this alternative is currently applicable to only Units 1-14.

The scroll case equalizer pipe system is connected to the fish ladder system via drain lines and fill pipe connections. The fish collection channel and the AWS conduit along the powerhouse include drains that are used when the system is dewatered. These drains connect into the main powerhouse sump system; however, there are also fill pipe connections that connect each powerhouse collection channel, diffuser chamber, and AWS drain to the equalizer header pipe and subsequently the scroll case fill line. The AWS and diffuser chamber fill pipe connections could be used to discharge flow from the scroll case fill inlet line to the AWS system.

Figure 5 shows a cross-section view of a unit and a simplified representation of the connection between the scroll case header and the AWS.

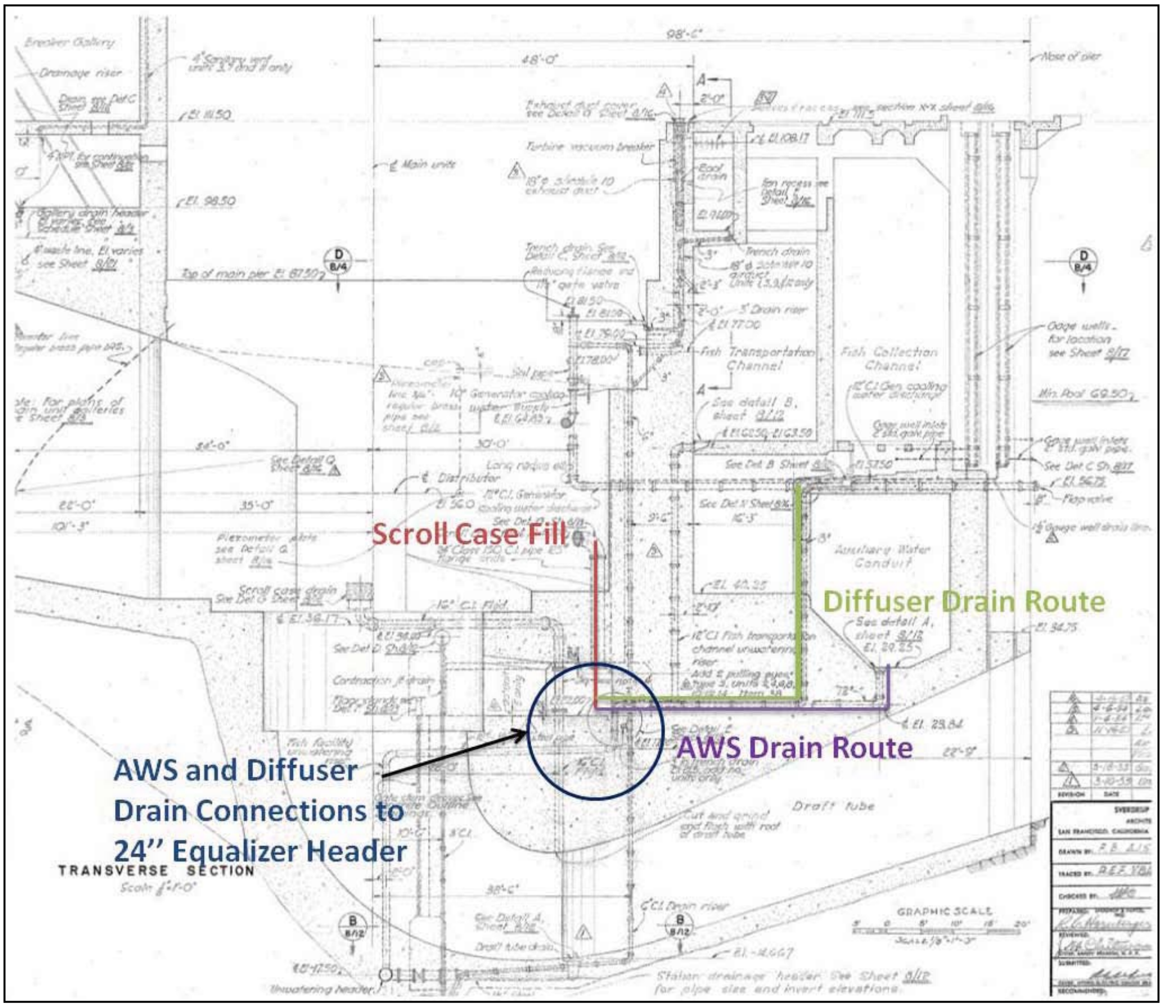

Figure 5. Schematic of Scroll Case Fill Line and AWS Connection

Figure 6 shows the AWS 12-inch diameter drain pipe, 6-inch diameter fill line pipe, and 24-inch diameter scroll case equalizer header pipe.

Figure 6. AWS Drain and Equalizer Header Pipe Connection

The diffuser chamber drain pipe system is very similar to the AWS drain system with the exception of the fill pipe connection and drain diameters. The diffuser chamber drain is connected to the equalizer pipe by a 4-inch diameter connection rather than a 6-inch diameter connection; and, the diffuser chamber drain line from the diffuser chamber is 8 inches in diameter instead of 12 inches in diameter and includes slightly different minor losses and pipe lengths.

Figure 7 shows the diffuser chamber drain system piping.

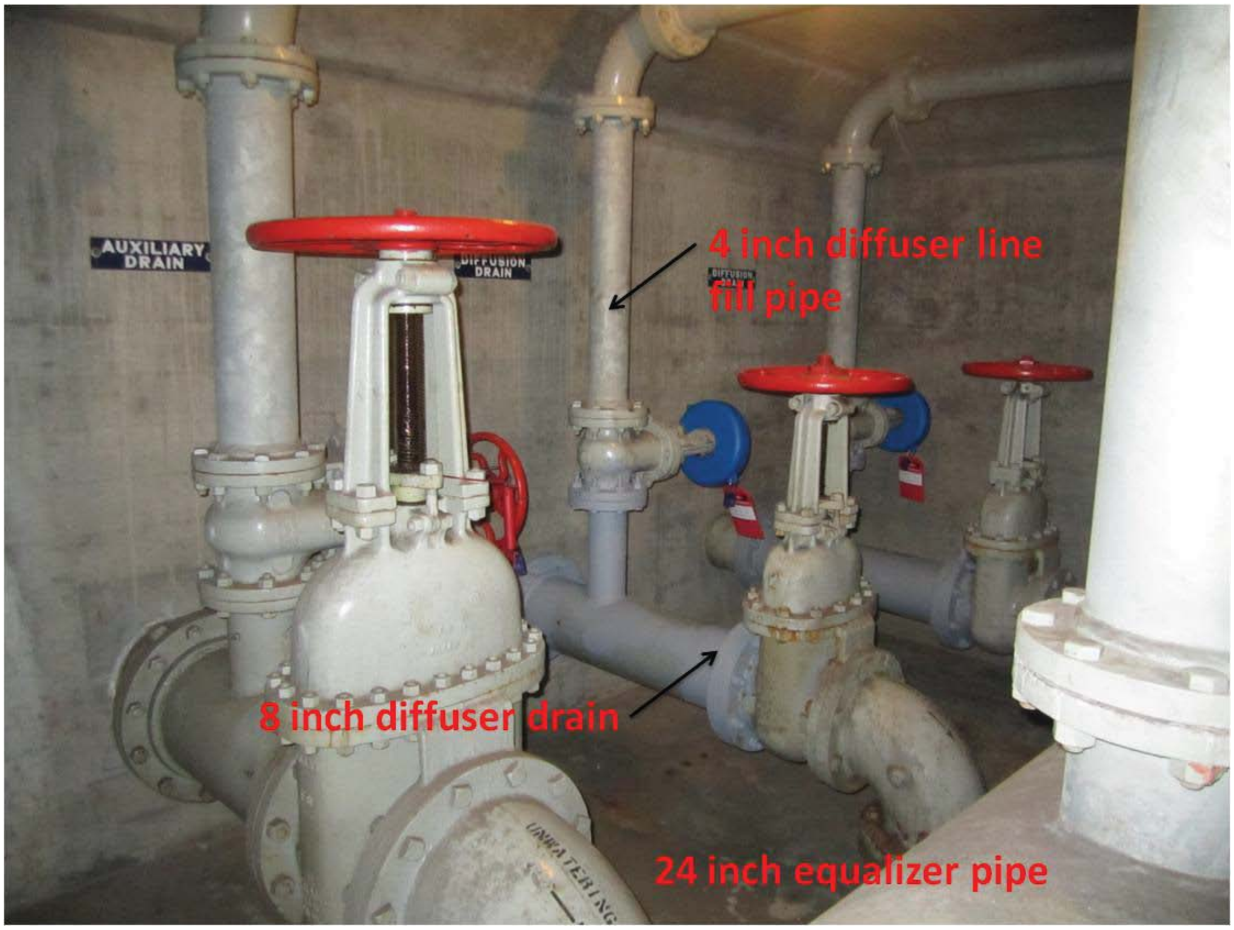

Figure 7. Diffuser Drain and Equalizer Header Pipe Connection

3.7.2.2 Assumptions

To simplify the hydraulic review and calculations, several assumptions were made as documented below.

1. Each drain connection was considered as an isolated pipeline to facilitate the calculations for the preliminary hydraulic review.

    a. Flow distribution and friction loss along the 24-inch diameter equalizer header pipe and variations in the head along the main AWS were not taken into account. This simplification results in a somewhat conservative (high) estimate of discharge in each drain. In reality, the equalizer header pipe would act as a manifold system supplying flow to the various drains. Likewise, the AWS pressure grade line varies slightly along the powerhouse; however, the differential was considered insignificant at this level of detail.

b. Flow in the scroll case fill line and equalizer header pipe will increase as multiple drains are operated at once. Since the pipe is 24 inches with relatively low velocities even with multiple drains operating, analyzing each drain line separately was still considered to be appropriate.

2. At the inlet to the scroll case fill line, the full normal forebay of 160 feet was used (i.e., assumed no energy loss between the reservoir and fill line entrance to scroll case).

3. An average tailwater elevation of 80 feet, msl was used; and, at the AWS input location, a pressure gradeline of 85 feet was assumed.

4. No modifications were made to the existing pipe sizes or layouts to optimize the system. As a result, this system was only applied to Units 1-14 since the drain system was never completed in Units 15-22.

5. This preliminary analysis did not consider transient or other hydraulic phenomena that could occur.

6. Absolute roughness of pipes ('k' value) estimates assumed mid-range of new steel pipe and steel water mains with general tuberculations (Miller, 1990).

3.7.2.3 Hydraulic Analysis

The discharge estimate was calculated using two simple Mathcad programs developed for the AWS drain line and the diffuser drain line (Appendix B). As noted previously, losses in the equalizer header pipe and connections were neglected which will make some difference in the flow distribution; however, this simplified method of evaluating one line at a time was considered to be acceptable for this level of detail. The system between the scroll case fill line inlet location and the AWS was divided into three sections including the following:

1. 25-foot long, 24-inch diameter scroll case fill pipe.

2. 15-foot long, 6-inch diameter fill pipe for AWS line and 4-inch diameter fill pipe for diffuser line.

3. 40-foot long, 12-inch diameter drain pipe for AWS line and 60-foot long, 8-inch diameter drain pipe for diffuser line.

The minor losses between the scroll case inlet location and AWS included valves, 90-degree bends, expansions, contractions, inlet, exit, and friction losses. The minor losses, friction values, and pipe lengths used in this analysis are only approximations. If this alternative is pursued in detail, the losses would be refined in more detail. Multiple references including 'Internal Flow Systems' (Miller, 1990) and EM 1110-2-1602 'Hydraulic Design of Reservoir Outlet Works' were used to estimate minor losses.

Based on the initial calculations, the discharge estimates for a typical AWS and diffuser drain are 5.3 cfs and 2.0 cfs, respectively. If these estimates are multiplied by the number of drain lines available in Units 1-14 (7 AWS drain lines and 14 diffuser drain lines), the total estimated discharge for this alternative is on the order of 65 cfs. With the 5.3 cfs estimate for the 6-inch fill pipe associated with the AWS drain system, the velocities in the 6-inch diameter pipe would exceed 27 fps. This velocity exceeds the pipe velocity design criterion and could result in damage to components of the existing system such as gate valve seats. Appendix B contains the Mathcad files and provides the calculations used to develop the discharge and velocity estimates.

Sensitivity analyses were conducted by varying the valve loss coefficients, AWS pressure elevation, and pipe friction factor. For all of the sensitivity analyses conducted (using reasonable losses), the discharge varied at the most by 0.5 cfs per drain. As an overall check on the discharge estimates, a simplified computation was made assuming the scroll case was connected directly to the AWS via a 15-foot long, 6-inch diameter pipe (i.e., simulating the existing 6-inch diameter connection between the 24-inch diameter equalizer header and 12-inch diameter drain line). For this condition, the computed discharge per drain was about 8.6 cfs. In other words, with the losses in all valves, the 24-inch diameter fill pipe, the 12-inch diameter drain pipe, and associated connections neglected, the maximum possible discharge per drain is 8.6 cfs. Based on this very simplistic check, the computed 5.3 cfs per drain estimate is considered reasonable.

As a potential improvement to the existing system, an analysis was completed to determine the increased capacity of the system if the 6-inch and 4-inch drain pipe constrictions are replaced with larger diameter pipes. With the 6-inch pipe constriction replaced with a 12-inch pipe, the capacity for a typical AWS drain would be 18 cfs. With the 4-inch pipe constriction replaced with an 8-inch pipe, the capacity for a typical AWS drain would be 7 cfs. If these estimates are multiplied by the number of drain lines available in Units 1-14, the total estimated discharge for this alternative is on the order of 224 cfs. Although the smallest diameter pipes would be replaced with these modifications, the velocities would still exceed 20 fps in both systems.

There are several items that would need to be investigated in detail should this alternative be pursued.

- A network model connecting the multiple drains and equalizer header pipe would need to be developed. There would likely be additional head losses due to friction and the multiple connections from the equalizer header pipe as flow is distributed along the manifold-type system. In addition, there would be minor differences in the AWS hydraulic grade line along the powerhouse that would need to be taken into account.
- If this option was pursued, additional modifications to the piping system as described above could be considered that would reduce losses and subsequently increase the flow.
- Potential issues associated with the high velocities in the 4-inch and 6-inch diameter fill pipes should be investigated and addressed.

3.7.3 Summary Discussion

The potential EAWS supplemental discharge that could be obtained utilizing the existing piping/drain arrangement is approximately 65 cfs based on the initial review. As noted, several assumptions were made in this estimate and a more detailed analysis is recommended if this alternative is pursued as a potential water supply source for the EAWS.

4.0 EVALUATION OF ALTERNATIVES TAKEN TO 60% DESIGN LEVEL

4.1 Introduction

Per guidance from the USACE, at the 60% design level, all four alternatives evaluated during the initial phase of the study were to be ranked and compared with each other. The top two alternatives that appear to have the most merit would then be taken to the 90% design level. The evaluation of alternatives not selected would cease. Evaluation factors consisted of the following and are detailed in Section 4.2:

- Constructability
- Ease of Operations
- Maintenance Requirements
- Biological Impacts
- Impact to Existing Facility
- Expected Reliability
- Construction Cost (included in evaluation but not scored)
- Operational Cost (included in evaluation but not scored)
- Maintenance Cost (included in evaluation but not scored)

With the exception of construction, operational, maintenance cost, all evaluation factors were given a ranking score between 1 and 4, with 1 being a nonfavorable score and 4 being a highly favorable score. The composite scores displayed in Table 11 represent the average score of HDR's PDT. A total of ten team members participated in the evaluation and scoring process. Table 11 also displays the results of the ranking and scoring evaluation, and cost information. Sections 4.3 thru 4.6 provide a summary discussion of each alternative.

a le 11. e Dalles E L S ac up lternatives an ing Matri

Alternatives		Ranked Items						Total Score	Ranking	Cost(s)				Total Costs
o.	Description	Constructa ilit	Ease o Operations	Maintenance e uire ents	iological I pacts	I pact to E isting acilit	E pected elia ilit			Construction	Operational	Maintenance	Valve oo I prove ents	
1	**Siphon for Additional Water to the Fishlock**	2.5	3	2.5	2	4	3.5	**17.5**	**2**	$4,771,220	$48,195	$238,000	$817,256	**$5,874,671**
2	**Low Level Intake**	3	4	3.5	2.5	2.5	4	**19.5**	**1**	$4,151,543	$48,195	$238,000	$817,256	**$5,254,994**
10	**Single Pump/Pump House on East Side of Cul-de-sac Area**	2	3	0.5	1	2	1.5	**10**	**4**	$22,208,230	$207,803	$1,958,400	$817,256	**$25,191,689**
11	**Intake Tower with Siphon to Fishlock**	2.5	3	2.5	2	3.5	3.5	**17**	**3**	$3,826,139	$48,195	$238,000	$817,256	**$4,929,590**

Matrix Assumptions:
1. Score: Poor = 1; Fair = 2; Good = 3; Excellent =4
2. Title for alternative numbers taken from Brainstorming Session
3. Operational Costs assume 1 year for operation
4. Maintenance Costs for 50 years.
5. Start up time for all alternatives is less than 24 hours, therefore this item was not included in the ranking system.
6. If more than one alternative has the same Ranking Score, higher ranking given to alternative with lowest Cost.

Note(s):
* Operational costs for Alternative 10 do not include electrical costs for operating the pump.
** Valve Room Improvements are the same for all alternatives

4.2 Matrix Evaluation Factors

This section describes the evaluation factors that were listed in Section 4.1 of this report.

Constructability: evaluation factors considered the overall difficulty or ease of constructing the alternative. If components need to be fabricated in smaller manageable parts and then assembled in place to make a larger component, this received a relatively low score (1-2). Whereas, if the major components of the alternative could be installed or assembled in one or two pieces, it received a higher ranking score (3-4).

Ease of Operations: evaluation factors were based on the overall ease to operate the backup system. For example, if the alternative had multiple complicated steps, required numerous USACE staff to implement the emergency backup system, and needed to be monitored on a continual basis, it received a low ranking score when compared to an alternative that could be activated in one step by very few USACE staff and would require little or no monitoring and adjustments.

Maintenance Requirements: evaluation factors considered the overall maintenance of the alternative. For example, if a hydraulic controller system was to be continually submerged or needed to be inspected weekly, it received a low ranking score. But, an alternative that had yearly maintenance or components that were simple to maintain, received a high ranking score.

Biological Impacts: evaluation factors were based on the ability of the alternative to keep the EFL system within compliance and meet fish passage criteria while, at the same time, minimizing negative effects on fish in the Columbia River. Some of the factors that were considered pertained to locations of juvenile salmonids, lamprey, and white sturgeon in the reservoir and water column, the ability of entrained fish to survive in the diversion system, and the overall induced stress to fish. Effects of construction and operation on adult salmonids, lamprey, and white sturgeon were also considered.

Impact to Existing Facilities: evaluation factors that were considered but not necessarily inclusive included requirements for additional manpower needed to maintain and start the system, accessibility to the different components (valves and piping), impact to normal operations, physical impacts to the area, cost of utilities, etc.

Expected Reliability: This factor takes into account how dependable the alternative will perform and obtaining overall performance objectives. The overall complexity of the alternative is included in the reliability.

Construction Cost was considered in the overall evaluation of each alternative, but did not receive a ranking score. Each alternative has a write-up that describes the methodology and assumptions used.

Operational Cost was considered in the overall evaluation of each alternative, but did not receive a ranking score. Each alternative has a write-up that describes the methodology and assumptions used.

Maintenance Cost was considered in the overall evaluation of each alternative, but did not receive a ranking score. Each alternative has a write-up that describes the methodology and assumptions used.

4.3 Evaluation of Alternative #1—Siphon for Additional Water to the Fishlock

Alternative #1 has an overall score of 15.5, which would rank this alternative in second place. Constructability and Ease of operation were scored as "fair to good." This alternative would be somewhat difficult to construct because of the existing infrastructure (as would most of the alternatives). Impacts to the existing structure would be low which resulted in an "excellent" score of 4 points.

This alternative was scored as fair for biological impacts. Entrainment of juvenile salmonids and lamprey into the siphon pipes is possible, especially for juvenile salmonids approaching the dam near the south shore of the Columbia River.

The overall construction cost of this alternative would be approximately $4,771,000.

Construction could be classified as "fair to good" due to confined space issues and potentially could take several construction seasons to complete because of in-water work period constraints.

4.4 Evaluation of Alternative #2 – Low Level Intake

Alternative #2 has an overall score of 17, which would place this alternative as the highest ranked alternative. Constructability and Ease of Operation were scored as "good to excellent." This alternative would be relatively easy to construct because of the layout of the proposed alternative features. Impacts to the existing structure would be "fair to good" which resulted in a score of 2.5 points.

This alternative was rated between "fair and good" for biological impacts. Entrainment of juvenile white sturgeon and lamprey into the pipes is possible; however, entrainment levels would likely be low.

The overall construction cost of this alternative would be approximately $4,152,000.

Construction could be classified as "good" and potentially could take several construction seasons to complete because of in-water work period constraints.

4.5 Evaluation of Alternative #10 – Single Pump/Pump house on East Side of Cul-de-sac

Alternative #10 has an overall score of 10.5, which would rank this alternative in fourth place. Constructability was scored at 3; a "good" rating and Ease of operation were scored as 2.5, "fair to good." This alternative would be relatively easy to construct because of the layout of the proposed alternative features. Impacts to the existing structure would be classified as "fair" which resulted in a score of 2 points.

Maintenance requirements for this alternative would be high which is reflected in a rating "poor" and a score of 1.0 points.

The overall construction cost of this alternative would be approximately $22,208,000.

Construction could be classified as "good" and potentially could take several construction seasons to complete because of in-water work period constraints.

This alternative was scored as "poor" for biological considerations. Construction, placement, and operation in the cul-de-sac may disrupt adult white sturgeon, which congregate in the area during winter months. The supporting structures may also attract non-native predatory fish in the tailrace. Operations could entrain juvenile salmonids that have already migrated from the forebay to the tailrace.

4.6 Evaluation of Alternative #11 –Intake Tower with Siphon

Alternative #11 has an overall score of 15, which would rank this alternative in third place. Constructability has a score of 2.5 points ("fair to good") and Ease of operation was scored at 3.0, a rating of "good."

This alternative was scored as "fair" for biological impacts. Potential effects are similar to those for Alternatives #1 and #2 (entrainment of juvenile fish), although few juvenile salmonids would likely be entrained. In addition, the structure may attract non-native predatory fish in the forebay.

The overall construction cost of this alternative would be approximately $3,826,000.

Construction could be classified as "fair to good" due to confined space issues and potentially could take several construction seasons to complete because of in-water work period constraints.

4.7 Discussion of Selected Alternatives

Based on the evaluation factors developed for the alternatives under consideration, final matrix scores (Table 11), cost considerations, HDR PDT team meetings, meetings with USACE PDT team, Alternatives #2 and #11 have been selected as the alternatives that will be carried forward to the 90% design level as well as the improvements to fishlock, valve room, and approach channel. Minutes from these meetings are provided in Appendix H.

The following alternatives will be evaluated in more detail:

- Alternative #2 – Low Level Intake
- Alternative #11 – Intake Tower with Siphon to Fishlock
- Improvements to Fishlock, Valve Room, and Approach Channel

5.0 SELECTED ALTERNATIVES TAKEN TO 90% DESIGN LEVEL

5.1 Alternative #2 – Low Level Intake

This alternative proposes the use of two, 72-inch steel pipes that will convey water from the forebay to the existing fishlock. The fishlock will then discharge into the approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. The pipes will be sized for approximately 1,000 cfs. Improvements to the existing piping systems in the valve room will provide an additional flow of about 400 cfs, for a combined flow of 1,400 cfs.

Sheets 21-35 have been prepared for the 90% EDR submittal and reflect review comments and meeting discussions since the 60% EDR submittal. Sheet 21 and Sheet 23 through Sheet 25 display the plan layout of the alternative and its major features.

Changes to the 60 % design are as follows:

- At the intake for each pipe, a double bulkhead has been added, one of the bulkheads will serve as an emergency closure structure,
- Replace two downstream emergency closure gate valves with an emergency bulkhead,
- Re-design of trashrack enclosure structure,
- Five trashracks 11 feet -6 inches by 16 feet -0 inches are be proposed, the former design had six trashracks,
- Mechanical trash rakes will be used for debris removal, formerly an airburst system was proposed,
- Concrete thrust block and pipe support added,
- Minor adjustments to overall alignment of the pipes, and
- Addition of flow measurement equipment.

The preliminary design of each pipe has a discharge capacity of about 760 cfs, for total combined capacity of about 1,520 cfs. A downstream flow control valve on each pipe would be used to limit the velocities in the pipes and discharge into the fishlock. Further engineering will be required in the next phase of the study if this alternative is selected.

The invert elevation of the intake trashrack is 104.0 feet, msl, the invert elevation for each pipe is at 111.5 feet, msl, and the invert of the discharge outlet pipes at the fishlock are at elevation 111.5 feet, msl.

Trashracks with ¾-inch spacing will be provided at the upstream intake. Bulkheads will be attached to the upstream face of the dam at the entrance to each pipe to keep the system in a "dewatered" mode when not in operation. A crane will be needed to lower and raise the bulkheads. It is assumed that the trashrack enclosure will be attached by divers.

5.1.1 Biological Considerations

Alternative #2 received the highest rating (between "fair and good") for biological impacts. None of the changes to the design summarized above will result in substantial changes to these potential impacts. A low-level intake has the potential to entrain juvenile white sturgeon and larval lamprey; however, if substrate is primarily bedrock, as expected, abundance of lamprey should be low. Furthermore, the intake will be located about 10 feet off the bottom, but still 50 feet below the lake level, further reducing the likelihood of entraining juvenile white sturgeon and larval lamprey.

The intake also has the possibility of entraining juvenile salmonids, especially as it has been located off the bottom. Juvenile salmonids may be located throughout the water column, however, the overwhelming majority are usually found in the upper portions of the water column (Faber et al. 2005). Therefore, levels of entrainment of juvenile salmonids will likely be very low.

5.1.2 Hydraulic Design

Due to the minor changes made from the 60%, the hydraulics of the system were not re-evaluated. Minor changes in the alignment would have negligible impact on the hydraulics based on sensitivity analyses conducted during the 60% design. In future phases of the project, the pipe size should be confirmed after the final valve selection is made and loss coefficients from the manufacturer are obtained.

5.1.3 Mechanical Design

Due to the addition of isolation bulkheads on the upstream side of the dam, the isolation gate valves were removed from this alternative. This alternative is currently showing the use of jet flow valves for controlling the flow of the system. This is one of several available valve types that can be used for this application. Final valve selection will be determined during final design.

The trashrack cleaning system has been changed from an airburst system to a mechanical trash rake system. The mechanical trash rake system will be supported off of the dam and operated on a rail that will allow the rake system to move along the trashracks. The debris removed by the mechanical rake system will not be physically removed from the water. It is assumed that sufficient cross velocity is available to sweep debris away from the trashrack after it has been dislodged by the mechanical rake. This will be verified later via velocity measurement at the location and depth of the intake.

Another addition to this alternative is the installation of strap-on ultrasonic flow meters in the valve room pipes. Accurate flow measurement is needed to facilitate system startup and ensure the system is providing adequate flow.

.1.4 Structural Design

Two, 72-inch diameter steel pipes will be placed through monolith number 5 of the non-overflow section of the dam. It is assumed that for the method of coring or mining through the concrete dam, the contractor will select one of these options. For both methods, the steel pipes will be fully grouted in place. The size of the tunnel boring machine is 84 inches in diameter which will leave 6 inches of grout around the pipe. The invert elevations of the pipes are 111.5 feet, msl and they will run horizontal to the fishlock. The pipes will be supported on two concrete pipe saddles (Sheet 24). A thrust will be needed at the change in direction at the jet flow valves.

There is one trashrack steel enclosure slightly over 66 feet long attached to the upstream face of the dam using 1-inch diameter stainless steel undercut anchors. This enclosure will hold five trashrack panels. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spacing between the bars. All panels are 11 feet 6 inches wide by 16 feet tall. The vertical bars are welded to three horizontal members that are welded to vertical 6 by 6 angles. All members are welded. The trashrack panels are bolted to the steel enclosure and can be removed if needed. The 1-inch vertical bars were designed for a 5-foot head differential per EM 1110-2-3104. A vibrational analysis of the vertical members was not completed for this level of design.

There are two bulkheads for each pipe inlet. One will be used as an emergency bulkhead and the other is used when the AWS is not in use. The dual bulkheads for each pipe outlet slide down into the enclosures on guide rails. When the AWS system is called into operation, one bulkhead is lowered while the emergency bulkhead is locked into place out of the way. The invert elevation of the trashracks is 102.5 feet, msl.

.1. Electrical Evaluation

A new 480-volt motor control center (FCQ9) is proposed to be installed outdoors near the fishlock approach channel. The new unit substation described in the 60% level design to feed power to the FCQ9 has been removed. Instead, power for the FCQ9 will be provided from existing unit substation FSQ6, which is located in the powerhouse near the main turbine unit #22. A new 150-Amp, 3-pole circuit breaker is proposed to be installed in FSQ6 to supply 480-volt power to the new FCQ9. The motor control center will include an enclosure suitable for outdoor locations.

Motor control center FCQ9 will be used to provide power to the bulkhead crane, hydraulic power units and debris cleaning system as shown in the electrical one-line diagram on Sheet 34. FCQ9 will also include a transformer and panelboard to supply power for convenience receptacles, lighting, and heating loads.

A control panel with a programmable logic controller is proposed to provide automatic controls and monitoring capabilities of the new equipment as required. The programmable logic controller will be connected to the existing fiber optic network to allow remote monitoring of the equipment.

There is existing electrical equipment and electrical conduits near the fishlock (see Figure 8) 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.

Figure 8: Electrical Equipment near Fishlock

5.1.6 Cost Evaluation

A conceptual level Total Project Cost estimate has been developed for this alternative. Costs presented were effective price levels as of March 2012. Cost data is based on estimates from vendors, fabricators, contractors, and other projects in the Pacific Northwest. The estimates contain contractor markups and contingencies. Contingency amounts were established based on an Abbreviated Risk Analysis (see guidance at www.nww.usace.army/mil/html/OFFICES/ED/C/default.asp). Cost estimates were developed using Micro Computer Aided Cost Estimating System (MCACES) MII. The cost estimates conforms to USACE publications ER 1110-2-1150, Engineering and Design for Civil Works Projects; ER 1110-2-1302, Civil Works Cost Engineering; and ETL1110-2-573 Engineering and Design: Construction Cost Estimating Guide for Civil Works. The MII cost sheets and the abbreviated risk analysis sheets are contained in Appendix G. The cost estimate for Alternative #2 also includes the cost for the modifications to the valve room, fishlock, and approach channel. The estimate assumes:

- Procurement will be with a standard Design Bid Build contract, and that the contract will be awarded 1 July 2014 with construction completed in 365 days.
- Alternative #2 will require mining or drilling for two, 72-inch steel pipes through the east non-overflow structure and fishlock, and fabrication of upstream bulkheads and trashrack structures.
- 84 inch diameter bored tunnels are assumed for the pipes through the non-overflow structure. Mined 84 inch holes through reinforced concrete are assumed for the pipes into the fishlock.

- A cofferdam or the bulkhead structure will be constructed during the in-water work period and will require divers to perform the in-water work.
- The bulkhead structure will be in place before mining begins.
- The mining will be performed from the downstream elevation 111.5-foot bench.
- A crane will be able to operate from the roadway on top of the dam.

The estimated construction cost for Alternative #2 including contingency is approximately $10,304,000 which includes approximately $3,626,000 for modifications to the valve room and fishlock approach channel. The Total Project Cost (fully funded) was computed to be approximately $16,588,000. O&M costs for this alternative are not included in the Total Project Cost. The life cycle cost for O&M was computed to be approximately $2,937,000 over the 50-year project life. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and source of the estimate are shown on the backup data provided in Appendix G. Cost increases over the 60% estimate are the result of design changes to the intake trashrack/bulkhead structure, valves, and a more refined evaluation of required construction.

5.1.7 Constructability

The low level intake alternative will require boring or mining openings for two, 72-inch diameter steel pipes through the east non-overflow structure. The borings will be made at an invert elevation of approximately 111.5 feet, msl from the downstream roadway and parking area which is at elevation 111.5 feet, msl (Sheet 24). The excavation will require installation of the bulkhead structures or a cofferdam bolted on the upstream face of the dam. It is assumed that most work can be performed from the downstream elevation 111.5 feet, msl roadway or from the roadway on the top of the dam. Installation of the cofferdam and trashracks will require divers working from a dive barge. The valves and pipes are commercially available but typically require lead time for fabrication. Northwest contractors have been identified that have indicated they can perform the pipe boring and grouting operations. It is assumed that this alternative can be constructed in a single year, but only if the contractor has several months lead time prior to the in-water work period (1 December through 28 February) to fabricate the trashrack/bulkhead structure.

5.2 Alternative #11 – Intake Tower with Siphon to Fishlock

This alternative requires two, 72-inch siphon pipes that will convey water from an upstream intake tower with low level inlet openings. Water will be routed to the existing fishlock. The fishlock will then discharge into the fishway approach channel (no longer in use) which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool. Flow through the culvert (8 feet x 8 feet) goes to the AWC and through diffusers before entering the junction pool, ladder, and east entrance. Sheet 22 and Sheet 26 display the general plan layout and flow path for this alternative.

The siphon pipes will be sized for approximately 1,000 cfs. Proposed improvements to the existing piping systems in the “valve room” will provide about 400 cfs, for a combined flow of 1,400 cfs. Sheet 27 through Sheet 29 show the pipe layout sectional view for this alternative. The piping geometry from elevation 120.0 feet, msl in the fishlock through the dam monolith is the exact same configuration as Alternative #1.

Changes to the 60 % design are as follows:

- The intake tower structure has had a significant re-design; it is now more of a trapezoidal shape,
- The intake structure will be pre-cast concrete sections that will be lowered into place and post-tensioned to the rock,
- A concrete maintenance platform and wall has been added for the upstream gate valves that are located in the intake tower,
- Better access and a floor for maintenance of the jet flow valves in the fishlock have been added,
- The elevation of the jet flow valves has changed to elevation 140.0 feet,
- Most, if not all, of the existing buildings and mechanical equipment located on the top deck of the fishlock will be demolished,
- Mechanical trash rakes will be used to control and remove debris on the trashracks,
- The 90% design has five trashracks; the 60% design had six trashracks,
- The capacity of the siphon fill pumps has been slightly adjusted, and
- Addition of flow measurement.

The siphons will be primed by pumps prior to the beginning of operation. An upstream gate valve at elevation 150.0 feet, msl will be provided for priming purposes. Downstream jet flow valves in the fishlock at elevation 140.0 feet, msl will be used for flow control. The design will include small pumps used to fill the pipes that will prime the siphons. The operation of the upstream and downstream valves needs to open and close simultaneously to ensure initiation of the siphon action.

The invert elevation of the trashrack at the intake tower is at 100.0 feet, msl, the intake invert for the siphon is at elevation 134.0 feet msl, the crest invert elevation for the siphon pipes is at 161.0 feet, msl and the invert elevation of the discharge outlet pipes is at 120.0 feet, msl, which is located in the fishlock. This proposed alternative is designed to function over the range of the normal operating pool limits of 160.0 to 155.0 feet, msl.

The proposed design calls for five flat rectangular trashrack openings at the base of the intake tower. A mechanical rake cleaning system will be used to remove debris from the trashrack faces.

5.2.1 Biological Considerations

Alternative #11 was scored as “fair” for biological impacts, which places it slightly behind Alternative #2, the Low Level Intake. Because of the depth of the intake slots and therefore trashracks, potential effects such as entrainment of juvenile salmonids, juvenile white sturgeon, and larval lamprey are similar to those of Alternative 2; however, the intake tower has the additional potential effect of providing additional structure for predatory fish.

Reconfiguring the intake tower so that it is more trapezoidal in shape than the original design may decrease the effects on juvenile and larval fish. All trashracks will be oriented parallel to the flow, and therefore have sweeping velocities to better remove trash and lessen entrainment of fish.

5.2.2 Geotechnical Evaluation

The intake for this alternative will be founded on bedrock at about elevation 100 feet, msl. The rock in this area is hard sound Basalt with relatively high unconfined compressive strengths. The Dalles Foundation Report for the East Non-Overflow Structure shows the area to be within the more massive P unit (Appendix C). Based on information from The Dalles Spillwall construction, the rock is assumed to be suitable for support of the intake tower and for installation of rock anchors. The toe of the embankment dam is located 35 to 40 feet west of the intake location and will not be impacted by the structure. The above assumptions are based on available information. If this alternative is selected for construction it is recommended that the foundation area be investigated to confirm the elevation of the rock and to insure that there has been no significant amounts of sediments deposited post construction.

5.2.3 Hydraulic Design

Due to the minor changes made from the 60%, the hydraulics of the system were not re-evaluated. Minor changes in the alignment would have negligible impact on the hydraulics based on sensitivity analyses conducted during the 60% design. In future phases of the project, the pipe size should be confirmed after the final valve selection is made and loss coefficients from the manufacturer are obtained.

5.2.4 Mechanical Design

Two vertical turbine pumps will be provided to fill the siphon lines and will draw water from within the intake tower as shown on Sheet 29. The capacity of the pumps has been slightly adjusted based on the layout of the pumps and piping. The pumps will have a capacity of 600 gpm at a TDH of approximately 25 feet. This pump requires a 7.5-hp motor instead of a 10-hp motor as previous assumed.

Similar to Alternative #2, the trashrack cleaning system has been changed from an airburst system to a mechanical trash rake system. The mechanical trash rake system will be supported on the bottom by the concrete foundation pad and on the sides by precast concrete columns. It will operate on a rail that will allow the rake system to move along the trashracks. The debris removed by the mechanical rake system will not be physically removed from the water. It is assumed that sufficient cross velocity is available to sweep debris away from the trashrack after it has been dislodged by the mechanical rake. This assumption will be confirmed later during final design.

Like the previous alternative, strap-on ultrasonic flow meters will be installed to provide feedback on the flow rate during startup and operation.

5.2.5 Structural Design

A preliminary structural design was completed for Alternative #11. A trapezoidal shaped (in plan) precast concrete intake tower is used for siphoning water from the bottom of the trashrack opening at elevation 100.0 feet, msl. Two, 72-inch diameter steel siphon pipes will also be placed through a bored/mined section of Monolith number 7 of the non-overflow section of the dam. The method for coring through the dam will be contractor designed. For either construction method, the steel pipes will be fully grouted in place. Grouting the pipes will act as a thrust restraint for the change in direction of the pipes. Both siphon pipes will exit the intake tower at an invert elevation of 161.0 feet, msl at approximately Station 43+50. The pipes will enter the fishlock at approximately 110 degrees to the axis of the dam (and the parallel centerline of the fishlock). The average length of the pipes from elevation 134.0 feet, msl to the upstream face of the dam monolith is 165 feet. The pipes are supported at the intake tower wall at the East Fishway Exit Channel pier (Sta. 44+18.63). They enter just east of the Monolith Number 7 joint. Sheet 26 shows the piping layout in plan view and Sheet 27 shows sections. Sheet 28 shows the pipe support at the Fishway Channel Pier and Sheet 29 shows the plan and elevation of the intake tower and dimensions. There are five trashrack panels along one edge of the tower which are supported on the bottom by the concrete foundation pad and on the sides by precast concrete columns. The trashrack panels are sized using 1-inch vertical bars and ¾-inch spacing between the bars. All panels are 11 feet 6 inches wide by 16 feet tall. The vertical bars are welded to three horizontal members that are welded to vertical 6 by 6 angles. The angles are connected to embedded steel plates in the columns and can be removed. All trashrack members are welded. The 1-inch vertical bars were designed for the case when the trashrack is 50% covered by debris. A vibrational analysis of the vertical members was not completed for this level of preliminary design.

The concrete intake tower is 85 feet tall. The walls of the concrete intake tower are 2 feet by 6 inches thick. The panels have shear keys with male and female profiles for interlocking. It is assumed that the tower will not be dewatered so the walls were not designed for a differential pressure. See Sheet 29 for additional dimensions and elevations. The precast panels above the trashracks are 6 feet tall by a length sized for shipping. Lengths of panels will be chosen for the preferred method of shipping during final design. The 3-foot-thick foundation slab is cast-in-place concrete placed by tremie on bedrock. The panels are post-tensioned together using 1-inch, 150 ksi all-thread stainless steel rod with couplings at each 6-foot panel height. There are approximately 8 post-tensioned rods that will be embedded into the bedrock approximately 3 feet through the concrete foundation slab. Once all the sections are place, the all-thread rod is grouted for corrosion resistance. The top slab of the tower will also use precast elements to eliminate the cost of shoring a cast-in-place floor slab and the environmental issue of pouring concrete over the water. Six precast, post-tensioned beams will span from notches in the upstream face of the existing dam to fabricated notches in the last precast wall panel. The beams will be approximately 13 feet on center. Spanning the beams and outside walls there will be 6-inch deep by 48-inch wide prestressed hollow core slabs with a 2-inch topping. The slabs are designed for a minimum of 300 psf live load. There will be a removable waterproof section of slab above the two gate valves for maintenance. A 3-foot by 4-foot Bilco style hatch will provide access to the concrete maintenance platform at elevation 145.0 feet, msl. Inside the tower, the maintenance platform will also serve to support the gate valves. This enclosed area will also be used for quarterly valve maintenance. It will be maintained as a dry platform having a separation wall up to elevation 161.0 feet, msl. This platform will also be constructed of precast, prestressed hollow core slabs for the floor and wall. The walls will be attached to the upstream face of the dam using specially design stainless steel connections. The top deck of the tower will be at elevation 185.0 feet, msl to match the existing top of dam. Part of the existing concrete railing on the dam will be removed and a similar rail used along the perimeter of the new concrete deck.

.2.6 Electrical Evaluation

A new 480-volt motor control center (FCQ9) is proposed to be installed outdoors near the fishlock approach channel. The new unit substation described in the 60% level design to feed power to FCQ9 has been removed. Instead, power for FCQ9 will be provided from existing unit substation FSQ6, which is located in the powerhouse near the main turbine unit #22. A new 150A, 3-pole circuit breaker is proposed to be installed in FSQ6 to supply 480-volt power to the new FCQ9. The motor control center will include an enclosure suitable for outdoor locations.

Motor control center FCQ9 will be used to provide power to the siphon priming pumps, hydraulic power units, and debris cleaning system as shown in the electrical one-line diagram on Sheet 35. FCQ9 will also include a transformer and panelboard to supply power for convenience receptacles, lighting, and heating loads.

A control panel with a programmable logic controller is proposed to provide automatic controls and monitoring capabilities of the new equipment as required. The programmable logic controller will be connected to the existing fiber optic network to allow remote monitoring of the equipment.

.2.7 Cost Evaluation

A conceptual level Total Project Cost estimate has been developed for this alternative. Costs presented were effective price levels as of March 2012. Cost data is based on estimates from vendors, fabricators, contractors, and other projects in the Pacific Northwest. The estimates contain contractor markups and contingencies. Contingency amounts were established based on an Abbreviated Risk Analysis (see guidance at www.nww.usace.army/mil/html/OFFICES/ED/C/default.asp). Cost estimates were developed using Micro Computer Aided Cost Estimating System (MCACES) MII. The cost estimates conform to USACE publications ER 1110-2-1150, Engineering and Design for Civil Works Projects; ER 1110-2-1302, Civil Works Cost Engineering; and ETL1110-2-573 Engineering and Design: Construction Cost Estimating Guide for Civil Works. The MII cost sheets and abbreviated risk analysis sheets are contained in Appendix G. The cost estimate for Alternative #11 also includes the cost for the modifications to the valve room and approach channel. The estimate assumes:

- Procurement will be with a standard Design Bid Build contract, and the contract will be awarded 1 July 2014 with construction completed in 365 days.
- Alternative #11 will require mining or drilling for two, 84-inch diameter tunnels for the two, 72-inch steel pipes through the east non-overflow structure above normal high pool elevation and construction of a prefabricated intake structure that attaches to the face of the dam.

- Mining through the dam will be performed from a work platform suspended in the fishlock structure.
- Crane support for work in the fishlock will need to occur from the land side since there is not sufficient room for a large crane on top of the dam adjacent to the fishlock structure.
- Construction of the intake structure will occur during the in-water work period (1 December through 28 February) and will require divers and a crane barge to lift the individual sections into place.

The estimated construction cost for Alternative #11 including contingency is approximately $13,930,000. This includes approximately $3,626,000 for modifications to the valve room and fishlock approach channel. The Total Project Cost (fully funded) was computed to be approximately $22,426,000. O&M costs for this alternative are not included in the Total Project Cost. The life cycle cost for O&M was computed to be approximately $2,144,000 over the 50-year project life. The cost estimate has attempted to capture the additional cost associated with in-water work. The cost per unit and the source of the estimate are shown on the backup data provided in Appendix G. Cost increases over the 60% estimate are the result of design changes to the intake structure, valves, and a more refined evaluation of required construction.

5.2.8 Constructability

Alternative # 11 will require construction of an upstream prefabricated intake tower, boring or mining openings for two, 72-inch diameter steel pipes through the east non-overflow structure and fishlock structure, and supporting the two pipes on the upstream face of the dam. The borings will be made from the fishlock structure at an invert elevation of 161.0 feet, msl (Sheet 27). Construction of the intake tower will require divers working from a dive barge and a crane barge. Delivery of the intake structure segments can be by truck or barge. The valves and pipes are commercially available but typically require lead time for fabrication. Northwest contractors have been identified that have indicated they can perform the pipe boring and grouting operations. It is assumed that this alternative can be constructed in a single year, but only if the contractor has several month lead time prior to the in-water work period (1 December through 28 February) to fabricate the intake structure segments.

5.3 Improvements to Fishlock, Valve Room, and Approach Channel

Several improvements to the existing project infrastructure were identified as part of this evaluation. The listed improvements will provide about 400 cfs which is needed to help obtain the total discharge of 1,400 cfs. The selected alternative will provide an addition 1,000 cfs. These improvements to the existing infrastructure are as follows:

- Improvements to the existing valve room,
- Improvements to the existing fishlock, and
- Improvements to the existing fishlock approach channel.

Changes to the 60 % design are as follows:

- Proposed valve room improvements (Sheet 31 and Sheet 32) include:

- Installation of two, 48-inch sleeve valves,
- Installation of four, 48-inch bonneted knife gate valves for isolation of piping components,
- One 48-inch x 36-inch transition pipe; one 48-inch x 42-inch transition pipe, and
- Removal of most of the existing pipes in the valve room,

- Proposed fishlock improvements are as follows:
  - Removal of the existing brail system (Sheet 27),
  - Removal of the existing downstream entrance gate (Sheet 27).
- Proposed fishlock approach channel improvements are as follows:
  - New stoplogs will be added at the end of the approach channel (Sheet 30),
  - The southeast wall of the approach channel to be raised to elevation, 111.0 feet, msl (Sheet 30), and
  - Demolition of four existing diffuser gates and walls (Sheet 30).

All of the above changes to the 60% design are discussed in more detail in the next sections of the report.

5.3.1 Hydraulic Design

The valve room hydraulics were previously evaluated for both the existing condition as well as a condition where the three, 18-inch pipes were removed and replaced with one, 42-inch pipe. With the elimination of the 18-inch pipes and manifold system, the head losses are reduced and the overall capacity of the system is increased. With these changes, the capacity of the valve room system would be higher; however, the velocities would also be high and the valves would be used to control the flow and reduce velocities.

The changes to the fishlock including removing the brail and entrance gate were already evaluated as a part of the 60% design.

The modifications to the approach channel by removing the four diffuser gates and walls were already evaluated and recommended as a part of the 60% design. Removing the gates and walls is required to discharge 1,400 cfs from the approach channel to the AWS.

5.3.2 Mechanical Design

After submitting the 60% report, it was determined that retaining the existing piping and valves in the valve room is not recommended as the velocity criteria through the valves would be exceeded to achieve the necessary flow. Therefore, all of the piping inside the valve room will be removed and replaced with larger piping that will provide the target flow rate. To obtain 200 cfs in each line, the pipes and valves will need to be upsized to 48-inch diameter pipes. The upsized pipes will only be provided inside the valve room, as it is neither cost effective nor practical to increase the diameter of the pipes embedded in concrete.

At this time, the design assumes sleeve valves will be used to control the flow in the pipes and maintain the 16 fps velocity criteria through the valves. Example drawings (Sheet 32) and cutsheets (Appendix F) are provided for more information on these valves. The sleeve valves will be equipped with back flushing capabilities that will remove any trapped debris on the perforated sleeve. The back flushing system will take high pressure water from upstream of the sleeve valve and connect it to the downstream side, sending water backwards through the sleeve valve. This water then goes to a drain for disposal using hydraulically-actuated isolation valves located upstream and downstream of the sleeve valve.

The 36-inch pipe entering the valve room will be upsized to 48 inches and connected to a 48-inch angle pattern sleeve valve. This line will then reduce and connect to the existing 42-inch pipe leaving the valve room that formally served as the fishlock drain. To connect this drain into the fishlock approach channel, a section of concrete must be removed to gain access to this pipe. The pipe will then be plugged on the downstream end and allowed to flow into the fishlock approach channel (Sheet 31).

The 42-inch pipe entering the valve room will also be upsized to 48 inches and connected to a 48-inch in-line sleeve valve. This line will then reduce and connect to the existing 42-inch pipe that formally served as the fishlock fill line.

Both sleeve valves will have 48-inch hydraulically-actuated bonneted knife gate valves on the upstream and downstream sides to provide isolation for valve maintenance and backflushing.

Like the other alternatives, ultrasonic flow meters will be installed to facilitate startup and operation of the system.

5.3.3 Structural Design

The fishlock approach channel will become the main waterway for a combined flow of 1,400 cfs through the existing concrete conduit and into the junction pool. This will require structural demolition and improvements. Due to the existing hydraulic constraints and maintaining the water surface at elevation 109.0 feet, msl, the southeast training walls will be raised to level for approximately 256 feet. It is assumed that the existing concrete wall slopes at 10 percent with the roadway. The wall will be raised to maintain an elevation of 110.8 feet, msl for this length. The top cap will be left in place and a new 1-foot by 6-inch thick concrete wall will be doweled into the existing. There are also four gates that will be removed to allow the water to leave the fishlock approach channel unencumbered and enter the concrete conduit. Stoplogs will be required at the end of the channel and new stoplogs will be designed to fit into the existing stoplog guides.

Modifications to the holding pond will include demolition of the floor to get access to the 36-inch pipe from the valve room. This pipe currently travels parallel to and below the fishlock channel. Once the 36-inch pipe is exposed, the pipe will be cut and a tee will be attached with a blind flange and an opening into the holding pond.

. .4 Electrical Evaluation

There are five existing motor operated valves located in the valve room, which are powered from the existing 480-volt motor control center FSQ7. These valves are to be removed and the associated electrical conduit is to be demolished. The new valves associated with these improvements will be hydraulically actuated. One hydraulic power unit will be used for the new valves installed on the 42-inch-diameter pipe, and another hydraulic power unit will be used for the new valves installed on the 36-inch-diameter pipe. The hydraulic power units will be powered from the existing 480-volt motor control center FSQ7 as shown on the electrical one-line diagram on Sheet 33.

A control panel with a programmable logic controller is proposed to provide automatic controls and monitoring capabilities of the new equipment as required. The programmable logic controller will be connected to the existing fiber optic network to allow remote monitoring of the equipment.

. . Cost Evaluation

A conceptual level Total Project Cost estimate has been developed for these improvements. The costs for valve room, fishlock, and approach channel improvements are included in the costs sheets for both Alternatives #2 and #11 and are found in Appendix G. The estimate assumes:

- Procurement will be with a standard Design Bid Build contract, and that the contract will be awarded 1 July 2014 with construction completed in 365 days.
- Significant modifications to piping and valves in the Valve Room and to the conduit to the fishlock.
- Demolition and removal of gates and portion of walls in the fishlock approach channel, and construction of an extension of the south wall of the fishlock approach channel to an elevation of 111.0 feet, msl.
- This work can be performed outside of the in-water work period if it can be isolated from the fish ladder.
- Much of the work will be in confined areas.
- Access will be from the downstream elevation 111.5 feet, msl which is the same elevation as the roadway and parking areas.

The estimated construction cost for the Fishlock, Valve Room, and Approach Channel Improvements is approximately $3,626,000. The cost estimate has attempted to capture the additional cost associated with working in confined areas with difficult access. The cost has significantly increased over the 60% estimate as the result of significant design changes to valve room, and fishlock approach channel, and a more refined evaluation of required construction costs.

5.3.6 Constructability

The Fishlock, Valve Room, and Approach Channel Improvements require significant modifications to pipes and valves in the valve room, demolition of a wall in a conduit of the fishlock, demolition and removal of gates and portion of walls in the fishlock approach channel, and construction of an extension of the south wall of the fishlock approach channel to an elevation of 111.0 feet, msl. Most work will be in confined areas with limited or no access for anything but hand-operated equipment. This type of work is often performed by local contractors during retrofitting of industrial facilities. It is assumed that these improvements will be constructed concurrently with the selected alternative.

5.4 Recommendations

Alternatives #2 and #11, as evaluated in this report during the 90% design phase, are both capable of providing a reliable emergency backup system for the EFL AWS Backup. Each alternative has been designed to provide 1,000 cfs. Improvements in the existing valve room will provide an additional 400 cfs. Additionally, modifications to the fishlock and approach channel are required. Modifications to the valve room, fishlock, and approach channel were considered to be an integral part of the evaluation. USACE and HDR staff considered these improvements a as "baseline condition." Project photographs are provided in Appendix I.

Based on input from the design team and the evaluation matrix that was developed during 60% design phase, ***Alternative #2, Low Level Intake is being recommended as the final selected alternative.*** The construction cost estimate for Alternative #2, including contingency and modifications to the valve room, fishlock, and approach channel is approximately $10,304,000 (with contingency). The positive and negative factors that were considered in reaching this recommendation are discussed in the follow paragraphs.

The ***positive*** factors in support of Alternative #2, Low Level Intake, are presented below:

- Relatively uncomplicated construction features,
- Simple boring techniques, major platforms for construction are not required,
- The upstream bulkhead enclosure structure serves as a cofferdam during boring operations,
- Only two downstream control valves are required,
- Flexibility in overall operation,
- Flows in excess of 1,000 cfs could be obtained if required,
- Better flow control when compared to Alternative #11,
- Slightly less biological impacts than Alternative #11,
- Less overall maintenance required for project features,
- Overall, easy to implement the emergency backup system, and
- A limited amount of what would be considered "in-water work."

The ***negative*** factors in non-support of Alternative #2, Low Level Intake are presented below:

- During the boring phase of the project, risk of failure is relatively high, the upstream cofferdam is providing a single level of the protection,
- Boring into the fishlock and removal of existing reinforcement steel will require additional work, and
- A concrete reinforcing block on the exterior of the fishlock will most likely be needed (due to cutting of existing reinforcing steel).

The positive and negative factors for the evaluation of ***Alternative #11, Intake Tower with Siphon to Fishlock*** are discussed below. Alternative #11, including contingency and modifications to the valve room, fishlock, and approach channel, is estimated to cost approximately $13,930,000.

The ***positive*** factors in support of Alternative #11, Intake Tower with Siphon to Fishlock are presented below:

- Low risk during boring operations, boring will be above operational lake levels, and
- Once operational, simple to operate.

The ***negative*** factors in non-support of Alternative #11, Intake Tower with Siphon to Fishlock are presented below:

- Siphons can be difficult to operate,
- Downstream and upstream flow control valves will need to have digital flow operation controls, this is a critical part of the operational startup procedure,
- Relatively complicated construction features,
- Simple boring techniques, but major downstream platforms for construction will be required to support boring equipment,
- Somewhat complicated to implement the emergency backup system, siphons will need to be primed,
- More overall maintenance required for project features, four valves and two priming pumps to maintain and operate,
- Slightly more biological impacts than Alternative #2,
- Limited flow control/flexible operation when compared to Alternative #2, and
- The intake tower will require a considerable amount of "in-water work."

If the USACE Portland District decides to adopt and implement Alternative #2, Low Level Intake, it will require additional detailed technical analysis. This should include refined investigations for geotechnical, hydraulic, mechanical, structural, and electrical, as well as operational costs and biological considerations.

6.0 FINAL SELECTED ALTERNATIVE

6.1 Discussion of Final Selected Alternative

6.1.1 Biological Considerations

6.1.2 Geotechnical Evaluation

6.1.3 Hydraulic Design

6.1.4 Mechanical Design

6.1.5 Structural Design

6.1.6 Electrical Evaluation

6.1.7 Cost Evaluation

6.1.8 Constructability

7.0 RECOMMENDATION

8.0 REFERENCES

Boysen, K. A. and J. J. Hoover. 2009. Swimming performance of juvenile white sturgeon (*Acipenser transmontanus*): training and the probability of entrainment due to dredging. Journal of Applied Ichthyology, 25: 54–59.

Burke, B. J., K. E. Frick, M. L. Moser, T. J. Bohn, and T. C. Bjornn. 2005. Adult fall Chinook salmon passage through fishways at lower Columbia River dams in 1998, 2000, and 2001. Report to U.S. Army Corps of Engineers, Portland District.

Chapman, C. G. and T. A. Jones. 2011. Report A. Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams. Pages 6-32 *in* C. Mallette, editor. White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Chapman, C. G. and J.C. Kern. 2005. Sturgeon Population Characteristics in Oregon. Annual Progress Report by Oregon Department of Fish and Wildlife to United States Fish and Wildlife Service. Project Number F-178-R-05.

Clabough, T.S., E.L. Johnson, M.L. Keefer, C.C. Caudill, and M.L. Moser. 2011. General passage and fishway use summaries for adult Pacific lamprey at Bonneville, The Dalles, and John Day dams, 2010. Report to U.S. Army Corps of Engineers, Portland District.

Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (Lampetra tridentata) in the Columbia River Basin. Technical Report to Bonneville Power Administration DOE/BP-39067-1.

Faber, D. M., M. E. Hanks, S. A. Zimmerman, J. R. Skalski, and P. W. Dillingham. 2005. The distribution and flux of fish in the forebay of The Dalles Dam in 2003. Final Report by Pacific Northwest National Laboratory to the U.S. Army Corps of Engineers , Portland District.

Fish Passage Center. 2011. http://www.fpc.org/

Graham, J. C. and C. V. Brun. 2006. Determining lamprey species composition, larval distribution, and adult abundance in the Deschutes River, Oregon, Subbasin, 2005-2006. Annual Report to Bonneville Power Administration, Project No. 200201600.

Hatten, J. R. and M. J. Parsley. 2009. A spatial model of white sturgeon rearing habitat in the lower Columbia River, USA. Ecological Modeling 220:3638-3646.

Hone, J. D., P. V. Dunlap, and E. C. Winther. 2011. Report D. Northern pikeminnow dam angling on the Columbia River. Pages 105-125 *in* R. Porter, editor. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin experimental northern pikeminnow removal program. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Johnson, G. E., J. W. Beeman, I. N. Duran, and A. L. Puls. 2007. Synthesis of juvenile salmonid passage studies at The Dalles Dam volume II: 2001-2005. Final report by Pacific Northwest National Laboratory and U.S. Geological Survey to U.S. Army Corps of Engineers, Portland District.

Jolley, J. C., G. S. Silver, and T. A. Whitesel. 2010. Occurrence, detection, and habitat use of larval lamprey in mainstem environments: the lower Willamette River. 2009 Annual Report, U.S. Fish and Wildlife Service, Vancouver, Washington.

Miller, D.S. 1990. Internal Flow Systems.

Moser, M. L. and D. A. Close. 2003. Assessing Pacific lamprey status in the Columbia River Basin. Northwest Science 77:116-125.

Moser, M. L., A. L. Matter, L. C. Stuehrenberg, and T. C. Bjornn. 2002. Use of an extensive radio receiver network to document Pacific lamprey (Lampetra tridentata) entrance efficiency at fishways in the Lower Columbia River, USA. Hydrobiologia 483: 45-53.

Moser, M. L., H. T. Pennington, and J. M. Roos. 2007. Grating size needed to protect adult Pacific lamprey in the Columbia River Basin. Report to U.S. Army Corps of Engineers, Portland District.

Moursund, R. A, M. D. Bleich, K. D. Ham, and R. P. Mueller. 2003. Evaluation of the effects of extended length submerged bar screens on migrating juvenile Pacific lamprey at John Day Dam in 2002. Final Report of Research, U. S. Army Corps of Engineers, Portland, Oregon.

National Marine Fisheries Service (NMFS) 2008. Anadromous salmonid passage facility design.

Parsley, M. J. and L.G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M.J., L.G. Beckman, and G.T. McCabe, Jr. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122: 217–227.

Parsley, M. P., C. D. Wright, B. K. van der Leeuw, and E. E. Kofoot, C. A. Peery, and M. L. Moser. 2007. White sturgeon (*Acipenser transmontanus*) passage at the Dalles Dam, Columbia River, USA. Journal of Applied Ichthyology 23:627-635.

Pirtle. J, J. Stone, and S. Barndt. 2003. Evaluate habitat use and population dynamics of lampreys in Cedar Creek. 2002 Annual Report to Bonneville Power Administration Project, Project No. 200001400.

Pribyl, A. L., J. S. Vile, and T. A. Friesen. 2005. Population structure, movement, habitat use, and diet of resident piscivorous fishes in the lower Willamette River. Pages 139-184 *in* T. A. Friesen, editor. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River. Final Report of Research, 2000-2004 to City of Portland, Bureau of Environmental Services, Portland, Oregon.

Robinson, T. C. and J. M. Bayer. 2005. Upstream migration of Pacific lampreys in the John Day River, Oregon: behavior, timing, and habitat use. Northwest Science 79:106-119.

Sutphin, Z. A., and C. D. Hueth. 2010. Swimming performance of larval Pacific lamprey (Lampetra tridentata). Northwest Science 84:196-200.

U.S. Army Corps of Engineers (USACE). 1964. Closure and Non-overflow Dams, Foundation Report, Part 4, The Dalles Dam.

U.S. Army Corps of Engineers (USACE). 2011. Fish passage plan. U.S. Army Corps of Engineers, Northwestern Division. http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2011/final/20110310_2011_FPP_Final.pdf

U.S. Department of Agriculture. 2009. Report D. 2008 Dam Angling Season Report. Pages 97-100 *in* R. Porter, editor. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin experimental northern pikeminnow removal program. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

U.S. Department of the Interior, Bureau of Reclamation. 1977. Hydraulic Tests and Development of Multijet Sleeve Valves by P.H. Burgi.

U.S. Geological Survey (USGS). 2008. "United States National Seismic Hazard Maps – Open File Report 2008-11," http://earthquake.usgs.gov/regional/qfaults/.

Weaver, M. H., H. K. Takata, M. J. Reesman, and E. S. Van Dyke. 2009. Report C. System-wide predator control program: indexing and fisheries evaluation. Pages 49-96 in R. Porter, editor. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin experimental northern pikeminnow removal program. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Weaver, M. H., H. K. Takata, M. J. Reesman, L. D. Layng, G. E. Reed, and T. A. Jones. 2007. Report C. System-wide predator control program: indexing and fisheries evaluation. Pages 51-111 *in* R. Porter, editor. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin experimental northern pikeminnow removal program. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Weaver, M. H., H. K. Takata, and E. S. Van Dyke. 2010. Report C. System-wide predator control program: indexing and fisheries evaluation. Pages 50-99 *in* R. Porter, editor. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin experimental northern pikeminnow removal program. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Webb, M. A. H., C. L. Anthony, C. B. Schreck, and M. S. Fitzpatrick. 2005. Report E. Develop methods to determine sex of white sturgeon in the Columbia River using plasma, urine, and mucus sex steroid and calcium concentrations. Pages 137-156 in T. A. Rien, editor. White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Webb, M. A. H. and K. M. Kappenman. 2008. Report E. Determine spawning interval of white sturgeon in the Columbia River. Pages 89-99 in C. Mallette, editor. White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

9.0 SHEETS

Sheet 1. General Layout of All Alternatives Show Flow

Sheet 2. Plan View, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 3. Section View, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 4. Detail, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 5. Plan View, Low Level Intake

Sheet 6. Section View, Low Level Intake

Sheet 7. Detailed View, Low Level Intake – Trashrack and Cofferdam

Sheet 8. Plan View, Alternative #10 Single Pump/Pump House

Sheet 9. Section Views, Alternative #10 Single Pump/Pump House

Sheet 10. Section Views and Details, Alternative #10 Single Pump/Pump House

Sheet 11. Bridge Details, Alternative #10 Single Pump/Pump House

Sheet 12. Plan View, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 13. Section Views, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 14. Detailed Views, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 15. Intake Tower, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 16. General Plan and Profile

Sheet 17. Fishlock Approach Channel Modifications Plan and Section

Sheet 18. Alternatives #1 and #11 Electrical One-Line Diagrams

Sheet 19. Alternative #2 Electrical One-Line Diagrams

Sheet 20. Alternative #10 Electrical One-Line Diagram

Sheet 21. General Layout of Alternative #2 Low Level Intake (90% Submittal)

Sheet 22. General Layout of Alternative #11 Siphon and Tower (90% Submittal)

Sheet 23. Plan View, Alternative #2 Low Level Intake (90% Submittal)

Sheet 24. Section View, Alternative #2 Low Level Intake (90% Submittal)

Sheet 25. Plan, Elevations, and Section, Alternative #2 Low Level Intake Trashrack and Cofferdam (90% Submittal)

Sheet 26. Plan View, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 27. Sections, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 28. Details, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 29. Intake Tower, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 30. Fishlock Approach Channel Modifications Plan and Section

Sheet 31. Valve Room Demolition Plan

Sheet 32. Valve Room Mechanical Plan

Sheet 33. Fishlock Valve Room Electrical One-Line Diagram

Sheet 34. Alternative #2 Electrical One-Line Diagram

Sheet 35. Alternative #11, Electrical One-Line Diagram

Sheets 1-20

Note: Sheets 1-20 prepared for the EDR, 60% submittal, have been revised based on review comments received. Minor revisions have been made for the 90% submittal.

Sheet 1. General Layout of All Alternatives Show Flow

Sheet 2. Plan View, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 3. Section View, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 4. Detail, Alternative #1 Siphon for Additional Water to Fishlock

Sheet 5. Plan View, Low Level Intake

Sheet 6. Section View, Low Level Intake

Sheet 7. Detailed View, Low Level Intake – Trashrack and Cofferdam

Sheet 8. Plan View, Alternative #10 Single Pump/Pump House

Sheet 9. Section Views, Alternative #10 Single Pump/Pump House

Sheet 10. Section Views and Details, Alternative #10 Single Pump/Pump House

Sheet 11. Bridge Details, Alternative #10 Single Pump/Pump House

Sheet 12. Plan View, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 13. Section Views, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 14. Detailed Views, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 15. Intake Tower, Alternative #11 Intake Tower with Siphon to Fishlock

Sheet 16. General Plan and Profile

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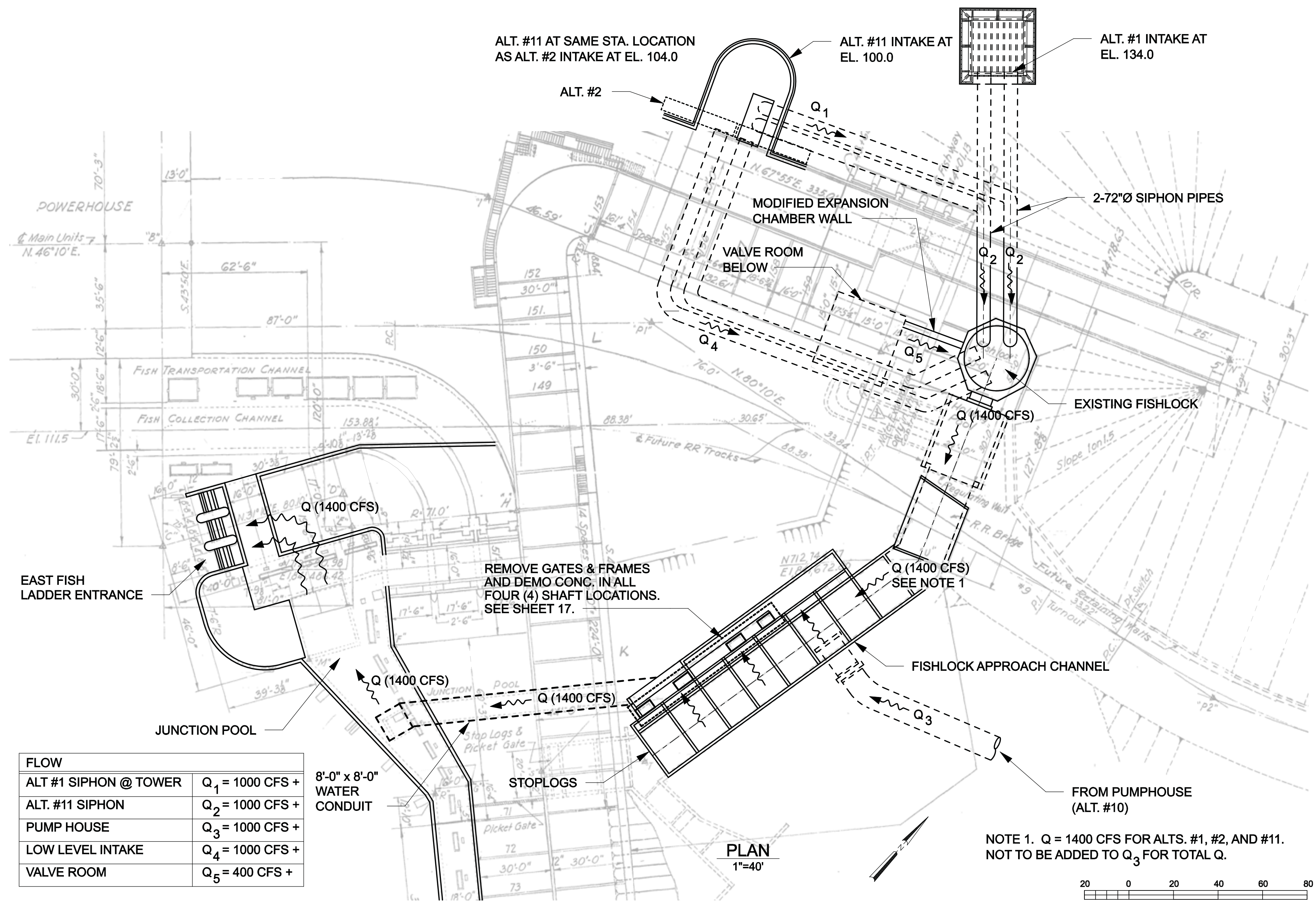
Sheet 18. Alternatives #1 and #11 Electrical One-Line Diagrams

Sheet 19. Alternative #2 Electrical One-Line Diagrams

Sheet 20. Alternative #10 Electrical One-Line Diagram



FLOW	
ALT #1 SIPHON @ TOWER	Q_1 = 1000 CFS +
ALT. #11 SIPHON	Q_2 = 1000 CFS +
PUMP HOUSE	Q_3 = 1000 CFS +
LOW LEVEL INTAKE	Q_4 = 1000 CFS +
VALVE ROOM	Q_5 = 400 CFS +

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GENERAL LAYOUT OF ALL ALTERNATIVES
SHOW FLOW

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: RCM | DWN BY: TTN | CKD BY: RCM | SUBMITTED BY: RCM | PLOT SCALE: NTS | PLOT DATE: | DRAWING NUMBER: 1 | SIZE: 17X11 | FILE NAME: S01-Typical Flow Path Plan View.DGN | DATE: January 25, 2012

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
1
SHEET 1 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

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BY USERNAME: TAM NGUYEN

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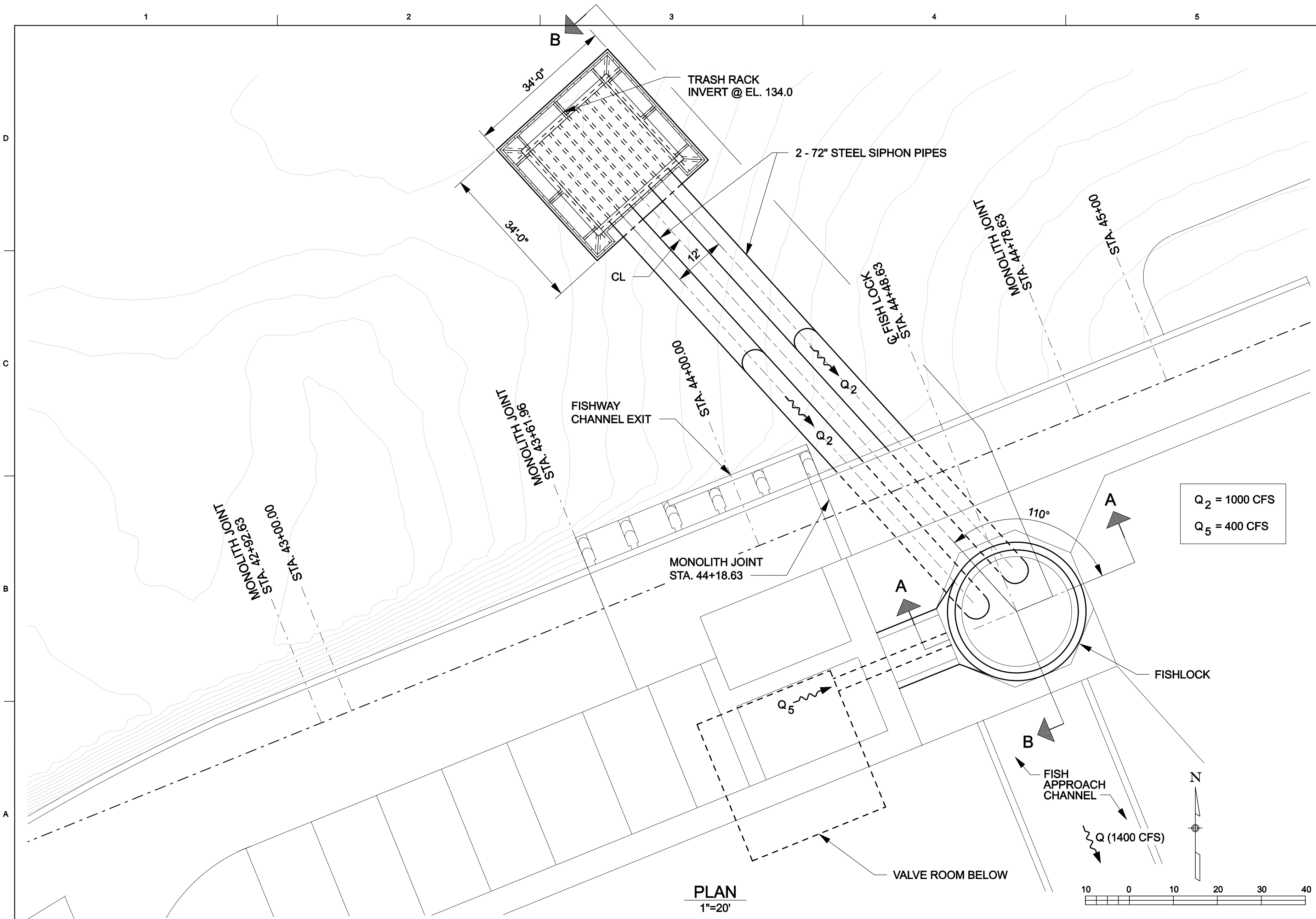

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PLAN VIEW
ALTERNATIVE #1
SIPHON FOR ADDITIONAL WATER TO FISH LOCK

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 2
SIZE: 17X11	FILE NAME: S02-Siphon Alt 1 Plan.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
2
SHEET 2 OF 20

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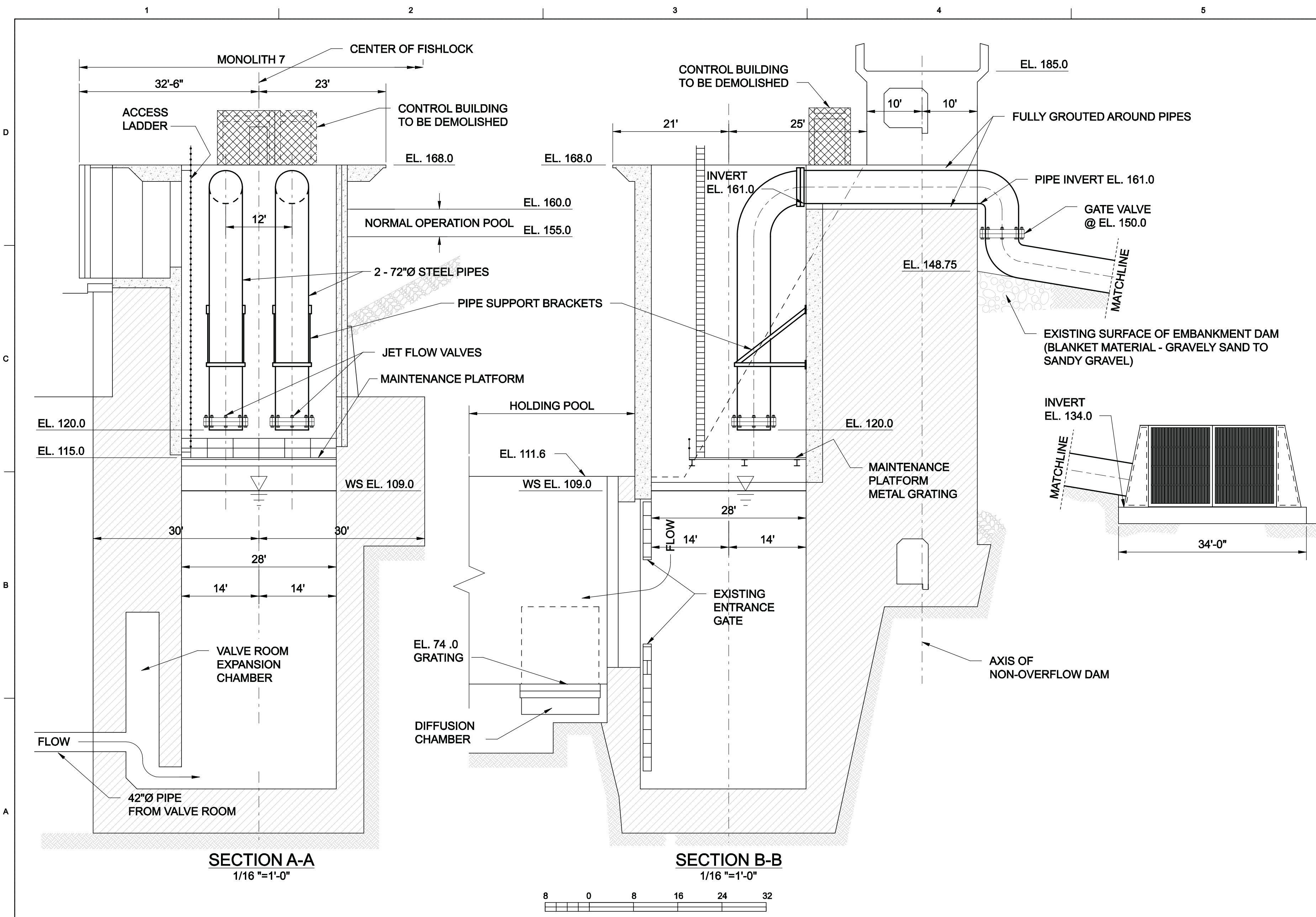

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SECTIONS
ALTERNATIVE #1
SIPHON FOR ADDITIONAL WATER TO FISHLOCK

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

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SUBMITTED BY: RCM
PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 3
SIZE: 17X11 | FILE NAME: S02-Siphon Alt 1 Section.dgn

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THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
3
SHEET 3 OF 20

DATE AND TIME PLOTTED: 4/5/2012 11:34:33 AM
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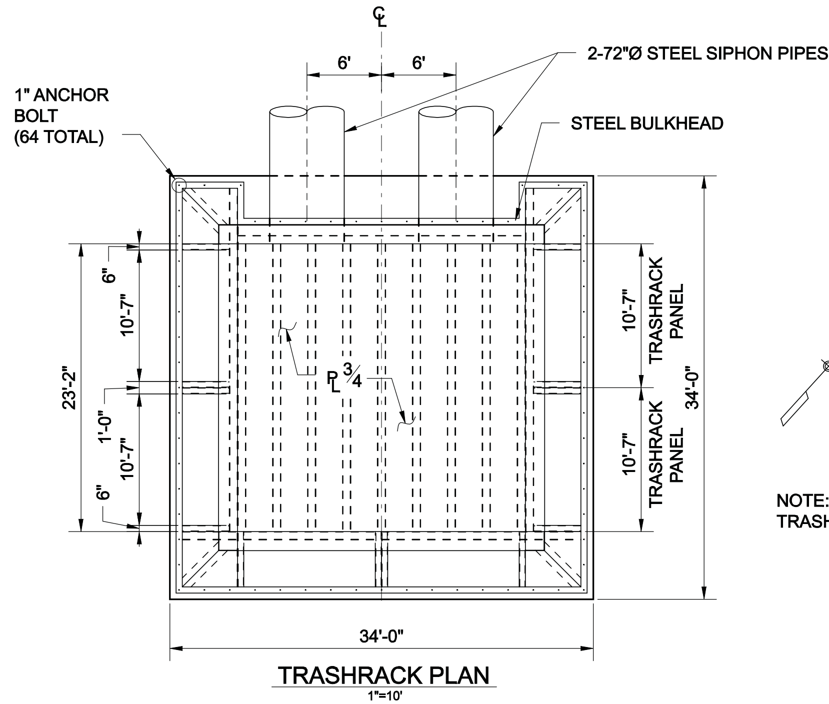
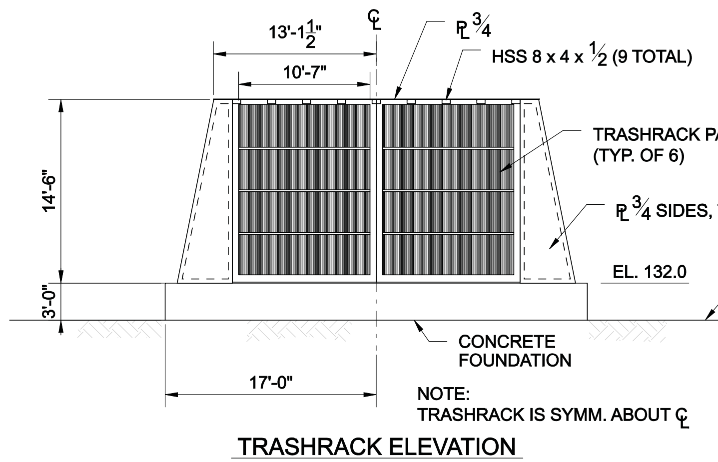


TRASHRACK PLAN
1"=10'

NOTE:
TRASHRACK BARS NOT SHOWN FOR CLARITY.



NOTE:
TRASHRACK IS SYMM. ABOUT CL

TRASHRACK ELEVATION
1"=10'

EXISTING SURFACE OF EMBANKMENT DAM (BLANKET MATERIAL - GRAVELY SAND TO SANDY GRAVEL)

NOTE:
TRASHRACK PANELS ARE ALL ONE SIZE, SAME AS LOW LEVEL INLET.

5 0 5 10 20 30

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ALTERNATIVE #1
SIPHONS FOR ADDITIONAL WATER TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
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PORTLAND, OREGON

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DESIGNED BY: JPG		DATE: January 25, 2012
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SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 4
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THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
4
SHEET 4 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

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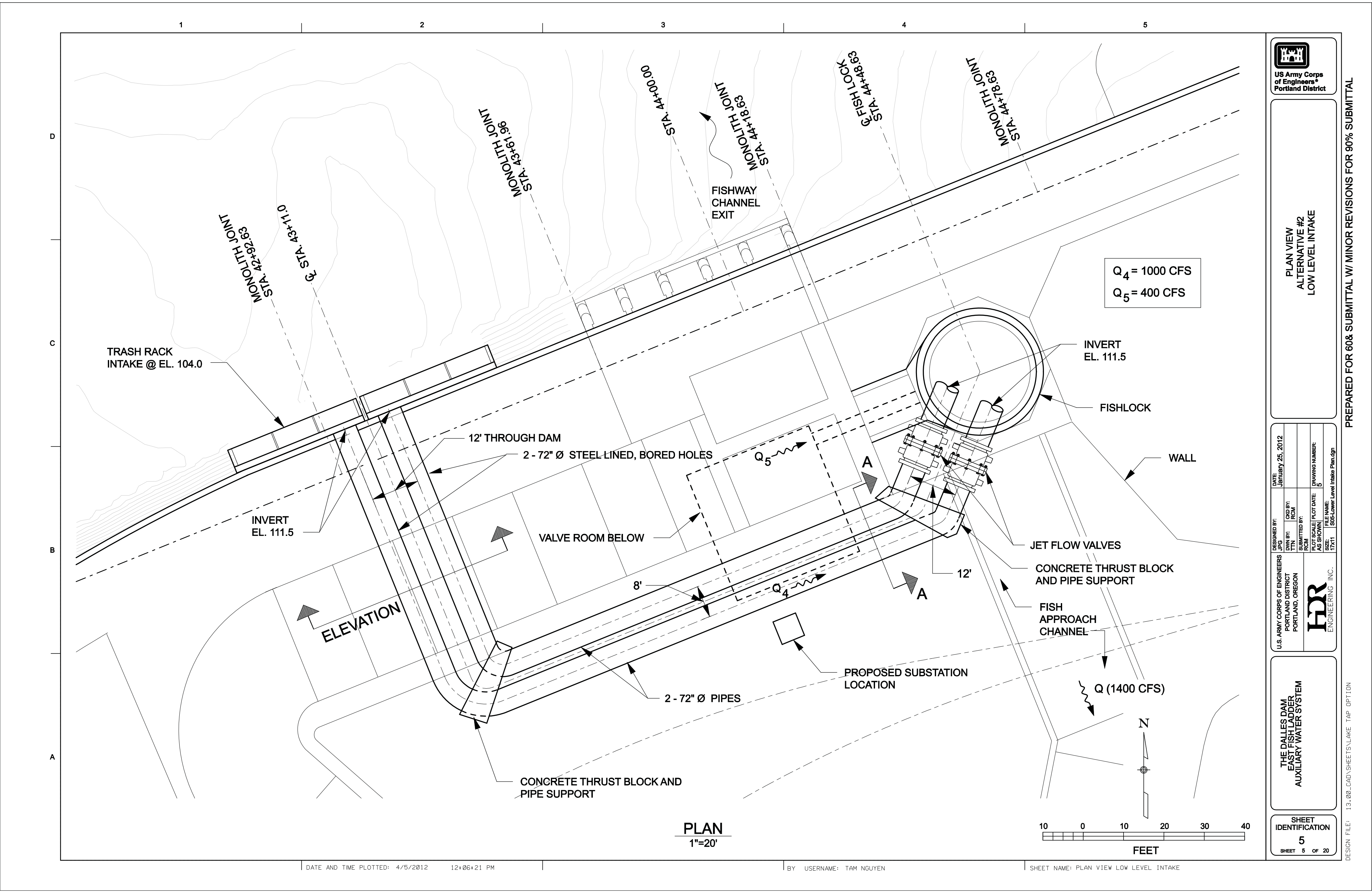
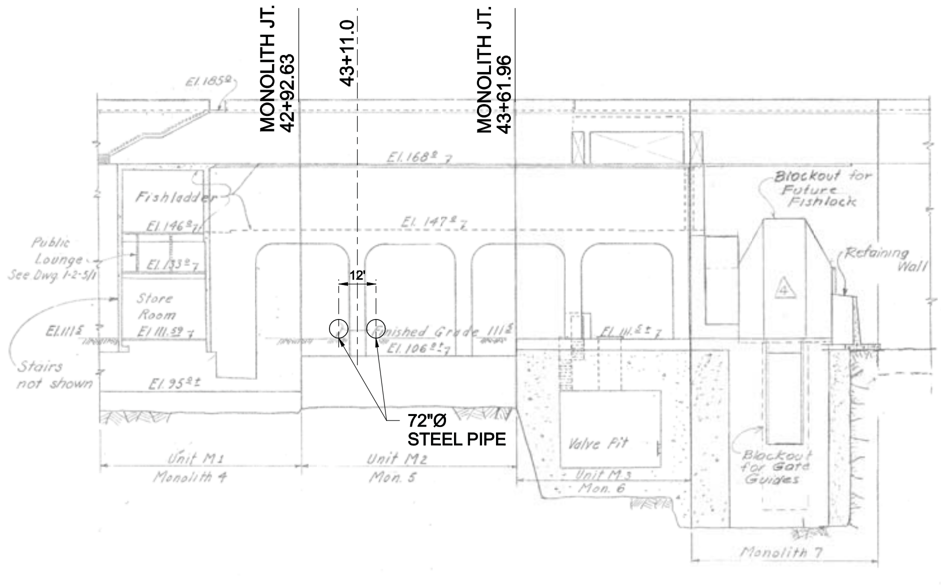
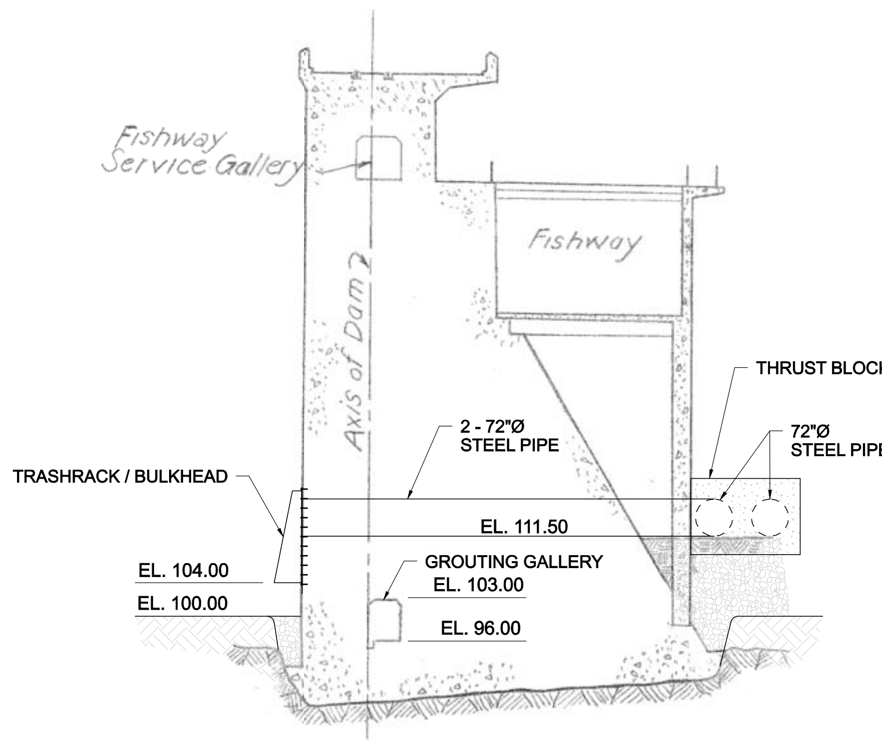

MONOLITH JOINT STA. 42+92.63
℄ STA. 43+11.0
MONOLITH JOINT STA. 43+61.96
STA. 44+00.00
MONOLITH JOINT STA. 44+18.63
℄ FISH LOCK STA. 44+48.63
MONOLITH JOINT STA. 44+78.63
FISHWAY CHANNEL EXIT
Q_4 = 1000 CFS
Q_5 = 400 CFS
TRASH RACK INTAKE @ EL. 104.0
INVERT EL. 111.5
FISHLOCK
12' THROUGH DAM
2 - 72" Ø STEEL LINED, BORED HOLES
Q_5
A
WALL
INVERT EL. 111.5
VALVE ROOM BELOW
JET FLOW VALVES
CONCRETE THRUST BLOCK AND PIPE SUPPORT
12'
8'
Q_4
FISH APPROACH CHANNEL
ELEVATION
PROPOSED SUBSTATION LOCATION
2 - 72" Ø PIPES
Q (1400 CFS)
N
CONCRETE THRUST BLOCK AND PIPE SUPPORT
PLAN
1"=20'
10 0 10 20 30 40
FEET
US Army Corps of Engineers® Portland District
PLAN VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON
HDR ENGINEERING INC.
DESIGNED BY: JPG
DATE: January 25, 2012
DWN BY: TTN
CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: AS SHOWN
PLOT DATE:
DRAWING NUMBER: 5
SIZE: 17X11
FILE NAME: S05-Lower Level Intake Plan.dgn
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM
SHEET IDENTIFICATION
5
SHEET 5 OF 20
PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL
DATE AND TIME PLOTTED: 4/5/2012 12:06:21 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW LOW LEVEL INTAKE
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



ELEVATION - EAST NON-OVERFLOW DAM
1"=40'



SECTION A-A
1"=20'

US Army Corps of Engineers® Portland District

SECTION VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGNED BY: JPG | DWN BY: TTN | CKD BY: RCM | SUBMITTED BY: RCM | PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: 17X11 | FILE NAME: S06-Low Level Intake Section.dgn | DATE: January 25, 2012 | DRAWING NUMBER: 6

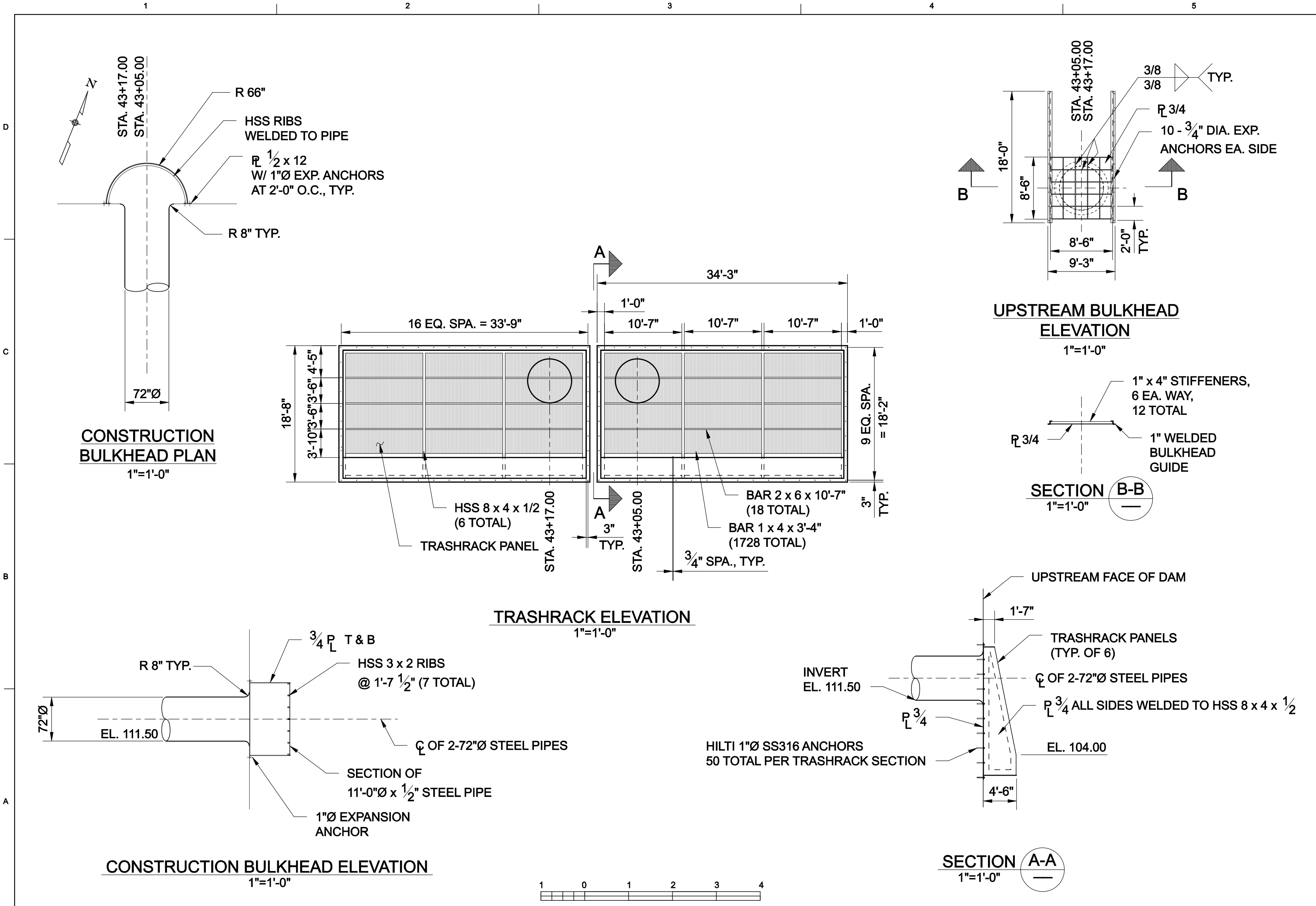
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
6
SHEET 6 OF 20

DATE AND TIME PLOTTED: 4/5/2012 12:52:04 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW LOW LEVEL OPTION
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



US Army Corps of Engineers® Portland District

PLAN, ELEVATIONS, AND SECTION
ALTERNATIVE #2
LOW LEVEL INTAKE
TRASHRACK AND COFFERDAM

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

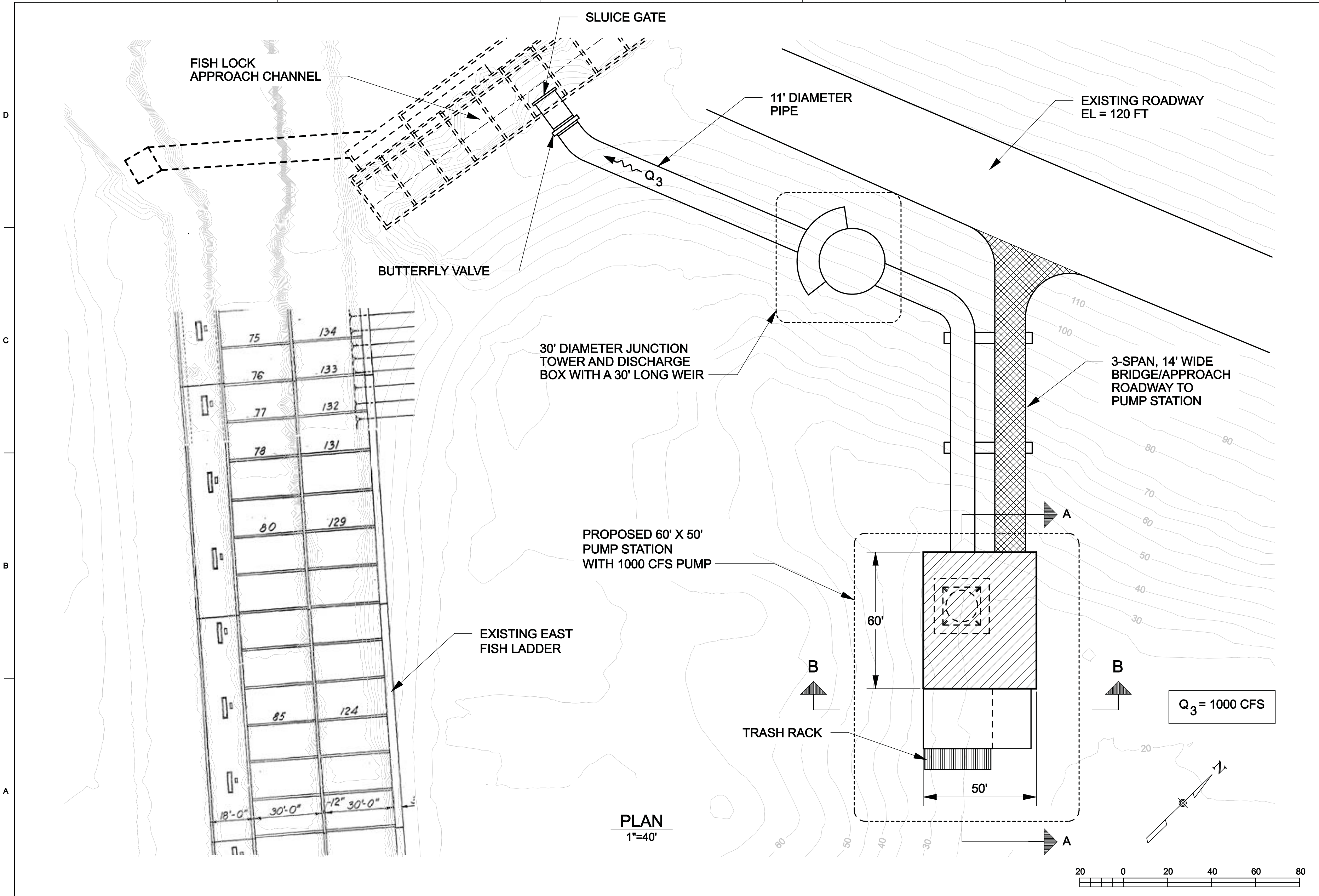
DESIGNED BY: JPG		DATE: January 25, 2012	
DWN BY: TTN	CKD BY: RCM		
SUBMITTED BY: RCM			
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 7	
SIZE: 17X11	FILE NAME: S07-Low Level Intake Detail.dgn		

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
7
SHEET 7 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DATE AND TIME PLOTTED: 4/5/2012 3:34:45 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAIL LOW LEVEL OPTION CONSTRUCTION COFFERDAM
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



US Army Corps of Engineers® Portland District

PLAN VIEWS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: RCM	DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 8
SIZE: 17X11	FILE NAME: S08-Pump Station.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

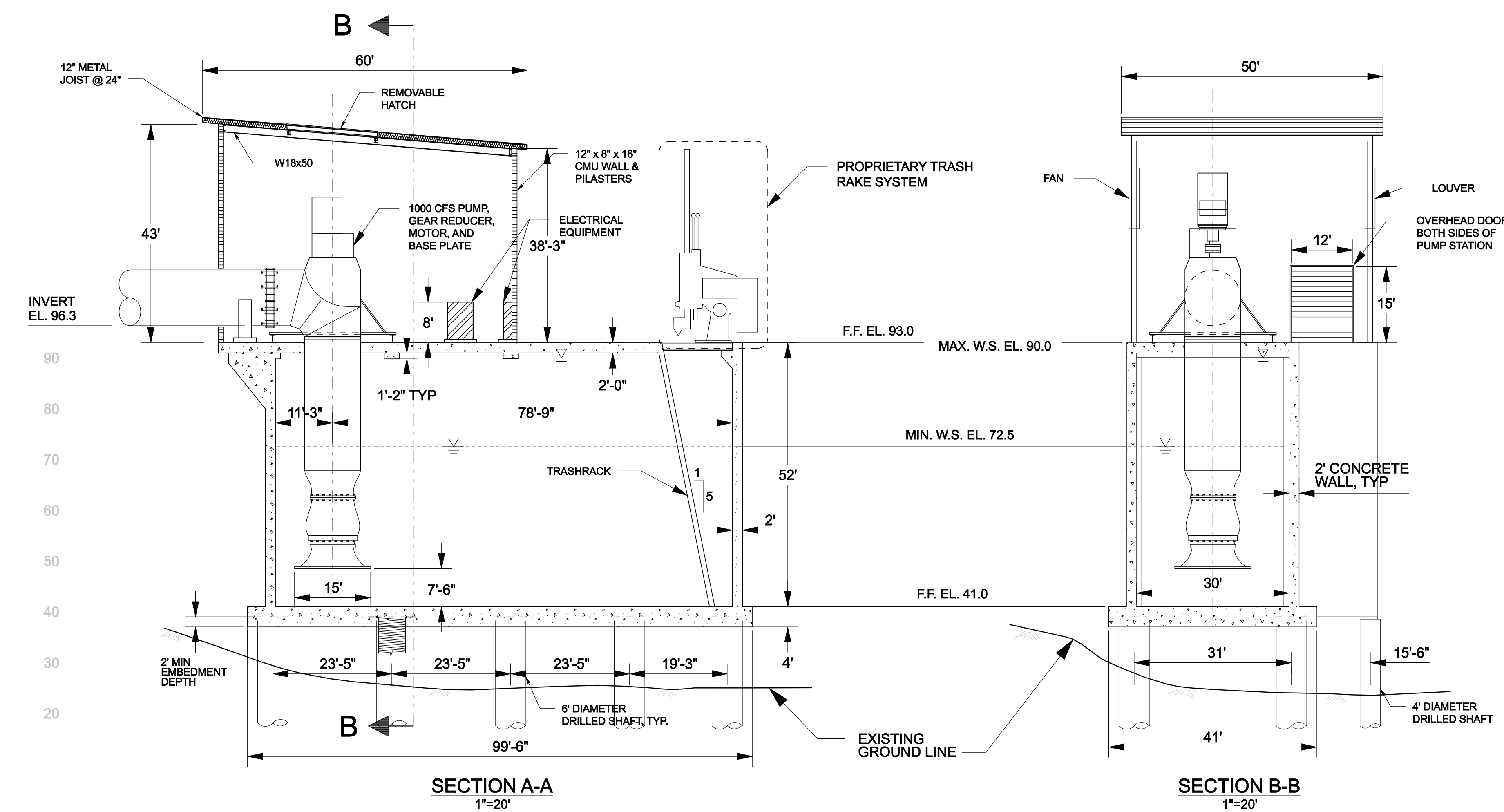
SHEET IDENTIFICATION
8
SHEET 8 OF 20

DATE AND TIME PLOTTED: 4/5/2012 1:02:43 PM

BY USERNAME: NINA SASS

SHEET NAME: SECTION VIEWS SINGLE PUMP PUMP HOUSE ALTERNATIVE #10

DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION



PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

US Army Corps of Engineers® Portland District

SECTION VIEWS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

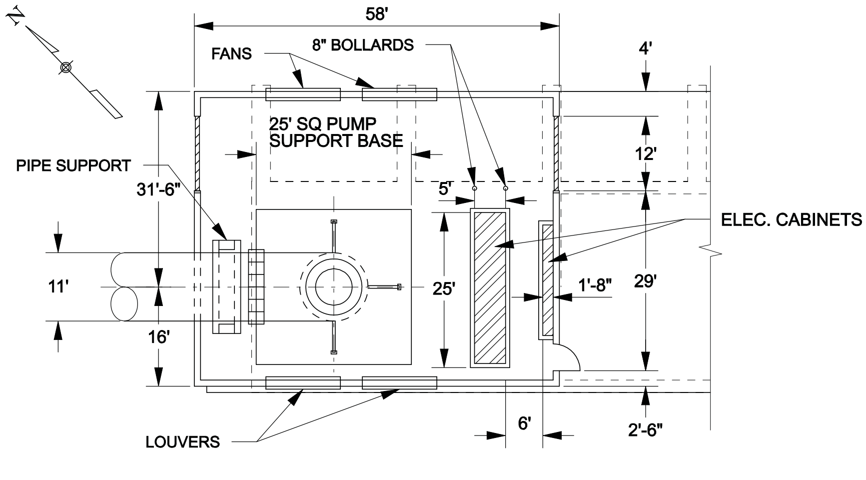
DESIGNED BY: PJG		DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 9
SIZE: 17X11	FILE NAME: S09-Pump Station.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

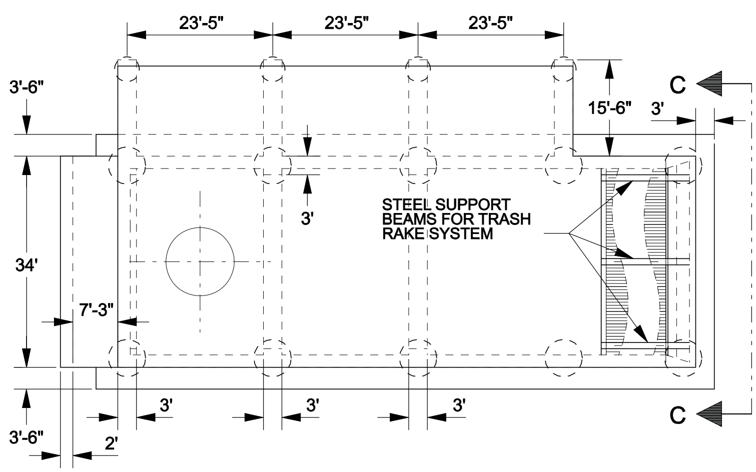
SHEET IDENTIFICATION
9
SHEET 9 OF 20

DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION

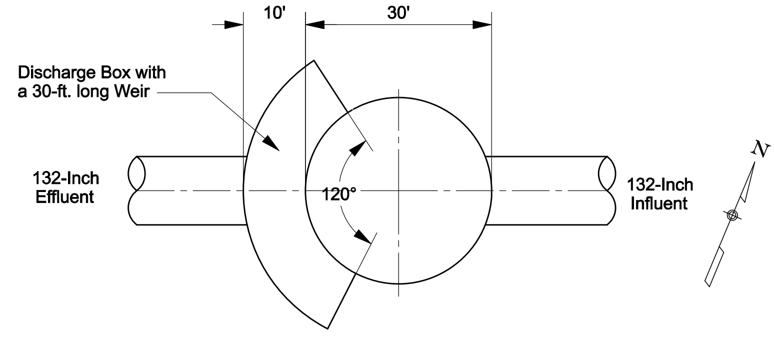
DATE AND TIME PLOTTED: 4/5/2012 1:05:37 PM
BY USERNAME: NINA SASS
SHEET NAME: SECTION VIEWS SINGLE PUMP PUMP HOUSE ALTERNATIVE #10



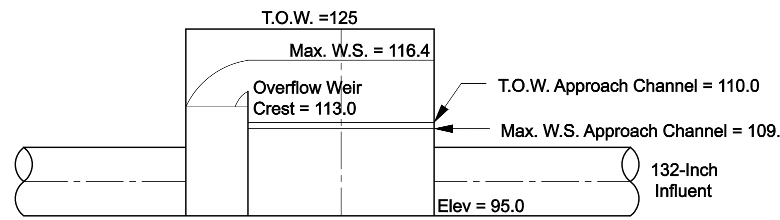
PLAN @ EL. 123.0
1"=20'



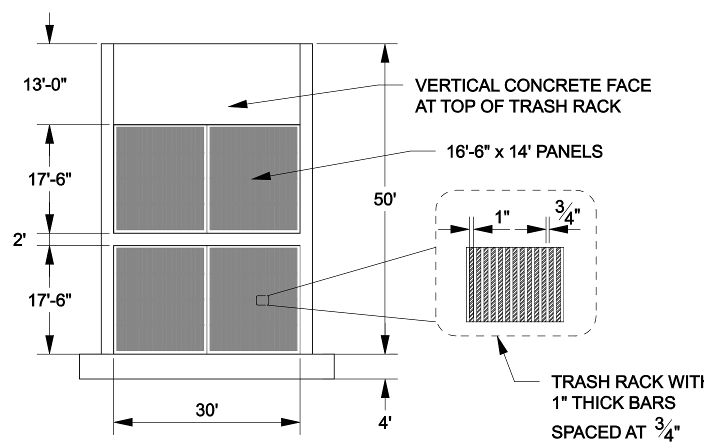
PLAN @ EL. 93.0
1"=20'



JUNCTION TOWER STRUCTURE
1"=20'



JUNCTION TOWER PROFILE ALONG PIPE CENTERLINE
1"=20'



SECTION C-C
1"=20'

US Army Corps
of Engineers®
Portland District

SECTION VIEWS AND DETAILS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: PJG	DATE: January 25, 2012
DWN BY: N.S	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 10
SIZE: 17X11	FILE NAME: S10-Pump Station.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
10
SHEET 10 OF 20

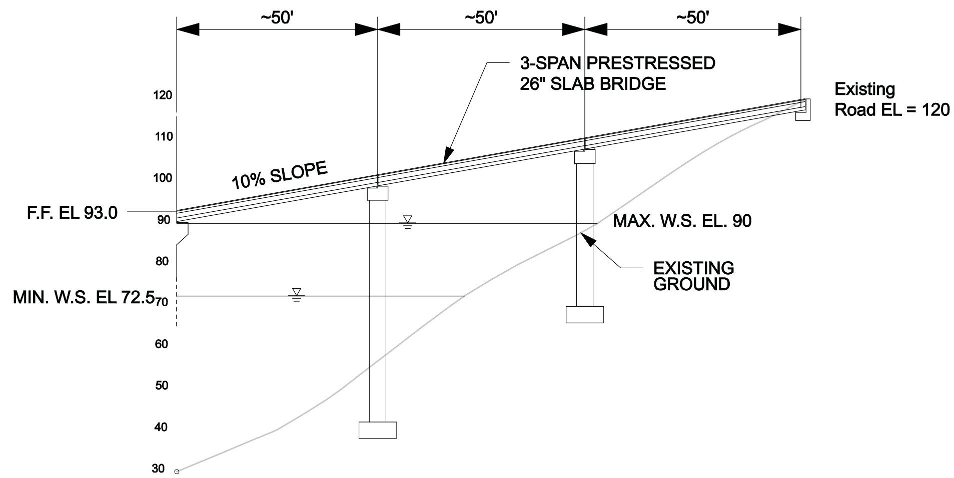
PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DATE AND TIME PLOTTED: 4/6/2012 9:23:24 AM

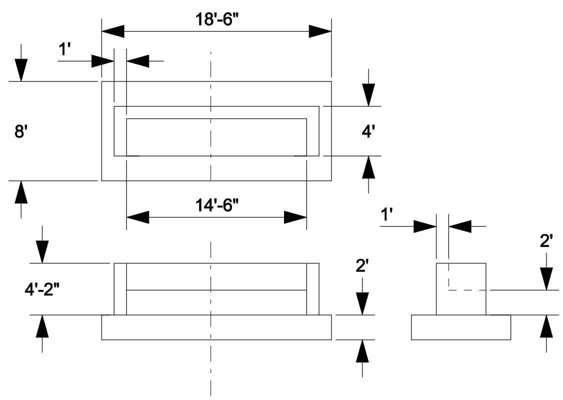
BY USERNAME: NINA SASS

SHEET NAME: SECTION VIEWS AND DETAILS ALTERNATIVE #10 SINGLE PUMP PUMP HOUSE

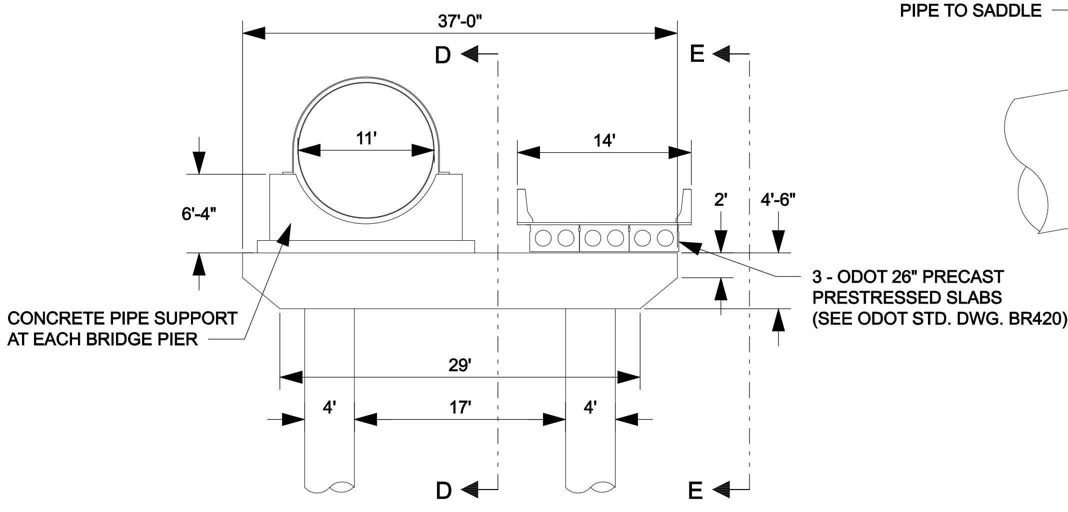
DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION



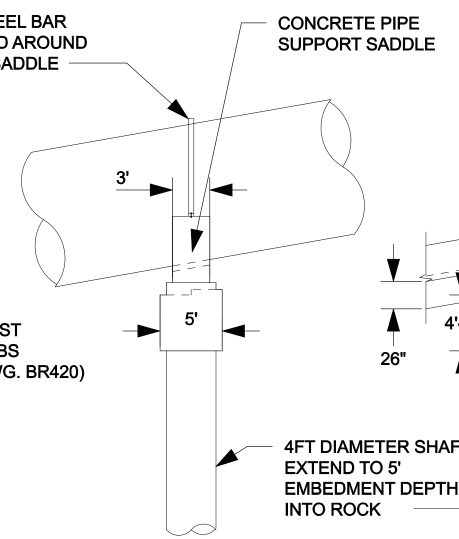
BRIDGE PROFILE
SCALE 1" = 30'



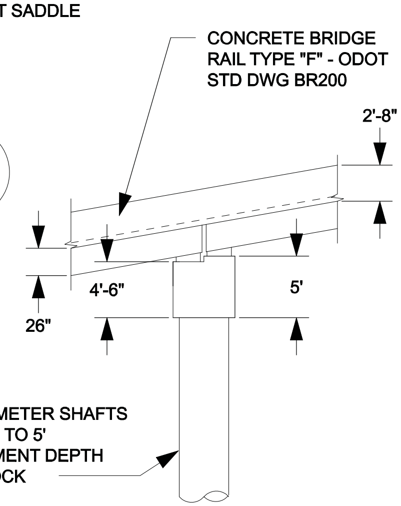
BRIDGE ABUTMENT LAYOUT
SCALE 1" = 10'



BRIDGE PIER CROSS SECTION
SCALE 1" = 10'



SECTION D-D
SCALE 1" = 10'



SECTION E-E
SCALE 1" = 10'

US Army Corps
of Engineers®
Portland District

BRIDGE DETAILS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

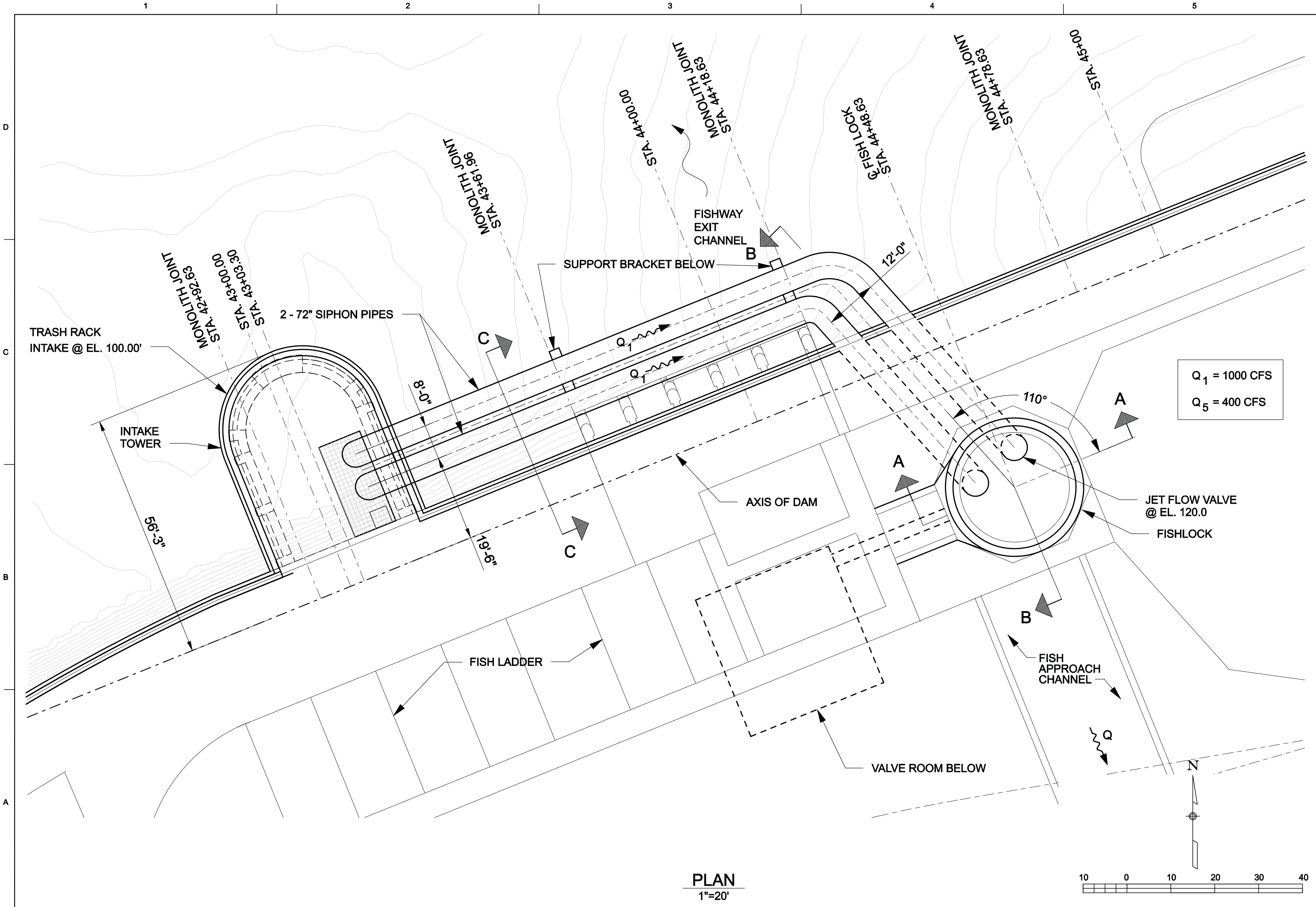
DESIGNED BY: PJG		DATE: January 25, 2012	
DWN BY: N.S	CKD BY: RCM		
SUBMITTED BY: RCM			
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 11	
SIZE: 17X11	FILE NAME: S11-Pump Station.dgn		

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
11
SHEET 11 OF 20



PLAN
1"=20'

DATE AND TIME PLOTTED: 4/5/2012 1:45:14 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #11

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

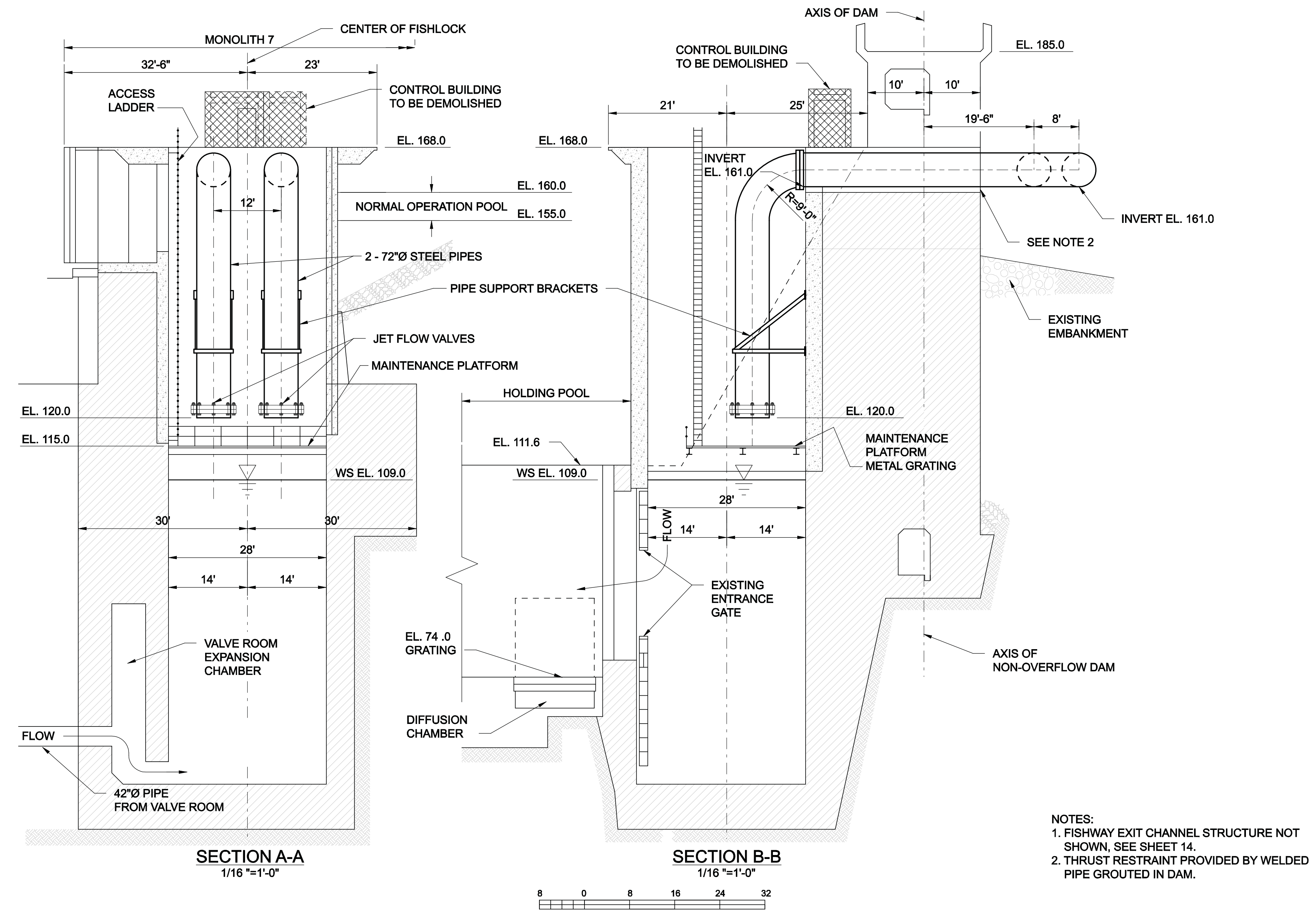
DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 12
SIZE: 17X11	FILE NAME: S12-Siphon Alt 11 Plan.DGN

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
12
SHEET 12 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



NOTES:
1. FISHWAY EXIT CHANNEL STRUCTURE NOT SHOWN, SEE SHEET 14.
2. THRUST RESTRAINT PROVIDED BY WELDED PIPE GROUTED IN DAM.

US Army Corps of Engineers® Portland District

SECTIONS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

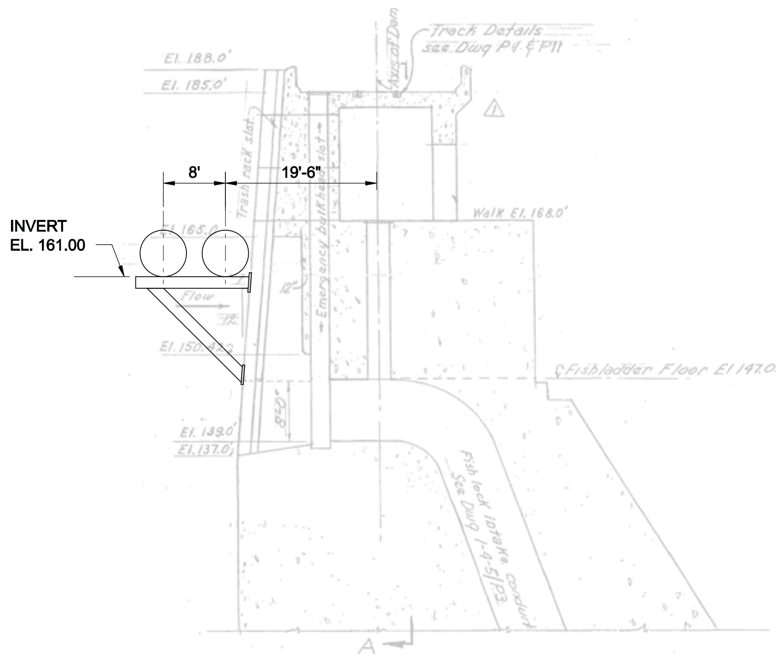
DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 13
SIZE: 17X11	FILE NAME: S13-Siphon Alt 11 Section.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
13
SHEET 13 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DATE AND TIME PLOTTED: 4/6/2012 9:28:28 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



SECTION C-C
1/16 "=1'-0"

8 0 8 16 24 32

US Army Corps of Engineers®
Portland District

DETAILS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S03-Siphon-Alternative 11.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
14
SHEET 14 OF 20

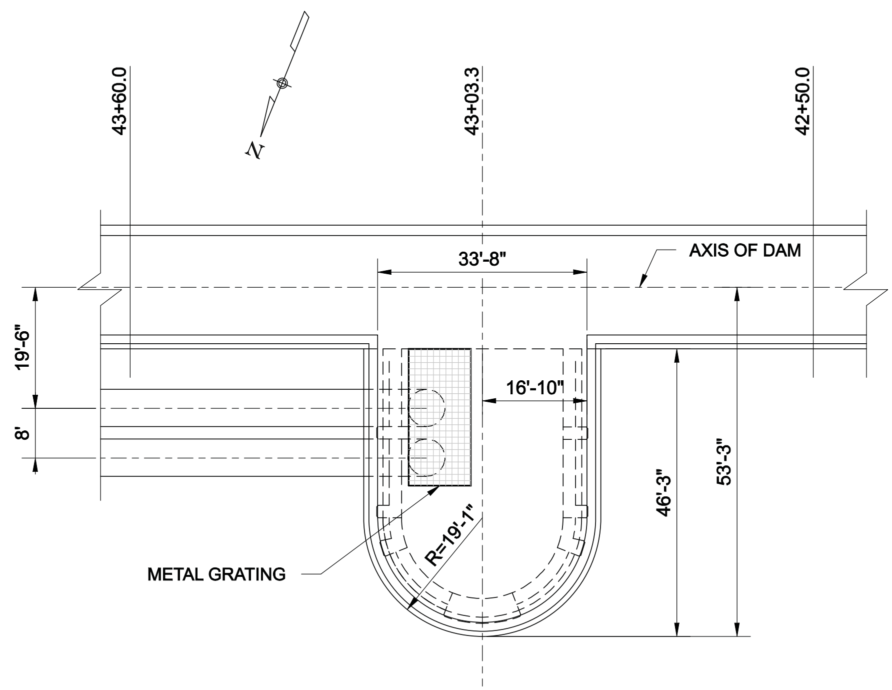
PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

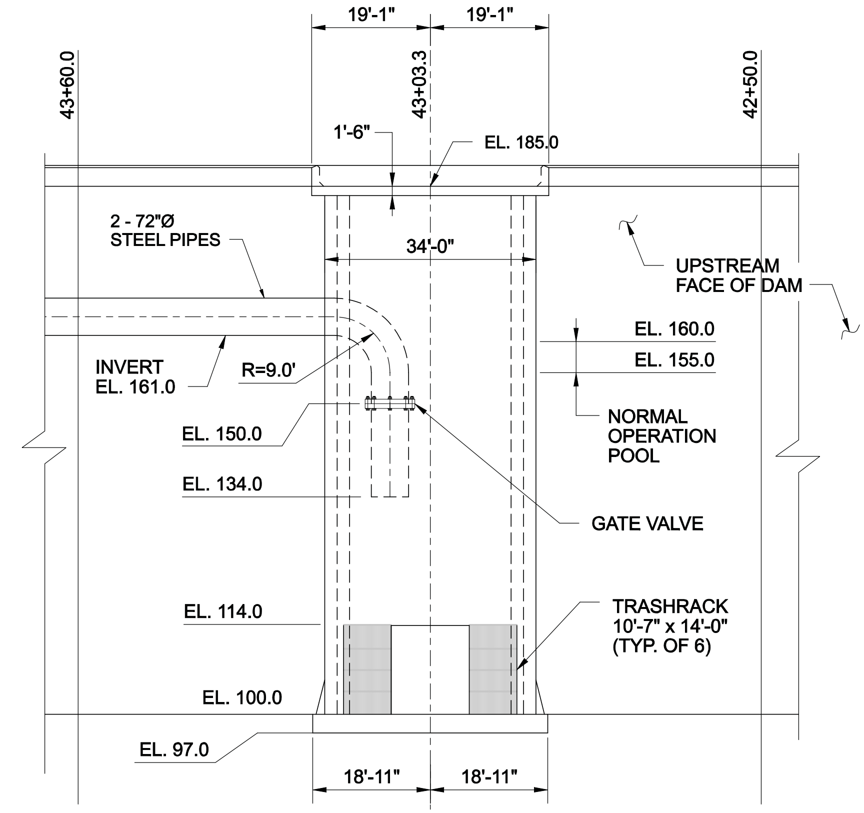
DATE AND TIME PLOTTED: 4/5/2012 1:55:46 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: DETAILS SIPHON OPTION ALTERNATIVE 11



INTAKE TOWER PLAN
1"=20'



INTAKE TOWER ELEVATION
1"=20'

US Army Corps of Engineers®
Portland District

INTAKE TOWER
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S15-Siphon Alt 11 Intake.dgn	

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

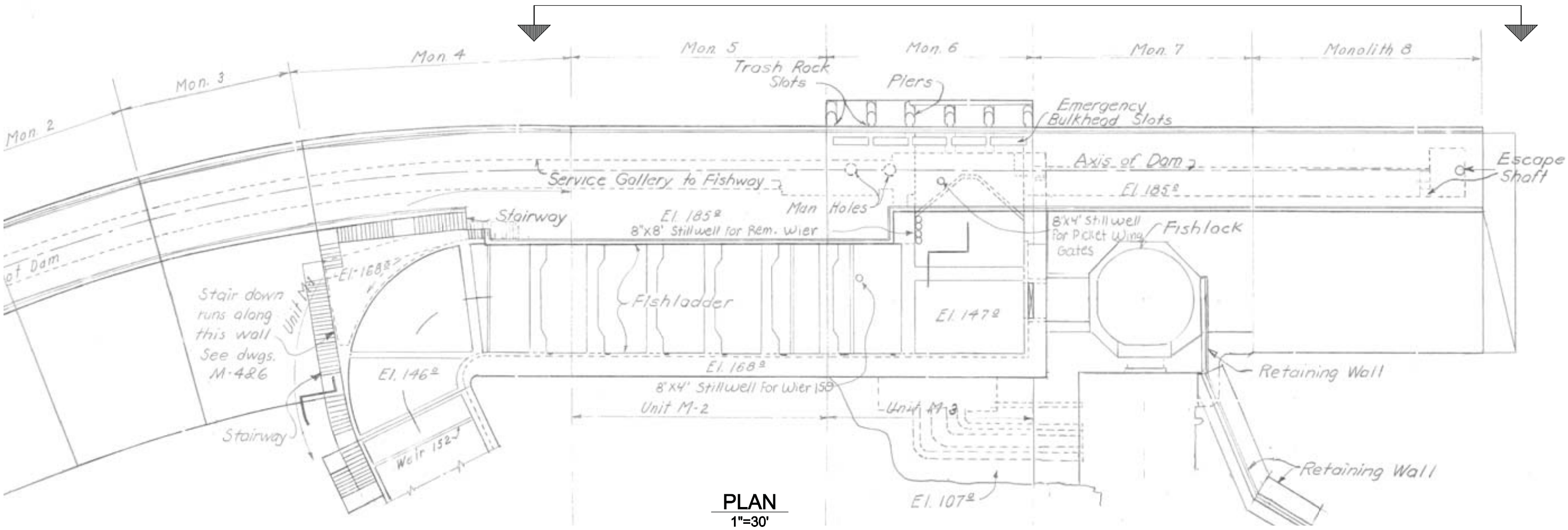
SHEET IDENTIFICATION
15
SHEET 15 OF 20

DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION

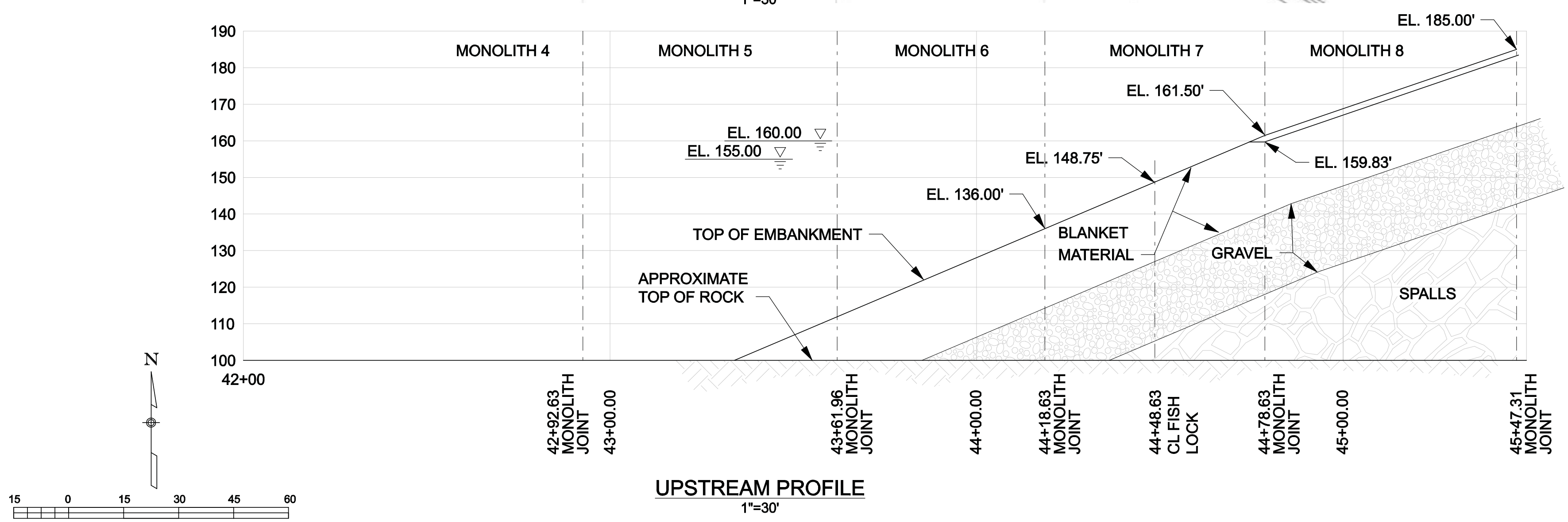
DATE AND TIME PLOTTED: 4/5/2012 2:34:33 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #11



PLAN
1"=30'



UPSTREAM PROFILE
1"=30'

US Army Corps of Engineers® Portland District

GENERAL PLAN AND PROFILE

DESIGNED BY: JPG | DATE: January 25, 2012
DWN BY: TTN | CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 16
SIZE: 17X11 | FILE NAME: S16-Siphon Plan Profile.dgn

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
16
SHEET 16 OF 20

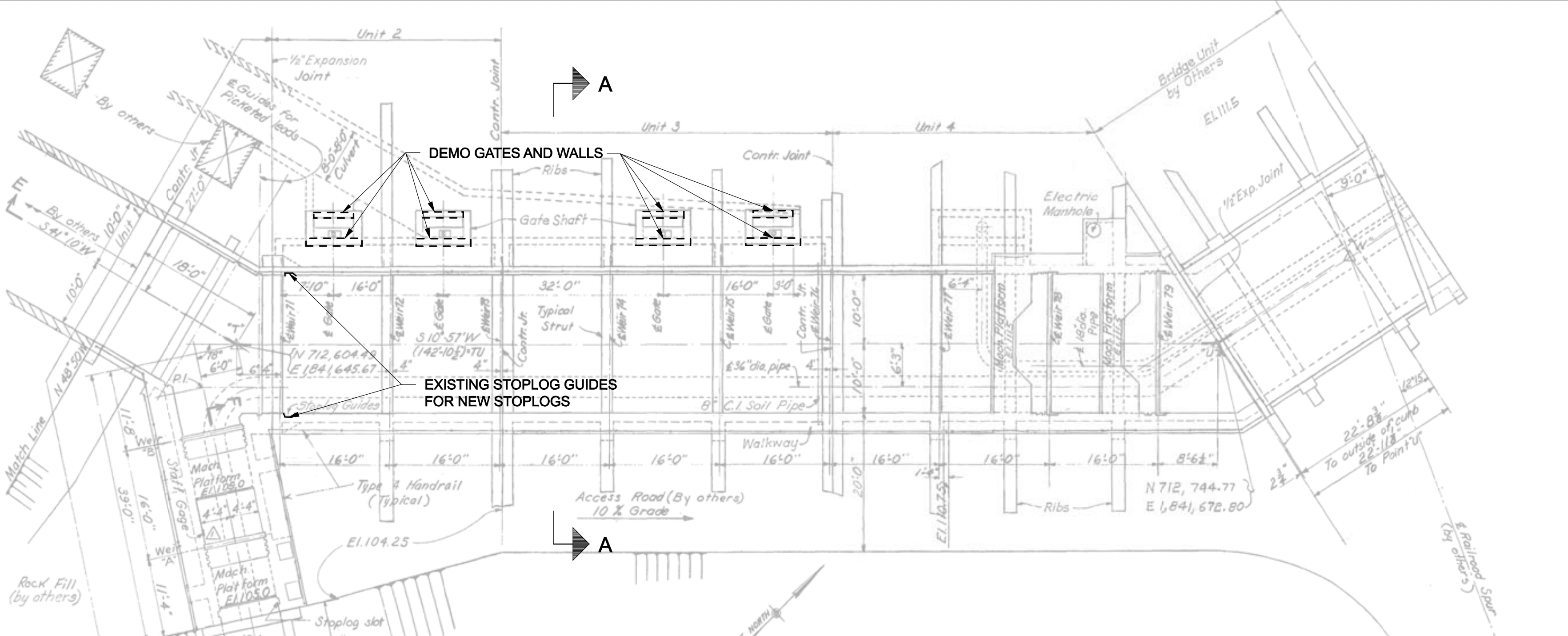
PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

DATE AND TIME PLOTTED: 4/5/2012 2:36:44 PM

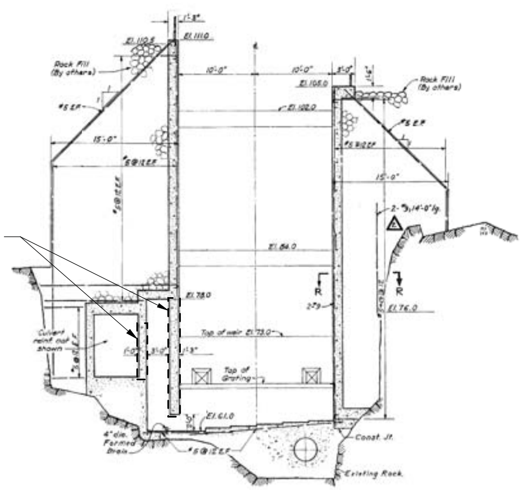
BY USERNAME: TAM NGUYEN

SHEET NAME: PLAN AND PROFILE EMBANKMENT ALTERNATIVE #1



FISHLOCK APPROACH CHANNEL PLAN

1/16 "=1'-0"



SECTION A-A

1/16 "=1'-0"

8 0 8 16 24 32

US Army Corps of Engineers® Portland District

FISHLOCK APPROACH
CHANNEL MODIFICATIONS
PLAN AND SECTION

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 17	
SIZE: 17X11	FILE NAME: S17-Fishlock Approach Channel Mods.dgn

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

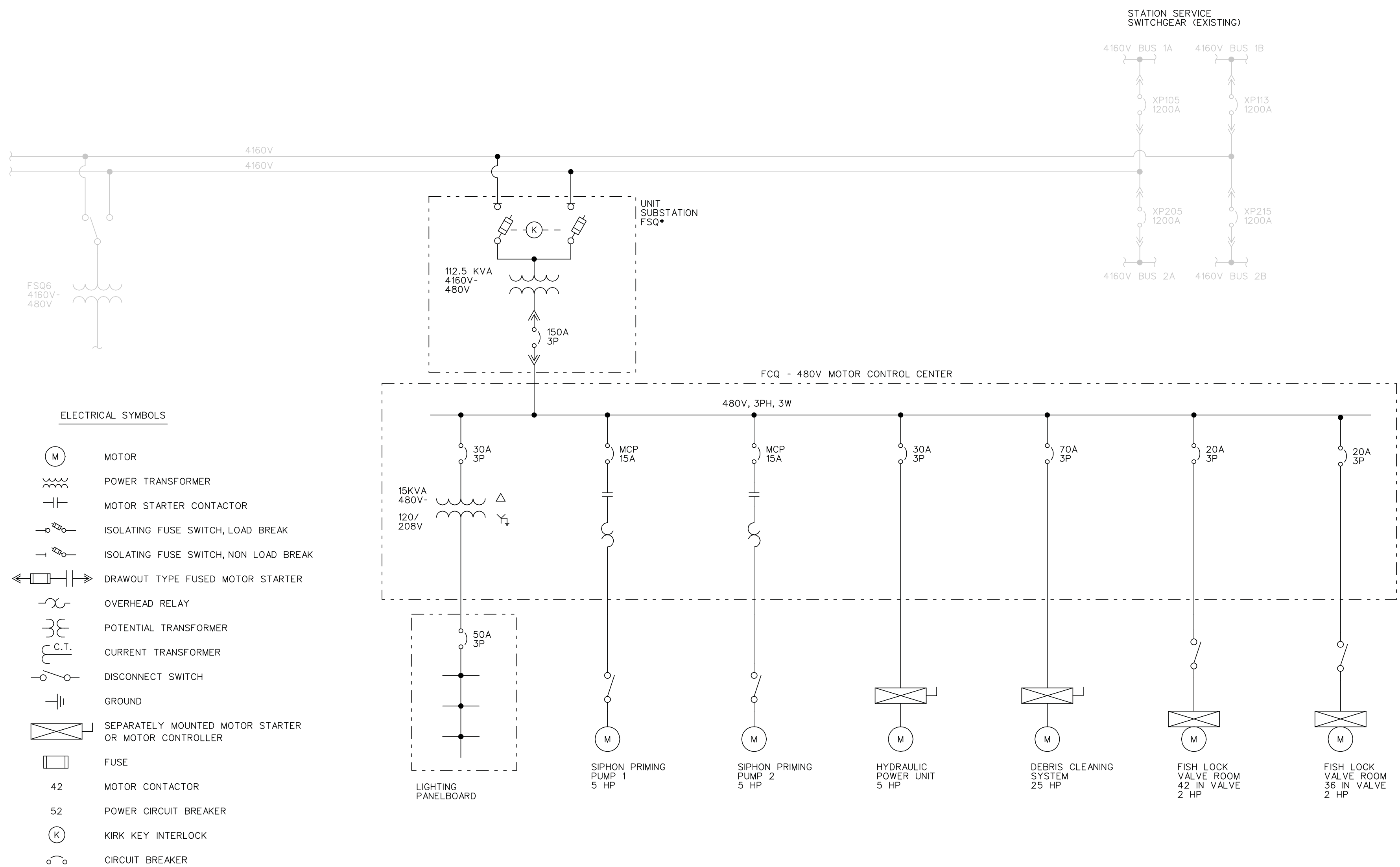
SHEET IDENTIFICATION
17
SHEET 17 OF 20

DATE AND TIME PLOTTED: 4/5/2012 2:44:17 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: FISHLOCK CHANNEL MODIFICATIONS PLAN AND SECTION

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



ALTERNATIVE •1 - SIPHON FOR ADDITIONAL WATER TO THE FISH LOCK

ALTERNATIVE •11 - UPSTREAM INTAKE TOWER WITH SIPHON

US Army Corps of Engineers® Portland District

ALTERNATIVES #1 AND #11
ELECTRICAL ONE-LINE DIAGRAMS

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

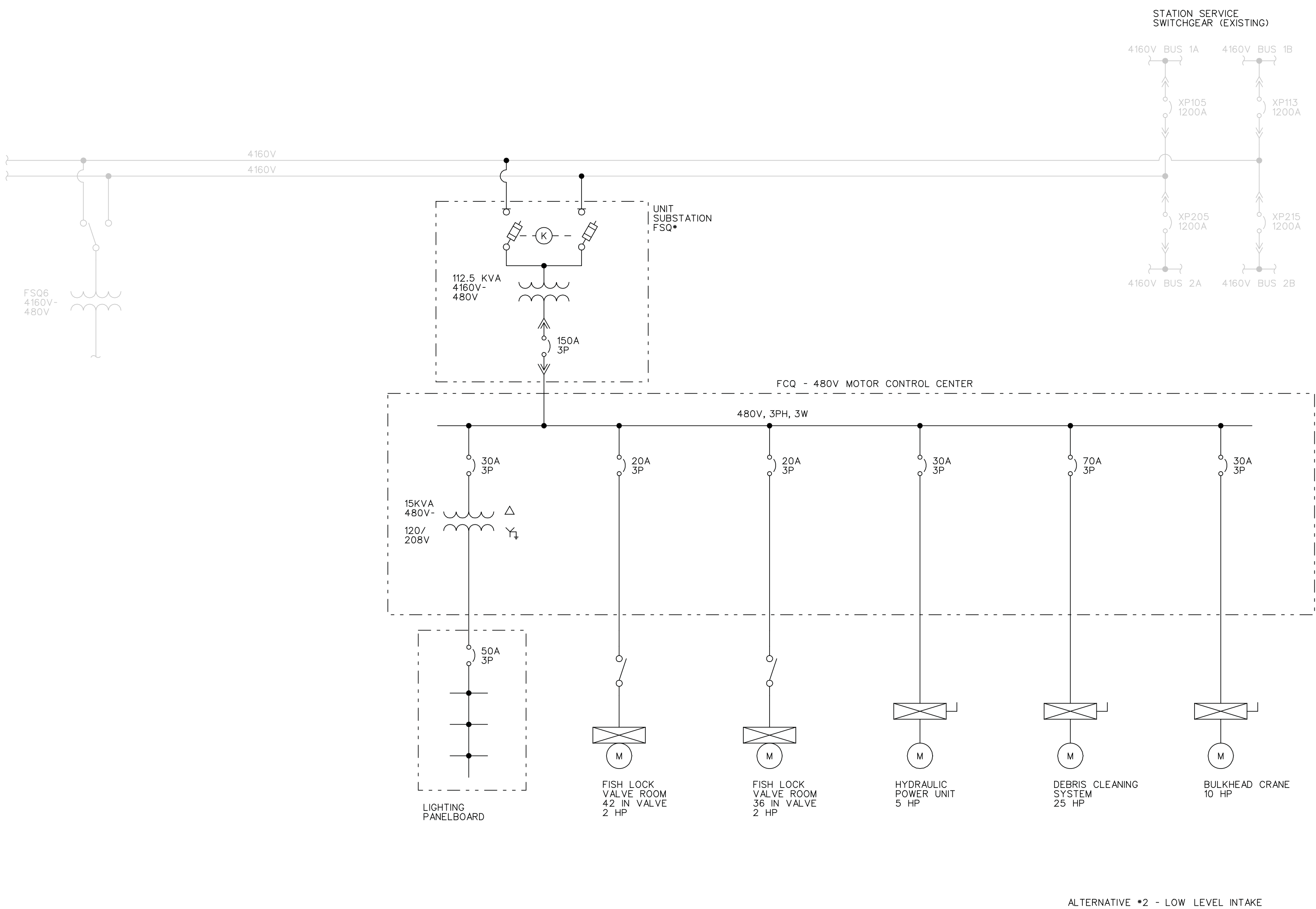
DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 18
SIZE: 17X11	FILE NAME: S18-Alternative 1 & 11.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
18
SHEET 18 OF 20

DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

DATE AND TIME PLOTTED: 4/5/2012 2:47:17 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: ALTERNATIVES •1 AND •11 - ELECTRICAL ONE-LINE DIAGRAMS



US Army Corps of Engineers® Portland District

ALTERNATIVE #2
ELECTRICAL ONE-LINE DIAGRAMS

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 19
SIZE: 17X11	FILE NAME: S19-Alternative 2.DGN	

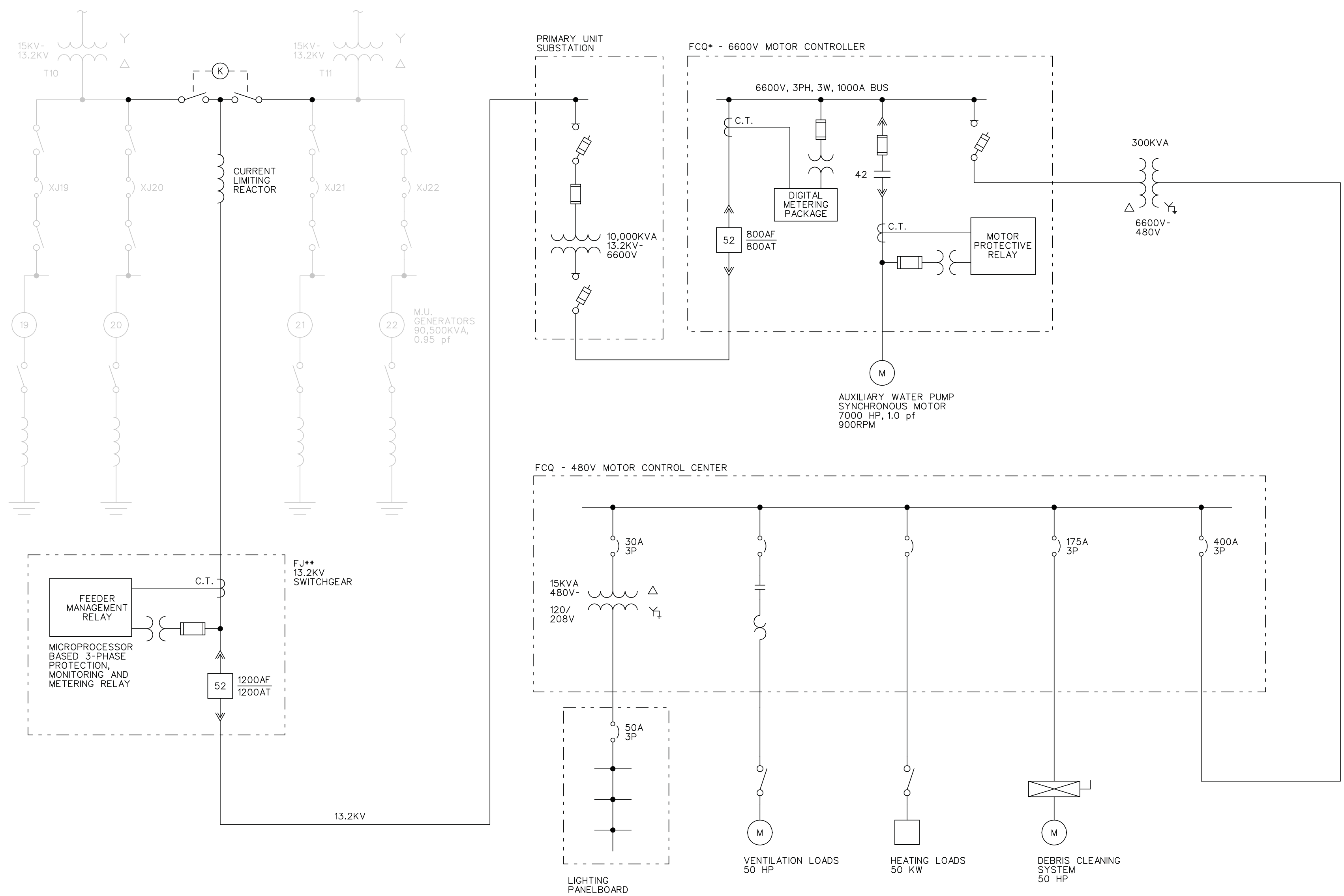
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
19
SHEET 19 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

DATE AND TIME PLOTTED: 4/5/2012 2:49:08 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: ALTERNATIVES *1 AND *11 - ELECTRICAL ONE-LINE DIAGRAMS



ALTERNATIVE *10 - SINGLE PUMP/PUMP HOUSE ON EAST SIDE OF CUL-DE-SAC

DATE AND TIME PLOTTED: 4/5/2012 2:52:38 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVE *10 - ELECTRICAL ONE-LINE DIAGRAM

US Army Corps of Engineers® Portland District

ALTERNATIVE #10
ELECTRICAL ONE-LINE DIAGRAM

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 20
SIZE: 17X11	FILE NAME: S20-Alternative 10.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
20
SHEET 20 OF 20

PREPARED FOR 60& SUBMITTAL W/ MINOR REVISIONS FOR 90% SUBMITTAL

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

Sheets 21-35

Note: Sheets 21-35 have been prepared for the EDR, 90% submittal, and reflect review comments and meeting discussions since the EDR 60% submittal.

Sheet 21. General Layout of Alternative #2 Low Level Intake (90% Submittal)

Sheet 22. General Layout of Alternative #11 Siphon and Tower (90% Submittal)

Sheet 23. Plan View, Alternative #2 Low Level Intake (90% Submittal)

Sheet 24. Section View, Alternative #2 Low Level Intake (90% Submittal)

Sheet 25. Plan, Elevations, and Section, Alternative #2 Low Level Intake Trashrack and Cofferdam (90% Submittal)

Sheet 26. Plan View, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 27. Sections, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 28. Details, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 29. Intake Tower, Alternative #11 Intake Tower with Siphon to Fishlock (90% Submittal)

Sheet 30. Fishlock Approach Channel Modifications Plan and Section

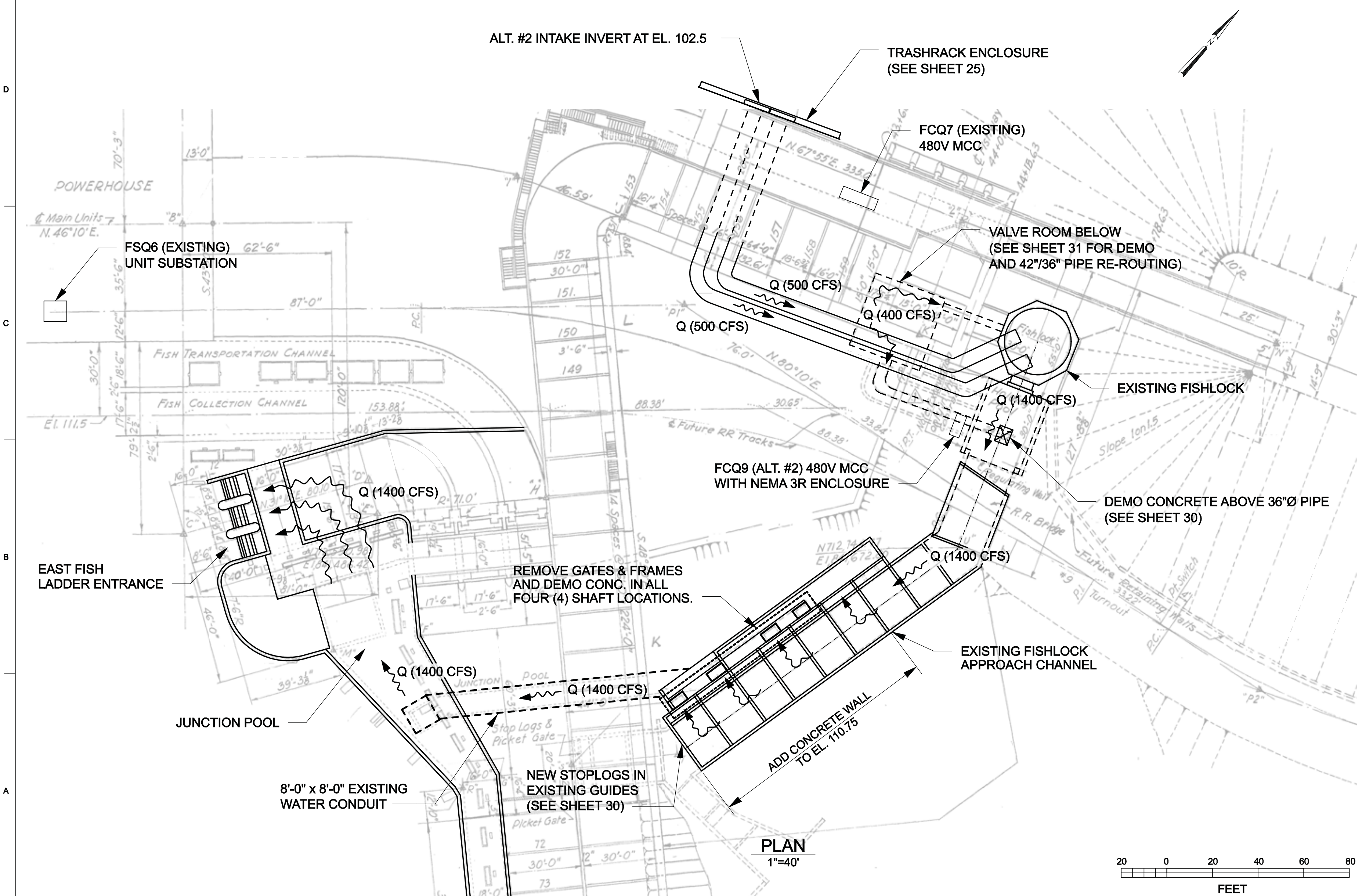
Sheet 31. Valve Room Demolition Plan

Sheet 32. Valve Room Mechanical Plan

Sheet 33. Fishlock Valve Room Electrical One-Line Diagram

Sheet 34. Alternative #2 Electrical One-Line Diagram

Sheet 35. Alternative #11, Electrical One-Line Diagram



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GENERAL LAYOUT OF ALTERNATIVE #2
LOW LEVEL INTAKE

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 21
SIZE: 17X11	FILE NAME: S21-Layout Alt2.dgn	

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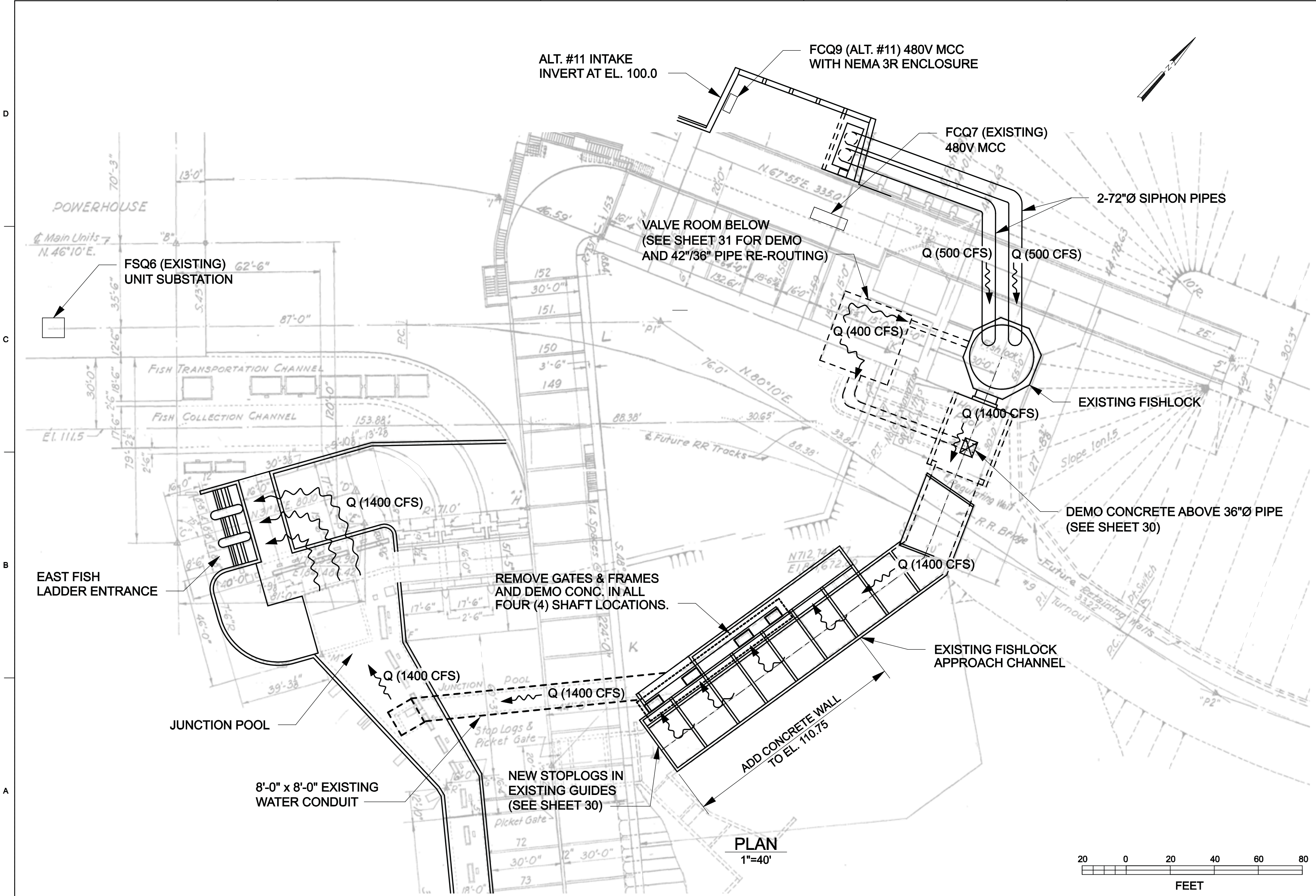
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
21
SHEET 21 OF 35

DATE AND TIME PLOTTED: 4/5/2012 2:58:35 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: TYPICAL FLOW PATH - GENERAL PLAN VIEW
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



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GENERAL LAYOUT OF ALTERNATIVE #11
SIPHON & TOWER

PREPARED FOR 90% SUBMITTAL

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PORTLAND DISTRICT
PORTLAND, OREGON

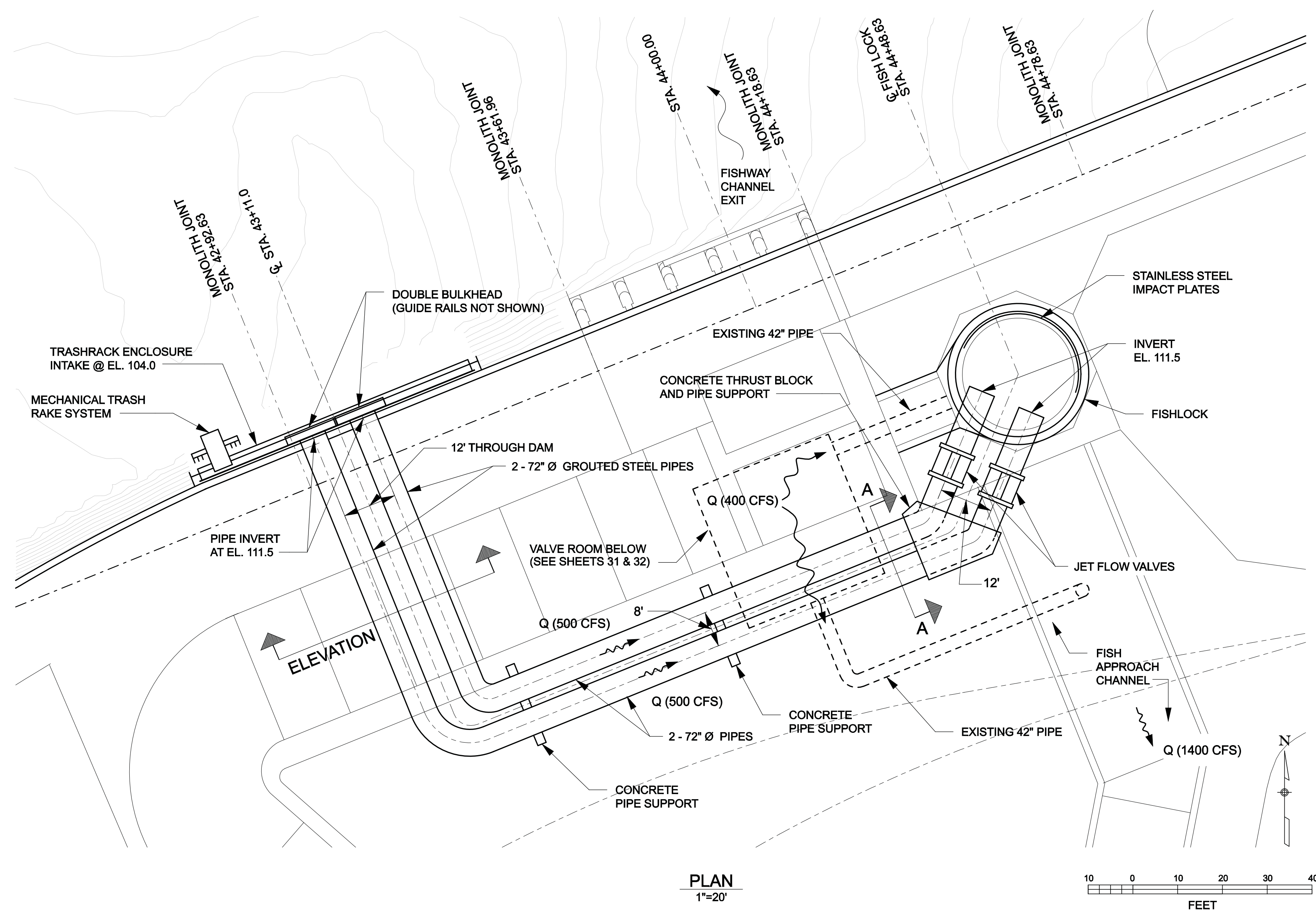
HDR ENGINEERING INC.

DESIGNED BY: JPG | DATE: March 19, 2012
DWN BY: HG | CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 22
SIZE: 17X11 | FILE NAME: S22-Layout Alt 11.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
22
SHEET 22 OF 35

DATE AND TIME PLOTTED: 4/5/2012 3:02:55 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: TYPICAL FLOW PATH - GENERAL PLAN VIEW
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1"=20'

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PLAN VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

PREPARED FOR 90% SUBMITTAL

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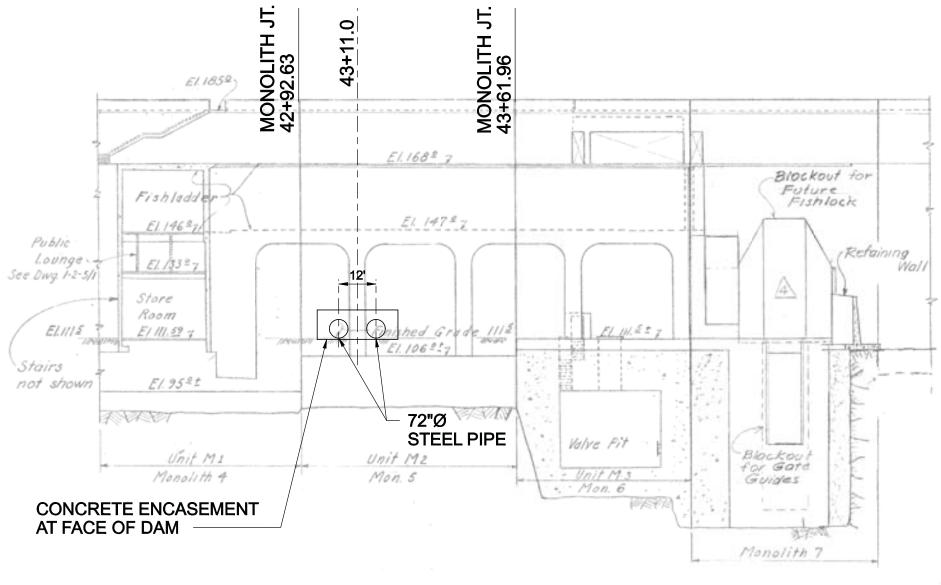
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE: 23	DRAWING NUMBER:
SIZE: 17X11	FILE NAME: S23-Alt 2 Plan.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
23
SHEET 23 OF 35

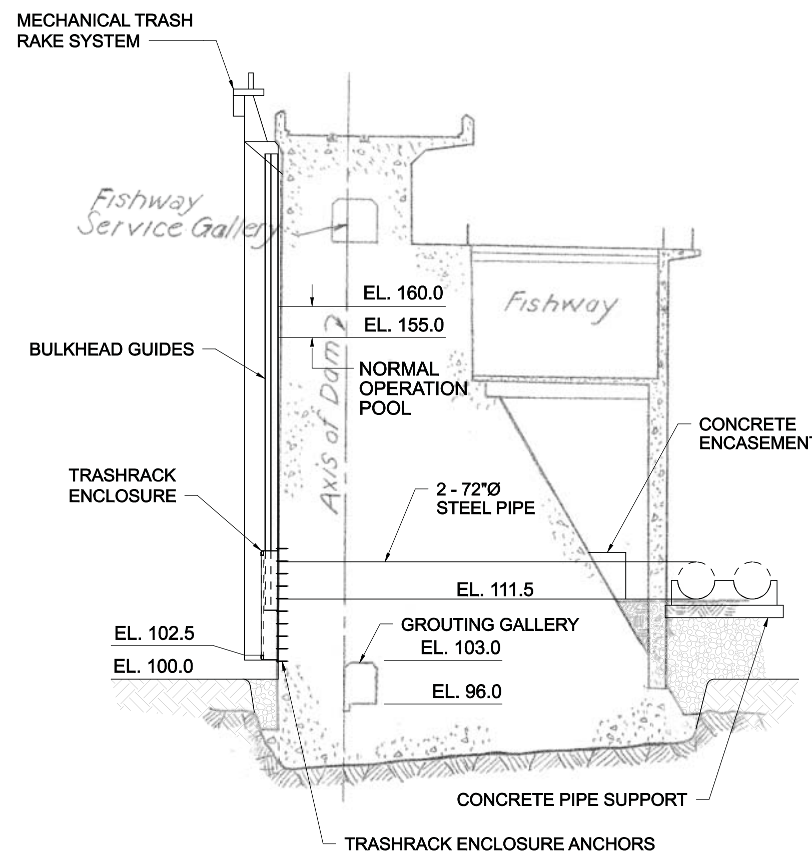
DATE AND TIME PLOTTED: 4/5/2012 3:19:53 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN VIEW LOW LEVEL INTAKE

DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



ELEVATION - EAST NON-OVERFLOW DAM

1"=40'



SECTION A-A

1"=20'

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SECTION VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 24
SIZE: 17X11	FILE NAME: S24-Low Level Intake Section.dgn	

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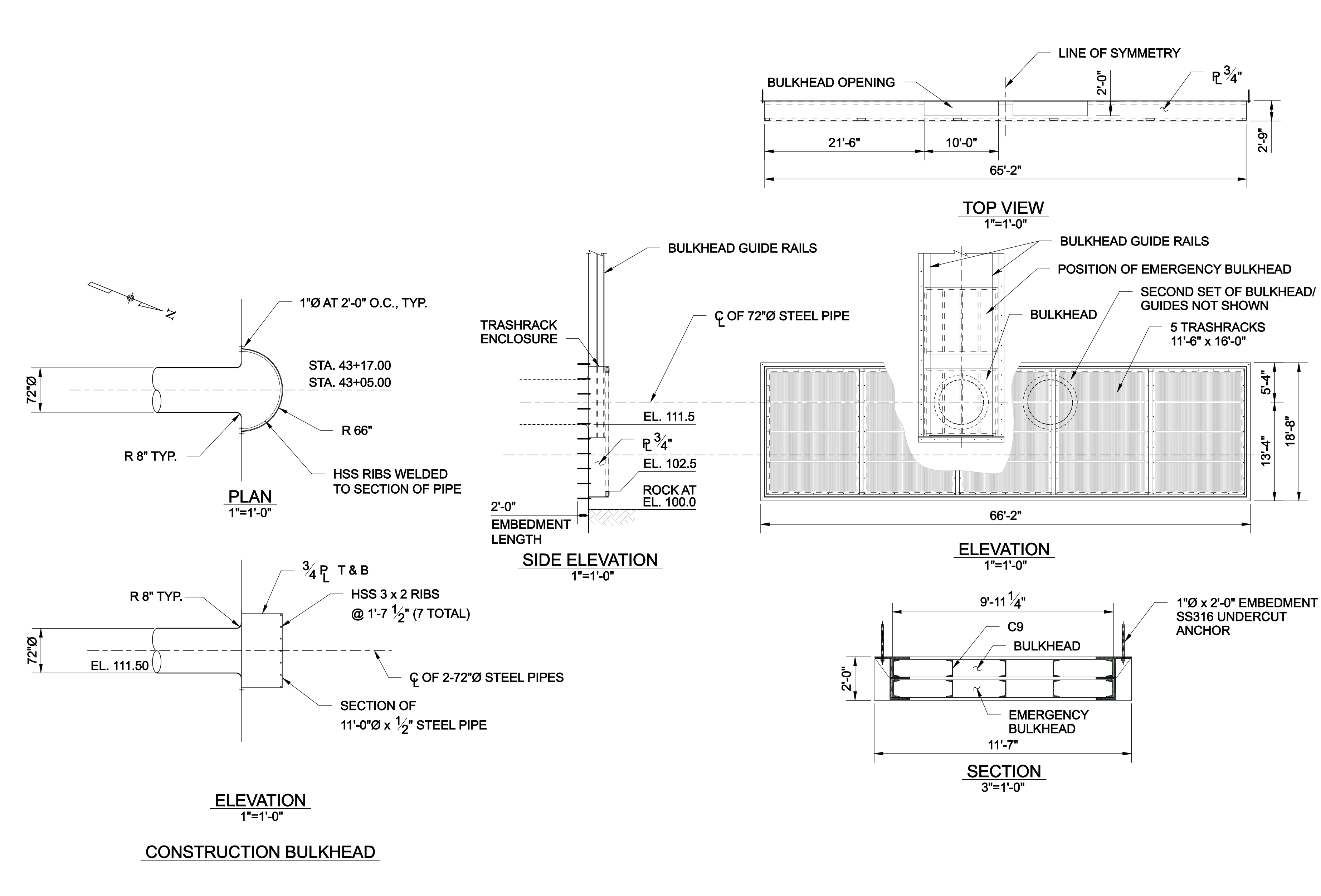
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
24
SHEET 24 OF 35

DATE AND TIME PLOTTED: 4/6/2012 9:35:35 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW LOW LEVEL OPTION
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



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PLAN, ELEVATIONS, AND SECTION
ALTERNATIVE #2
LOW LEVEL INTAKE
TRASHRACK AND COFFERDAM

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 25
SIZE: 17X11	FILE NAME: S25-Low Level Intake Detail.dgn	

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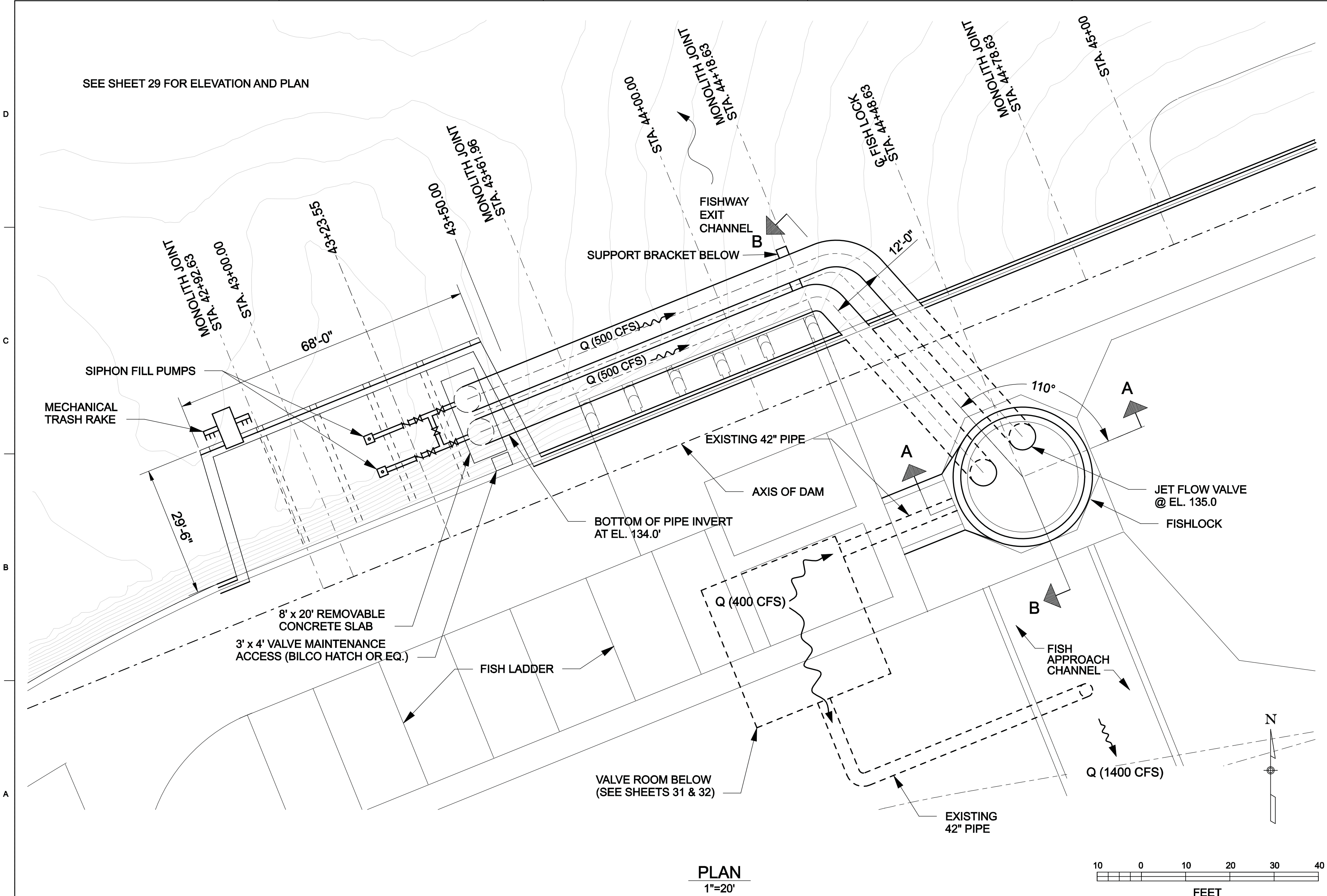
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
25
SHEET 25 OF 35

DATE AND TIME PLOTTED: 4/6/2012 9:33:40 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAIL LOW LEVEL OPTION CONSTRUCTION COFFERDAM
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



PLAN
1"=20'

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PLAN VIEW
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

PREPARED FOR 90% SUBMITTAL

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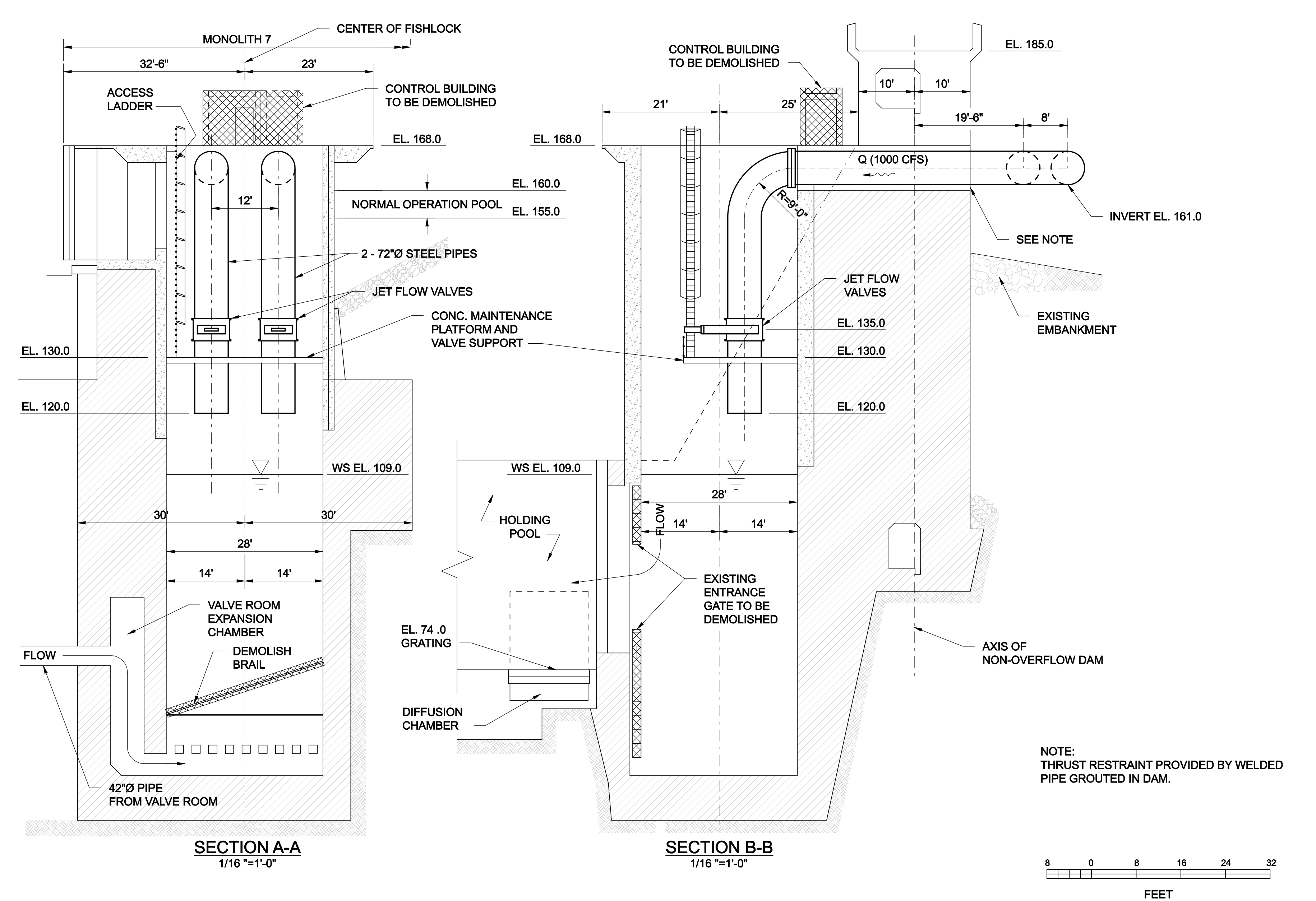
DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 26
SIZE: 17X11	FILE NAME: S26-Siphon Alt 11 Plan.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
26
SHEET 26 OF 35

DATE AND TIME PLOTTED: 4/5/2012 3:52:18 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



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SECTIONS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 27
SIZE: 17X11	FILE NAME: S27-Siphon Alt 11 Section.dgn	

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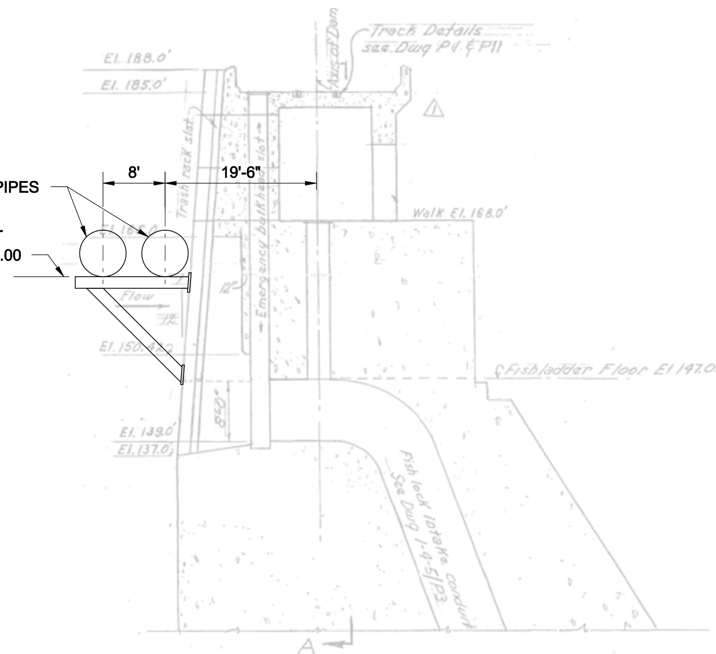
HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
27
SHEET 27 OF 35

DATE AND TIME PLOTTED: 4/6/2012 9:30:43 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



SECTION C-C
1/16 "=1'-0"

8 0 8 16 24 32
FEET

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DETAILS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

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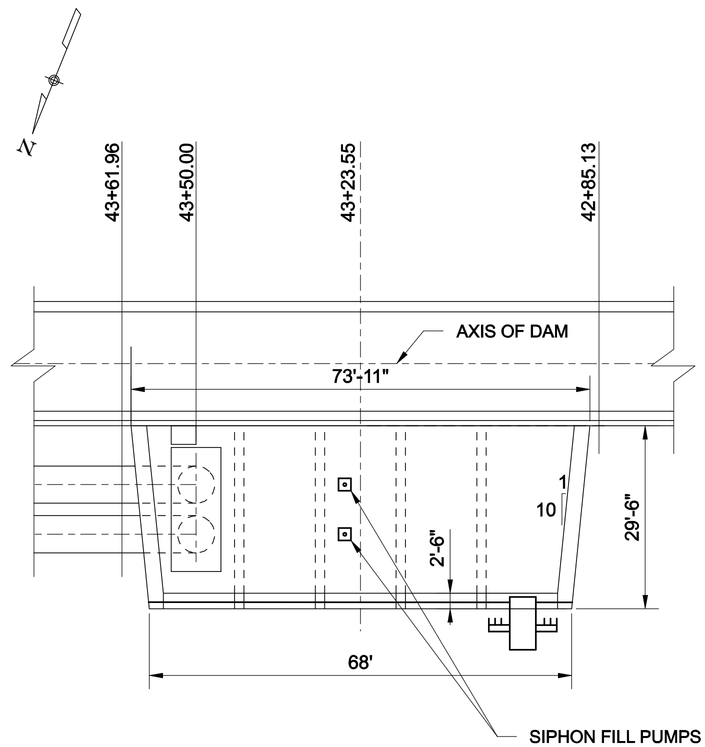
DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 28
SIZE: 17X11	FILE NAME: S28-Siphon-Alternative 11.dgn	

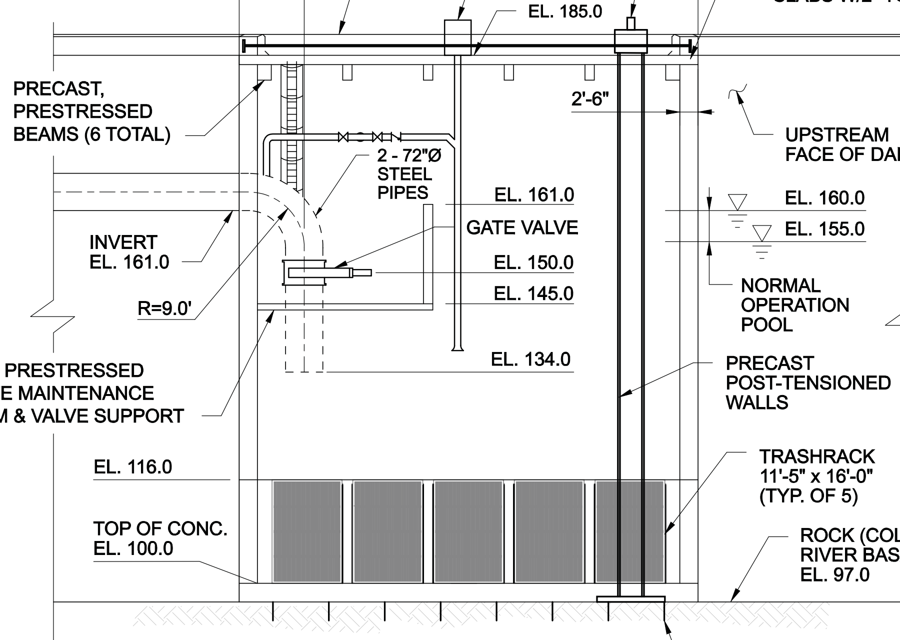
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
28
SHEET 28 OF 35

DATE AND TIME PLOTTED: 4/5/2012 3:59:54 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAILS SIPHON OPTION ALTERNATIVE 11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



INTAKE TOWER PLAN
1"=20'



INTAKE TOWER ELEVATION
1"=20'

10 0 10 20 30 40
FEET

US Army Corps of Engineers® Portland District

INTAKE TOWER
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG	DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 29	
SIZE: 17X11	FILE NAME: S29-Siphon Alt 11 Intake.dgn

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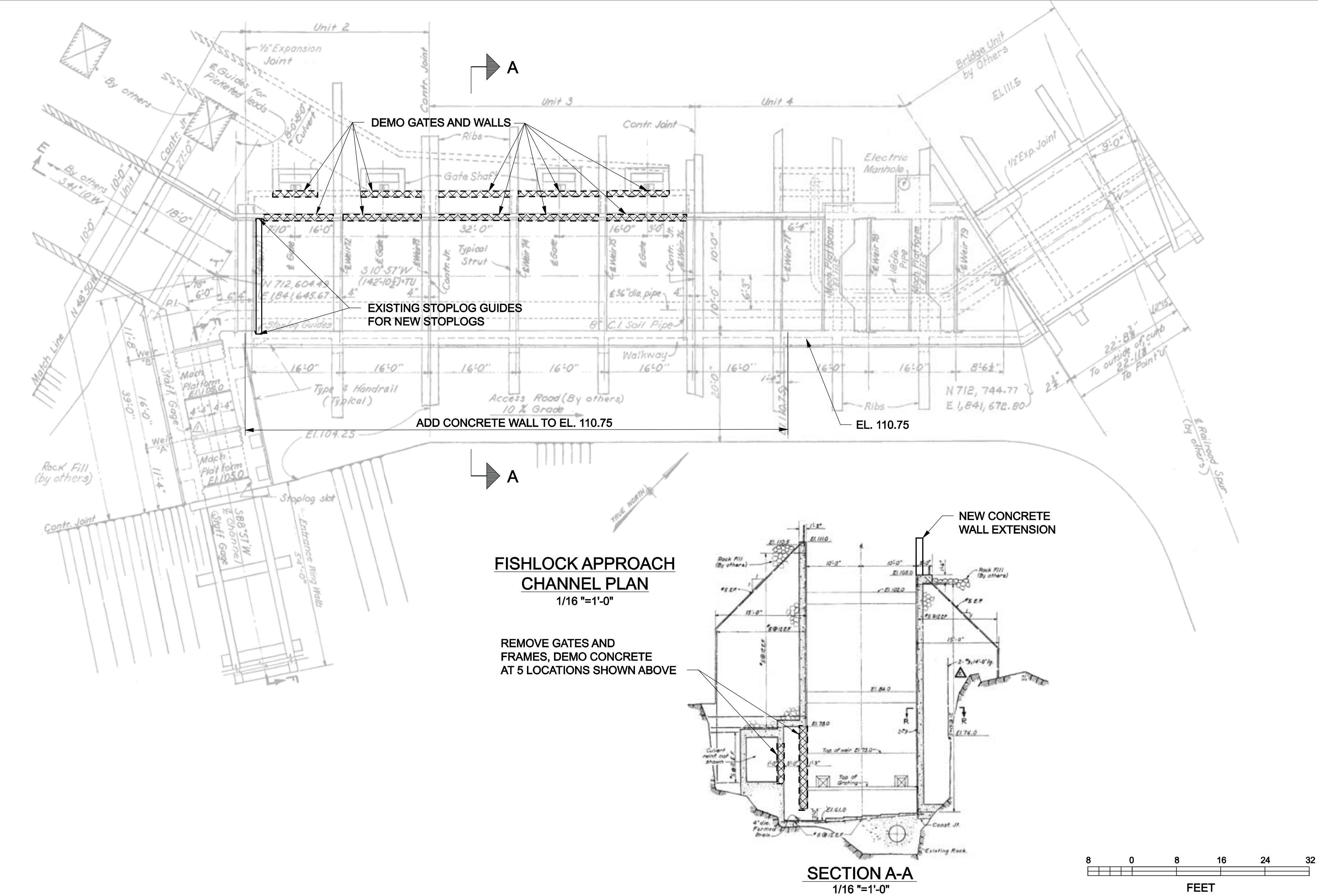
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
29
SHEET 29 OF 35

DATE AND TIME PLOTTED: 4/5/2012 4:11:18 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



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FISHLOCK APPROACH
CHANNEL MODIFICATIONS
PLAN AND SECTION

PREPARED FOR 90% SUBMITTAL

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PORTLAND, OREGON

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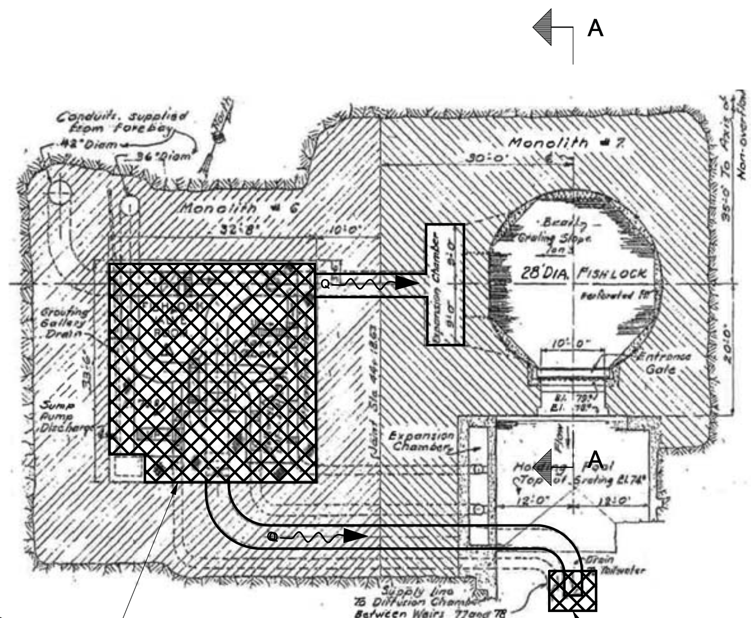
DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 30
SIZE: 17X11	FILE NAME: S30-Fishlock Approach Channel Mods.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
30
SHEET 30 OF 35

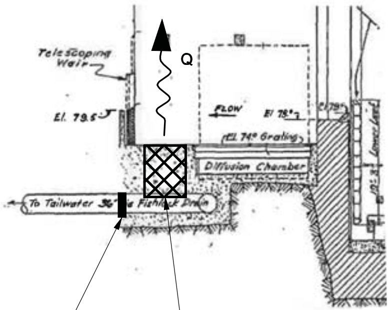
DATE AND TIME PLOTTED: 4/5/2012 4:15:43 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: FISHLOCK CHANNEL MODIFICATIONS PLAN AND SECTION
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



DEMO ALL PIPING, VALVES, PIPE SUPPORTS, PLATFORMS, STAIRS, AND OTHER ACCESSORIES

REMOVE CONCRETE TO EXPOSE EXISTING 36" PIPE

PLAN - EL. 84.0
1" = 20'-0"



INSTALL PLUG IN DOWNSTREAM END OF EXISTING 36" PIPE

REMOVE CONCRETE TO EXPOSE EXISTING 36" PIPE

SECTION A-A
1" = 20'-0"

US Army Corps of Engineers® Portland District

VALVE ROOM DEMOLITION PLAN

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: JPG	DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 31	
SIZE: 17X11	FILE NAME: S31-Valve Room Demo Plan.dgn

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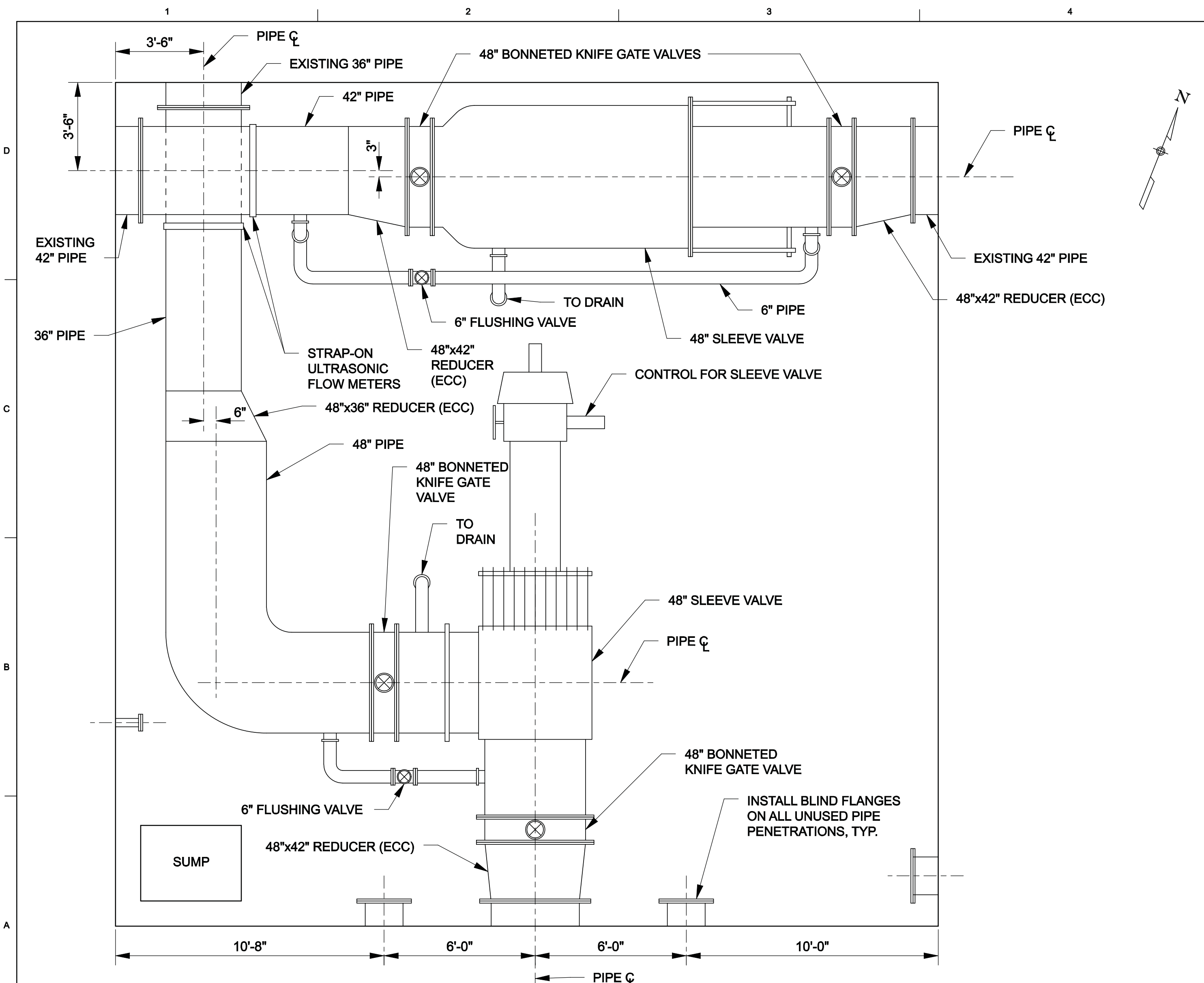
HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
31
SHEET 31 OF 35

DATE AND TIME PLOTTED: 4/5/2012 4:33:25 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN - VALVE ROOM

¼" = 1'-0"

US Army Corps of Engineers® Portland District

VALVE ROOM MECHANICAL PLAN

PREPARED FOR 90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

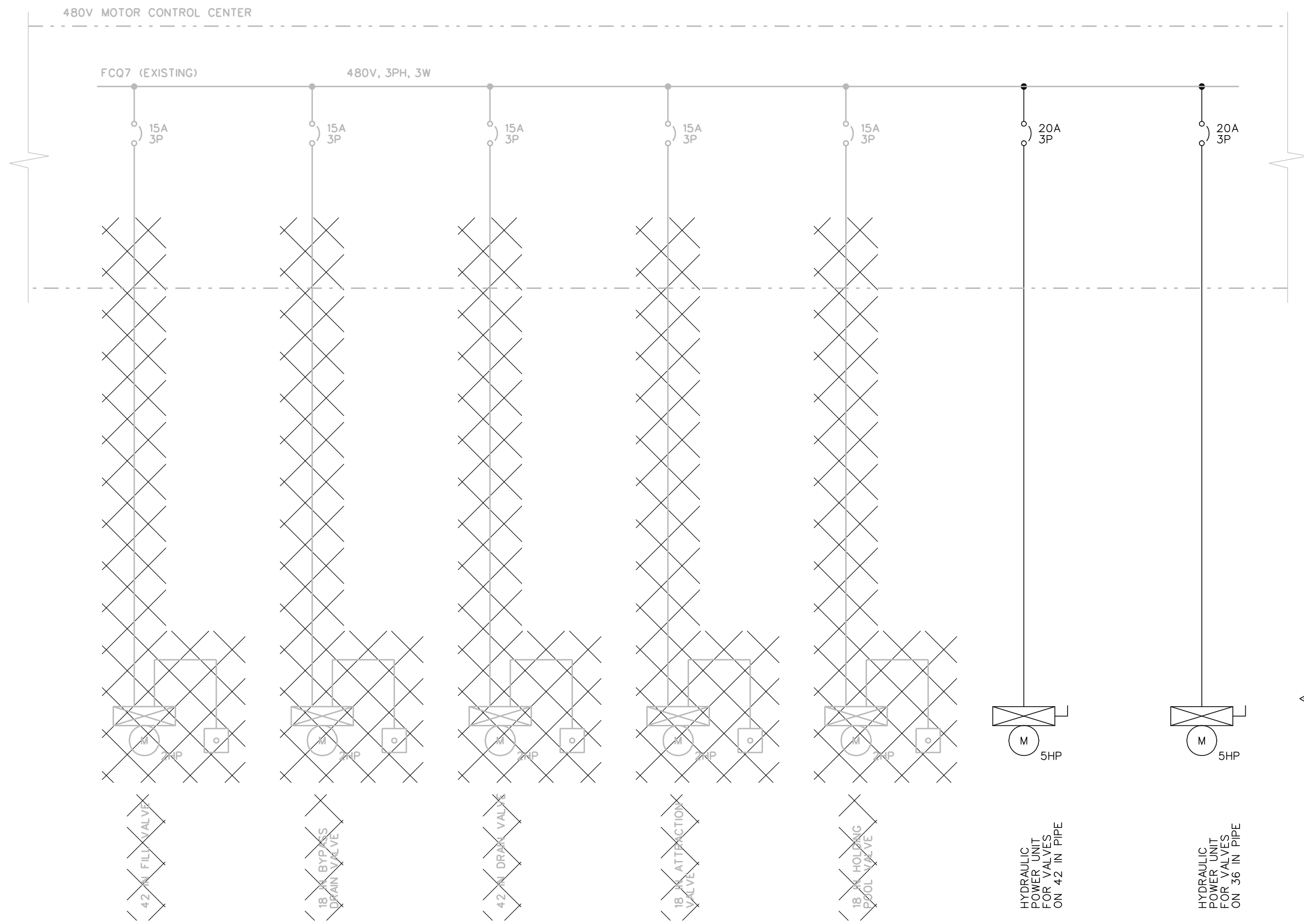
DESIGNED BY: JPG		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 32
SIZE: 17X11	FILE NAME: S32-Valve Room Mech Plan.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
32
SHEET 32 OF 35

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

DATE AND TIME PLOTTED: 4/5/2012 4:31:16 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1



ELECTRICAL SYMBOLS

- MOTOR
- POWER TRANSFORMER
- MOTOR STARTER CONTACTOR
- ISOLATING FUSE SWITCH, LOAD BREAK
- ISOLATING FUSE SWITCH, NON LOAD BREAK
- DRAWOUT TYPE FUSED MOTOR STARTER
- OVERHEAD RELAY
- POTENTIAL TRANSFORMER
- C.T. CURRENT TRANSFORMER
- DISCONNECT SWITCH
- GROUND
- SEPARATELY MOUNTED MOTOR STARTER OR MOTOR CONTROLLER
- FUSE
- 42 MOTOR CONTACTOR
- 52 POWER CIRCUIT BREAKER
- K KIRK KEY INTERLOCK
- CIRCUIT BREAKER
- CONTROL STATION

US Army Corps of Engineers® Portland District

FISHLOCK VALVE ROOM
ELECTRICAL ONE-LINE DIAGRAM

PREPARED FOR 90% SUBMITTAL

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PORTLAND, OREGON

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DESIGNED BY: DB | DATE: March 19, 2012
DWN BY: HG | CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: NTS | PLOT DATE: | DRAWING NUMBER: 33
SIZE: 17X11 | FILE NAME: S33-Electrical valve room.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

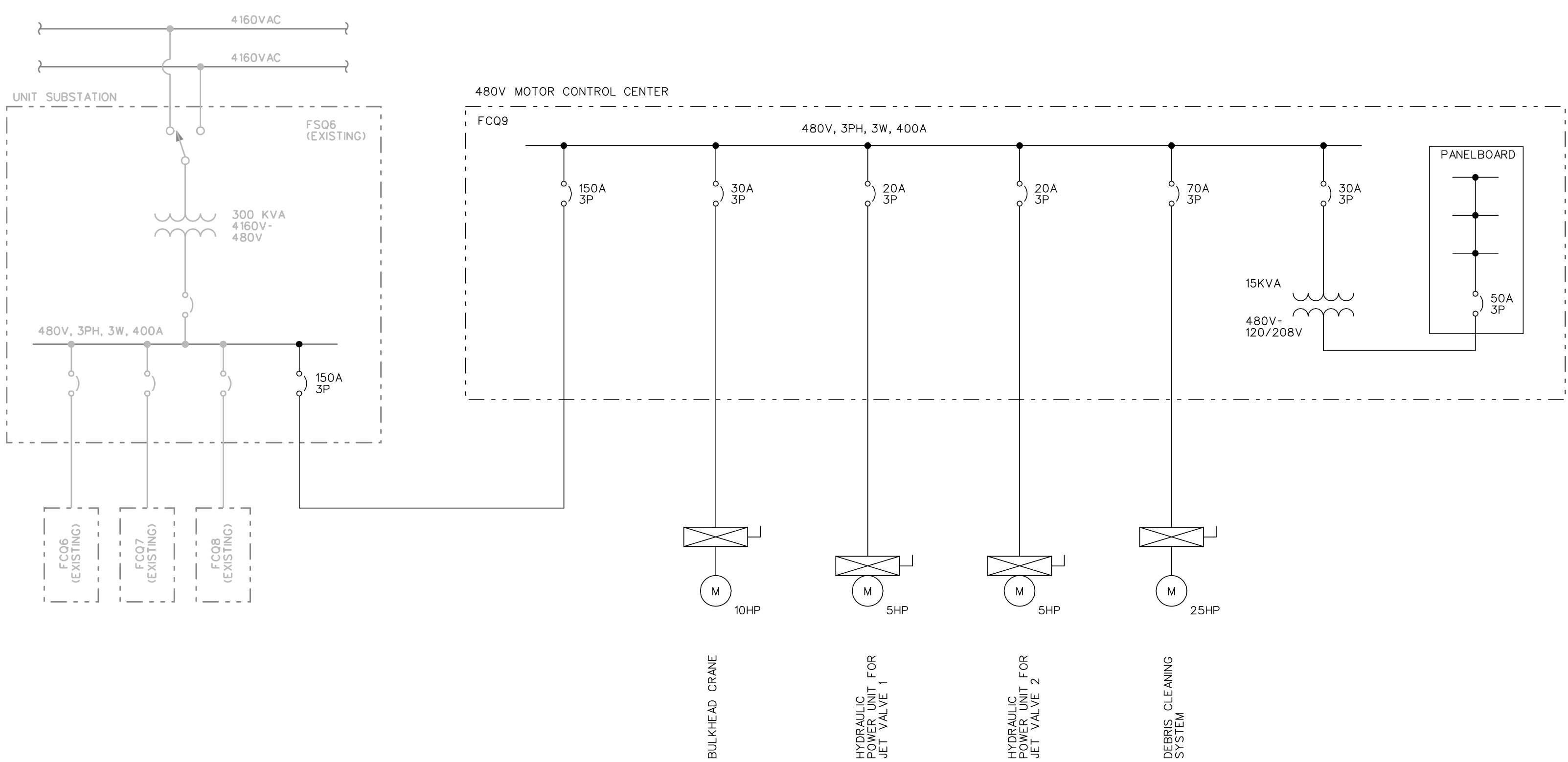
SHEET IDENTIFICATION
33
SHEET 33 OF 35

DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

DATE AND TIME PLOTTED: 4/5/2012 4:35:28 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVES •1 AND •11 - ELECTRICAL ONE-LINE DIAGRAMS



US Army Corps of Engineers® Portland District

ALTERNATIVE #2
ELECTRICAL ONE-LINE DIAGRAM

PREPARED FOR 90% SUBMITTAL

DESIGNED BY: DB		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 34
SIZE: 17X11	FILE NAME: S34-Electrical Alt 2.dgn	

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THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

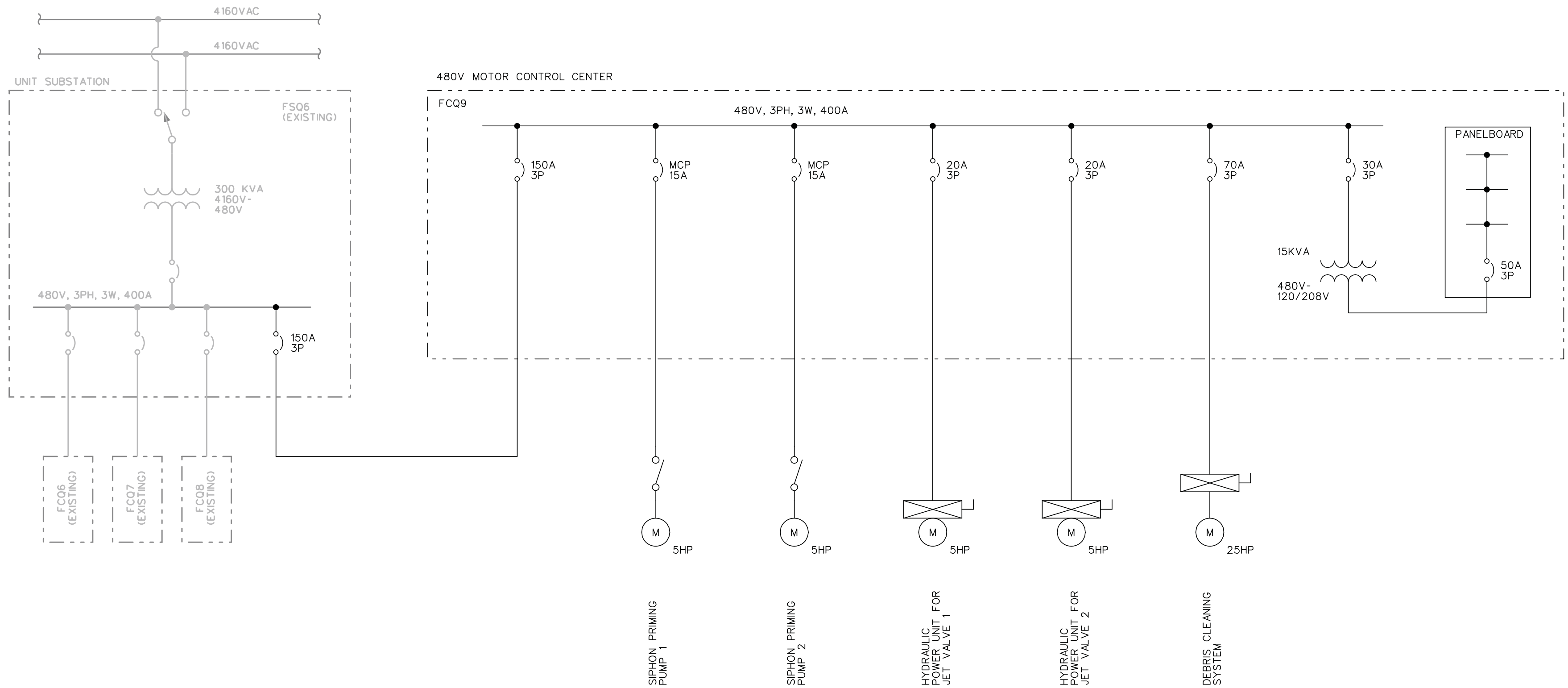
SHEET IDENTIFICATION
34
SHEET 34 OF 35

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

DATE AND TIME PLOTTED: 4/5/2012 4:39:41 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVES •1 AND •11 - ELECTRICAL ONE-LINE DIAGRAMS



US Army Corps of Engineers® Portland District

ALTERNATIVE #11
ELECTRICAL ONE-LINE DIAGRAM

PREPARED FOR 90% SUBMITTAL

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PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: DB		DATE: March 19, 2012
DWN BY: HG	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 35
SIZE: 17X11	FILE NAME: S35-Electrical Alt 11.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
35
SHEET 35 OF 35

DATE AND TIME PLOTTED: 4/5/2012 4:41:22 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: ALTERNATIVES •1 AND •11 - ELECTRICAL ONE-LINE DIAGRAMS
DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

Appendix A

USACE Memorandum for Estimated Minimum Discharge

CENWP-EC-HD 21 January 2011

MEMORANDUM FOR Randy Lee, CENWP-EC-HD

SUBJECT: The Dalles East Fish Ladder Emergency Backup for the Auxiliary Water Supply System– Minimum Discharge

Objective:

1. This memo will present the rationale for choosing 1400 cfs as the minimum discharge target for emergency backup flow to the Auxiliary Water System (AWS) at The Dalles East Fish Ladder (TDEFL) for the purpose of initial alternatives brainstorming by HDR and USACE Portland District (NWP).

Background:

2. The AWS at TDEFL supplies water to the east, west, and south fish ladder entrances, the fish ladder itself, as well as the transportation and collection channels in order to attract and transport upstream migrating adult fish. Water is currently supplied to the AWS by two fish unit turbines located on the west end of the powerhouse. The AWS normally operates with a total flow of up to 5,000 cfs (2,500 cfs per turbine unit). If both turbines were to fail at the same time, water supplied to the AWS would be severely limited or eliminated.

3. Previous studies have been undertaken to find alternatives to provide a backup supply of water to the AWS for a one-year duration in the event that both fish units fail. For these studies, alternatives have been evaluated assuming that at least 3400 cfs is required to allow the ladder system (including east, west and south entrances) to meet fisheries criteria. Estimated costs for the alternatives that were deemed most promising turned out to be very expensive and consequently impractical.

4. A special Fish Facilities Design Review Work Group (FFDRWG) meeting was held on 2 November 2010 in part for the purpose of discussing the possible reduction of operational constraints for a one-year emergency situation where both fish turbine units were unavailable. Based on discussions at this meeting, it was agreed that the minimum acceptable one-year emergency operation would be to use TDEFL east entrance exclusively.

5. The relative importance of various design criteria was also discussed at the FFDRWG meeting and is shown below in relative order of priority:
    a. Maintain 1.5 ft. of head differential over the entrance weir(s).
    b. Assume operation of two of the three weirs (however, there was additional interest in considering a variable width vertical entrance structure instead with the goal of improved downstream attraction flow properties).
    c. Maintain at least 8 ft. depth at entrance weir(s) (depth from tailwater elevation to top of the weir)

Other operational criterion that were not discussed but need to be considered include:

d. Water velocity of 1.5 to 4 fps (2 fps optimum) maintained for the full length of the lower end of the fish ladder that is affected by tailwater elevation.
e. Water depth over fish ladder weirs: 1.0 ft. +/- 0.1 ft. and 1.3 ft, +/- 0.1 ft, during shad season.
f. Maximum diffuser velocity = 0.5 ft/s

Discussion:

6. Calculations of a single weir discharge at the TDEFL east entrance were made for a range of tailwater elevations with the following equations, criteria, assumptions and constants:
   - Villamonte Equation for Submergence:
     - Q = (1 – (H2/H1)^1.5)^0.385*CwLH1^1.5
     - H1 = depth from water surface elevation (WSE) to top of weir;
     - H2 = depth from tailwater elevation (TW) to top of weir
   - Rehbock Equation for Weir Coefficient:
     - Cw = 3.22 + 0.44 H/P
     - H = H1; P = weir height
   - Entrance weir head (WSE – TW) at entrance weir(s) of 1.5 ft.
   - Depth of weir (H2) minimum of 8 ft.
   - Entrance weir width of 8.67 ft.
   - Invert elevation at entrance of 60 ft.
   - Entrance channel width just upstream of weir of 34 ft.
   - No pier or contraction losses were used to allow for a more conservative discharge (ie: higher acceptable minimum emergency flow).

7. Tailwater (TW) elevation used in the above equations can markedly influence the estimated minimum flow. Therefore it was necessary to choose a reasonable range for this analysis. Both stage and flow duration curves for the period of record (1974-1999) were used to compile a range of tailwater elevations of note at The Dalles Dam (Table 1). As seen in the table, the forebay of Bonneville Dam can influence the tailrace elevation of The Dalles Dam such that there is a range of possible tailwater levels for any given total river flow. A range of probable flow operations within the fish passage season would be banded by the higher flows in May/June and the lower flows in September/October. For the upper tailwater limit in May/June the 5% exceedance TW elevation range is 85.4 to 86.6 ft. Additionally, within the range of high flows, there is a peak where river flow conditions are such that adult fish will hold rather than travel upstream. Until a more defined estimate can be identified using existing fish passage data, it is estimated that this river discharge is around 400 to 450 kcfs, The corresponding TW elevation range (based on Bonneville forebay) for this condition is 84.7-88.6 ft. or an average of 86.6 ft which coincides with the 5% exceedance for June. Therefore, 86.6 ft. was chosen as the upper TW elevation limit for this analysis. Focusing on lower TW levels, the range of 95% exceedance for September and October is 74.0 to 74.2 ft. These values fall within the TW elevation range for the minimum powerhouse flow of 50,000 cfs (72.6 to 77.6 ft.). Therefore the 95% exceedance TW elevation for October (74.0 ft.) was chosen for the lower TW elevation limit for this analysis.

8. Using the criteria deemed most critical for an emergency operation (the ability to maintain 1.5 ft. entrance weir differential head and a minimum of 8 ft. weir depth) through the range of TW elevations 74.0 to 86.6 ft. results in design flows of 1200 cfs and 1000 cfs respectively. However, if minimum channel velocities are to be maintained at the downstream end of the east entrance, more flow would be needed at the higher TW elevation limit of 86.6 ft. If 1.5 fps (minimum channel velocity criteria) is required at the entrance then the flow would need to be 1400 cfs. For the purposes of this analysis, the upper flow of 1400 cfs has been chosen for the minimum allowable emergency flow for TDEFL east entrance-only condition. When the inflow from the upper ladder flow control section (80-120 cfs) is subtracted, the actual total AWS flow required would be 1320 to 1280 cfs. However, for this level of analysis a conservative AWS discharge of 1400 cfs has been chosen.

9. Considerations that could help maintain and/or reduce the minimum allowable emergency flow required for TDEFL include the potential for reduction of the forebay elevation at Bonneville dam during the higher TW period of an emergency operation. Also, further analyses should include the development of an operational logic for the full range of design TW elevations (ie: prescribing weir depth as a function of TW) as the weir height is pivotal to keeping within the minimum discharge needed for emergency operations.

Conclusions:

10. For this initial analysis, 1400 cfs is determined to be a minimum allowable emergency backup flow for TDEFL based on meeting ladder entrance head and 8 feet of passage depth over 2 of the 3 East entrance weirs. A range of TW elevation conditions were defined and flows approximated given certain fisheries criteria. Ultimately, for future alternative analyses, the hydraulics throughout the ladder system will need to be analyzed to ensure that all internal hydraulic criteria are met in order to maximize fish passage success. Also, as studies progress to a recommended design solution, the impact of system operations (such as the elevation of the Bonneville forebay) on an emergency ladder operation should be discussed and possible emergency operations to improve adult movement should be defined.

Recommendations:

11. For this phase of the comparison of alternatives for supplying emergency backup water to the Auxiliary Water Supply System for The Dalles East Fish Ladder in the case where both fish units are unable to function, we recommend using 1400 cfs.

Karen Kuhn
Hydraulic Engineer

REVIEW PROCESS:

HD – Steve Schlenker

CF:
CENWP-EC-HD - Randy Lee
CENWP-EC-HD – Kyle McCune
CENWP-PM-E – Sean Tackley

Table 1 - Range of Significant River Discharge and Tailwater Conditions for The Dalles Dam*

Condition	Discharge	Approximate Tailwater Range at Powerhouse by Flow **		TW at Powerhouse by Exceedance***
	kcfs	ft	ft	ft
100 year event	680	95.6	97.0	
Maximum Tailwater				92.2
5% Exceedance June***				***86.6***
Max Q for Adult Movement****	400-450	84.7	88.6	
5 % Exceedance May***				85.4
Max Ph w/ 40% spill	430	85.3	88.0	
Max Ph	270	77.8	81.3	
Discharge 100kcfs (92% Flow Exceedance)	100	73.5	78.2	
Min Ph w/40% Spill	85	73.3	78.0	
Min Ph	50	72.6	77.6	
95% Exceedance Sept***				74.2
95% Exceedance Oct***				***74.0***
Minimum Operating Tailwater*****				70.0

*Data Source: Stage exceedance, stage/discharge relationships, and tailwater ranges for the period of record (1974-1999) developed by CENWP-EC-HY October 2000.
**Tailwater range based on forebay fluctuations at Bonneville Dam from 71.5-76.5 ft. Tailwater elevations were adjusted from RM 188.95 to location at TDEFL powerhouse (RM 192.43) using relationships developed in Oct. 2000 study.
***Based on hourly readings at Powerhouse gage.
****Estimate to be verified with fish passage data.
*****From Fish Passage Plan 2010

Note: Highlighted values used in final selection of minimum emergency flow analysis.

Appendix B

Hydraulic

SIPHON CALCULATIONS

FINAL SIPHON CALCULATIONS

CALCULATIONS REPRESENT 60% DRAWING GEOMETRY

21936 The Dalles EAWS
Revised Siphon Pipe Size Options

Pipe size restrictions due to velocities and maximum capacities:

	Pipe dia (ft)	Pipe area (ft)	Max Velocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Siphon Pipes -EPANET -Velocities and Pressures:

	Pipe dia (ft)	Pipe area (ft)	Max V elocity (fps)	Max Discharge (cfs)	Top Pipe (ft)	PGL crest (ft)	Neg Pressure (ft)
Sleeve Type Valve - FB 160							
72 inch	6	28.26	23.2	653	166	151.2	-15
Sleeve Type Valve - FB 155							
72 inch	6	28.26	21.7	610	166	147.3	-19

siphon invert elev. 160 ft
For Sleeve Valve Option - Close valve to slow down velocities, this will also increase the borderline pressures for the FB of 155

northwest hydraulic consultants inc.	DATE 1/12/12	BY LWL	CHK
CLIENT USACE/HDR		JOB No. 21936	
SUBJECT The Dalles - Siphons			

Revise siphon calcs to reflect 1/5/11 drawings.

Minor losses are the same, as previous assumptions for Alternative I.

Pipe lengths should be modified.
Use sleeve valve only.

Siphon Alternative I -

Pipe 100 Ln ~ 60 ft — Scaled from drwgs. Close enough for this level of detail

Pipe 200 Ln ~ 40 ft

Pipe 300 Ln ~ 40 ft

Lengths scaled from drawings

These are minor differences; however, update model + calcs.

Siphon Alternative II -

Pipe 100 Ln ~ 110 ft

Modify model to reflect Alt. II design

FB=160 ft

3


```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6 ft dia 1.5.12 drwg Sleeve Valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	60	72
2	2	3	40	72
3	3	5	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	151.72	65.74	0.00	
3	0.00	151.15	65.50	0.00	
1	-652.48	160.00	0.00	0.00	Reservoir
5	652.48	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	652.48	23.08	138.07	Open
2	652.48	23.08	14.05	Open
3	652.48	23.08	778.85	Open

```
[TITLE]

[JUNCTIONS]
;ID                  Elev            Demand          Pattern
 2                   0               0                                ;
 3                   0               0                                ;

[RESERVOIRS]
;ID                  Head            Pattern
 1                   160                             ;
 5                   120                             ;

[TANKS]
;ID                  Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID                  Node1                   Node2                   Length          Diameter
Roughness       MinorLoss       Status
 1                   1                       2                       60              72              0.2
        0.9          Open       ;
 2                   2                       3                       40              72              0.2
        0            Open       ;
 3                   3                       5                       40              72              0.2
        3.7          Open       ;

[PUMPS]
;ID                  Node1                   Node2                   Parameters

[VALVES]
;ID                  Node1                   Node2                   Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction            Demand          Pattern                 Category

[STATUS]
;ID                  Status/Setting

[PATTERNS]
;ID                  Multipliers

[CURVES]
;ID                  X-Value         Y-Value

[CONTROLS]
```

```
[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
```


5

```
 Headloss            D-W
 Specific Gravity    1
 Viscosity           0.00001
 Trials              40
 Accuracy            0.001
 CHECKFREQ           2
 MAXCHECK            10
 DAMPLIMIT           0
 Unbalanced          Continue 10
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node                X-Coord           Y-Coord
 2                   -175.00           8283.33
 3                   1008.33           8300.00
 1                   -1258.33          7766.67
 5                   1958.33           6550.00

[VERTICES]
;Link                X-Coord           Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS          0.00              0.00              10000.00          10000.00
 UNITS               None
 FILE
 OFFSET              0.00              0.00

[END]
```

FB=155 ft

Page 1 1/6/2012 2:00:44 PM

```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6 ft dia 1.5.12 drwg Sleeve Valve FB 155.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	60	72
2	2	3	40	72
3	3	5	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	147.75	64.02	0.00	
3	0.00	147.26	63.81	0.00	
1	-610.30	155.00	0.00	0.00	Reservoir
5	610.30	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	610.30	21.59	120.82	Open
2	610.30	21.59	12.32	Open
3	610.30	21.59	681.45	Open

```
[TITLE]


[JUNCTIONS]
;ID              Elev            Demand          Pattern
 2               0               0                               ;
 3               0               0                               ;

[RESERVOIRS]
;ID              Head            Pattern
 1               155                             ;
 5               120                             ;

[TANKS]
;ID              Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID              Node1           Node2           Length          Diameter
Roughness       MinorLoss       Status
 1               1               2               60              72              0.2
        0.9      Open    ;
 2               2               3               40              72              0.2
        0        Open    ;
 3               3               5               40              72              0.2
        3.7      Open    ;

[PUMPS]
;ID              Node1           Node2           Parameters

[VALVES]
;ID              Node1           Node2           Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction        Demand          Pattern         Category

[STATUS]
;ID              Status/Setting

[PATTERNS]
;ID              Multipliers

[CURVES]
;ID              X-Value         Y-Value

[CONTROLS]
```

```
[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
```

```
 Headloss             D-W
 Specific Gravity     1
 Viscosity            0.00001
 Trials               40
 Accuracy             0.001
 CHECKFREQ            2
 MAXCHECK             10
 DAMPLIMIT            0
 Unbalanced           Continue 10
 Pattern              1
 Demand Multiplier    1.0
 Emitter Exponent     0.5
 Quality              None mg/L
 Diffusivity          1
 Tolerance            0.01

[COORDINATES]
;Node                 X-Coord            Y-Coord
 2                    -175.00            8283.33
 3                    1008.33            8300.00
 1                    -1258.33           7766.67
 5                    1958.33            6550.00

[VERTICES]
;Link                 X-Coord            Y-Coord

[LABELS]
;X-Coord          Y-Coord           Label & Anchor Node

[BACKDROP]
 DIMENSIONS           0.00               0.00               10000.00           10000.00
 UNITS                None
 FILE
 OFFSET               0.00               0.00

[END]
```

northwest hydraulic consultants inc.	DATE 1/10/12	BY CWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles			

Check submergence / vortex activity

FB 160 $S = 160 - (140 + 6) = 14$ ft
FB 155 $S = 155 - (140 + 6) = 9$ ft

$VD^{\frac{1}{2}}$ EM 1110-2-1602

Velocity will likely be around 18 fps, valves up sized to handle velocities per HDR discussions

18 fps $18(6)^{\frac{1}{2}} = 54$

Submergence is borderline re vortex activity

Higher velocities would make submergence issues greater

SIPHON CALCULATIONS

PRELIMINARY CALCULATIONS, EVALUATING DIFFERENT TYPES OF VALVES

INCLUDES SUPPORTING HAND CALCS USED TO DEVELOP EPANET MODEL

21936 The Dalles EAWS

Revised Siphon Pipe Size Options

Pipe size restrictions due to velocities and maximum capacities:

	Pipe dia (ft)	Pipe area (ft)	~~Min~~ max V elocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Siphon Pipes.-EPANET -Velocities and Pressures:

	Pipe dia (ft)	Pipe area (ft)	Max V elocity (fps)	Max Discharge (cfs)	Top Pipe (ft)	PGL crest (ft)	Neg Pressure (ft)
Monovar Type Valves - FB 160							
72 inch	6	28.26	16.2	460	167	156	-11
78 inch	6.5	33.17	16.3	540	168	156	-12
Movovar Type Valves - FB 155							
72 inch	6	28.26	15.2	430	167	151	-16
78 inch	6.5	33.17	15.2	504	168	151	-16
Sleeve Type Valve - FB 160							
72 inch	6	28.26	23.2	657	167	151.6	-15
78 inch	6.5	33.17	23.3	772	168	151.7	-16
Sleeve Type Valve - FB 155							
72 inch	6	28.26	21.7	614	167	147.7	-19
78 inch	6.5	33.17	21.8	722	168	147.7	-20

siphon invert elev. 161 ft

For Sleeve Valve Option - Close valve to slow down velocities, this will also increase the borderline pressures for the FB of 155

northwest hydraulic consultants inc.	DATE 12/21/11	BY LWL	CHK	1
CLIENT USACE / HOR		JOB No. 21936		
SUBJECT The Dalles EAWS - Siphons				

Revise siphon calcs:

Focus on 6' + 6.5' dia (72" + 78")

Check high + low FB   FB = 160' high
FB = 155' low

Use D/S siphon invert = 120 ft

Check orifice type valve + standard sleeve valve for energy dissipation

Pipe 100   Node 1 to 2

Ln ~ 10 + 20 = 30'

Entrance K = 0.2   USBR/USACE Rounded U/S edges

Trash Rack K = 0.1   see trash rack calcs

2 Bends K = 0.2 × 2 = 0.4   EM 1602 + check USBR / Miller

1 closure valve K = 0.2 (may be 0.1)

$K_T = 0.9$

Pipe 200   Node 2 to 3

Ln ~ 30'   No minor losses, only friction

Pipe 300   Node 3 to 4

1 Bend K = 0.2

1 valve K = ?   see next page

Exit Loss K = 1.0

northwest hydraulic consultants inc.	DATE 12/23/11	BY LWL	CHK	2
CLIENT USACE / HDR		JOB No. 21936		
SUBJECT The Dalles EAWS - siphons				

Pipe 300 (cont)

valve: may be monovar type or sleeve valve
Fully open:
monovar K = 7.5 Estimate from graph on-line
Difficult to read, interpret
check later

Polyjet sleeve valve K = 2.5
USBR 1977 model studies
Should verify w/ manufacturer
model tests - small pipe size
Bailey

Check K = 7.5 Monovar type

K = 2.5 sleeve valve type

Ln = ~160 - 120 ~ 40 ft

Total K (monovar option) = 1.2 + 7.5 = 8.7

Total K (sleeve valve option) = 1.2 + 2.5 = 3.7

Note: Monovar will also require isolation valve U/S (full closure) - Assume loss is low in fully open position & ignore for now

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK	3
CLIENT HDR/USACE		JOB No. 21936		
SUBJECT The Dalles EAWS – Siphon				

Results: 6 ft diameter pipe
72 inch

Monorar Valve option

1) FB 160 D/S Invert 120

Q = 460 cfs
V = 16.2 fps

PGL Check 155.9 @ siphon – okay
w/ crest @ 161

2) FB 155 D/S Invert 120

Q = 430 cfs
V = 15.2 fps

PGL check 151.40 @ siphon – okay
w/ crest @ 161

Sleeve Valve option

1) FB 160 D/S Invert 120

Q = 657 cfs
V = 23.2 fps

PGL Check 151.6 @ siphon – okay
w/ crest @ 161

2) FB 155 D/S Invert 120

Q = 614 cfs
V = 21.7 fps

PGL Check 147.7 @ siphon – okay
w/ crest @ 161

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK	4
CLIENT HDR/USACE		JOB No. 21936		
SUBJECT The Dalles EAWS - siphon				

Results: 6.5 ft diameter pipe
78 inch

Monovar valve option

1) FB 160 D/S Invert 120

Q = 540 cfs
V = 16.3 fps

PGL Check 155.9 @ siphon - okay
w/ crest @ 161

2) FB 155 D/S Invert 120

Q = 504 cfs
V = 15.2 fps

PGL check 151.4 @ siphon - okay
w/ crest @ 161

Sleeve valve option

1) FB = 160 D/S Invert 120

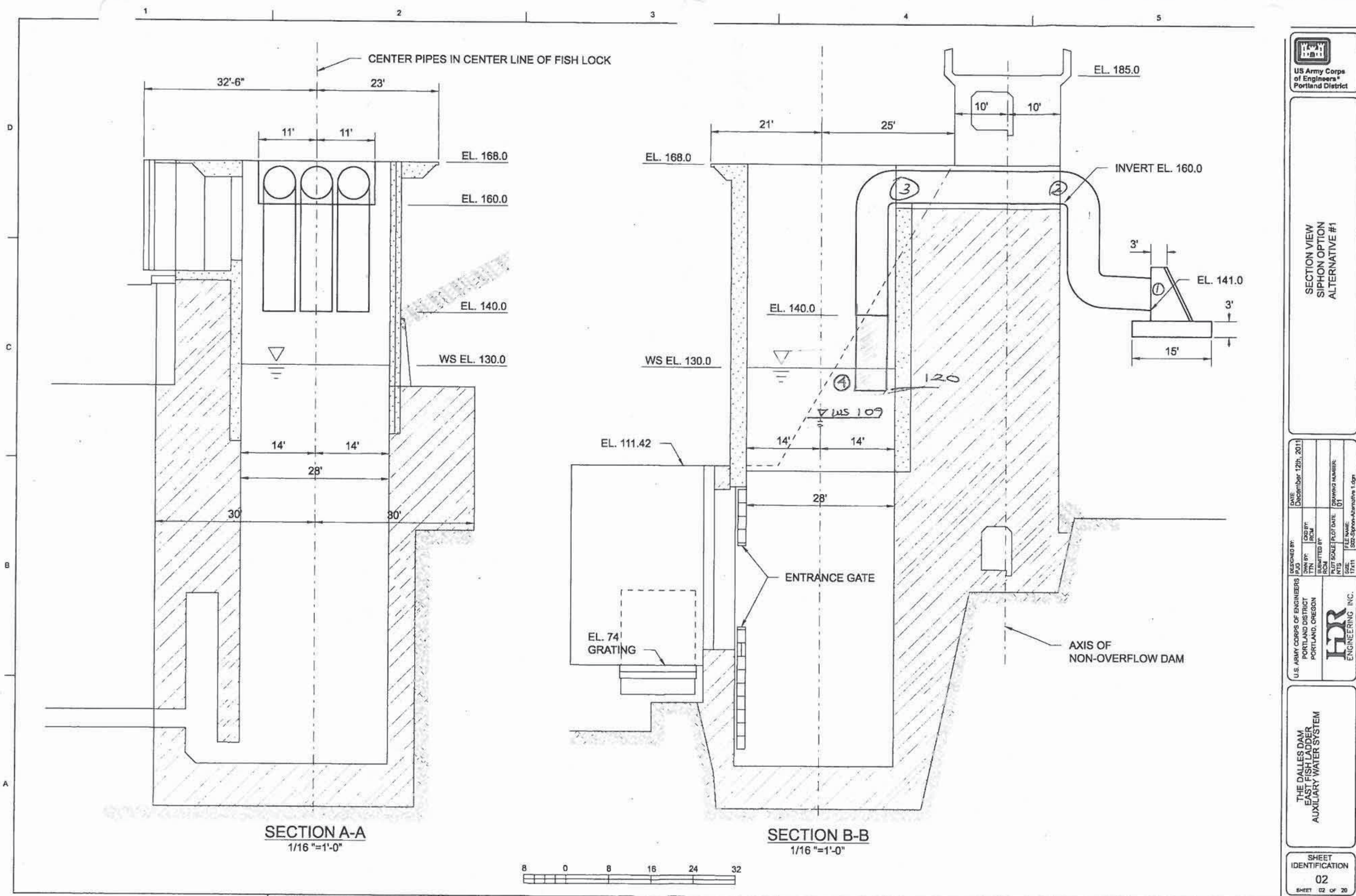
Q = 772 cfs
V = 23.3 fps

PGL check 151.7 @ siphon - okay
w/ crest @ 161

2) FB = 155 D/S Invert 120

Q = 722 cfs
V = 21.8 fps

PGL check 147.7 @ siphon - okay
w/ crest @ 161


CENTER PIPES IN CENTER LINE OF FISH LOCK
32'-6"
23'
11'
11'
EL. 168.0
EL. 160.0
EL. 140.0
WS EL. 130.0
14'
14'
28'
30'
30'
SECTION A-A
1/16 "=1'-0"
EL. 185.0
10'
10'
21'
25'
EL. 168.0
INVERT EL. 160.0
3'
EL. 141.0
3'
15'
EL. 140.0
WS EL. 130.0
120
WS 109
EL. 111.42
14'
14'
28'
ENTRANCE GATE
EL. 74
GRATING
AXIS OF
NON-OVERFLOW DAM
SECTION B-B
1/16 "=1'-0"
8 0 8 16 24 32
US Army Corps of Engineers Portland District
SECTION VIEW
SIPHON OPTION
ALTERNATIVE #1
DATE: December 12th, 2011
DRAWING NUMBER: 01
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON
HDR ENGINEERING INC.
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM
SHEET IDENTIFICATION
02
SHEET 02 OF 20
DATE AND TIME PLOTTED: 12/12/2011 11:10:23 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #1

24

Page 1 12/23/2011 11:08:57 AM

```
**********************************************************************
*                              E P A N E T                           *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6.5 ft dia 12.12 drwg Sleeve Valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	78
2	2	3	30	78
3	3	5	40	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	152.04	65.88	0.00	
3	0.00	151.65	65.71	0.00	
1	-772.42	160.00	0.00	0.00	Reservoir
5	772.42	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	772.42	23.28	265.40	Open
2	772.42	23.28	13.01	Open
3	772.42	23.28	791.20	Open

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;
 3                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                                     ;
 5                      120                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                               2               30
        78              0.2             0.9             Open    ;
 2                      2                               3               30
        78              0.2             0               Open    ;
 3                      3                               5               40
        78              0.2             3.7             Open    ;

[PUMPS]
;ID                     Node1                           Node2
Parameters

[VALVES]
;ID                     Node1                           Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern
```

```
[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -175.00                 8283.33
 3                      1008.33                 8300.00
 1                      -1258.33                7766.67
 5                      1958.33                 6550.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord          Y-Coord           Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
        10000.00                10000.00
 UNITS                  None
```

```
 FILE
 OFFSET                  0.00                    0.00

[END]
```

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```
**********************************************************************
*                              E P A N E T                           *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6 ft dia 12.12 drwg Sleeve Valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	72
2	2	3	30	72
3	3	5	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	152.03	65.87	0.00	
3	0.00	151.60	65.69	0.00	
1	-657.11	160.00	0.00	0.00	Reservoir
5	657.11	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	657.11	23.24	265.82	Open
2	657.11	23.24	14.24	Open
3	657.11	23.24	789.95	Open

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;
 3                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                                     ;
 5                      120                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                   Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                       2                       30
        72              0.2             0.9             Open    ;
 2                      2                       3                       30
        72              0.2             0               Open    ;
 3                      3                       5                       40
        72              0.2             3.7             Open    ;

[PUMPS]
;ID                     Node1                   Node2
Parameters

[VALVES]
;ID                     Node1                   Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern
```

```
[REACTIONS]
;Type           Pipe/Tank              Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                   Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01

[COORDINATES]
;Node                   X-Coord                Y-Coord
 2                      -175.00                8283.33
 3                      1008.33                8300.00
 1                      -1258.33               7766.67
 5                      1958.33                6550.00

[VERTICES]
;Link                   X-Coord                Y-Coord

[LABELS]
;X-Coord           Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS              0.00                   0.00
        10000.00                10000.00
 UNITS                   None
```

FILE		
OFFSET	0.00	0.00

[END]

```
**********************************************************************
*                             E P A N E T                            *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6 ft dia 12.12 drwg Monovar Control.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	72
2	2	3	30	72
3	3	5	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	156.10	67.64	0.00	
3	0.00	155.89	67.55	0.00	
1	-459.09	160.00	0.00	0.00	Reservoir
5	459.09	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	459.09	16.24	129.84	Open
2	459.09	16.24	7.04	Open
3	459.09	16.24	897.34	Open

```
[TITLE]

[JUNCTIONS]
;ID                 Elev            Demand          Pattern
 2                  0               0
        ;
 3                  0               0
        ;

[RESERVOIRS]
;ID                 Head            Pattern
 1                  160                                     ;
 5                  120                                     ;

[TANKS]
;ID                 Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                 Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                  1                               2                       30
        72          0.2             0.9                     Open    ;
 2                  2                               3                       30
        72          0.2             0                       Open    ;
 3                  3                               5                       40
        72          0.2             8.7                     Open    ;

[PUMPS]
;ID                 Node1                           Node2
Parameters

[VALVES]
;ID                 Node1                           Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction           Demand          Pattern                         Category

[STATUS]
;ID                 Status/Setting

[PATTERNS]
;ID                 Multipliers

[CURVES]
;ID                 X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency  75
 Global Price       0
 Demand Charge      0

[EMITTERS]
;Junction           Coefficient

[QUALITY]
;Node               InitQual

[SOURCES]
;Node               Type            Quality         Pattern
```

```
[REACTIONS]
;Type            Pipe/Tank                Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                    Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01

[COORDINATES]
;Node                    X-Coord                  Y-Coord
 2                       -175.00                  8283.33
 3                       1008.33                  8300.00
 1                       -1258.33                 7766.67
 5                       1958.33                  6550.00

[VERTICES]
;Link                    X-Coord                  Y-Coord

[LABELS]
;X-Coord           Y-Coord            Label & Anchor Node

[BACKDROP]
 DIMENSIONS              0.00                     0.00
        10000.00                 10000.00
 UNITS                   None
```

```
FILE
OFFSET                 0.00                     0.00

[END]
```

```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: siphon 6.5 ft dia 12.12 drwg Monovar Control.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	78
2	2	3	30	78
3	3	5	40	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	156.12	67.65	0.00	
3	0.00	155.93	67.56	0.00	
1	-539.22	160.00	0.00	0.00	Reservoir
5	539.22	120.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	539.22	16.25	129.41	Open
2	539.22	16.25	6.42	Open
3	539.22	16.25	898.13	Open

```
[TITLE]

[JUNCTIONS]
;ID                      Elev          Demand          Pattern
 2                       0             0
        ;
 3                       0             0
        ;

[RESERVOIRS]
;ID                      Head          Pattern
 1                       160                                    ;
 5                       120                                    ;

[TANKS]
;ID                      Elevation     InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                      Node1                         Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                       1                             2                      30
        78               0.2           0.9                 Open    ;
 2                       2                             3                      30
        78               0.2           0                   Open    ;
 3                       3                             5                      40
        78               0.2           8.7                 Open    ;

[PUMPS]
;ID                      Node1                         Node2
Parameters

[VALVES]
;ID                      Node1                         Node2
Diameter        Type     Setting       MinorLoss

[TAGS]

[DEMANDS]
;Junction                Demand        Pattern                  Category

[STATUS]
;ID                      Status/Setting

[PATTERNS]
;ID                      Multipliers

[CURVES]
;ID                      X-Value       Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency       75
 Global Price            0
 Demand Charge           0

[EMITTERS]
;Junction                Coefficient

[QUALITY]
;Node                    InitQual

[SOURCES]
;Node                    Type          Quality          Pattern
```

```
[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -175.00                 8283.33
 3                      1008.33                 8300.00
 1                      -1258.33                7766.67
 5                      1958.33                 6550.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord           Y-Coord            Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
        10000.00                10000.00
 UNITS                  None
```

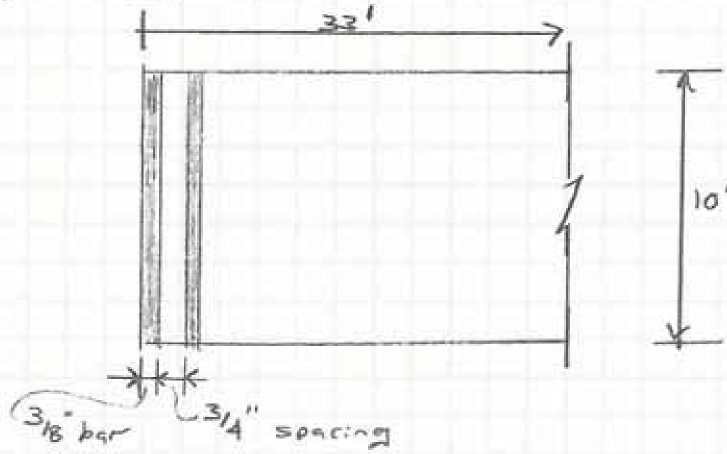
FILE		
OFFSET	0.00	0.00

[END]

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles			

Trash Rack losses:

Estimate an equivalent 'K' value for Pipe inlet to represent trash rack loss



Q = V A   velocity req = 3 fps
Q = 1,000 cfs

Q = V A
1,000 = (3)(A)

A = 333 ft²

USBR

$$K_T = 1.45 - 0.45\left(\frac{a_n}{a_g}\right) - \left(\frac{a_n}{a_g}\right)^2$$

0.375" Bar
0.75" Opening
Total = 1.125"

$$\frac{33'}{\frac{1.125"}{12}} = 352 \text{ Bars/openings}$$

$$a_n = (10')\left(\frac{0.75"}{12}\right) \times 352 = 220 \text{ ft}^2$$

(0.75"/12: Bar thickness; 352: Bars)

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles			

$$K_T = 1.45 - 0.45\left(\frac{220}{333}\right) - \left(\frac{220}{333}\right)^2$$

$$K_T = 0.72$$

$$h_t = K_T\left(\frac{V_n^2}{2g}\right) \qquad h_t = 0.72\left(\frac{4.55^2}{2g}\right) = 0.23$$

$$V_n = \frac{1{,}000}{(10)\left(\frac{0.75}{12}\right)(352)} = 4.55$$

Convert $h_t = 0.23$ to 'K' loss for siphon inlet

$$h_L = K\frac{V^2}{2g} \qquad \text{say } V = 16 \text{ fps}$$

$$0.23 = K\frac{(16)^2}{64.4}$$

$$K = 0.057$$

Used $K = 0.1$ okay Conservative

SIPHON CALCULATIONS REFLECTING 12/12/2011 DRAWINGS

northwest hydraulic consultants inc.	DATE 12/13/11	BY LWL	CHK
CLIENT USACE/HDR		JOB No. 21936	
SUBJECT The Dalles			

Revise siphon calcs to reflect 12/12/11 drawings

Invert siphon crest @ EL 160 ft

Siphon Inlet @ EL 141 ft

Ln ~ 10' + 20' + 20' + 10' + 20' = 80 ft

Pipe 100 — Same as 11/23 calcs w/ exception of entrance loss

Bellmouth → K ~ 0.1 } K = 0.2
Trashrack → K ~ 0.1 }

Previous entrance K = 1 was too high

$\Sigma K = (1.6 - 1) + 0.2 = 0.8$

Ln ~ 10 + 20 = 30 ft slightly longer

Pipe 200 — Friction only

Ln ~ 30 ft same as before

Pipe 300 — 1 Bend K = 0.2
1 valve K = 0.2 (fully open)

Exit loss K = 1.0

Total K = 1.4

Ln ~ 20 ft

northwest hydraulic consultants inc.	DATE 12/13/11	BY LWL	CHK	2
CLIENT HDR/USACE		JOB No. 21936		
SUBJECT The Dalles				

Try 6 ft dia pipe:

w/ no valve PGL @ end of crest = 149.66

Siphon crest = 161

$P = 149.66 - (161 + 6) = -17$ ft Q = 870 cfs, V = 30 fps

Sensitivity analysis

Pipe 100 Increase entrance Loss to K=1
+ bend loss to K = 0.5

$\Sigma K = 2(0.5) + 1.0 + \underset{valve}{0.2} = 3.2$

Pipe 200 okay

Pipe 300
1 bend K=0.5
1 valve K=0.2
Exit K=1

Total K=1.7

Q = 554 cfs
V = 20 fps
PGL = 140.3

$P = 140.3 - (161 + 6) = -27$ ft

northwest hydraulic consultants inc.	DATE 12/13/11	BY LWL	CHK	3
CLIENT USACE/HDR		JOB No. 21936		
SUBJECT The Dalles				

Revise siphon calcs to document all Loss details due to wide sensitivity

Pipe 100 - minor Losses

Entrance Loss - Assume rounded corners $r/d > 0.1$

$K = < 0.1$ say $K = 0.1$
miller

Check USACE EM 1602
K = 0.1 reasonable for rounded corners

Trash Rack - Assume 1 ft spacing

1 ft spacing
80% free area

K ~ 0.2 miller P. 370
Likely square bars, not rounded

Two tight 90° bends

USACE 1602 - circular bends
90° angle
K 0.1 to 0.2 depending on r/d

Miller $r/d = 1 \Rightarrow K\ 90° \sim 0.25$

Use K=0.2 for 90° bends & check later

Valve

Assuming K=0.2 fully open, may be much higher

$K_{Total} = 0.1 + 0.2 + (0.2 \times 2) + 0.2 = 0.9$

northwest hydraulic consultants inc.	DATE 12/13/11	BY LWL	CHK	4
CLIENT USACE / HOR		JOB No. 21936		
SUBJECT The Dalles				

Pipe 300 - minor Losses

1 Bend - see P.3 use K=0.2

1 valve - K=0.3 see monovar valve → Incorrect

Exit K=1.0

Total K=1.5

New Results

1) No Control

PGL critical = 147.66

Q = 161   161 + 6 = 167

152.10 - 167 = -14.9 ft

167.00
152.10
14.9

Q = ~640 cfs
V = 22.5 fps

Two 6' dia pipes would work in this case

2) Control

Q = 480 cfs
V = 16.9 fps

X 3 = 1,440 cfs   Need 3 pipes

PGL = 155.58   P = 155.58 - 167 = -11 ft

```
[TITLE]


[JUNCTIONS]
;ID                    Elev            Demand          Pattern
 2                     0               0
        ;
 3                     0               0
        ;

[RESERVOIRS]
;ID                    Head            Pattern
 1                     160                                     ;
 5                     140                                     ;

[TANKS]
;ID                    Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                    Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                     1                               2                30
        72             0.2             0.9             Open    ;
 2                     2                               3                30
        72             0.2             0               Open    ;
 3                     3                               5                20
        72             0.2             3.5             Open    ;

[PUMPS]
;ID                    Node1                           Node2
Parameters

[VALVES]
;ID                    Node1                           Node2
Diameter        Type   Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction              Demand          Pattern                 Category

[STATUS]
;ID                    Status/Setting

[PATTERNS]
;ID                    Multipliers

[CURVES]
;ID                    X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency     75
 Global Price          0
 Demand Charge         0

[EMITTERS]
;Junction              Coefficient

[QUALITY]
;Node                  InitQual

[SOURCES]
;Node                  Type            Quality         Pattern
```

```
[REACTIONS]
;Type           Pipe/Tank              Coefficient


[REACTIONS]
 Order Bulk            1
 Order Tank            1
 Order Wall            1
 Global Bulk           0
 Global Wall           0
 Limiting Potential    0
 Roughness Correlation 0

[MIXING]
;Tank                  Model

[TIMES]
 Duration              0
 Hydraulic Timestep    1:00
 Quality Timestep      0:05
 Pattern Timestep      1:00
 Pattern Start         0:00
 Report Timestep       1:00
 Report Start          0:00
 Start ClockTime       12 am
 Statistic             None

[REPORT]
 Status                No
 Summary               No
 Page                  0

[OPTIONS]
 Units                 CFS
 Headloss              D-W
 Specific Gravity      1
 Viscosity             0.00001
 Trials                40
 Accuracy              0.001
 CHECKFREQ             2
 MAXCHECK              10
 DAMPLIMIT             0
 Unbalanced            Continue 10
 Pattern               1
 Demand Multiplier     1.0
 Emitter Exponent      0.5
 Quality               None mg/L
 Diffusivity           1
 Tolerance             0.01

[COORDINATES]
;Node                  X-Coord               Y-Coord
 2                     -175.00               8283.33
 3                     1008.33               8300.00
 1                     -1258.33              7766.67
 5                     1958.33               6550.00

[VERTICES]
;Link                  X-Coord               Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS            0.00                  0.00
        10000.00               10000.00
 UNITS                 None
```

FILE		
OFFSET	0.00	0.00

[END]

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```
**********************************************************************
*                            E P A N E T                             *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 6 ft dia 12.12 drwg sensitivity control.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	72
2	2	3	30	72
3	3	5	20	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	155.81	67.51	0.00	
3	0.00	155.58	67.41	0.00	
1	-476.40	160.00	0.00	0.00	Reservoir
5	476.40	140.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	476.40	16.85	139.80	Open
2	476.40	16.85	7.57	Open
3	476.40	16.85	778.94	Open

northwest hydraulic consultants inc.	DATE 12/13/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles			

Check Vortex Activity on Siphon Entrance

$S = 160 - (141 + 6) = 11$ ft

$V = \sim 16$ fps

Dia = 6 ft

$VD^{\frac{1}{2}} = (16)(6)^{\frac{1}{2}} = 48 \cdot 10$

Borderline vortex

$S = 0.3\ VD^{\frac{1}{2}} = 0.3\ (16)(6)^{\frac{1}{2}} = 14.4$

$\text{Invert} = (160 - 14.4) - 6 = 139.6$

Invert of 141 probably okay for this level of design, no higher though

northwest hydraulic consultants inc.	DATE 12/16/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles			

Try 6' dia siphons w/ pipe extension into reservoir - say 100 ft

with Control valve - Previous 6' dia
Q = 480 cfs
V = 16.9 fps

- Revised to add 100' of Ln
Q = 467 cfs
V = 16.5 fps

Adding Length isn't as significant as other types of losses

6' dia pipe - Monovar vs. sleeve valve

K = 7 monovar

Total K = 0.2 + 7.5 + 1.0 = 8.7

FB = 160 | FB = 150
Q = 455 | Q = 430 | V = 15 fps

K = 2 sleeve valve

total K = 0.2 + 2 + 1.0 = 3.2

FB 160 | FB = 155
Q = 680 cfs | Q = 640

V = 22 fps

Need to investigate valves

northwest hydraulic consultants inc.	DATE 11/25/11	BY LWL	CHK	1
CLIENT HOR / USACE		JOB No. 21936		
SUBJECT The Dalles				

Fish Lock to AWS Connection

- Connection limits flow to AWS
- With 109 WSEL (110' deck, 1 ft FB), Q ~ 1,000 cfs
- Raise WSEL until 1,400 cfs is achieved

WSEL required ~ 128 ft to discharge 1,400 cfs

Note: Re-run 36"
46"
+ siphon or other pipe

Tower now WS ~ 128 vs. 109

42" – 322 cfs
36" – 164 cfs } 486 cfs

Siphon will be less < 350 cfs.

Siphon required Q   1400 – 430 = 970 cfs

northwest hydraulic consultants inc.	DATE 11/25/11	BY LWL	CHK	2
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles EAWS				

Non-pressurized / 109 WSEL in Channel

Fish lock / AWS Connection

WSEL 109'
Q Limit ~ 1,000 cfs

36" = 200 cfs
42" = 400 cfs
} 600 cfs

Siphon - w/ valve, limit pressure -10 ft head Q = 358 cfs

84" = 7 ft diameter

Siphon required Q 1400 - 600 = 800 cfs via siphon

northwest hydraulic consultants inc.	DATE 11/30/11	BY LWL	CHK	3
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT				

Other changes could be made to obtain 1,400 cfs

Remove constriction to diffuser chimney as well as 4'x4' gates & replace w/ large opening.

Based on initial calcs Q = 1,400 cfs may be achievable

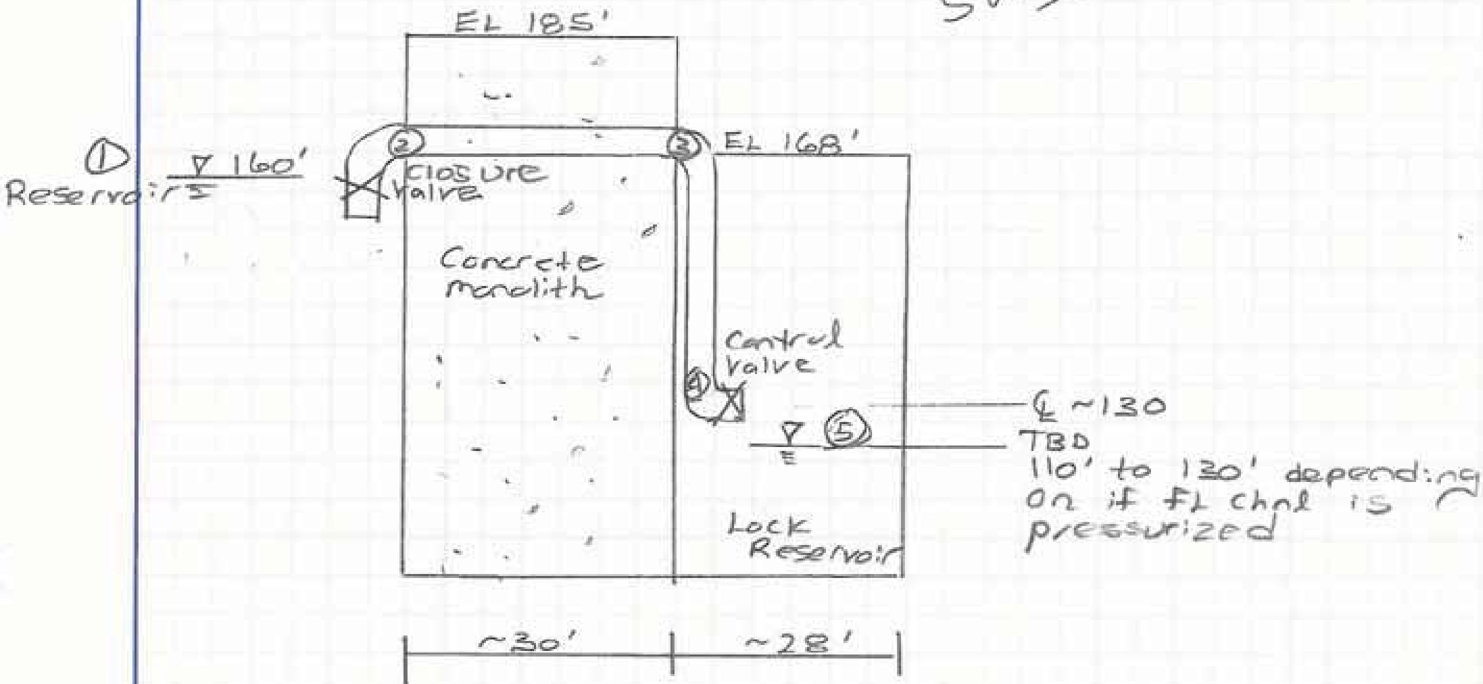
SIPHON CALCULATIONS

ORIGINAL CALCULATIONS BEFORE DRAWINGS WERE AVAILABLE, ROUGH ESTIMATE OF ALIGNMENT

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles EAWS – Siphon			

Estimate size of siphon pipes to deliver 1,400 cfs to fish lock.

Superseded



Assumptions:

1) Assume pipe follows direct route thru monolith

2) Siphon invert 168 ft

3) Closure valve u/s end, Control valve d/s end

4) Steel pipe

5) Compare pressures to ℄ pipe (PGL)

Pipe size restrictions due to velocities and maximum capacities:

Valve Room Pipes: 16 fps criterion limitation

	Pipe dia (ft)	Pipe area (ft)	Min V elocity (fps)	Max Discharge (cfs)		
42 inch	3.5	9.62	16	154		
36 inch	3	7.07	16	113		
18 inch	1.5	1.77	16	28	x 3 pipes	84.78

Valve Room Pipes: capacities

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
42 inch	3.5	9.62	400	42	109	42
42 inch	3.5	9.62	320	33	128	33
36 inch	3	7.07	210	30	109	30
36 inch	3	7.07	165	23	128	23
18 inch	1.5	1.77	53	30	109	30
18 inch	1.5	1.77	42	24	128	24

Sipon Pipes:

	Pipe dia (ft)	Pipe area (ft)	Min V elocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Siphon Pipes -EPANET -Velocities and Pressures:

	Pipe dia (ft)	Pipe area (ft)	Min V elocity (fps)	Max Discharge (cfs)	Top Pipe (ft)	PGL crest (ft)	Neg Pressure (ft)
60 inch	5	19.63	15.7	310	173	153	-20
66 inch	5.5	23.75	15.9	380	174	153	-21
72 inch	6	28.26	14.9	420	174	154	-20
78 inch	6.5	33.17	15.8	520	175	153	-21

siphon invert elev. 168 ft

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles EAWS Siphon			

Pipe 100 — Reservoir to siphon invert (u/s end)
Node 1-2

Entrace loss K= 1.0

2 bends K = 0.4

1 valve K = 0.2

$K_{Total} = 1.6$

Dia = 6 ft = 72 inches — To start with Trial & error — Ln ~ 18 ft

Pipe 200 — Siphon Reach Node 2-3

Friction only Ln ~ 30 ft

Pipe 300 — Node 3-4 vertical section

1 bend K= 0.2

Ln ~ 40 ft

Pipe 400 — Node 4-5 valve section

1 Bend K=0.2
1 Control valve K=0.2 (Fully open)
Exit Loss K= 1.0

Total K=1.6

Length ~ 6 ft

northwest hydraulic consultants inc.	DATE 11/30/11	BY LWL	CHK	3
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles EAWS - Siphon				

Siphon w/o valve control: EPANET Results

Q = 480 cfs   V = 25 fps

PGL @ Node 3 = 143.25 ft

℄ 5 ft dia pipe = 168 + 2.5 = 170.5 ft

Negative Pressure ~ -27 ft

If reference to crown, 168 + 5 = 173
173 - 143.25 = -30

Siphon w/ valve: EPANET Results

Adjust control valve K + pipe dia to obtain required Q thru multiple siphon pipes

84" pipe, Valve Loss = 20.6,

Q = 360
PGL = 157.68 @ Node 3

℄ pipe Dia = 168 + 3.5 = 171.5

Negative Pressure = 13.82 ft

$K_{valve} = 20.6 - 1.4_{Base} = 19.2$

If ref to crown

168 + 7 = 175

175 - 157.68 = 17.32

northwest hydraulic consultants inc.	DATE 11/30/11	BY LWL	CHK
CLIENT HDR /USACE		JOB No. 21936	
SUBJECT The Dalles EAWS – siphon			

Siphon w/ valve: Relax criteria to -20 ft

Reduce pipe dia + allow pressures as low as -20 ft

Reduce pipe to 6.5' dia w/ valve

6.5' dia = 78" $A = \pi r^2 = \pi\left(\frac{6.5}{2}\right)^2 = 33$

168 + 6.5 = 174.5 ft V=15.8 fps

$V = \frac{Q}{A} = \frac{524}{33} = 15.8$

Q = 524 cfs
valve K = 6 - 1.4 = 4.6

174.5 - 153.3 = -21.2 ft

Try 6 ft dia w/ valve V=15 fps

6' dia = 72"

168 + 6 = 174 ft

Q = 420 cfs
valve K = 7 - 1.4 = 5.6

P = 174 - 154 = -20 ft

Try 5 ft dia w/ valve

5' dia = 60" $A = \pi r^2 = \pi\left(\frac{5}{2}\right)^2 = 19.6$

168 + 5 = 173 ft

Q = 309 cfs $V = \frac{Q}{A} = \frac{309}{19.6} = \sim 15.7$ fps

173 - 153 = -20 ft

6,5' dia

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```
[TITLE]

[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;
 3                      0               0
        ;
 4                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                                     ;
 5                      130                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                   Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                       2                       18
        78              0.2             1.6             Open    ;
 2                      2                       3                       30
        78              0.2             0               Open    ;
 3                      3                       4                       40
        78              0.2             0               Open    ;
 4                      4                       5                       6
        78              0.2             6               Open    ;

[PUMPS]
;ID                     Node1                   Node2
Parameters

[VALVES]
;ID                     Node1                   Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
```

```
;Node                 InitQual

[SOURCES]
;Node                 Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank             Coefficient


[REACTIONS]
 Order Bulk            1
 Order Tank            1
 Order Wall            1
 Global Bulk           0
 Global Wall           0
 Limiting Potential    0
 Roughness Correlation 0

[MIXING]
;Tank                  Model

[TIMES]
 Duration              0
 Hydraulic Timestep    1:00
 Quality Timestep      0:05
 Pattern Timestep      1:00
 Pattern Start         0:00
 Report Timestep       1:00
 Report Start          0:00
 Start ClockTime       12 am
 Statistic             None

[REPORT]
 Status                No
 Summary               No
 Page                  0

[OPTIONS]
 Units                 CFS
 Headloss              D-W
 Specific Gravity      1
 Viscosity             0.00001
 Trials                40
 Accuracy              0.001
 CHECKFREQ             2
 MAXCHECK              10
 DAMPLIMIT             0
 Unbalanced            Continue 10
 Pattern               1
 Demand Multiplier     1.0
 Emitter Exponent      0.5
 Quality               None mg/L
 Diffusivity           1
 Tolerance             0.01

[COORDINATES]
;Node                  X-Coord             Y-Coord
 2                     -175.00             8283.33
 3                     1008.33             8300.00
 4                     1075.00             6550.00
 1                     -1258.33            7766.67
 5                     1958.33             6550.00

[VERTICES]
;Link                  X-Coord             Y-Coord

[LABELS]
;X-Coord           Y-Coord          Label & Anchor Node
```

```
[BACKDROP]
 DIMENSIONS          0.00                        0.00
        10000.00                10000.00
 UNITS               None
 FILE
 OFFSET              0.00                        0.00

[END]
```

6.5' dia

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```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: siphon valve 20 ft neg.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	78
2	2	3	30	78
3	3	4	40	78
4	4	5	6	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	153.70	66.60	0.00	
3	0.00	153.51	66.52	0.00	
4	0.00	153.27	66.41	0.00	
1	-524.05	160.00	0.00	0.00	Reservoir
5	524.05	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	524.05	15.79	350.27	Open
2	524.05	15.79	6.07	Open
3	524.05	15.79	6.07	Open
4	524.05	15.79	3878.36	Open

```
[TITLE]


[JUNCTIONS]
;ID                 Elev          Demand        Pattern
 2                  0             0
        ;
 3                  0             0
        ;
 4                  0             0
        ;

[RESERVOIRS]
;ID                 Head          Pattern
 1                  160                                  ;
 5                  130                                  ;

[TANKS]
;ID                 Elevation     InitLevel     MinLevel
MaxLevel      Diameter      MinVol        VolCurve

[PIPES]
;ID                 Node1                       Node2
Length        Diameter      Roughness     MinorLoss     Status
 1                  1                           2                     18
        72          0.2           1.6           Open      ;
 2                  2                           3                     30
        72          0.2           0             Open      ;
 3                  3                           4                     40
        72          0.2           0             Open      ;
 4                  4                           5                     6
        72          0.2           7             Open      ;

[PUMPS]
;ID                 Node1                       Node2
Parameters

[VALVES]
;ID                 Node1                       Node2
Diameter      Type  Setting       MinorLoss

[TAGS]

[DEMANDS]
;Junction           Demand        Pattern                     Category

[STATUS]
;ID                 Status/Setting

[PATTERNS]
;ID                 Multipliers

[CURVES]
;ID                 X-Value       Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency  75
 Global Price       0
 Demand Charge      0

[EMITTERS]
;Junction           Coefficient

[QUALITY]
```

```
;Node                    InitQual

[SOURCES]
;Node                    Type            Quality         Pattern

[REACTIONS]
;Type          Pipe/Tank                 Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                    Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01

[COORDINATES]
;Node                    X-Coord                   Y-Coord
 2                       -175.00                   8283.33
 3                       1008.33                   8300.00
 4                       1075.00                   6550.00
 1                       -1258.33                  7766.67
 5                       1958.33                   6550.00

[VERTICES]
;Link                    X-Coord                   Y-Coord

[LABELS]
;X-Coord             Y-Coord             Label & Anchor Node
```

```
[BACKDROP]
 DIMENSIONS             0.00                        0.00
        10000.00                10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                        0.00

[END]
```

```
**********************************************************************
*                           E P A N E T                              *
*                 Hydraulic and Water Quality                        *
*                 Analysis for Pipe Networks                         *
*                        Version 2.0                                 *
**********************************************************************
```

Input File: siphon valve 6 ft dia.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	72
2	2	3	30	72
3	3	4	40	72
4	4	5	6	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	154.42	66.91	0.00	
3	0.00	154.24	66.83	0.00	
4	0.00	154.00	66.73	0.00	
1	-419.87	160.00	0.00	0.00	Reservoir
5	419.87	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	419.87	14.85	310.25	Open
2	419.87	14.85	5.91	Open
3	419.87	14.85	5.91	Open
4	419.87	14.85	4000.32	Open

siphon 5.5 ft dia with valve.inp 12/8/2011

```
[TITLE]

[JUNCTIONS]
;ID              Elev        Demand        Pattern
 2               0           0
        ;
 3               0           0
        ;
 4               0           0
        ;

[RESERVOIRS]
;ID              Head        Pattern
 1               160                                  ;
 5               130                                  ;

[TANKS]
;ID              Elevation   InitLevel     MinLevel
MaxLevel      Diameter    MinVol        VolCurve

[PIPES]
;ID              Node1                     Node2
Length        Diameter    Roughness     MinorLoss     Status
 1               1                         2                 18
       66        0.2         1.6              Open    ;
 2               2                         3                 30
       66        0.2         0                Open    ;
 3               3                         4                 40
       66        0.2         0                Open    ;
 4               4                         5                 6
       66        0.2         5.8              Open    ;

[PUMPS]
;ID              Node1                     Node2
Parameters

[VALVES]
;ID              Node1                     Node2
Diameter      Type       Setting       MinorLoss

[TAGS]

[DEMANDS]
;Junction        Demand      Pattern                  Category

[STATUS]
;ID              Status/Setting

[PATTERNS]
;ID              Multipliers

[CURVES]
;ID              X-Value     Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency   75
 Global Price        0
 Demand Charge       0

[EMITTERS]
;Junction        Coefficient

[QUALITY]
```

```
;Node                   InitQual

[SOURCES]
;Node                   Type             Quality          Pattern

[REACTIONS]
;Type           Pipe/Tank                Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                   Y-Coord
 2                      -175.00                   8283.33
 3                      1008.33                   8300.00
 4                      1075.00                   6550.00
 1                      -1258.33                  7766.67
 5                      1958.33                   6550.00

[VERTICES]
;Link                   X-Coord                   Y-Coord

[LABELS]
;X-Coord             Y-Coord             Label & Anchor Node
```

```
[BACKDROP]
 DIMENSIONS         0.00                    0.00
        10000.00           10000.00
 UNITS              None
 FILE
 OFFSET             0.00                    0.00

[END]
```

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```
**********************************************************************
*                            E P A N E T                             *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 5.5 ft dia with valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	66
2	2	3	30	66
3	3	4	40	66
4	4	5	6	66

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	153.53	66.53	0.00	
3	0.00	153.30	66.43	0.00	
4	0.00	153.00	66.30	0.00	
1	-379.35	160.00	0.00	0.00	Reservoir
5	379.35	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	379.35	15.97	359.39	Open
2	379.35	15.97	7.54	Open
3	379.35	15.97	7.54	Open
4	379.35	15.97	3833.83	Open

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```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon 5.5 ft dia with valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	66
2	2	3	30	66
3	3	4	40	66
4	4	5	6	66

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	153.53	66.53	0.00	
3	0.00	153.30	66.43	0.00	
4	0.00	153.00	66.30	0.00	
1	-379.35	160.00	0.00	0.00	Reservoir
5	379.35	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	379.35	15.97	359.39	Open
2	379.35	15.97	7.54	Open
3	379.35	15.97	7.54	Open
4	379.35	15.97	3833.83	Open

```
[TITLE]

[JUNCTIONS]
;ID                  Elev          Demand        Pattern
 2                   0             0
        ;
 3                   0             0
        ;
 4                   0             0
        ;

[RESERVOIRS]
;ID                  Head          Pattern
 1                   160                                   ;
 5                   130                                   ;

[TANKS]
;ID                  Elevation     InitLevel     MinLevel
MaxLevel     Diameter      MinVol        VolCurve

[PIPES]
;ID                  Node1                       Node2
Length       Diameter      Roughness     MinorLoss     Status
 1                   1                           2                 18
      60             0.2           1.6           Open      ;
 2                   2                           3                 30
      60             0.2           0             Open      ;
 3                   3                           4                 40
      60             0.2           0             Open      ;
 4                   4                           5                 6
      60             0.2           6             Open      ;

[PUMPS]
;ID                  Node1                       Node2
Parameters

[VALVES]
;ID                  Node1                       Node2
Diameter     Type    Setting       MinorLoss

[TAGS]

[DEMANDS]
;Junction            Demand        Pattern                     Category

[STATUS]
;ID                  Status/Setting

[PATTERNS]
;ID                  Multipliers

[CURVES]
;ID                  X-Value       Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency   75
 Global Price        0
 Demand Charge       0

[EMITTERS]
;Junction            Coefficient

[QUALITY]
```

```
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -175.00                 8283.33
 3                      1008.33                 8300.00
 4                      1075.00                 6550.00
 1                      -1258.33                7766.67
 5                      1958.33                 6550.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord            Y-Coord          Label & Anchor Node
```

```
[BACKDROP]
 DIMENSIONS            0.00                     0.00
        10000.00                10000.00
 UNITS                 None
 FILE
 OFFSET                0.00                     0.00

[END]
```

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```
**********************************************************************
*                            E P A N E T                             *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                          Version 2.0                               *
**********************************************************************
```

Input File: siphon 5 ft dia with valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	60
2	2	3	30	60
3	3	4	40	60
4	4	5	6	60

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	153.70	66.60	0.00	
3	0.00	153.45	66.49	0.00	
4	0.00	153.12	66.35	0.00	
1	-309.03	160.00	0.00	0.00	Reservoir
5	309.03	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	309.03	15.74	350.06	Open
2	309.03	15.74	8.20	Open
3	309.03	15.74	8.20	Open
4	309.03	15.74	3854.13	Open

siphon.inp   No valve   12/1/2011

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;
 3                      0               0
        ;
 4                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                             ;
 5                      130                             ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                   Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                       2                       18
        60              0.2             1.6             Open    ;
 2                      2                       3                       30
        60              0.2             0               Open    ;
 3                      3                       4                       40
        60              0.2             0               Open    ;
 4                      4                       5                       6
        60              0.2             1.4             Open    ;

[PUMPS]
;ID                     Node1                   Node2
Parameters

[VALVES]
;ID                     Node1                   Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
```

79

```
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -175.00                 8283.33
 3                      1008.33                 8300.00
 4                      1075.00                 6550.00
 1                      -1258.33                7766.67
 5                      1958.33                 6550.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord            Y-Coord             Label & Anchor Node
```

```
[BACKDROP]
 DIMENSIONS             0.00                       0.00
        10000.00                 10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                       0.00

[END]
```

```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: siphon.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	18	60
2	2	3	30	60
3	3	4	40	60
4	4	5	6	60

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	144.63	62.67	0.00	
3	0.00	144.04	62.41	0.00	
4	0.00	143.25	62.07	0.00	
1	-482.68	160.00	0.00	0.00	Reservoir
5	482.68	130.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	482.68	24.58	853.71	Open
2	482.68	24.58	19.71	Open
3	482.68	24.58	19.71	Open
4	482.68	24.58	2208.96	Open

HIGH LEVEL OUTLET

21936 The Dalles EAWS
High Level Outlet

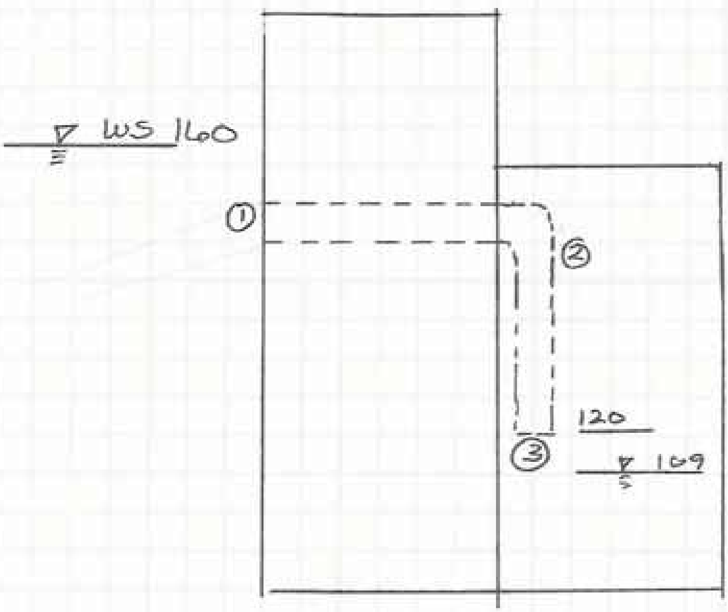
Pipe size restrictions due to velocities and maximum capacities:

	Pipe dia (ft)	Pipe area (ft)	Min V elocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Low Level Pipes -EPANET -Velocities and Pressures:

	Pipe dia (ft)	Pipe area (ft)	Max V elocity (fps)	Max Discharge (cfs)
Monovar Type Valves - FB 160				
72 inch	6	28.26	16.9	478
Movovar Type Valves - FB 155				
72 inch	6	28.26	15.8	447
Sleeve Type Valve - FB 160				
72 inch	6	28.26	25.3	716
Sleeve Type Valve - FB 155				
72 inch	6	28.26	23.7	670

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles EAWS High level Outlet			



Node 1 = Reservoir 160 + 155
Node 3 = Exit

Minor losses
- Entrance 0.1
- Trash Rack 0.1
- Bend 0.2
- Exit 1.0
- Valve: monovar 7.5; sleeve 2.5

Pipe 100 Ln ~ 30 ft

K = entrance + trash rack + bend
= 0.1 + 0.1 + 0.2 = 0.4

Pipe 200 Ln ~ 40 ft

K = exit + valve
= 1.0 + 7.5 OR 2.5

$K_{monovar} = 1 + 7.5 = 8.5$

$K_{sleeve} = 1 + 2.5 = 3.5$

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT HDR/USACE		JOB No. 21936	
SUBJECT The Dalles EAWS High Level outlet			

Results: 6 ft diameter pipe
72 inch.

Monovar valve option

1) FB 160 D/S Invert 120

Q= 478 cfs
V= 16.9 fps

2) FB 155 D/S Invert 155

Q= 447 cfs
V= 15.8 cfs

Sleeve valve option

1) FB 160 D/S Invert 120

Q= 716 cfs
V= 25.3 fps

2) FB 155 D/S Invert 120

Q= 670 cfs
V= 23.7 fps

```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                         Version 2.0                                *
**********************************************************************
```

Input File: High Level Outlet Sleeve Valve.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	72
2	2	3	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality
2	0.00	155.53	67.39	0.00
1	-716.31	160.00	0.00	0.00 Reservoir
3	716.31	120.00	0.00	0.00 Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	716.31	25.33	149.09	Open
2	716.31	25.33	888.18	Open

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
       ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                                     ;
 3                      120                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                               2               30
       72               0.15            .4              Open    ;
 2                      2                               3               40
       72               0.15            3.5             Open    ;

[PUMPS]
;ID                     Node1                           Node2
Parameters

[VALVES]
;ID                     Node1                           Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient
```

```
[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -150.00                 8214.29
 1                      -1392.86                9100.00
 3                      1035.71                 7500.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord           Y-Coord           Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
       10000.00                 10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                    0.00

[END]
```

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```
**********************************************************************
*                            E P A N E T                             *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                          Version 2.0                               *
**********************************************************************
```

Input File: High Level Outlet Monovar.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	30	72
2	2	3	40	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	158.01	68.46	0.00	
1	-477.96	160.00	0.00	0.00	Reservoir
3	477.96	120.00	0.00	0.00	Reservoir

Link Results:

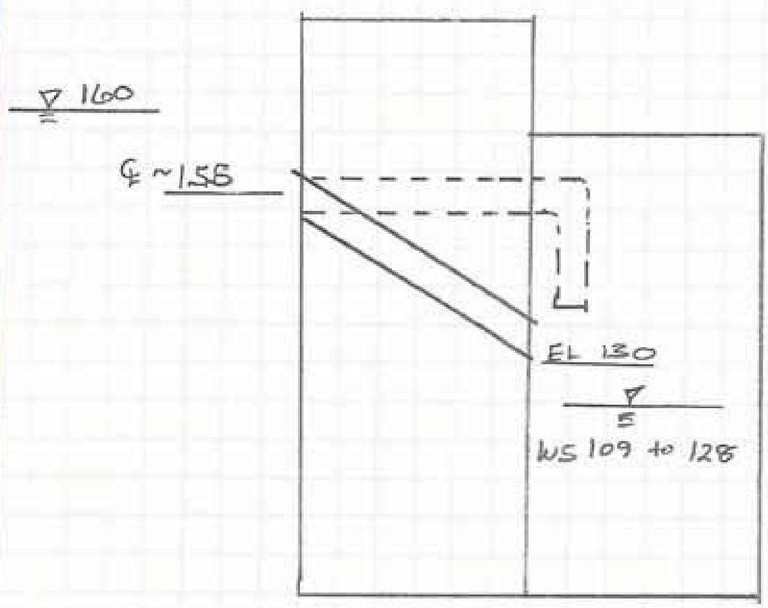
Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	477.96	16.90	66.50	Open
2	477.96	16.90	950.13	Open

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                             ;
 3                      120                             ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                               2                    30
        72              0.15            .4              Open    ;
 2                      2                               3                    40
        72              0.15            8.5             Open    ;

[PUMPS]
;ID                     Node1                           Node2
Parameters

[VALVES]
;ID                     Node1                           Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient
```

```
[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -150.00                 8214.29
 1                      -1392.86                9100.00
 3                      1035.71                 7500.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord           Y-Coord           Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
        10000.00                10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                    0.00

[END]
```

northwest hydraulic consultants inc.	DATE 12/1/11	BY LWL	CHK	1
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles EAWS Siphon				

Instead of a siphon, consider a pipe starting @ same elevation + discharging @ same elev.



Original calcs Superseded by 12/22/11 calcs

Node 1 = Reservoir
Node 2 = Fish lock

K_m = Entrance + Exit ~ 1.2 + valve + other : K = 1.4

Friction - steel

Try 4' dia $\qquad A = \pi r^2 = \pi\left(\frac{4}{2}\right)^2 = 12.6$

$H = 160 - 130 = 30$

$K_m \sim 1.2$

$K_f \sim f\frac{L}{D} \sim 0.015\frac{(50)}{4} \approx 0.20$

$\Delta H = K\frac{V^2}{2g} \qquad V^2 = \frac{Q^2}{A^2} = \frac{Q^2}{12.6^2} = \frac{Q^2}{158}$

$30 = 1.6\frac{Q^2}{158} \qquad Q \sim 440$ cfs → Revised 12/12

$\frac{158}{644}$

EPANET ⇒ Q = 446 cfs $\qquad V = \frac{378}{12.6} = 30$ fps

northwest hydraulic consultants inc.	DATE 12/1/11	BY LWL	CHK	2
CLIENT HOR/USACE		JOB No. 21936		
SUBJECT The Dalles EAWS siphon				

Try 5' dia pipe

$Q \sim 700$ cfs EPANET

$A = \pi r^2 = 3.14 \left(\frac{5}{2}\right)^2 = 19.6$

$Q = VA$

$V = \frac{Q}{A} = \frac{600}{19.6} = 30$ fps

Limit V to 16 fps

$Q = VA$
$Q = (19.6)(16) = 314$ cfs

Try 4' dia

velocity limit

$Q = VA$
$Q = (16)(12.6)$

$Q = 200$ cfs

$A = \pi r^2 = \pi \left(\frac{4}{2}\right)^2 = 12.6$

Try 5'' dia

velocity Limit

$A = \pi r^2 = \pi \left(\frac{5}{2}\right)^2 = 19.6$

$Q = VA$
$Q = (16)(19.6)$

$Q = 314$ cfs

LOW LEVEL OUTLET

FINAL LOW LEVEL OUTLET CALCULATIONS

CALCULATIONS REPRESENT FINAL GEOMETRY, 60% DRAWINGS

Pipe size restrictions due to velocities and maximum capacities:
Adjusted downstream elevation to reflect non-submerged condition
Sleeve Valve Assumptions

Low Level Pipes - 16 fps velocity restriction

	Pipe dia (ft)	Pipe area (ft)	Max Velocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
54 inch	4.5	15.90	16	254
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Low Level Pipes -EPANET -Velocities and Pressures:
FB WSEL 160, Fish Lock WSEL 110

	Pipe dia (ft)	Pipe area (ft)	Max discharge (cfs)	Velocity (fps)
72 inch	6	28.26	730	40

FB WSEL 155, Fish Lock WSEL 110

	Pipe dia (ft)	Pipe area (ft)	Max discharge (cfs)	Velocity (fps)
72 inch	6	28.26	689	40

northwest hydraulic consultants inc.	DATE 1/4/12	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles EAWS			

Revise low level outlet calculations!

1) Assume sleeve valve $K = 2.5$ (see siphon calcs)

$K_{sleeve} = 2.5$ fully open

2) Raise d/s invert (previously assumed submerged conditions)

Pipe 100 Ln = 190 ft

Entrance $K = 0.1$
Trash rack $K = 0.1$
2 bends. $K = 0.4$

$K_T = 0.6$

Pipe 200 Ln = 20 ft

$K_{valve} = 2.5$
$K_{exit} = 1.0$ - conservative, may not be needed if valve @ very d/s end

$K_T = 3.5$

Check FB 160 + FB 155

D/S Elev ~ 111 ft + $\frac{1}{2}(6)$ = 114 ft

Sensitivity on valve

Say $K = 10$
FB 155

Q = 420 cfs

Say $K = 6$
FB 155

Q = 515 cfs

Say $K = 8$
FB 155

Q = 460 cfs

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```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                         Version 2.0                                *
**********************************************************************
```

Input File: Low Level Pipe Valve 6 ft dia FB 160.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	190	72
2	2	3	20	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	150.58	65.25	0.00	
1	-730.24	160.00	0.00	0.00	Reservoir
3	730.24	114.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	730.24	25.83	49.56	Open
2	730.24	25.83	1829.22	Open

```
[TITLE]

[JUNCTIONS]
;ID                 Elev            Demand          Pattern
 2                  0               0                               ;

[RESERVOIRS]
;ID                 Head            Pattern
 1                  160                             ;
 3                  114                             ;

[TANKS]
;ID                 Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID                 Node1                 Node2                     Length          Diameter
Roughness       MinorLoss       Status
 1                  1                     2                         190             72              0.15
        .6          Open      ;
 2                  2                     3                         20              72              0.15
        3.5         Open      ;

[PUMPS]
;ID                 Node1                 Node2                     Parameters

[VALVES]
;ID                 Node1                 Node2                     Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction           Demand          Pattern             Category

[STATUS]
;ID                 Status/Setting

[PATTERNS]
;ID                 Multipliers

[CURVES]
;ID                 X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
```


4

```
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
```

```
 Trials              40
 Accuracy            0.001
 CHECKFREQ           2
 MAXCHECK            10
 DAMPLIMIT           0
 Unbalanced          Continue 10
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node               X-Coord             Y-Coord
 2                  -7.14               7457.14
 1                  -1450.00            7757.14
 3                  1750.00             7157.14

[VERTICES]
;Link               X-Coord             Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS         0.00                0.00                10000.00            10000.00
 UNITS              None
 FILE
 OFFSET             0.00                0.00

[END]
```

```
**********************************************************************
*                            E P A N E T                             *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                         Version 2.0                                *
**********************************************************************
```

Input File: Low Level Pipe Valve 6 ft dia FB 155.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	190	72
2	2	3	20	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	146.60	63.52	0.00	
1	-689.36	155.00	0.00	0.00	Reservoir
3	689.36	114.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	689.36	24.38	44.19	Open
2	689.36	24.38	1630.17	Open

```
[TITLE]

[JUNCTIONS]
;ID              Elev            Demand          Pattern
 2               0               0                               ;

[RESERVOIRS]
;ID              Head            Pattern
 1               155                             ;
 3               114                             ;

[TANKS]
;ID              Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID              Node1           Node2           Length          Diameter
Roughness       MinorLoss       Status
 1               1               2               190             72              0.15
         .6      Open    ;
 2               2               3               20              72              0.15
         3.5     Open    ;

[PUMPS]
;ID              Node1           Node2           Parameters

[VALVES]
;ID              Node1           Node2           Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction        Demand          Pattern         Category

[STATUS]
;ID              Status/Setting

[PATTERNS]
;ID              Multipliers

[CURVES]
;ID              X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
```

```
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
```

```
 Trials              40
 Accuracy            0.001
 CHECKFREQ           2
 MAXCHECK            10
 DAMPLIMIT           0
 Unbalanced          Continue 10
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node               X-Coord            Y-Coord
 2                  -7.14              7457.14
 1                  -1450.00           7757.14
 3                  1750.00            7157.14

[VERTICES]
;Link               X-Coord            Y-Coord

[LABELS]
;X-Coord        Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS         0.00               0.00               10000.00           10000.00
 UNITS              None
 FILE
 OFFSET             0.00               0.00

[END]
```

Before adjusted d/S elev.

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```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: Low Level Pipe Valve 6 ft dia.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	2	190	72
2	2	3	20	72

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	149.77	64.90	0.00	
1	-761.37	160.00	0.00	0.00	Reservoir
3	761.37	110.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	761.37	26.93	53.84	Open
2	761.37	26.93	1988.47	Open

Ground e 111 ft
112 ft

```
[TITLE]


[JUNCTIONS]
;ID                  Elev            Demand          Pattern
 2                   0               0                                   ;

[RESERVOIRS]
;ID                  Head            Pattern
 1                   160                             ;
 3                   110                             ;

[TANKS]
;ID                  Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID                  Node1                Node2                Length          Diameter
Roughness       MinorLoss    Status
 1                   1                    2                    190             72              0.15
        .6           Open     ;
 2                   2                    3                    20              72              0.15
        3.5          Open     ;

[PUMPS]
;ID                  Node1                Node2                Parameters

[VALVES]
;ID                  Node1                Node2                Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction            Demand          Pattern                 Category

[STATUS]
;ID                  Status/Setting

[PATTERNS]
;ID                  Multipliers

[CURVES]
;ID                  X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
```

```
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
```


13

```
 Trials              40
 Accuracy            0.001
 CHECKFREQ           2
 MAXCHECK            10
 DAMPLIMIT           0
 Unbalanced          Continue 10
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node                X-Coord           Y-Coord
 2                   -7.14             7457.14
 1                   -1450.00          7757.14
 3                   1750.00           7157.14

[VERTICES]
;Link                X-Coord           Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS          0.00              0.00              10000.00          10000.00
 UNITS               None
 FILE
 OFFSET              0.00              0.00

[END]
```

ORIGINAL LOW LEVEL OUTLET CALCULATIONS

PRIOR TO COMPLETION OF DRAWINGS

The Dalles - Low Level Pipe Option
Pipe size restrictions due to velocities and maximum capacities:

Low Level Pipes - 16 fps velocity restriction

	Pipe dia (ft)	Pipe area (ft)	Min Velocity (fps)	Max Discharge (cfs)
48 inch	4	12.56	16	201
54 inch	4.5	15.90	16	254
60 inch	5	19.63	16	314
66 inch	5.5	23.75	16	380
72 inch	6	28.26	16	452
78 inch	6.5	33.17	16	531

Low Level Pipes -EPANET -Velocities and Pressures:
FB WSEL 160, Fish Lock WSEL 110

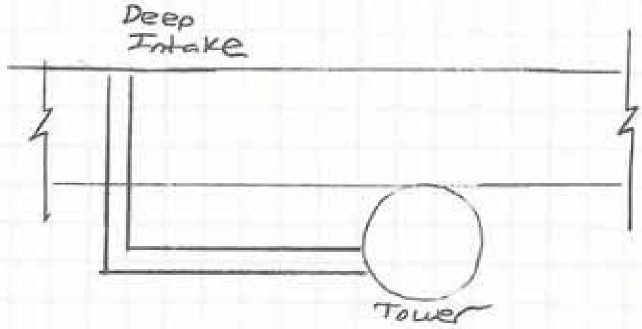
	Pipe dia (ft)	Pipe area (ft)	Max discharge (cfs)	Velocity (fps)
48 inch	4	12.56	476	38
54 inch	4.5	15.90	612	38.5
60 inch	5	19.63	765	39
72 inch	6	28.26	1124	40

FB WSEL 155, Fish Lock WSEL 110

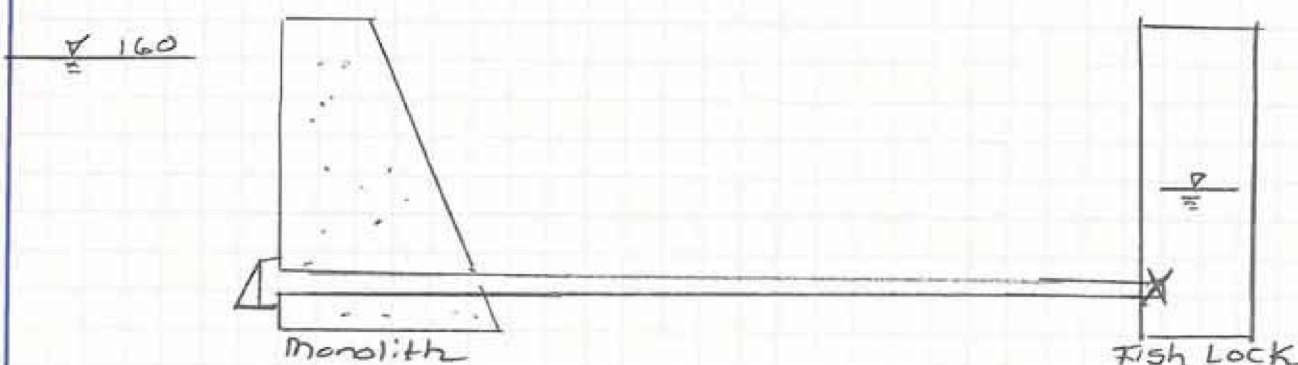
	Pipe dia (ft)	Pipe area (ft)	Max discharge (cfs)	Velocity (fps)
48 inch	4	12.56	450	36
54 inch	4.5	15.90	580	36.5
60 inch	5	19.63	726	37
72 inch	6	28.26	1066	38

northwest hydraulic consultants inc.	DATE 12/12	BY LWL	CHK	1
CLIENT USACE/HDR		JOB No. 21936		
SUBJECT The Dalles EAWS Low level outlet				

Alternative 2 - Deep Intake Option - See Rich's sketch



PLAN VIEW



Sectional View

Total Ln ~ 210 ft

~ Two 90° Bends for now

Entrance + Exit Loss

Assume bell mouth w/ trash rack - entrance

Valve on d/s end

Note: max Dia = 6 ft

northwest hydraulic consultants inc.	DATE 12/12	BY LWL	CHK	2
CLIENT USACE / HDR		JOB No. 21936		
SUBJECT The Dalles EAWS				

FB = 160 ft
Fish Lock WSEL = 110 to 130 ft

Minor Losses: EM 1602

Entrance K=0.1
Trash Rack K=0.1
Bends say 2 K = 0.1×2 = 0.2 → Increase to 0.4 see p.4
Exit K= 1.0
Valve open K=0.1 → more like K=0.3 fully open if use moncvar, okay for now 12/13/11 see p.4

$\Sigma K = 1.5 \rightarrow 1.7$

Friction Losses:

Steel pipe $e = 0.15 \times 10^{-3}$ EPANET manual (0.0015)

EM 1602 0.001 to 0.0006 Depending on finish

for 5' dia pipe $\frac{e}{d} = \frac{0.00015}{5} = 0.00003$

$K \sim 0.013$

$$f\frac{L}{D} = \frac{0.013}{5}(210) = 0.55$$

$K_T = 1.5 + 0.5 = 2.0$ Check prior to EPANET
(minor, friction)

$$\Delta H = K\frac{V^2}{2g} \qquad A = \pi r^2 = \pi\left(\frac{5}{2}\right)^2 = 19.6$$

$$V = \frac{Q}{A} = \frac{Q}{19.6}$$

Fish lock WS 130'

$$\Delta H = 30 = 2\,\frac{\frac{Q^2}{19.6^2}}{64.4} \qquad Q = 609 \text{ cfs}$$

EPANET Q = 620 cfs

	Fish Lock 130 Δ30'	Fish Lock 110 Δ50'	
Dia 5' (60")	620 cfs 32 fps	805 cfs 41 fps	EPANET Results
6' (72")	916 cfs 32 fps	1180 cfs 42 fps	
4' (48")	386 cfs 30.7 fps	500 cfs 40 fps	

Velocity Limit = 16 fps ?

6 ft dia $A = \pi r^2 = \pi (3)^2 = 28\ ft^2$

$Q = VA$

$Q = (16\ fps)(28\ ft^2)$

$Q = 448$ cfs Total Q ~ 1344 cfs

Use Valve on 6 ft dia pipe to limit velocities

Increase Friction as sensitivity run

6' dia, 72" Fish Lock 130

$\varepsilon = 0.15 \times 10^{-3}$ Q = 916 cfs V = 32 fps

$\varepsilon = 0.1 \times 10^{-3}$ Q = 920 cfs V = 33 fps

$\varepsilon = 0.6 \times 10^{-3}$ Q = 896 cfs V = 32 fps

Valve 72" to decrease velocities to 16 fps

Q ~ 475 cfs V ~ 16.8 fps

K = 0.5 pipe 1

K = 6.0 pipe 2 (w/o valve K ~ 1.0)

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT HDR/USACE		JOB No. 21936	
SUBJECT The Dalles EAWS – low level outlet			

Revise low level outlet calcs & make following mods.

Total K ⇒

Increase bend loss to 0.2

valve/control at end:

Assume sluice type gate for now K ~ 0.1, other controls should be discussed

Total K = 1.7

This small change in total K is insignificant – No need to revise EPANET

Summary Low Level outlet

Two 72" pipe required if use 16 fps criterion

If relax criterion to say 30 fps, two 60" pipes would work

northwest hydraulic consultants inc.	DATE 12/22/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles EAWS – Low level outlet			

Check low level outlet for FB 160' + 155'
D/S WSEL = 110 ft

Network:

Pipe 1 K = entrance + trashrack + bends
K = 0.1 + 0.1 + 0.2×2 = 0.6

Pipe 2 K = valve + exit
K = 1.1

Results EPANET

1) 72 inch dia (6 ft)
FB 160 Q = 1124 cfs
V = 39.8 fps

FB 155 Q = 1066 cfs
V = 37.7 fps

2) 60 inch dia (5 ft)
FB 160 Q = 765 cfs
V = 39 fps

FB 155 Q = 726 cfs
V = 37 fps

3) 48 inch dia (4 ft)
FB 160 Q = 476 cfs
V = 38 fps

FB 155 Q = 450 cfs
V = 36 fps

4) 54 inch dia (4.5 ft)
FB 160 Q = 612 cfs
V = 38.5 fps

FB 155 Q = 580 cfs
V = 36.5 fps

Page 1 12/23/2011 7:04:17 PM

```
**********************************************************************
*                          E P A N E T                               *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                         Version 2.0                                *
**********************************************************************
```

Input File: Low Level Pipe Slide Gate 4.5 ft dia.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	1	3	190	54
2	3	2	20	54

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
3	0.00	133.71	57.94	0.00	
1	-580.79	155.00	0.00	0.00	Reservoir
2	580.79	110.00	0.00	0.00	Reservoir

Link Results:

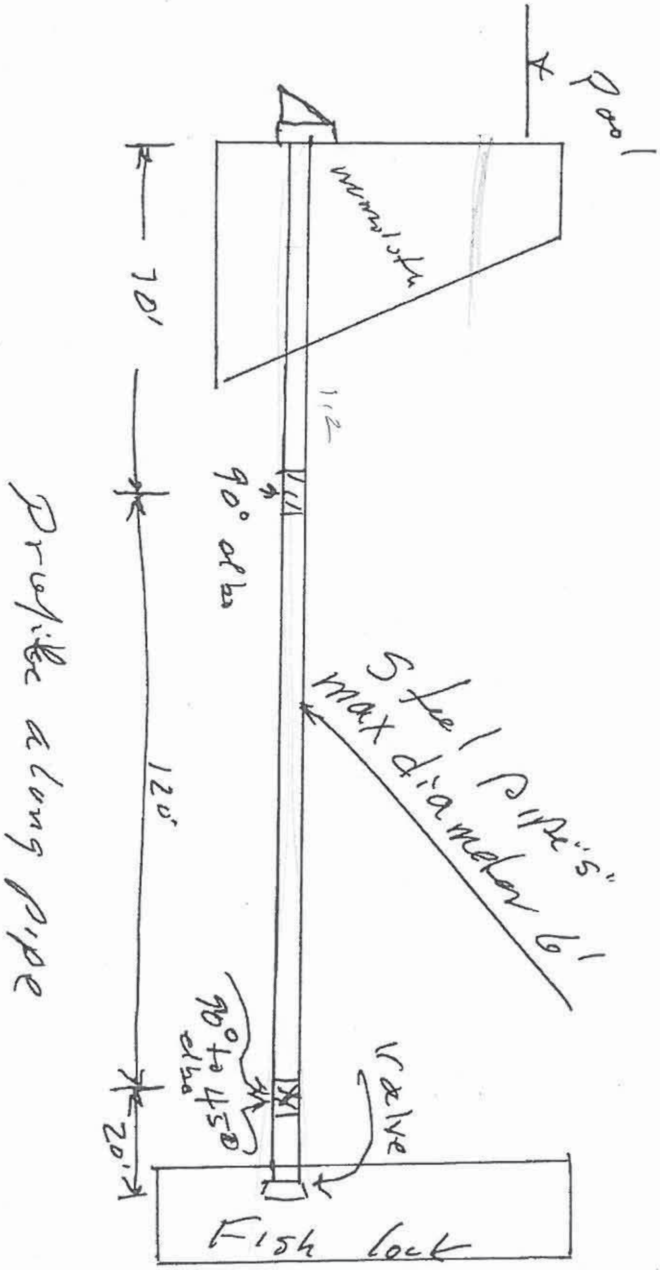
Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	580.79	36.52	112.06	Open
2	580.79	36.52	1185.44	Open

```
[TITLE]


[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 3                      0               0
       ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      155                                     ;
 2                      110                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                   Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                      1                       3                       190
       54               0.15            .6              Open    ;
 2                      3                       2                       20
       54               0.15            1.1             Open    ;

[PUMPS]
;ID                     Node1                   Node2
Parameters

[VALVES]
;ID                     Node1                   Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient
```

```
[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 3                      -7.14                   7457.14
 1                      -1450.00                7757.14
 2                      1750.00                 7157.14

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
        10000.00                10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                    0.00

[END]
```

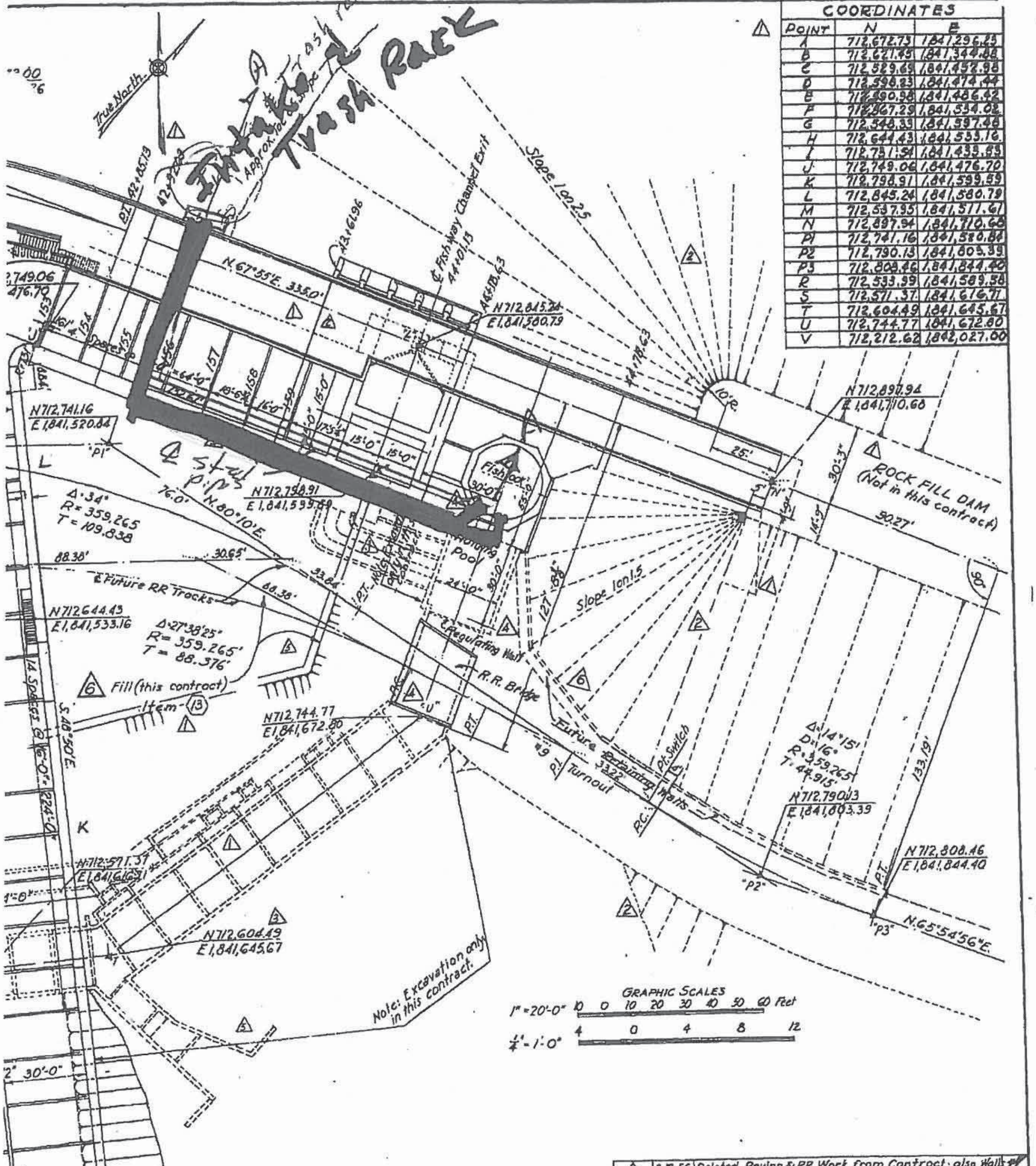
HDR | ONE COMPANY *Many Solutions*™

Project:		Computed:	Date:
Subject:		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



U. S. ARMY

COORDINATES		
POINT	N	E
A	712,672.73	1,841,296.25
B	712,621.45	1,841,344.88
C	712,529.69	1,841,452.98
D	712,598.23	1,841,474.44
E	712,590.98	1,841,486.42
F	712,567.29	1,841,554.02
G	712,548.39	1,841,597.46
H	712,644.43	1,841,533.16
I	712,751.54	1,841,439.69
J	712,749.06	1,841,476.70
K	712,798.91	1,841,599.59
L	712,845.24	1,841,580.79
M	712,537.95	1,841,517.61
N	712,897.94	1,841,710.68
P1	712,741.16	1,841,580.84
P2	712,790.13	1,841,805.39
P3	712,808.46	1,841,844.40
R	712,533.99	1,841,589.58
S	712,571.37	1,841,616.71
T	712,604.49	1,841,645.67
U	712,744.77	1,841,672.80
V	712,212.62	1,842,027.00



Revision	Date	Description	By
6	3-12-56	Deleted Paving & RR Work from Contract; also Walls	
5	1-19-55	Corrected dimension in Unit M, Fishlock & Fill	
4	7-12-54	Relocated Fishlock	
3	6-3-54	Corrected Stationing, dimensions, stairs.	
2	11-25-53	Fill, openings, curb, strut	
1	11-2-53	Pay items, fishlock approach, coordinates, notes, etc.	

AS CONSTRUCTED

Contract No. DA-35-026-eng-20700
Contractor: Atkinson Ostrander Co.
Date of Receipt of Notice to Proceed: 21 Jan. 1954
Date of Completion of Contract: 1 July 1956
Date of Acceptance: 2 July 1956

N. W. HANER & ASSOCIATES
MOFFATT, NICHOL & TAYLOR
ASSOCIATED ENGINEERS

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PORTLAND OREGON

DRAWN BY: C.B.
TRACED BY: C.B.
CHECKED BY: CHF

THE DALLES DAM

COLUMBIA RIVER WASHINGTON-OREGON

EAST FISHLADDER AND EAST NON-OVERFLOW DAM GENERAL PLAN

PREPARED:
REVIEWED:
APPROVED: DATE 7-3-53
SUBMITTED:
RECOMMENDED:
SCALE AS SHOWN
CONTRACT NUMBER:
DRAWING NUMBER DDF-1-0-5/3
SHEET 143

Deep Intake – Lake Tap Option

VALVE ROOM PIPING

VALVE ROOM PIPING

FINAL CALCULATIONS INCLUDING ITR COMMENTS

21936 The Dalles EAWS
Pipe size restrictions due to velocities and maximum capacities:

Valve Room Pipes: 16 fps criterion limitation

	Pipe dia (ft)	Pipe area (ft)	Max Velocity (fps)	Max Discharge (cfs)		
42 inch	3.5	9.62	16	154		
36 inch	3	7.07	16	113		
18 inch	1.5	1.77	16	28	x 3 pipes	84.78

Valve Room Pipes: Capacities
FB 160 ft

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
42 inch	3.5	9.62	374	39	110	39
36 inch	3	7.07	181	26	110	26

Note: Flow thru 18 inch varies by pipe, velocities all above 16 fps

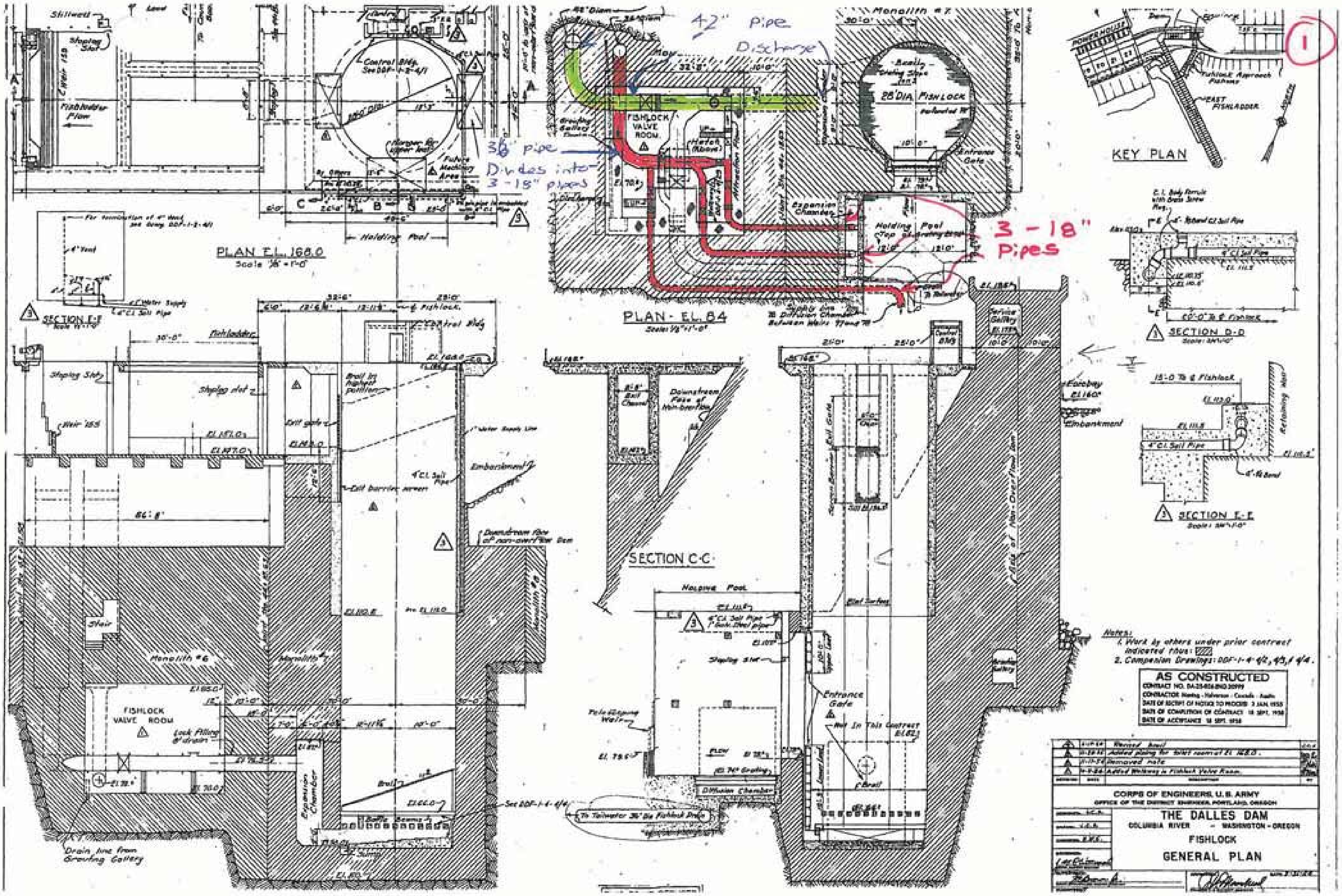
FB 155 ft

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
42 inch	3.5	9.62	349	36	110	36
36 inch	3	7.07	173	24	110	24

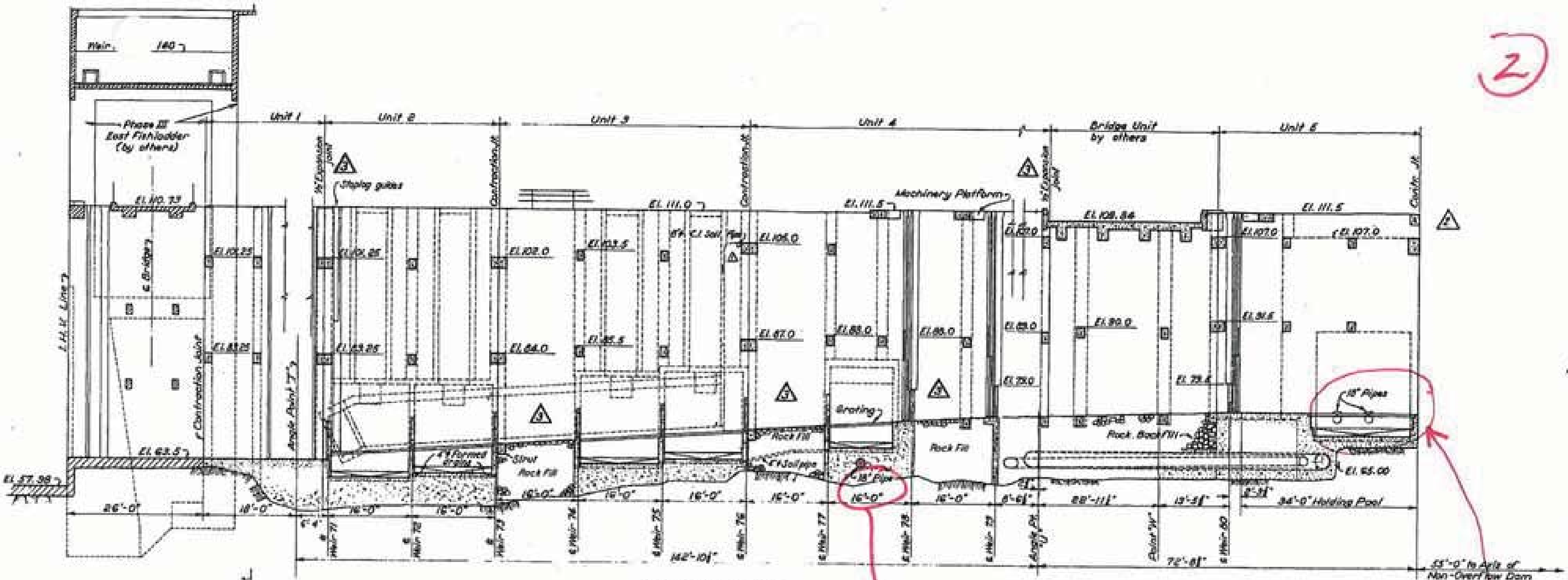
Note: Flow thru 18 inch varies by pipe, velocities all above 16 fps

Modify 36 inch pipe to remove 18 inch connections

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
FB 160	3	7.07	307	43	110	43
FB 155	3	7.07	292	41	110	41


1
42" pipe Discharge
36" pipe Divides into 3-18" pipes
3 - 18" Pipes
FISHLOCK VALVE ROOM
28' DIA. FISHLOCK
Holding Pool
Expansion Chamber
PLAN EL. 168.0
PLAN - EL. 84
KEY PLAN
EAST FISHLADDER
SECTION E-E
SECTION D-D
SECTION C-C
Monolith #6
FISHLOCK VALVE ROOM
Diffusion Chamber
Notes:
1. Work by others under prior contract indicated thus:
2. Companion Drawings: DDF-1-4-42, 43, & 44.
AS CONSTRUCTED
CORPS OF ENGINEERS, U.S. ARMY
THE DALLES DAM
COLUMBIA RIVER - WASHINGTON - OREGON
FISHLOCK
GENERAL PLAN
2

2

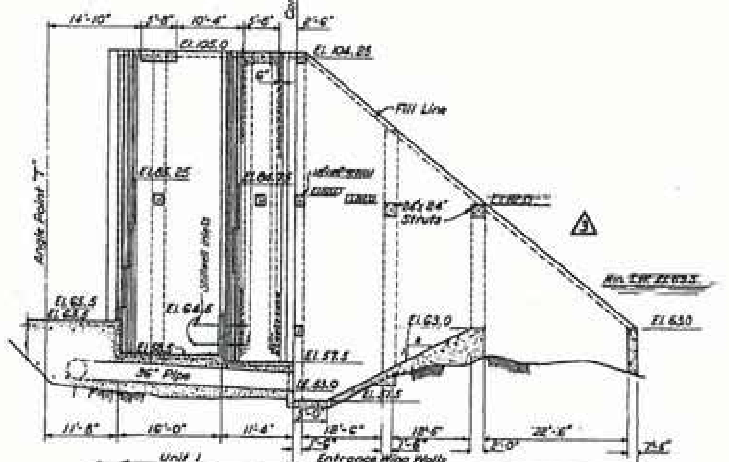


SECTION E-E
Scale: ⅛"=1'-0"

one 18" pipe discharges via diffuser into fish lock approach channel

Othe 2-18" pipes discharge into ~~[illegible]~~ holding pool –

See P. 1



SECTION F-F
Scale: ⅛"=1'-0"

AS CONSTRUCTED
CONTRACT NO. DA-35-026-ENG-20999
CONTRACTOR Morrison - Knudsen - Cascade - Austin
DATE OF RECEIPT OF NOTICE TO PROCEED 3 JAN. 1955
DATE OF COMPLETION OF CONTRACT 18 SEPT. 1958
DATE OF ACCEPTANCE 18 SEPT. 1958

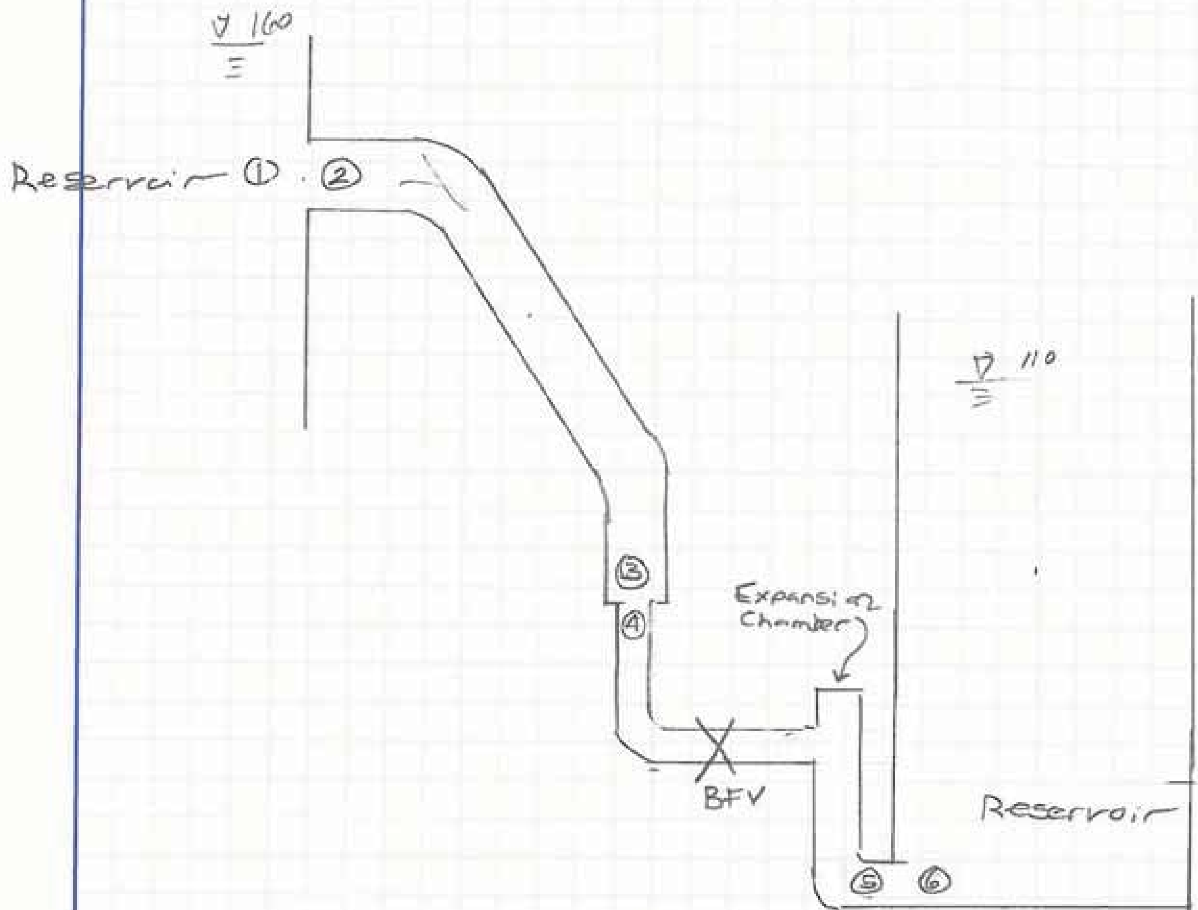
3		Added temporary stoplog guides, Exp. joints, rock fill, soil pipe. Corrected rock line. Revised Sec. F-F
2		Added pipe encasement - Unit 3
1		Added Soil Pipe

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON

THE DALLES DAM
COLUMBIA RIVER WASHINGTON - OREGON
FISHLOCK APPROACH FISHWAY
LONGITUDINAL SECTIONS

northwest hydraulic consultants inc.	DATE 11/22	BY LWL	CHK
CLIENT HDR/USACE		JOB No. 21936	
SUBJECT The Dalles EAWS 42" Valve Room			

Estimate Losses thru 42" Valve Room Pipe



Reservoir 1 WSEL = 160 ft

Reservoir 8[6] WSEL ~ 110 ft

400 cfs

northwest hydraulic consultants inc.	DATE 1/4/11	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 219-36	
SUBJECT The Dalles - Valve Room Pipes 42"			

42" pipe: Address ITR NHC comments

1) Add 0.6 loss to EPANET file
pipe 101 K=0.6 Total

2) Reduce bend angles + losses
K=0.14 + K=0.04 per ALS calcs
Total K= 0.18 Pipe 102

3) BF valve Loss
K=0.4 increase from K=0.2
Pipe 104 Total K=1.65

4) Expansion
Pipe 105 add K=1.0 to input file
Pipe 105 K= 1.2 Total

Page 1 1/4/2012 1:24:33 PM

```
**********************************************************************
*                          E P A N E T                               *
*                 Hydraulic and Water Quality                        *
*                 Analysis for Pipe Networks                         *
*                         Version 2.0                                *
**********************************************************************
```

Input File: 42 inch revised and roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	1	98.4
102	3	2	50	98.4
103	3	4	1	42
104	4	5	46	42
105	5	6	1	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	154.59	66.98	0.00	
3	0.00	154.42	66.91	0.00	
4	0.00	150.26	65.11	0.00	
5	0.00	112.07	48.56	0.00	
1	-349.20	155.00	0.00	0.00	Reservoir
6	349.20	110.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-349.20	6.61	408.36	Open
102	-349.20	6.61	3.50	Open
103	349.20	36.29	4155.26	Open
104	349.20	36.29	830.33	Open
105	349.20	10.52	2065.98	Open

```
[TITLE]

[JUNCTIONS]
;ID                 Elev            Demand          Pattern
 2                  0               0                                ;
 3                  0               0                                ;
 4                  0               0                                ;
 5                  0               0                                ;

[RESERVOIRS]
;ID                 Head            Pattern
 1                  155                             ;
 6                  110                             ;

[TANKS]
;ID                 Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID                 Node1                   Node2                   Length          Diameter
Roughness       MinorLoss       Status
 101                2                       1                       1               98.4            1
        0.6         Open        ;
 102                3                       2                       50              98.4            1
        0.18        Open        ;
 103                3                       4                       1               42              0.2
        0.2         Open        ;
 104                4                       5                       46              42              1.65
        1.65        Open        ;
 105                5                       6                       1               78              0.2
        1.2         Open        ;

[PUMPS]
;ID                 Node1                   Node2                   Parameters

[VALVES]
;ID                 Node1                   Node2                   Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction           Demand          Pattern                 Category

[STATUS]
;ID                 Status/Setting

[PATTERNS]
;ID                 Multipliers
```

```
[CURVES]
;ID                     X-Value          Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type             Quality          Pattern

[REACTIONS]
;Type           Pipe/Tank                Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
```

```
 Status               No
 Summary              No
 Page                 0

[OPTIONS]
 Units                CFS
 Headloss             D-W
 Specific Gravity     1
 Viscosity            0.00001
 Trials               40
 Accuracy             0.001
 CHECKFREQ            2
 MAXCHECK             10
 DAMPLIMIT            0
 Unbalanced           Continue 10
 Pattern              1
 Demand Multiplier    1.0
 Emitter Exponent     0.5
 Quality              None mg/L
 Diffusivity          1
 Tolerance            0.01

[COORDINATES]
;Node                 X-Coord              Y-Coord
 2                    -525.00              7933.33
 3                    658.33               6033.33
 4                    908.33               5500.00
 5                    2491.67              5450.00
 1                    -1091.67             7983.33
 6                    3191.67              5433.33

[VERTICES]
;Link                 X-Coord              Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS           0.00                 0.00                 10000.00             10000.00
 UNITS                None
 FILE
 OFFSET               0.00                 0.00

[END]
```


9

FB 160

10


```
**********************************************************************
*                             E P A N E T                            *
*                     Hydraulic and Water Quality                    *
*                     Analysis for Pipe Networks                     *
*                             Version 2.0                            *
**********************************************************************
```

Input File: 42 inch revised and roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	1	98.4
102	3	2	50	98.4
103	3	4	1	42
104	4	5	46	42
105	5	6	1	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	159.53	69.12	0.00	
3	0.00	159.33	69.04	0.00	
4	0.00	154.56	66.97	0.00	
5	0.00	112.37	48.69	0.00	
1	-374.27	160.00	0.00	0.00	Reservoir
6	374.27	110.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-374.27	7.09	469.10	Open
102	-374.27	7.09	4.02	Open
103	374.27	38.90	4773.29	Open
104	374.27	38.90	917.03	Open
105	374.27	11.28	2373.31	Open

```
[TITLE]

[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0                               ;
 3                      0               0                               ;
 4                      0               0                               ;
 5                      0               0                               ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                             ;
 6                      110                             ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID                     Node1                   Node2                   Length          Diameter
Roughness       MinorLoss       Status
 101                    2                       1                       1               98.4            1
        0.6             Open    ;
 102                    3                       2                       50              98.4            1
        0.18            Open    ;
 103                    3                       4                       1               42              0.2
        0.2             Open    ;
 104                    4                       5                       46              42              0.2
        1.65            Open    ;
 105                    5                       6                       1               78              0.2
        1.2             Open    ;

[PUMPS]
;ID                     Node1                   Node2                   Parameters

[VALVES]
;ID                     Node1                   Node2                   Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction              Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers
```

```
[CURVES]
;ID                       X-Value          Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency        75
 Global Price             0
 Demand Charge            0

[EMITTERS]
;Junction                 Coefficient

[QUALITY]
;Node                     InitQual

[SOURCES]
;Node                     Type             Quality          Pattern

[REACTIONS]
;Type             Pipe/Tank                Coefficient


[REACTIONS]
 Order Bulk               1
 Order Tank               1
 Order Wall               1
 Global Bulk              0
 Global Wall              0
 Limiting Potential       0
 Roughness Correlation    0

[MIXING]
;Tank                     Model

[TIMES]
 Duration                 0
 Hydraulic Timestep       1:00
 Quality Timestep         0:05
 Pattern Timestep         1:00
 Pattern Start            0:00
 Report Timestep          1:00
 Report Start             0:00
 Start ClockTime          12 am
 Statistic                None

[REPORT]
```


12

```
 Status              No
 Summary             No
 Page                0

[OPTIONS]
 Units               CFS
 Headloss            D-W
 Specific Gravity    1
 Viscosity           0.00001
 Trials              40
 Accuracy            0.001
 CHECKFREQ           2
 MAXCHECK            10
 DAMPLIMIT           0
 Unbalanced          Continue 10
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node                X-Coord            Y-Coord
 2                   -525.00            7933.33
 3                   658.33             6033.33
 4                   908.33             5500.00
 5                   2491.67            5450.00
 1                   -1091.67           7983.33
 6                   3191.67            5433.33

[VERTICES]
;Link                X-Coord            Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS          0.00               0.00               10000.00           10000.00
 UNITS               None
 FILE
 OFFSET              0.00               0.00

[END]
```

VALVE ROOM PIPING

CALCULATIONS REFLECT MODIFICATION TO ELIMINATE 18 PIPES

northwest hydraulic consultants inc.	DATE 12/16/11	BY LWL	CHK	1
CLIENT USACE / HDR		JOB No. 21936		
SUBJECT The Dalles EAWS				

36" Valve Room Pipe: Modification option

Connect 36" pipe to 42" Drain pipe that necks down to 32"

See 36" valve calcs

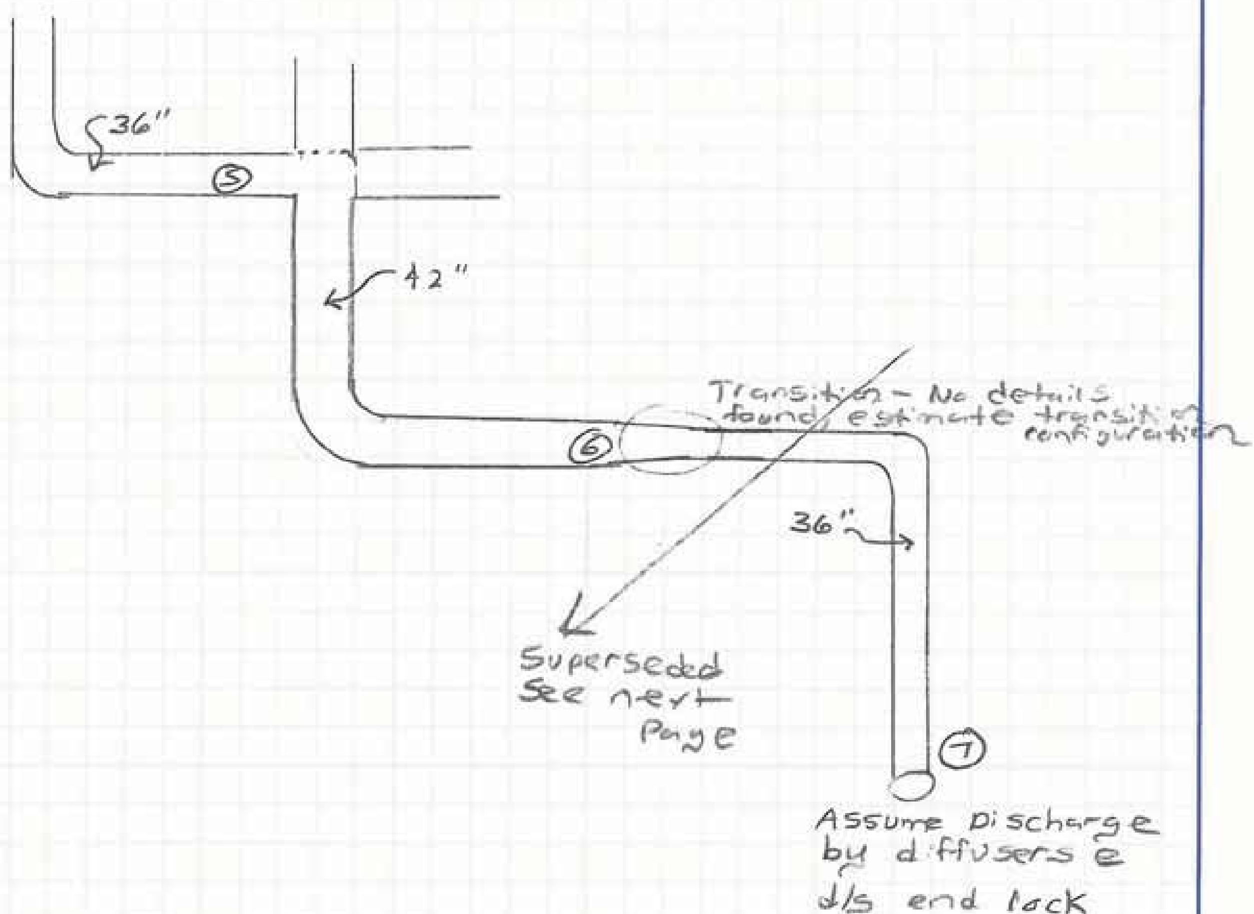
modify EPANET model used for 36" pipe w/ 18" branches

Pipe 1-2 Same

Pipe 2-3 same

Pipe 3-4 same

Pipe 4-5 same



northwest hydraulic consultants inc.	DATE 1/4/11	BY LWL	CHK
CLIENT HDR/USACE		JOB No. 21936	
SUBJECT The Dalles EAWS			

Modified 36" valve Room Pipe mod file:

See 36" ITA Comments – Applied

FB 160 Q = 307 cfs

FB 155 Q = 292 cfs

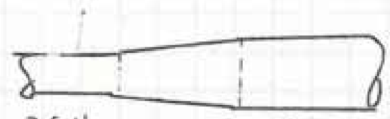
northwest hydraulic consultants inc.	DATE 12/16/11	BY LWL	CHK	2
CLIENT USACE / HDR		JOB No. 21936		
SUBJECT The Dalles EAWS				

Pipe 5-6 — 2-90° Bends + Transition from 36" to 42"
Ln ~ 50 ft

90° Bends – $K = 0.2 \times 2 = 0.4$

Will depend on connection method

36" to 42" – assume gradual expansion



42-36 = 6", 3" on each side, very minor

K=0.2 max, maybe less

Total K = 0.6

Pipe 6-7 — Gradual contraction
90° bend
Exit
Valve — Ln ~ 150'

Contract 42" to 32"

$$A_1 = \pi r^2 = \pi\left(\frac{42}{2(12)}\right)^2 = 9.6\ ft^2$$

$$A_2 = \pi r^2 = \pi\left(\frac{32}{2(12)}\right)^2 = 5.6\ ft^2$$

$$A/A = 1.71$$

make $H/R > 0.3$ $K \sim 0.1$

90° bend – K=0.2

Exit Loss – K=1

Valve loss – K=0.2

Total K = 1.5

northwest hydraulic consultants inc.	DATE 12/16/11	BY LWL	CHK	3
CLIENT USACE / HDR		JOB No. 21936		
SUBJECT The Dalles EAWS				

EPANET was modified.

D/S WSEL = 109 ft   FB = 160

Q = 250 cfs

This isn't a significant increase (using 3, 18" = 210 cfs)

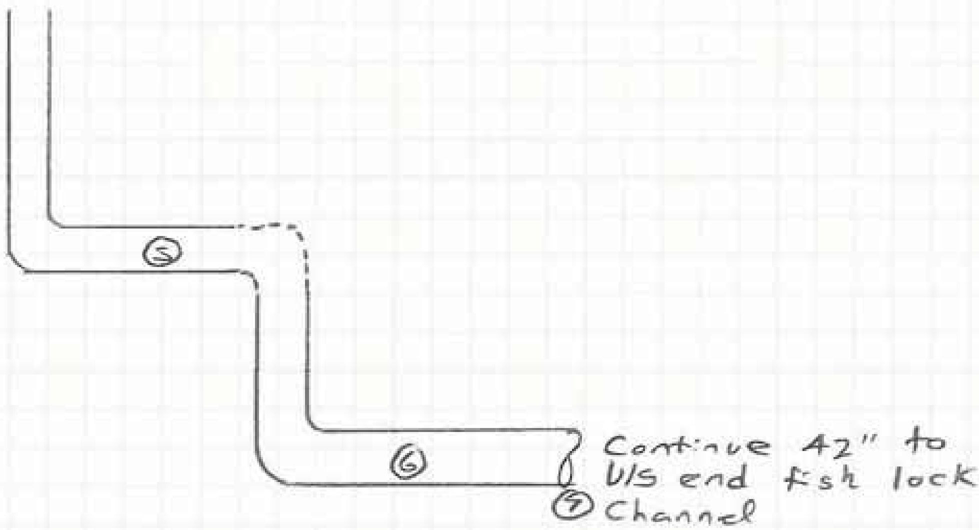
Discharge closer to lock to reduce friction

Q = 280 cfs

D/S WSEL = 128 ft

With short pipe Length, Q = 210 cfs

northwest hydraulic consultants inc.	DATE 12/19/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles			



42" necks down to 36"; however, to discharge @ U/S end of channel, the 42" could just be extended

Change EPANET model

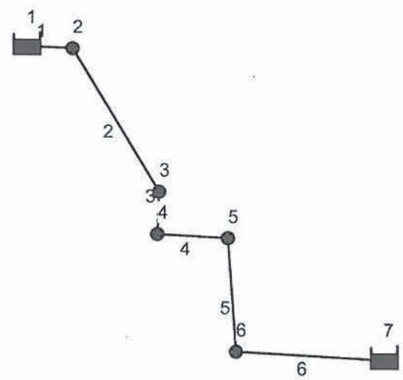
Pipe 6-7 = 42" dia
minor losses
K = 1.4
Removed contraction

Q = 333 cfs   D/S WS 109 ft

Q = 263 cfs   D/S WS 128 ft

36 inch pipe - valve room

Day 1, 12:0



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```
**********************************************************************
*                             E P A N E T                            *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 36 inch pipe drain connect option 2.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	50	42
6	6	7	20	42

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	160.00	69.33	0.00	
3	0.00	159.70	69.20	0.00	
4	0.00	152.68	66.16	0.00	
5	0.00	150.34	65.14	0.00	
6	0.00	136.23	59.03	0.00	
1	-333.04	160.00	0.00	0.00	Reservoir
7	333.04	109.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-333.04	6.31	0.96	Open
2	333.04	6.31	5.90	Open
3	333.04	47.12	7023.65	Open
4	333.04	47.12	130.25	Open
5	333.04	34.62	282.21	Open
6	333.04	34.62	1361.27	Open

```
[TITLE]

[JUNCTIONS]
;ID                    Elev         Demand       Pattern
 2                     0            0
        ;
 3                     0            0
        ;
 4                     0            0
        ;
 5                     0            0
        ;
 6                     0            0
        ;

[RESERVOIRS]
;ID                    Head         Pattern
 1                     160                                   ;
 7                     109                                   ;

[TANKS]
;ID                    Elevation    InitLevel    MinLevel
MaxLevel        Diameter     MinVol       VolCurve

[PIPES]
;ID                    Node1                     Node2
Length          Diameter     Roughness    MinorLoss    Status
 1                     2                         1                  1
        98.4           1            0            Open         ;
 2                     2                         3                  50
        98.4           1            0.4          Open         ;
 3                     3                         4                  1
        36             0.2          0.2          Open         ;
 4                     4                         5                  18
        36             0.2          0            Open         ;
 5                     5                         6                  50
        42             0.2          0.6          Open         ;
 6                     6                         7                  20
        42             0.2          1.4          Open         ;

[PUMPS]
;ID                    Node1                     Node2
Parameters

[VALVES]
;ID                    Node1                     Node2
Diameter        Type   Setting      MinorLoss

[TAGS]

[DEMANDS]
;Junction              Demand       Pattern      Category

[STATUS]
;ID                    Status/Setting

[PATTERNS]
;ID                    Multipliers

[CURVES]
;ID                    X-Value      Y-Value

[CONTROLS]

[RULES]

[ENERGY]
```

```
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -1550.00                7885.71
 3                      -507.14                 6157.14
 4                      -535.71                 5657.14
```

```
 5                       321.43                   5614.29
 6                       407.14                   4242.86
 1                       -2092.86                 7900.00
 7                       2178.57                  4157.14

[VERTICES]
;Link                    X-Coord                  Y-Coord

[LABELS]
;X-Coord            Y-Coord             Label & Anchor Node

[BACKDROP]
 DIMENSIONS              0.00                     0.00
        10000.00                 10000.00
 UNITS                   None
 FILE
 OFFSET                  0.00                     0.00

[END]
```

```
**********************************************************************
*                             E P A N E T                            *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                            Version 2.0                             *
**********************************************************************
```

Input File: 36 inch pipe drain connect option 2.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	50	42
6	6	7	20	42

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	160.00	69.33	0.00	
3	0.00	159.81	69.25	0.00	
4	0.00	155.41	67.34	0.00	
5	0.00	153.93	66.70	0.00	
6	0.00	145.08	62.86	0.00	
1	-263.72	160.00	0.00	0.00	Reservoir
7	263.72	128.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-263.72	4.99	0.61	Open
2	263.72	4.99	3.71	Open
3	263.72	37.31	4404.33	Open
4	263.72	37.31	82.03	Open
5	263.72	27.41	177.16	Open
6	263.72	27.41	853.75	Open

```
[TITLE]

[JUNCTIONS]
;ID                  Elev            Demand          Pattern
 2                   0               0
        ;
 3                   0               0
        ;
 4                   0               0
        ;
 5                   0               0
        ;
 6                   0               0
        ;

[RESERVOIRS]
;ID                  Head            Pattern
 1                   160                                     ;
 7                   128                                     ;

[TANKS]
;ID                  Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                  Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 1                   2                               1                       1
        98.4         1               0                       Open    ;
 2                   2                               3                       50
        98.4         1               0.4                     Open    ;
 3                   3                               4                       1
        36           0.2             0.2                     Open    ;
 4                   4                               5                       18
        36           0.2             0                       Open    ;
 5                   5                               6                       50
        42           0.2             0.6                     Open    ;
 6                   6                               7                       20
        42           0.2             1.4                     Open    ;

[PUMPS]
;ID                  Node1                           Node2
Parameters

[VALVES]
;ID                  Node1                           Node2
Diameter        Type Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction            Demand          Pattern                         Category

[STATUS]
;ID                  Status/Setting

[PATTERNS]
;ID                  Multipliers

[CURVES]
;ID                  X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
```

```
 Global Efficiency       75
 Global Price            0
 Demand Charge           0

[EMITTERS]
;Junction                Coefficient

[QUALITY]
;Node                    InitQual

[SOURCES]
;Node                    Type             Quality          Pattern

[REACTIONS]
;Type            Pipe/Tank                Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                    Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01

[COORDINATES]
;Node                    X-Coord                  Y-Coord
 2                       -1550.00                 7885.71
 3                       -507.14                  6157.14
 4                       -535.71                  5657.14
```

```
 5                       321.43                   5614.29
 6                       407.14                   4242.86
 1                       -2092.86                 7900.00
 7                       2178.57                  4157.14

[VERTICES]
;Link                    X-Coord                  Y-Coord

[LABELS]
;X-Coord             Y-Coord             Label & Anchor Node

[BACKDROP]
 DIMENSIONS              0.00                     0.00
        10000.00                 10000.00
 UNITS                   None
 FILE
 OFFSET                  0.00                     0.00

[END]
```

VALVE ROOM PIPING

CALCULATIONS USED FOR ITR

Prior to NHC ITR

21936 The Dalles EAWS

Pipe size restrictions due to velocities and maximum capacities:

Valve Room Pipes: 16 fps criterion limitation

	Pipe dia (ft)	Pipe area (ft)	Min Velocity (fps)	Max Discharge (cfs)		
42 inch	3.5	9.62	16	154		
36 inch	3	7.07	16	113		
18 inch	1.5	1.77	16	28	x 3 pipes	84.78

max

Valve Room Pipes: Capacities

FB 160 ft

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
42 inch	3.5	9.62	400	42	110	42 ✓
36 inch	3	7.07	210	30	110	30 ✓

Note: Flow thru 18 inch varies by pipe, velocities all above 16 fps

FB 155 ft

	Pipe dia (ft)	Pipe area (ft)	EPANET Discharge (cfs)	EPANET Velocity (fps)	Reservoir WSEL (cfs)	Calc V EPANET Velocity
42 inch	3.5	9.62	383	40	110	40 ✓
36 inch	3	7.07	197	28	110	28 ✓

Note: Flow thur 18 inch varies by pipe, velocities all above 16 fps

northwest hydraulic consultants inc.	DATE 11/22	BY LWL	CHK	2
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles EAWS 42" valve Room				

Pipe 101 — 8 × 8'-4" — Ln ~ 1 ft

8 × 8.33

A = 66.64

Hyd Dia = $4\frac{A}{P} = 4\frac{66.64}{2(8)+2(8.33)} = 8.2$

8.2×12 = 98.4

Entrance Loss – $r/d = 0$

K = 0.40 — 0.5 — miller P.373 — Sharp edge optimistic K ~ 0.5

80% ⇐ Blocking

Trash Rack Loss –

K = 0.20 ✓ — 0.3 Miller 14.8

Total K = 0.60 — 0.8

Pipe 102 — 8 × 8'-4" — Ln = ~ 50'

8 × 8.33

Bend R = 10 — R/d = 10/8 = 1.25

~120° ?

Deflection angles look high!

K ~ 0.25 — miller P.212

Bend R = 10

~160° ?

K ~ 0.20

Total K = 0.40

Pipe 103 — 8 × 8.33 to 42" pipe — dia = $\frac{42}{12}$ = 3.5'

Contraction — $A_1 = 66.64$

$A_2 = \pi r^2 = \pi\left(\frac{42}{2(12)}\right)^2 = 9.6$

$A/A = 0.14$ ✓

$r/d \sim 0.04$ est.

K ~ 0.20 — 0.25 — miller P.374

Ln = 1 ft

northwest hydraulic consultants inc.	DATE 11/22	BY LWL	CHK	3
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles EAWS 42" Valve Rm				

Pipe 104 3.5' dia Ln ~ 13 ft 1953 calcs
+ ~33 ft = 46 ft

mitre bend loss –
r ~ 7' (radius of bend)
Composite 3

$r/d = 7/3.5 = 2$

K ~ 0.25 ✓ P. 216 miller

Expansion to expansion chamber
Apply to small pipe

Ht = ~18'
W = 6 ft
A = ~108 ft²

Pipe A ~ 9.6

$A/A \sim 10$ K = 1.0 ✓

BFV Fully open K = 0.2 – 0.4
Total K = 1.45 → 1.65

Pipe 105 Contraction to lock Ln = 1 ft

Ht = 4'
W = ~18'
A = 72 ft²

Hyd dia = $\frac{(72)(4)}{2(4)+2(18)} = 6.5$
× 12 = 78"

$A/A = 72/100 = 0.72$

Abrupt contraction K = 0.20 ✓ @ 72 ft²

☆ Expansion K = 1.0 @ 72 ft²

6 blow Braws

2 sides, K = 0.8 each
K_T = 1.6 @ 26×18 = 468 ft²

northwest hydraulic consultants inc. | DATE 11/16/11 | BY [illegible] | CHK | 1

CLIENT | JOB No. [illegible]

SUBJECT AWS Loads

FOREBAY EL. = 160 ft

TAILWATER EL = 85 ft

AVAILABLE HEAD = 75 ft

MINOR LOSSES

ENTRANCE: A = 8' × 8' 4" = 66.67 ft
P_W = 32.67
D_H = 4A/P_W = 8.16 ft
r_{DIER} = ?
K = ~~0.5~~ 1.0 Assumed

BEND 1 : R_B = 10'
A = 66.67 ft
θ_B = 69° 54'
b = 8.33 ft
W = 8 ft
L = 27' 8 3/8" = 27.68'
D = 8.16 ft

b/W = 1.04
L/D = 3.39

r/W = 1.25

K = 0.14 Pg 211

BEND 2
R_B = 10'
A = 66.67
θ_{B2} = 20° 09'
b = 8.33
W = 8
L = 13'
D = 8.16'
L/D = 1.59
r/W = 1.25

K = 0.04

BELLMOUTH (Sharp)
A_1 = 66.67
A_2 = 10.25
P_W = 14
D_H = 3.5
r = (5.83 - 3.5) = 2.33
r/D = 0.67
A_2/A_1 = 6.18

K = 0.17 Pg 374

northwest hydraulic consultants inc. | DATE | BY | CHK

CLIENT | JOB No.

SUBJECT

TRANSITION $R_2 = 3.5$ $R_1 = 3.5$ $H = 6.5$ $E_1 2.9$

$K = 0.09$ $\Rightarrow$ 249 & $X = 12.5$

45° MITRE $A = 9.62\ ft^2$ $D = 3.5\ ft$ $\theta_{BS} = 45°$

$K = 0.3$

22.5° MITRE $K = 0.08 \times 2$; $K = 0.16$

MOTORIZED BUTTERFLY VALVE $K = 0.15, 0.20, 0.65$

FLOW SPLIT $\theta = 30°$ $Q_2 = 100\%$ $A_1 = A_3 = A_2$ $Q_1 = 0\%$ $Q_1/Q_3 = 0$

$K_{23} = 0.05$

$\Sigma K_m = 2.1$

FRICTION LOSSES: RUN OF 42" PIPE in VALVE ROOM

$L = 6.8" \times 2 = 13.6\ ft$ +

$f = 0.04$ Steel conduit, old pipe

$K_{fric} = \frac{fL}{D} = 0.12$

42" PIPE TUNNEL $L = 0.75 \times 8 =$

$f = 0.04$

$K = 0.087$

northwest hydraulic consultants inc.	DATE 11/16/11	BY MS	CHK
CLIENT		JOB No. 21936	
SUBJECT			

TRANSITION FRICTION

L = 6.5 D = 3.5 ~~f = 0.013~~ 0.04

K = 0.074

CONCRETE [illegible]

L = 3 + 27.38 + 2π·10 (69°34' / 360) + 21.5 × 0 = 58

= 58.9 ft

D = 8.6 ft f = 0.015

K_f = 0.289

ΣK_f = ~~[illegible]~~

$$Q = \left[\frac{Head}{\left(\frac{K_e}{A_c^2} + \frac{K_{ef}}{A_c^2} + \frac{K_c}{A_c^2} + \frac{K_f}{A_c^2} \right) / 64.4} \right]^{0.5}$$

$$\left[\frac{15}{\left(\frac{(0.5 + .14 + .04)}{(66.67)^2} + \frac{(0.289)}{(66.67)^2} + \frac{(.074 + .17 + 0.04)}{(12.3)^2} + \frac{(3.1 + .1 + .05 + .45 + 1.2 + .087)}{9.3^2} \right) / 64.4} \right]^{0.5}$$

Q = 528 cfs

northwest hydraulic consultants inc.	DATE	BY	CHK
CLIENT		JOB No.	
SUBJECT			

FRICTION ONLY

→ VALVE RM to EXPANSION 31' × 8' = 248'
← VALVE RM to LIFT 0.95' × 8' = 7.6'
LIFT 6.5'
SPILLWAY
8×8 3' tunnel 38.9 lf
= 97.78 lf

f = 0.04

$$K = \frac{L \cdot f}{D} = \frac{97.78(0.04)}{3.5} = 1.11$$

$$Q = \left[\frac{75}{\left[\frac{1.11}{9.62^2}\right]} \cdot 64.4\right]^{1/2} = 10.5 \text{ cfs}$$

$$Q = \frac{H}{f \frac{L}{D} \left(\frac{1}{A^2}/2g\right)}$$

$$H = f \frac{L}{D} \frac{V^2}{2g}$$

$$H = f \frac{L}{D} \frac{\frac{Q^2}{A^2}}{2g}$$

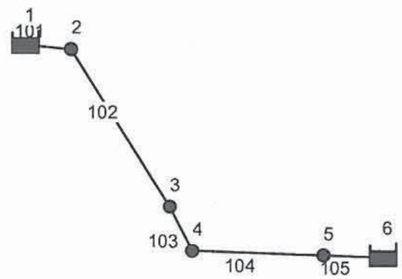
$$V = \frac{Q}{A} = \frac{Q^2}{A^2}$$

$$75 = 0.04 \left(\frac{98}{3.5}\right) \left(\frac{\frac{Q^2}{9.62^2}}{64.4}\right)$$

$$75 = 1.11 \left(\frac{\frac{Q^2}{9.62^2}}{64.4}\right)$$

$$Q = \frac{75}{1.11} \frac{64.4}{A^2}$$

42 inch revised



```
[TITLE]

[JUNCTIONS]
;ID                     Elev            Demand          Pattern
 2                      0               0
        ;
 3                      0               0
        ;
 4                      0               0
        ;
 5                      0               0
        ;

[RESERVOIRS]
;ID                     Head            Pattern
 1                      160                                     ;
 6                      128                                     ;

[TANKS]
;ID                     Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                     Node1                           Node2
Length          Diameter        Roughness       MinorLoss       Status
 101                    2                               1                       1
        98.4            1               0               Open            ;
 102                    3                               2                       50
        98.4            1               0.4             Open            ;
 103                    3                               4                       1
        42              0.2             0.2             Open            ;
 104                    4                               5                       46
        42              0.2             1.45            Open            ;
 105                    5                               6                       1
        78              0.2             0.2             Open            ;

[PUMPS]
;ID                     Node1                           Node2
Parameters

[VALVES]
;ID                     Node1                           Node2
Diameter        Type    Setting         MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0
```

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```
[EMITTERS]
;Junction                Coefficient

[QUALITY]
;Node                    InitQual

[SOURCES]
;Node                    Type            Quality         Pattern

[REACTIONS]
;Type            Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                    Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001   T = 75° F
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01

[COORDINATES]
;Node                    X-Coord                 Y-Coord
 2                       -525.00                 7933.33
 3                       658.33                  6033.33
 4                       908.33                  5500.00
 5                       2491.67                 5450.00
 1                       -1091.67                7983.33
 6                       3191.67                 5433.33
```

```
[VERTICES]
;Link                    X-Coord                  Y-Coord

[LABELS]
;X-Coord             Y-Coord             Label & Anchor Node

[BACKDROP]
 DIMENSIONS              0.00                     0.00
        10000.00                 10000.00
 UNITS                   None
 FILE
 OFFSET                  0.00                     0.00

[END]
```

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```
**********************************************************************
*                              E P A N E T                           *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 42 inch revised and roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	1	98.4
102	3	2	50	98.4
103	3	4	1	42
104	4	5	46	42
105	5	6	1	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	160.00	69.33	0.00	
3	0.00	159.72	69.21	0.00	
4	0.00	156.17	67.67	0.00	
5	0.00	128.30	55.59	0.00	
1	-322.71	160.00	0.00	0.00	Reservoir
6	322.71	128.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-322.71	6.11	0.90	Open
102	-322.71	6.11	5.54	Open
103	322.71	33.54	3549.01	Open
104	322.71	33.54	606.02	Open
105	322.71	9.73	296.05	Open

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```
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: 42 inch revised and roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	1	98.4
102	3	2	50	98.4
103	3	4	1	42
104	4	5	46	42
105	5	6	1	78

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	160.00	69.33	0.00	
3	0.00	159.57	69.14	0.00	
4	0.00	154.02	66.74	0.00	
5	0.00	110.46	47.86	0.00	
1	-403.47	160.00	0.00	0.00	Reservoir
6	403.47	110.00	0.00	0.00	Reservoir

Link Results:

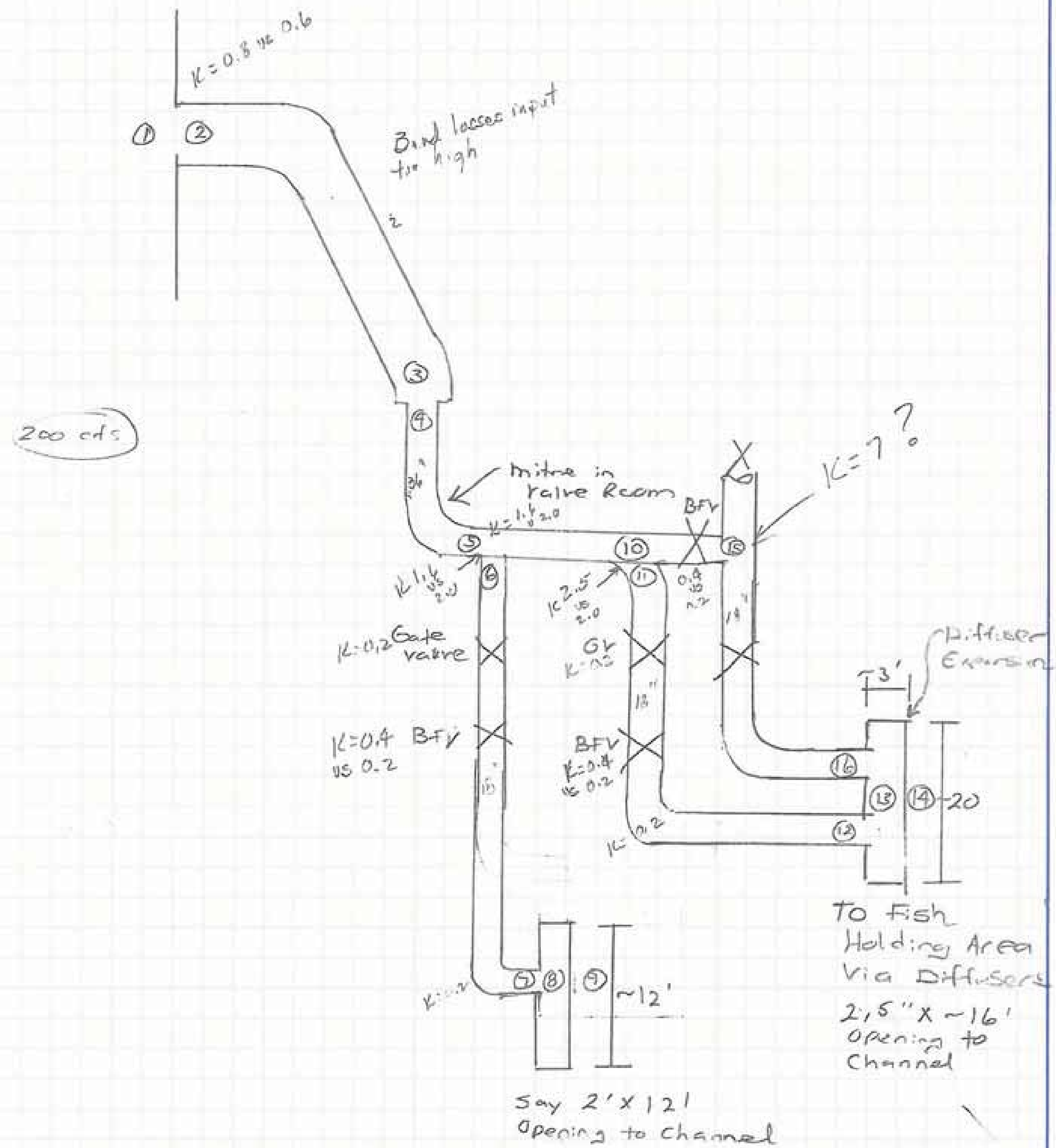
Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-403.47	7.64	1.40	Open
102	-403.47	7.64	8.66	Open
103	403.47	41.94	5547.07	Open
104	403.47	41.94	946.87	Open
105	403.47	12.16	462.72	Open

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK JL	1
CLIENT HOR / USACE		JOB No. 21936		
SUBJECT Dalles EAWS 36" valve room				

Checked

Estimate losses thru 36" - Note: splits into 3 pipes

36" is similar through transition to 36" Intake



northwest hydraulic consultants inc.	DATE 1/4/11	BY LWL	CHK
CLIENT HDR/USACE		JOB No. 21936	
SUBJECT Dalles EAWS - Valve Room Pipes 36"			

36" Pipe: Address NHC ITR Comments

1) Pipe 1 K=0.6 (not shown in input file)

2) Pipe 2 K=0.18 for bends
   See 42" pipe ITR

   total K=0.18

3) Pipe 4 K=0.25 (not shown in input file)

4) Pipe 5 K=1.6 (not shown in input file)

5) Pipe 7 K=1.0 (not shown in input file

6) Pipe 10 K=2.5 (increase slightly)

7) Pipe 14 K=5.0

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```
**********************************************************************
*                          E P A N E T                               *
*                 Hydraulic and Water Quality                        *
*                 Analysis for Pipe Networks                         *
*                        Version 2.0                                 *
**********************************************************************
```

Input File: 36 inch pipe mod roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	1	18
6	6	7	125	18
7	7	8	1	18
8	8	9	1	18
9	5	10	12	36
10	10	11	1	18
11	11	12	40	18
12	12	13	1	62
13	13	17	1	52
14	10	14	15	36
15	14	15	40	18
16	15	16	1	62
17	16	17	1	52

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality
2	0.00	154.90	67.12	0.00
3	0.00	154.86	67.10	0.00
4	0.00	152.97	66.28	0.00
5	0.00	150.02	65.01	0.00
6	0.00	139.07	60.26	0.00
7	0.00	124.78	54.07	0.00
8	0.00	117.91	51.09	0.00
10	0.00	149.76	64.89	0.00
11	0.00	120.39	52.16	0.00
12	0.00	109.28	47.35	0.00
13	0.00	109.19	47.31	0.00
14	0.00	137.87	59.74	0.00
15	0.00	109.89	47.62	0.00
16	0.00	109.62	47.50	0.00

Page 2
Node Results: (continued)

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
1	-172.49	155.00	0.00	0.00	Reservoir
9	37.01	109.00	0.00	0.00	Reservoir
17	135.48	109.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-172.49	3.27	99.64	Open
2	172.49	3.27	0.86	Open
3	172.49	24.40	1884.48	Open
4	172.49	24.40	163.87	Open
5	37.01	20.94	10953.75	Open
6	37.01	20.94	114.32	Open
7	37.01	20.94	6868.53	Open
8	37.01	20.94	8911.14	Open
9	135.48	19.17	22.05	Open
10	48.53	27.46	29372.99	Open
11	48.53	27.46	277.71	Open
12	48.53	2.31	83.38	Open
13	48.53	3.29	193.79	Open
14	86.95	12.30	792.40	Open
15	86.95	49.21	699.57	Open
16	86.95	4.15	267.65	Open
17	86.95	5.90	622.11	Open

```
[TITLE]

[JUNCTIONS]
;ID              Elev            Demand          Pattern
 2               0               0                               ;
 3               0               0                               ;
 4               0               0                               ;
 5               0               0                               ;
 6               0               0                               ;
 7               0               0                               ;
 8               0               0                               ;
 10              0               0                               ;
 11              0               0                               ;
 12              0               0                               ;
 13              0               0                               ;
 14              0               0                               ;
 15              0               0                               ;
 16              0               0                               ;

[RESERVOIRS]
;ID              Head            Pattern
 1               155                             ;
 9               109                             ;
 17              109                             ;

[TANKS]
;ID              Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID              Node1                Node2           Length          Diameter
Roughness       MinorLoss       Status
 1               2                    1               1               98.4            1
     0.6         Open    ;
 2               2                    3               50              98.4            1
     0.18        Open    ;
 3               3                    4               1               36              0.2
     0.2         Open    ;
 4               4                    5               18              36              0.2
     0.25        Open    ;
 5               5                    6               1               18              0.2
     1.6         Open    ;
 6               6                    7               125             18              0.2
     1           Open    ;
 7               7                    8               1               18              0.2
     1           Open    ;
 8               8                    9               1               18              0.2
     1.3         Open    ;
 9               5                    10              12              36              0.2
```

```
        0               Open    ;
 10                     10                      11                      1               18              0.2
        2.5             Open    ;
 11                     11                      12                      40              18              0.2
        0.6             Open    ;
 12                     12                      13                      1               62              0.2
        1               Open    ;
 13                     13                      17                      1               52              0.2
        1.15            Open    ;
 14                     10                      14                      15              36              0.2
        5               Open    ;
 15                     14                      15                      40              18              0.2
        0.4             Open    ;
 16                     15                      16                      1               62              0.2
        1               Open    ;
 17                     16                      17                      1               52              0.2
        1.15            Open    ;

[PUMPS]
;ID                     Node1                   Node2                   Parameters

[VALVES]
;ID                     Node1                   Node2                   Diameter        Type    Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient
```

```
[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type              Quality           Pattern

[REACTIONS]
;Type           Pipe/Tank                 Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
```

```
 Pattern              1
 Demand Multiplier    1.0
 Emitter Exponent     0.5
 Quality              None mg/L
 Diffusivity          1
 Tolerance            0.01

[COORDINATES]
;Node                 X-Coord             Y-Coord
 2                    -1550.00            7885.71
 3                    -507.14             6157.14
 4                    -535.71             5657.14
 5                    321.43              5614.29
 6                    321.43              5271.43
 7                    364.29              3214.29
 8                    407.14              2885.71
 10                   2007.14             5657.14
 11                   1992.86             5257.14
 12                   2035.71             3185.71
 13                   2021.43             2814.29
 14                   3350.00             5671.43
 15                   3392.86             3085.71
 16                   3364.29             2714.29
 1                    -2092.86            7900.00
 9                    407.14              2000.00
 17                   2707.14             2100.00

[VERTICES]
;Link                 X-Coord             Y-Coord

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS           0.00                0.00                10000.00            10000.00
 UNITS                None
 FILE
 OFFSET               0.00                0.00

[END]
```

FB 160


```
**********************************************************************
*                            E P A N E T                             *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 36 inch pipe mod roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	1	18
6	6	7	125	18
7	7	8	1	18
8	8	9	1	18
9	5	10	12	36
10	10	11	1	18
11	11	12	40	18
12	12	13	1	62
13	13	17	1	52
14	10	14	15	36
15	14	15	40	18
16	15	16	1	62
17	16	17	1	52

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality
2	0.00	159.89	69.28	0.00
3	0.00	159.84	69.26	0.00
4	0.00	157.75	68.35	0.00
5	0.00	154.48	66.94	0.00
6	0.00	142.33	61.67	0.00
7	0.00	126.50	54.81	0.00
8	0.00	118.88	51.51	0.00
10	0.00	154.19	66.81	0.00
11	0.00	121.62	52.70	0.00
12	0.00	109.31	47.36	0.00
13	0.00	109.21	47.32	0.00
14	0.00	141.01	61.10	0.00
15	0.00	109.99	47.66	0.00
16	0.00	109.69	47.53	0.00

Page 2
Node Results: (continued)

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
1	-181.64	160.00	0.00	0.00	Reservoir
9	38.97	109.00	0.00	0.00	Reservoir
17	142.67	109.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-181.64	3.44	110.50	Open
2	181.64	3.44	0.95	Open
3	181.64	25.70	2089.77	Open
4	181.64	25.70	181.67	Open
5	38.97	22.05	12148.01	Open
6	38.97	22.05	126.67	Open
7	38.97	22.05	7617.35	Open
8	38.97	22.05	9882.67	Open
9	142.67	20.18	24.41	Open
10	51.10	28.92	32570.28	Open
11	51.10	28.92	307.79	Open
12	51.10	2.44	92.45	Open
13	51.10	3.46	214.88	Open
14	91.57	12.95	878.75	Open
15	91.57	51.82	775.53	Open
16	91.57	4.37	296.83	Open
17	91.57	6.21	689.92	Open

```
[TITLE]

[JUNCTIONS]
;ID              Elev        Demand      Pattern
 2               0           0                       ;
 3               0           0                       ;
 4               0           0                       ;
 5               0           0                       ;
 6               0           0                       ;
 7               0           0                       ;
 8               0           0                       ;
 10              0           0                       ;
 11              0           0                       ;
 12              0           0                       ;
 13              0           0                       ;
 14              0           0                       ;
 15              0           0                       ;
 16              0           0                       ;

[RESERVOIRS]
;ID              Head        Pattern
 1               160                     ;
 9               109                     ;
 17              109                     ;

[TANKS]
;ID              Elevation   InitLevel   MinLevel    MaxLevel    Diameter
MinVol      VolCurve

[PIPES]
;ID              Node1            Node2                 Length      Diameter
Roughness   MinorLoss   Status
 1               2                1                     1           98.4        1
      0.6        Open    ;
 2               2                3                     50          98.4        1
      0.18       Open    ;
 3               3                4                     1           36          0.2
      0.2        Open    ;
 4               4                5                     18          36          0.2
      0.25       Open    ;
 5               5                6                     1           18          0.2
      1.6        Open    ;
 6               6                7                     125         18          0.2
      1          Open    ;
 7               7                8                     1           18          0.2
      1.0        Open    ;
 8               8                9                     1           18          0.2
      1.3        Open    ;
 9               5                10                    12          36          0.2
```

```
         0                 Open    ;
 10                        10                 11                1          18          0.2
         2.5               Open    ;
 11                        11                 12                40         18          0.2
         0.6               Open    ;
 12                        12                 13                1          62          0.2
         1                 Open    ;
 13                        13                 17                1          52          0.2
         1.15              Open    ;
 14                        10                 14                15         36          0.2
         5                 Open    ;
 15                        14                 15                40         18          0.2
         0.4               Open    ;
 16                        15                 16                1          62          0.2
         1                 Open    ;
 17                        16                 17                1          52          0.2
         1.15              Open    ;

[PUMPS]
;ID                        Node1              Node2             Parameters

[VALVES]
;ID                        Node1              Node2             Diameter   Type   Setting
MinorLoss

[TAGS]

[DEMANDS]
;Junction                  Demand     Pattern          Category

[STATUS]
;ID                        Status/Setting

[PATTERNS]
;ID                        Multipliers

[CURVES]
;ID                        X-Value    Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency         75
 Global Price              0
 Demand Charge             0

[EMITTERS]
;Junction                  Coefficient
```

```
[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type                Quality             Pattern

[REACTIONS]
;Type           Pipe/Tank                   Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
```

```
 Pattern             1
 Demand Multiplier   1.0
 Emitter Exponent    0.5
 Quality             None mg/L
 Diffusivity         1
 Tolerance           0.01

[COORDINATES]
;Node               X-Coord          Y-Coord
 2                  -1550.00          7885.71
 3                  -507.14           6157.14
 4                  -535.71           5657.14
 5                  321.43            5614.29
 6                  321.43            5271.43
 7                  364.29            3214.29
 8                  407.14            2885.71
 10                 2007.14           5657.14
 11                 1992.86           5257.14
 12                 2035.71           3185.71
 13                 2021.43           2814.29
 14                 3350.00           5671.43
 15                 3392.86           3085.71
 16                 3364.29           2714.29
 1                  -2092.86          7900.00
 9                  407.14            2000.00
 17                 2707.14           2100.00

[VERTICES]
;Link               X-Coord          Y-Coord

[LABELS]
;X-Coord       Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS         0.00             0.00             10000.00         10000.00
 UNITS              None
 FILE
 OFFSET             0.00             0.00

[END]
```

northwest hydraulic consultants inc.	DATE 12/23/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles EAWS Valve Rm Piping			

42" & 36" Valve Room Pipes

Check FB 155 (previously FB 160)

42" Q = 383 cfs
V = 40 fps

36" Q = 197 cfs
V = 28 fps (36 inch)

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK	2
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT Dalles EAWS 36" valve Room				

Pipe 101 ① See 42" Fill Entrance Hyd dia = 8.2' = 98.4"

Ln ~ 1 ft K = 0.60 → 0.8

Pipe 102 ② See 42" Fill 2 bends Hyd dia = 8.2' = 98.4"

Ln ~ 50' K = 0.40 high

Pipe 103 ③ 8 x 8.33 to 36" pipe (3' dia) Ln = 1 ft

Contraction $A/A = 7.1/66.61 = 0.10$

Fig 14.14 $A_{36} = \pi r^2 = \pi \left(\frac{3}{2}\right)^2 = 7.1$

K ~ 0.2 ✓

Pipe 104 ④ mitre bend in valve Room 36"

Ln ~ 18 ft

mitre bend - say K = 0.25 ✓ like 42"

Pipe 105 ⑤ Connection to 18" to Diff 77/78

Dividing Flow loss

Say $Q/Q = 0.3$

$A/A = 1.78/7 = 0.25$

$A\ 18" = \pi r^2 = \pi \left(\frac{18}{2 \times 12}\right)^2 = 1.78$

1.6 ← K = 2.0 Miller 318 Dividing Flow

Ln ~ 1 ft

Pipe 106 Valve Room to Diffuser 77/78
(6)

Ln ~ 125 ft approx from drwgs Dia = 18"

Butterfy valve - open K = 0.2 0.4

Gate valve - open K = 0.2 ✓

3 90° Bends K = 3(0.2) = 0.60 ✓

Total K = 1.0 → 1.2

Pipe 107 Expansion to Expansion chamber
(7)

Ln ~ 1 ft Dia = 18"

A_1 = 1.78 ft²

A_2 = say 15' X 3' = 45' Rough approx. Dwgs difficult to read

A/A = 0.0395

K = 1.0 expansion ✓ full velocity head loss

Pipe 108 Contraction + Expansion to diffuser Chamber
(8)

A_1 = ~45 ft² Ln ~ 1 ft

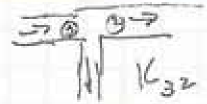
A_2 ~ 12' x 2' ~ 24 ft² Equiv Dia = $\frac{4(24)}{2(12)+2(2)}$ = 3.4

A/A ~ 0.5 K ~ 0.3 - miller

Also, expands again to fish ladder Yes
K = 1.0 ✓

K_T = 1.3

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK	4
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT Dalles EAWS 36" valve Room				



Pipe 109 ⑨ Dia = 36" Ln = 12'

Dividing Flow loss is also applied to main pipe

↓

Due to Flow Ratio, K=0 ✓ here

Fig 13.23 Miller

Pipe 110 ⑩ 36" to 18" Dia = 18"

$Q_1/Q_3 = 0.5$

$A_1/A_3 = 0.25$

Same as Pipe 105 (K = 2.0, K = 2.5) Ln = 1 ft

Pipe 111 ⑪ 18" dia Ln = ~ 40 ft

Butterfly valve K=0.2

Gate valve K=0.2

90° Bend K=0.2

Total K = 0.6 0.8

Pipe 112 ⑫ 18" to Expansion chamber Ln = 1 ft

Say A = 3' X 20' = 60 ft²

$\frac{4(60)}{2(3)+2(20)} = 5.2$ ft dia = 62 inches

A/A ⇒ K=1.0 ✓ large expansion from 18"

Pipe 113 ⑬ Expansion chamber through orifice type opening to diffuser chamber

A = 60 ft² → A = ~2.5 X 16 = 40

$\frac{4(40)}{2(2.5)+2(16)} = 4.3$ ft dia = 52 inches

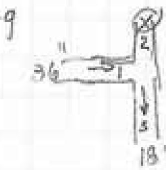
A/A = 0.66 K ~ 0.15 ✓

Ln ~ 1 ft

Expansion K = 1.0

K_T = 1.15 ✓

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK	5
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT Dalles EAWS 36" Valve Room				



Pipe 110 Dia = 36" Ln = 15'

(14)

BFV K = 0.2 [0.4] open valve

90° bend / Q/Q = 1.0 A/A = 1.78/7.1 = 0.25

K = High = 3 or greater miller P. 318

Fig 13.10 Miller K > 5.0 maybe as high as 7.0

Dividing flow w/ no flow in one branch

Total K = (3.2) Low

Pipe 115 Dia = ~~36"~~ 18" Ln = 40 ft

(15)

Total K = 0.6 − 0.2 = 0.4

BFV included in 36" Y10

$K_{90° bend} = 0.2$
$K_{gvalve} = 0.2$
$K_T = 0.4$

Except for BFV, same as 111

Pipe 116 same as 112

(16)

K = 1.0 ✓ Dia = 62" Ln = 1 ft

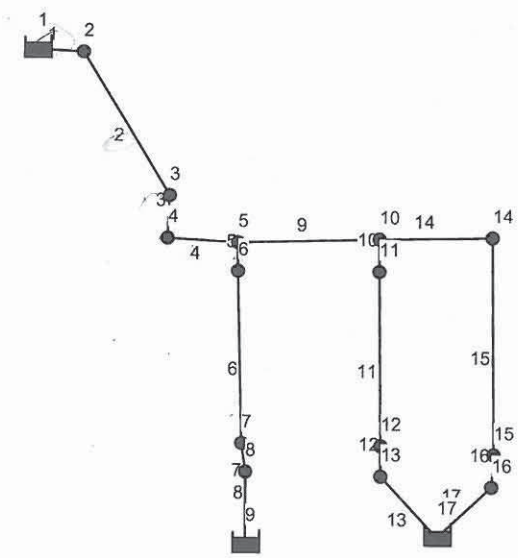
Pipe 117 Same as 113

(17)

K = 1.15 ✓ Ln = 1 ft dia = 52"

36 inch pipe - valve room

Day 1, 12:0



```
[TITLE]

[JUNCTIONS]
;ID                    Elev            Demand          Pattern
 2                     0               0
        ;
 3                     0               0
        ;
 4                     0               0
        ;
 5                     0               0
        ;
 6                     0               0
        ;
 7                     0               0
        ;
 8                     0               0
        ;
 10                    0               0
        ;
 11                    0               0
        ;
 12                    0               0
        ;
 13                    0               0
        ;
 14                    0               0
        ;
 15                    0               0
        ;
 16                    0               0
        ;

[RESERVOIRS]
;ID                    Head            Pattern
 1                     160                             ;
 9                     128                             ;
 17                    128                             ;

[TANKS]
;ID                    Elevation       InitLevel       MinLevel
MaxLevel        Diameter        MinVol          VolCurve

[PIPES]
;ID                    Node1           Node2           Length
Diameter        Roughness       MinorLoss       Status
 1                     2               1               1
        98.4           1               0               Open    ;
 2                     2               3               50
        98.4           1               0.4             Open    ;
 3                     3               4               1
        36             0.2             0.2             Open    ;
 4                     4               5               18
        36             0.2             0               Open    ;
 5                     5               6               1
        18             0.2             0               Open    ;
 6                     6               7               125
        18             0.2             1               Open    ;
 7                     7               8               1
        18             0.2             0               Open    ;
 8                     8               9               1
        18             0.2             1.3             Open    ;
 9                     5               10              12
        36             0.2             0               Open    ;
 10                    10              11              1
        18             0.2             2               Open    ;
 11                    11              12              40
```

```
        D18         0.2         0.6 - 0.8      Open    ;
 12                 12                   13                   1
        D62         0.2         1 ✓            Open    ;
 13                 13                   17                   1
        D52         0.2         1.15 ✓         Open    ;
 14                 10          7.5      14                   15
        D36         0.2         (3.2 -)        Open    ;
 15                 14                   15                   40
        D18         0.2         0.4 ✓          Open    ;
 16                 15                   16                   1
        D62         0.2         1 ✓            Open    ;
 17                 16                   17                   1
        D52         0.2         1.15 ✓         Open    ;

[PUMPS]
;ID                 Node1                Node2
Parameters

[VALVES]
;ID                 Node1                Node2
Diameter     Type   Setting     MinorLoss

[TAGS]

[DEMANDS]
;Junction           Demand      Pattern         Category

[STATUS]
;ID                 Status/Setting

[PATTERNS]
;ID                 Multipliers

[CURVES]
;ID                 X-Value     Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction           Coefficient

[QUALITY]
;Node               InitQual

[SOURCES]
;Node               Type        Quality         Pattern

[REACTIONS]
;Type         Pipe/Tank         Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
```

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```
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001   Temp =
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -1550.00                7885.71
 3                      -507.14                 6157.14
 4                      -535.71                 5657.14
 5                      321.43                  5614.29
 6                      321.43                  5271.43
 7                      364.29                  3214.29
 8                      407.14                  2885.71
 10                     2007.14                 5657.14
 11                     1992.86                 5257.14
 12                     2035.71                 3185.71
 13                     2021.43                 2814.29
 14                     3350.00                 5671.43
 15                     3392.86                 3085.71
 16                     3364.29                 2714.29
 1                      -2092.86                7900.00
 9                      407.14                  2000.00
 17                     2707.14                 2100.00

[VERTICES]
;Link                   X-Coord                 Y-Coord

[LABELS]
;X-Coord           Y-Coord            Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                    0.00
        10000.00                10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                    0.00
```

[END]

5

Page 1 11/28/2011 12:13:51 PM

```
**********************************************************************
*                             E P A N E T                            *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 36 inch pipe mod roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	1	18
6	6	7	125	18
7	7	8	1	18
8	8	9	1	18
9	5	10	12	36
10	10	11	1	18
11	11	12	40	18
12	12	13	1	62
13	13	17	1	52
14	10	14	15	36
15	14	15	40	18
16	15	16	1	62
17	16	17	1	52

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality
2	0.00	160.00	69.33	0.00
3	0.00	159.93	69.30	0.00
4	0.00	158.22	68.56	0.00
5	0.00	157.64	68.30	0.00
6	0.00	157.56	68.27	0.00
7	0.00	139.41	60.41	0.00
8	0.00	139.34	60.38	0.00
10	0.00	157.42	68.21	0.00
11	0.00	137.60	59.62	0.00
12	0.00	128.23	55.56	0.00
13	0.00	128.16	55.53	0.00
14	0.00	151.26	65.54	0.00
15	0.00	128.72	55.77	0.00
16	0.00	128.50	55.68	0.00

$1 \text{ psi} = \frac{144}{62.4} = 2.308 \text{ ft}$

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Page 2
Node Results: (continued)

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
1	-164.30	160.00	0.00	0.00	Reservoir
9	41.74	128.00	0.00	0.00	Reservoir
17	122.55	128.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-164.30	3.11	0.24	Open
2	164.30	3.11	1.44	Open
3	164.30	23.24	1709.82	Open
4	164.30	23.24	32.23	Open
5	41.74	23.62	75.87	Open
6	41.74	23.62	145.18	Open
7	41.74	23.62	75.85	Open
8	41.74	23.62	11338.90	Open
9	122.55	17.34	18.11	Open
10	44.55	25.21	19818.21	Open
11	44.55	25.21	234.22	Open
12	44.55	2.12	70.25	Open
13	44.55	3.02	163.30	Open
14	78.01	11.04	410.87	Open
15	78.01	44.14	563.53	Open
16	78.01	3.72	215.42	Open
17	78.01	5.29	500.69	Open

Page 1 11/23/2011 5:45:40 PM

```
**********************************************************************
*                             E P A N E T                            *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                            Version 2.0                             *
**********************************************************************
```

Input File: 36 inch pipe mod roughness.net

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
1	2	1	1	98.4
2	2	3	50	98.4
3	3	4	1	36
4	4	5	18	36
5	5	6	1	18
6	6	7	125	18
7	7	8	1	18
8	8	9	1	18
9	5	10	12	36
10	10	11	1	18
11	11	12	40	18
12	12	13	1	62
13	13	17	1	52
14	10	14	15	36
15	14	15	40	18
16	15	16	1	62
17	16	17	1	52

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality
2	0.00	160.00	69.33	0.00
3	0.00	159.88	69.28	0.00
4	0.00	157.16	68.10	0.00
5	0.00	156.24	67.70	0.00
6	0.00	156.12	67.64	0.00
7	0.00	127.23	55.13	0.00
8	0.00	127.11	55.08	0.00
10	0.00	155.89	67.55	0.00
11	0.00	124.28	53.85	0.00
12	0.00	109.37	47.39	0.00
13	0.00	109.26	47.34	0.00
14	0.00	146.06	63.29	0.00
15	0.00	110.14	47.72	0.00
16	0.00	109.80	47.58	0.00

Page 2
Node Results: (continued)

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
1	-207.57	160.00	0.00	0.00	Reservoir
9	52.76	109.00	0.00	0.00	Reservoir
17	154.81	109.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
1	-207.57	3.93	0.38	Open
2	207.57	3.93	2.30	Open
3	207.57	29.36	2728.74	Open
4	207.57	29.36	51.10	Open
5	52.76	29.85	120.38	Open
6	52.76	29.85	231.09	Open
7	52.76	29.85	120.38	Open
8	52.76	29.85	18109.28	Open
9	154.81	21.90	28.66	Open
10	56.26	31.84	31609.95	Open
11	56.26	31.84	372.74	Open
12	56.26	2.68	112.06	Open
13	56.26	3.81	260.45	Open
14	98.55	13.94	655.68	Open
15	98.55	55.77	897.85	Open
16	98.55	4.70	343.83	Open
17	98.55	6.68	799.15	Open

SCROLL CASE

EQUALIZER HEADER SYSTEM

EQUALIZER HEADER CALCULATIONS

FINAL CALCULATIONS REFLECT ITR COMMENTS

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge through the **AWS 'Diffuser Chamber Drain' System**.

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := 160$

$TW := 80$

$AWS := 85$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = 75$

Pipe 1: Scroll case equalizer pipe opening to AWS 4 inch connection at El. 22

$Pipe_{1dia} := 2$ 24 inch pipe $Pipe_{1length} := 25$

$$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2 \qquad Pipe_{area1} = 3.142$$

Minor Losses Pipe 1:

$K_{1inlet} := 1.2$ entrance plus grating cover

$K_{1bends} := 7.3$ two 90 degree bends and two 't' connnections (total high due to 't' connnection)

$K_{valve1} := 0.2$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1} \qquad K_{1minor} = 8.7$$

Friction Losses Pipe 1:

$Friction_1 := 0.04$ steel conduit, refine later

$$K_{friction1} := \frac{\left(Friction_1 \cdot Pipe_{1length}\right)}{Pipe_{1dia}} \qquad K_{friction1} = 0.5$$

$$K_{1total} := K_{friction1} + K_{1minor} \qquad K_{1total} = 9.2$$

Pipe 2: 4 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.33$ 4 inch pipe $Pipe_{2length} := 20$

$$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2 \qquad Pipe_{area2} = 0.086$$

Minor Losses Pipe 2:

$K_{2contraction} := 0$ 6 inch to 12 inch, already included in Pipe 1 calcs

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open

apply contraction to smaller diameter pipe

$$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2} \qquad K_{2minor} = 4.6$$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia

$$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}} \qquad K_{friction2} = 3.636$$

$$K_{2total} := K_{friction2} + K_{2minor} \qquad K_{2total} = 8.236$$

Pipe 3: 8 inch pipe to diffuser chamber

$Pipe_{3dia} := 0.67$ 8 inch drain pipe $Pipe_{3length} := 60$ longer than AWS drain

$$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2 \qquad Pipe_{area3} = 0.353$$

Minor Losses Pipe 3:

$K_{3expansion} := 0$ Included in 't' loss value in Pipe 2

$K_{3bends} := 0.4$ two 90 degree bends, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := 1$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $\quad K_{3minor} = 1.6$

Friction Losses Pipe 3:

$Friction_3 := 0.04$

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}} \qquad K_{friction3} = 3.582$$

$K_{3total} := K_{friction3} + K_{3minor}$ $\quad K_{3total} = 5.182$

Pipe 4: Diffuser Chamber to AWS

$Pipe_{4dia} := 64$ opening to AWS $\quad Pipe_{4length} := 0.5$

$$Pipe_{area4} := \pi \cdot \left(\frac{Pipe_{4dia}}{2}\right)^2 \qquad Pipe_{area4} = 3.217 \times 10^3$$

Minor Losses Pipe 4:

$K_{4turn} := 0.5$ turning flow and turbulence

$K_{gate4} := 0$ fully open 8x8 gate, no gate loss,

$K_{exit4} := 1$ full velocity head, contraction/exit

$K_{4minor} := K_{4turn} + K_{gate4} + K_{exit4}$

$K_{4total} := K_{4minor}$

$K_{4total} = 1.5$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\frac{\left(\frac{K_{1total}}{Pipe_{area1}^{2}}+\frac{K_{2total}}{Pipe_{area2}^{2}}+\frac{K_{3total}}{Pipe_{area3}^{2}}+\frac{K_{4total}}{Pipe_{area4}^{2}}\right)}{64.4}}\right]^{.5}$$

$Q = 2.033$

Velocities in Sections of Pipes:

$V_{pipe1} := \frac{Q}{Pipe_{area1}}$ $\quad V_{pipe1} = 0.647$

$V_{pipe2} := \frac{Q}{Pipe_{area2}}$ $\quad V_{pipe2} = 23.77$

$V_{pipe3} := \frac{Q}{Pipe_{area3}}$ $\quad V_{pipe3} = 5.767$

$V_{pipe4} := \frac{Q}{Pipe_{area4}}$ $\quad V_{pipe4} = 6.32 \times 10^{-4}$

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge through the **'AWS Drain' System.**

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := 160$

$TW := 80$

$AWS := 85$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = 75$

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := 2$ 24 inch pipe $Pipe_{1length} := 25$

$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2$ $Pipe_{area1} = 3.142$

Minor Losses Pipe 1:

$K_{1inlet} := 1.2$ entrance plus grating cover

$K_{1bends} := 7.3$ two 90 degree bends and two 't' connnections (total high due to 't' connection

$K_{valve1} := 0.2$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1}$ $K_{1minor} = 8.7$

Friction Losses Pipe 1:

$Friction_1 := 0.04$ steel conduit, older pipe

$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}}$ $K_{friction1} = 0.5$

$K_{1total} := K_{friction1} + K_{1minor}$ $K_{1total} = 9.2$

Pipe 2: 6 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.5$ 6 inch pipe $Pipe_{2length} := 15$

$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2$ $Pipe_{area2} = 0.196$

Minor Losses Pipe 2:

$K_{2contraction} := 0$ 6 inch to 12 inch, already included in Pipe 1 losses

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open, check valve type later

apply contraction to smaller diameter pipe

$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2}$ $K_{2minor} = 4.6$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia

$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}}$ $K_{friction2} = 1.8$

$K_{2total} := K_{friction2} + K_{2minor}$ $K_{2total} = 6.4$

Pipe 3: 12 inch pipe to AWS drain location within AWS

$Pipe_{3dia} := 1$ 12 inch drain pipe $Pipe_{3length} := 40$

$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2$ $Pipe_{area3} = 0.785$

Minor Losses Pipe 3:

$K_{3expansion} := 0$

$K_{3bends} := 0.2$ 90 degree bend, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := 1$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $\qquad K_{3minor} = 1.4$

Friction Losses Pipe 3:

$Friction_3 := 0.04$

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}} \qquad K_{friction3} = 1.6$$

$K_{3total} := K_{friction3} + K_{3minor}$ $\qquad K_{3total} = 3$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\frac{\left(\frac{K_{1total}}{Pipe_{area1}^{2}} + \frac{K_{2total}}{Pipe_{area2}^{2}} + \frac{K_{3total}}{Pipe_{area3}^{2}} \right)}{64.4}} \right]^{.5} \qquad Q = 5.302$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = 1.688$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = 27.004$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = 6.751$$

21936 The Dalles Dam - Equalizer Header November 17, 2011

Estimate potential discharge through the **'AWS Drain' System without 6 inch constriction (change to 12 inch pipe).**

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := \mathbf{160}$

$TW := \mathbf{80}$

$AWS := \mathbf{85}$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = \mathbf{75}$

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := \mathbf{2}$ 24 inch pipe $Pipe_{1length} := \mathbf{25}$

$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2$ $Pipe_{area1} = \mathbf{3.142}$

Minor Losses Pipe 1:

$K_{1inlet} := \mathbf{1.2}$ entrance plus grating cover

$K_{1bends} := \mathbf{7.3}$ two 90 degree bends and two 't' connnections (total high due to 't' connection

$K_{valve1} := \mathbf{0.2}$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1}$ $K_{1minor} = \mathbf{8.7}$

Friction Losses Pipe 1:

$Friction_1 := \mathbf{0.04}$ steel conduit, older pipe

$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}}$ $K_{friction1} = \mathbf{0.5}$

$K_{1total} := K_{friction1} + K_{1minor}$ $K_{1total} = \mathbf{9.2}$

Pipe 2: Mod 6 inch connector between AWS drain and 24 inch equalizer pipe to make it a 12 inch pipe

$Pipe_{2dia} := 1$ 12 inch pipe $Pipe_{2length} := 15$

$$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2 \qquad Pipe_{area2} = 0.785$$

Minor Losses Pipe 2:

$K_{2contraction} := 0$

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open, check valve type later

apply contraction to smaller diameter pipe

$$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2} \qquad K_{2minor} = 4.6$$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia

$$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}} \qquad K_{friction2} = 0.9$$

$$K_{2total} := K_{friction2} + K_{2minor} \qquad K_{2total} = 5.5$$

Pipe 3: 12 inch pipe to AWS drain location within AWS

$Pipe_{3dia} := 1$ 12 inch drain pipe $Pipe_{3length} := 40$

$$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2 \qquad Pipe_{area3} = 0.785$$

Minor Losses Pipe 3:

$K_{3expansion} := 0$

$K_{3bends} := 0.2$ 90 degree bend, tight radius

$K_{valve3} := \mathbf{0.2}$ AWS drain valve, need to verify type later

$K_{exit3} := \mathbf{1}$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $\quad K_{3minor} = \mathbf{1.4}$

Friction Losses Pipe 3:

$Friction_3 := \mathbf{0.04}$

$$K_{friction3} := \frac{\left(Friction_3 \cdot Pipe_{3length}\right)}{Pipe_{3dia}} \qquad K_{friction3} = \mathbf{1.6}$$

$K_{3total} := K_{friction3} + K_{3minor}$ $\quad K_{3total} = \mathbf{3}$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\dfrac{\left(\dfrac{K_{1total}}{Pipe_{area1}^{\ 2}} + \dfrac{K_{2total}}{Pipe_{area2}^{\ 2}} + \dfrac{K_{3total}}{Pipe_{area3}^{\ 2}}\right)}{\mathbf{64.4}}}\right]^{.5} \qquad Q = \mathbf{18.119}$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = \mathbf{5.768}$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = \mathbf{23.07}$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = \mathbf{23.07}$$

21936 The Dalles Dam - Equalizer Header November 17, 2011

Estimate potential discharge through the **AWS 'Diffuser Chamber Drain' System without 4 inch constriction (change 4 inch to 8 inch)**

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := 160$

$TW := 80$

$AWS := 85$ rough approx for now

$Head_{available} := FB - AWS \qquad Head_{available} = 75$

Pipe 1: Scroll case equalizer pipe opening to AWS 4 inch connection at El. 22

$Pipe_{1dia} := 2$ 24 inch pipe $\qquad Pipe_{1length} := 25$

$$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2 \qquad Pipe_{area1} = 3.142$$

Minor Losses Pipe 1:

$K_{1inlet} := 1.2$ entrance plus grating cover

$K_{1bends} := 7.3$ two 90 degree bends and two 't' connnections (total high due to 't' connnection)

$K_{valve1} := 0.2$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1} \qquad K_{1minor} = 8.7$$

Friction Losses Pipe 1:

$Friction_1 := 0.04$ steel conduit, refine later

$$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}} \qquad K_{friction1} = 0.5$$

$$K_{1total} := K_{friction1} + K_{1minor} \qquad K_{1total} = 9.2$$

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Pipe 2: Replace 4 inch connector between AWS drain and 24 inch equalizer pipe to 8 inch

$Pipe_{2dia} := 0.67$ 8 inch pipe $Pipe_{2length} := 20$

$$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2} \right)^2 \qquad Pipe_{area2} = 0.353$$

Minor Losses Pipe 2:

$K_{2contraction} := 0$

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 8 inch

$K_{valve2} := 0.2$ assume fully open

apply contraction to smaller diameter pipe

$$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2} \qquad K_{2minor} = 4.6$$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia

$$K_{friction2} := \frac{\left(Friction_2 \cdot Pipe_{2length}\right)}{Pipe_{2dia}} \qquad K_{friction2} = 1.791$$

$$K_{2total} := K_{friction2} + K_{2minor} \qquad K_{2total} = 6.391$$

Pipe 3: 8 inch pipe to diffuser chamber

$Pipe_{3dia} := 0.67$ 8 inch drain pipe $Pipe_{3length} := 60$ longer than AWS drain

$$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2} \right)^2 \qquad Pipe_{area3} = 0.353$$

Minor Losses Pipe 3:

$K_{3expansion} := 0$ Included in 't' loss value in Pipe 2

$K_{3bends} := 0.4$ two 90 degree bends, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := 1$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $K_{3minor} = 1.6$

Friction Losses Pipe 3:

$Friction_3 := 0.04$

$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}}$ $K_{friction3} = 3.582$

$K_{3total} := K_{friction3} + K_{3minor}$ $K_{3total} = 5.182$

Pipe 4: Diffuser Chamber to AWS

$Pipe_{4dia} := 64$ opening to AWS $Pipe_{4length} := 0.5$

$Pipe_{area4} := \pi \cdot \left(\frac{Pipe_{4dia}}{2}\right)^2$ $Pipe_{area4} = 3.217 \times 10^3$

Minor Losses Pipe 4:

$K_{4turn} := 0.5$ turning flow and turbulence

$K_{gate4} := 0$ fully open 8x8 gate, no gate loss,

$K_{exit4} := 1$ full velocity head, contraction/exit

$K_{4minor} := K_{4turn} + K_{gate4} + K_{exit4}$

$K_{4total} := K_{4minor}$

$K_{4total} = 1.5$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\dfrac{\left(\dfrac{K_{1total}}{Pipe_{area1}^{\,2}} + \dfrac{K_{2total}}{Pipe_{area2}^{\,2}} + \dfrac{K_{3total}}{Pipe_{area3}^{\,2}} + \dfrac{K_{4total}}{Pipe_{area4}^{\,2}}\right)}{64.4}}\right]^{.5} \qquad Q = 7.167$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = 2.281$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = 20.328$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = 20.328$$

$$V_{pipe4} := \frac{Q}{Pipe_{area4}} \qquad V_{pipe4} = 2.228 \times 10^{-3}$$

EQUALIZER HEADER SYSTEM

ORGINAL CALCULATIONS WITH ITR COMMENTS

northwest hydraulic consultants inc.	DATE 11/1	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles			

Use re-scanned drawings to verify pipe lengths + losses

Units 1-8 ⇒ 4 sets of AWS/fish channel drains

Units 10-14 ⇒ 3 sets of AWS/fish channel drains

Total = 7 AWS Drains

DOP-1-3-8/1, DOP-1.2-3-8/42, DOP-1-3-8/13

Pipe 1

Scroll case Fill Line to AWS 6"

(1) EL 49 → EL 22 = 27 ft vertical

L = 27 ft ✓

(2) Horizontal distance

Distance between vertical fill line + AWS 6" drain connection

Neglect 24" φ header ∴ No horiz distance

L = 7'-7" × 3 + 16" + 11'

L = 23 ft   Total Ln ~ 50 ft

Losses 1) 90° bend vert. to horiz.

90° bend @ inlet

24" pipe - 90° bend

Tight radius

K = 0.56 Miller P. 207

K = 0.50 avg EM 1110-2-1603

DOP 1-3-8/13

R = 33"

R/D = 33/24 = 1.4

K = 0.2

Miller Fig 9.2

$K_{Bends} = 2(0.25) = 1.0$ → 0.5

3) valve - wedge gate

Use fully open Gate valve

Miller P. 379

K = 0.2 ✓

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SUBJECT The Dalles				

4) Scroll case Inlet

Abrupt contraction
A/A = very large
K= 1.0

Grating Hole area ~ Say 80%
K ~ 0.2

K ~ 1.2

5) T Connection to 24" equalizer piper

Combining flow
Miller
Fig 13.14

Q/Q = 1 assume for now

A/A = 1 assume Chamfer

K ~ 0.8 P. 313

6) T Connection to 6" AWS connector pipe

Dividing flow

Fig 13.21
Miller

Q/Q = ~~1~~ 0.5 assume for now

A/A = ~~0.25~~ 0.0624

$A_{24"}$ = 3.14
$A_{6"}$ = 0.196
A_6/A_{24} = .0624

with Chamfer k ~ ~~0.8~~ 76.0 miller P. 315

minor loss Total K_{pipe} = ~~4~~ 78.7

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SUBJECT The Dalles				

Pipe 2

AWS 6" Connector pipe
1) contraction loss
T from 24" to 6" included in Pipe 1
Include contraction here since that loss assumed equal area

$\frac{A_2}{A_1} = 0.25$ Included in Pipe 1 'T'

~~K~0.3~~ Out radius inlet P. 374

2) valve loss

K=0.2 Fully open gate valve
* Verify valve type

3) 2 90° bends

Tight radius 90° bends R/D=1.4 Say r/d=1.0

K= 0.5 → 0.2 estimate K = 1.0 total
Revised K=0.4 + K=4 K=4.4

4) T connection w/ 12"

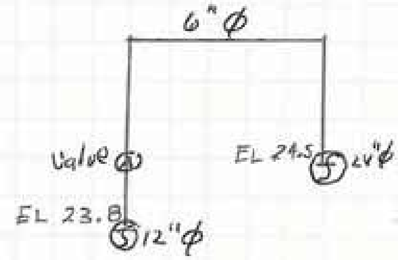
$A_{6"}$=.196
$A_{12"}$=.785

A_1/A_3 = 6/12 = ~~0.5~~ .196/.785 = .25 Q/Q=1.0

K ~ ~~2.0~~ 4.0 P. 313 (Includes expansion)

K minor K_T = ~~3.5~~ → 4.6

Pipe Lengths



Lh ~ 20"

Scale DDP-1-4/0L3
+ added F.S.

DDP, 1.2-3-8/42
15' scaled

/ 19

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CLIENT HDR / USACE		JOB No. 21936		
SUBJECT The Dalles				

Pipe 3

Length ~40 ft scaled from drwgs

minor losses

T-Connection includes expansion since A/A applied

$K_{90\,Bend} = 0.5$ tight radius — DDP 1-3-8/13 R=33" R/D = 33/24 = 1.4 ✓ assume all bends similar k=0.2 Fig 9.2 Miller

$K_{valve} = 0.2$ need to check type

$K_{expansion} = 1.0$

Expansion from 6" K~0.3

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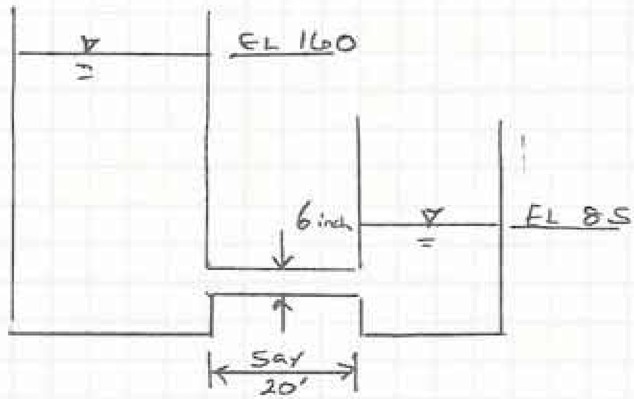
CLIENT HOR /USACE		JOB No. 21936	
SUBJECT The Dalles EAWS			

Scroll Case Equalizer Header Alt.

6 inch connector between 24" equalizer pipe & AWS drain is the controlling section.

Check best case scenario w/ 6 inch pipe & NO other components/pipes



dia = 6" = 0.5 ft

$H = 160 - 85 = 75$ ft

$H = K \frac{V^2}{2g}$

$H = 75 = \frac{V^2}{2g} K$ $\quad V = \frac{Q}{A}$

$\frac{V^2}{2g} = \frac{\left(Q^2/0.196^2\right)}{64.4}$ $\quad A = \pi r^2$, $A = \pi\left(\frac{0.5}{2}\right)^2$ $\quad A = 0.196$

K ⇒ friction + entrance + exit

f ~ 0.02 ⇒ Note JLL checked this via moody dia f ~ 0.02 okay

$K_f = 0.02\left(\frac{20}{0.5}\right) = 0.8$

$K_{ent} + K_{exit} \sim 2$

$K_{Total} = 2.5$

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SUBJECT The Dalles EAWS			

$$H = K_{total} \frac{V^2}{2g}$$

$$H = 75 = 2.5 \frac{Q^2 / 0.196^2}{64.4}$$

$$75 = 1.01\, Q^2$$

$$Q = 8.6 \text{ cfs}$$

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SUBJECT The Dalles EAWS			

Sensitivity Analysis on Scroll case Equalizer Header Calcs:

1) Vary valve 0.2 to 0.5 to 1.0

K = 0.2 all valves Q = 5.64 cfs

K = 0.5 all valves Q = 5.49 cfs

K = 1.0 all valves Q = 5.23 cfs

2) Vary AWS EL

PGL = 85 Q = 5.64 cfs

PGL = 83 Q = 5.71 cfs

3) Vary friction factor

f = 0.01 to 0.02

f = 0.01 Q = 5.64 cfs

f = 0.02 Q = 5.45 cfs

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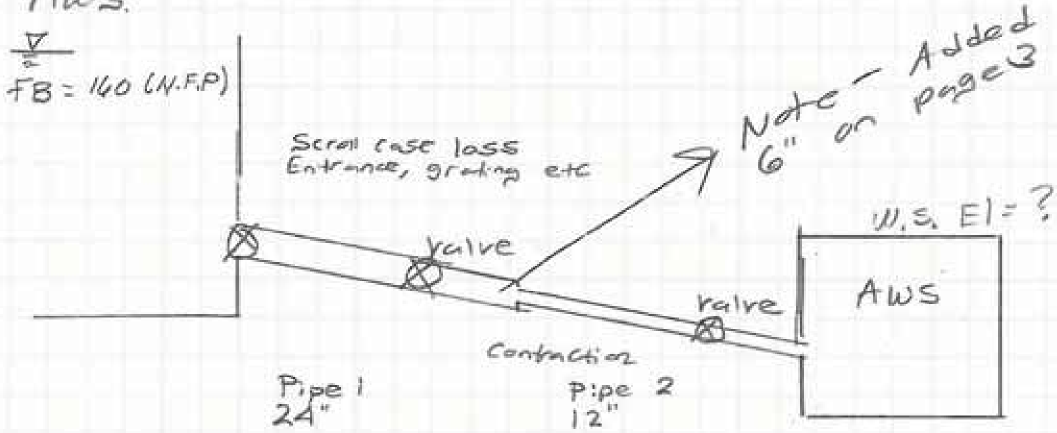
CLIENT HDR / USACE		JOB No.		
SUBJECT The Dalles - Scroll Case Alt				

Estimate potential Q from scroll case equalizer header to AWS.



$$FB - \left(\Sigma K_2 \frac{V_2^2}{2g} + f_2 L_2 \frac{V_2^2}{2g} + \Sigma K_1 \frac{V_1^2}{2g} + f_1 L_1 \frac{V_1^2}{2g} \right) = AWS$$

$K_1 \Rightarrow$ 2 90° bends = 2 × 1 $K = 2$

1 valve $K = 1$

Entrance $K = 2$ $K_1 = 5$

$\frac{f_1 L_1}{D_1} = (0.009)\frac{(55)}{2} = 0.25$ $K_T = 5.25$

$K_2 \Rightarrow$ 2 90° bends = 2 × 1 $K = 2$

1 valve $K = 1$

Contraction $K = 0.3$ miller $d/_d = 0.5$

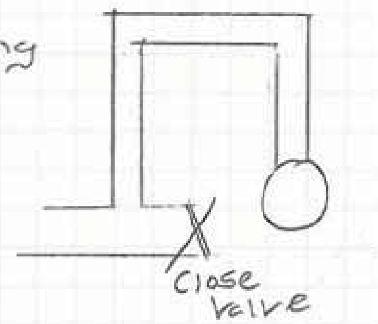
Exit $K = 1$ $K_2 = 4.3$

$\frac{f_2 L_2}{D_2} = (0.009)\left(\frac{35}{2}\right) = 0.16$ $K_T = 4.46$

northwest hydraulic consultants inc.	DATE 10/28	BY	CHK	2
CLIENT HOR/USACE		JOB No.		
SUBJECT The Dalles - Scroll case Alt				

Add 3rd pipe -

6" pipe - Say 20' long



Losses -

90' bend/T K=1.0

2 90° bends K=2.0

T w/ 24" K=1.0

6" = 0.5'

$K_{contraction} = 0.3$

$K_{minor} = 4.3$

$A = \pi r^2 = \pi \left(\frac{0.5}{2}\right)^2 = 0.196$ $A^2 = 0.0384$

$$K_x + \frac{f_x L_x}{D_x} = 4.3 + \frac{(0.009)(20)}{0.5} =$$

$$Q^2 = \frac{80}{\frac{1}{64.4}\left(\left(\frac{5.25}{9.86}\right) + \left(\frac{4.46}{0.616}\right) + \left(\frac{6.4}{0.0384}\right)\right)}$$

$$Q = \left(\frac{80}{2.7}\right)^{\frac{1}{2}} = 5.4 \text{ cfs}$$

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SUBJECT			

Estimate discharge available to AWS if use equalizer header system

Main Units 1-14

Scroll case fill – 24" pipe

EL 49 – Inlet to pipe

EL 22 'T' w/ header pipe

~55 ft from 'T' to inlet to AWS drain

AWS Drain

12" unwatering drain

valve
90° bend

EL 29.25" drain elev.

Length ~ 30' + 5' ~ 35'

DOP-1-0-0/2
NHC drwgs

Normal FB = 160
min FB = 155

max TW = 84.2
min TW = 72.5

Check rough Q for FB = 160
TW = 80

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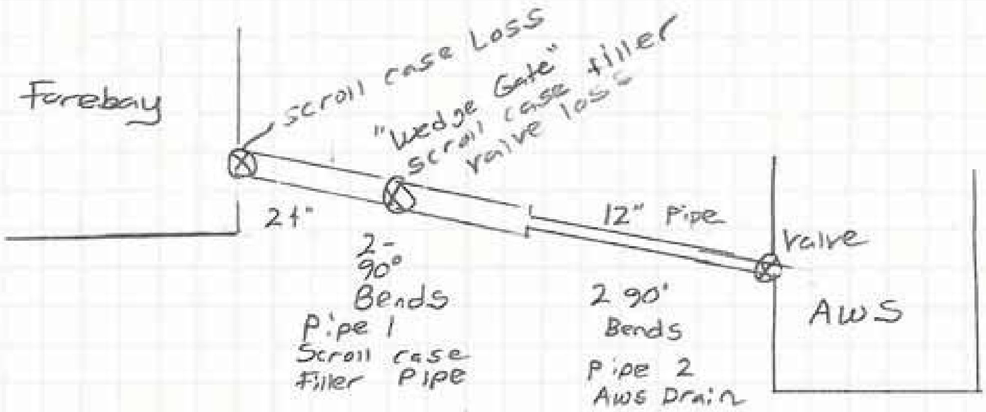
SUBJECT			

Rough estimate of Q from Unit in 1-14 section



$$FB - \left(\frac{K_1 V^2}{2g} + \frac{K_2 V^2}{2g} + f_1 \frac{L}{D_1} \frac{V_1^2}{2g} + f_2 \frac{L_2}{D_2} \frac{V_2^2}{2g} \right) = AWS$$

$$K_1 = 2(1.0) + 1.0 + 1.0 + 0.3 = 4.3$$

90° Bends; valve ? wedge Gate; Entrance; Contraction

Contraction 24" → 12" sharp

$$K_2 = 2(1.0) + 1.0 + 1.0 = 4.0$$

valve; exit

$e_{steel} = 0.0001$
say $f = 0.009$

$$FB - AWS = \left(\left(K_1 + f_1 \frac{L}{D_1}\right)\left(\frac{V_1^2}{2g}\right)\right) + \left(\left(K_2 + f \frac{L}{D_2}\right)\left(\frac{V_2^2}{2g}\right)\right)$$

$160 - 80 = 80 =$ " "

$$V_1 = \frac{Q}{A_1} = \frac{Q}{\pi (1)^2} = \frac{Q}{3.14}$$

$$V_2 = \frac{Q}{A_2} = \frac{Q}{\pi (0.5)^2} = \frac{Q}{0.785}$$

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$$80 = \left(4.3 + \frac{0.009}{2'}(55)\right)\cdot\frac{Q}{3.14} + \left(4 + \frac{0.009}{1'}(35)\right)\frac{Q}{0.785}$$

$$80 = (4.3 + 0.25)\left(\frac{Q}{3.14}\right) + (4 + 0.32)\left(\frac{Q}{0.785}\right)$$

$$80 = 1.45(Q) + 5.50(Q)$$

$$80 = 6.95(Q)$$

$$Q = 11.5 \text{ cfs}$$

$$K\frac{V^2}{2g} \quad \frac{Q^2}{A^2}$$

$$H = (X+Y)Q^2$$

$$\frac{H}{X+Y} = Q^2 \quad Q = \frac{H}{\cdot}$$

$$Q = K\frac{V^2}{2g} + K\frac{V^2}{2g}$$

$$\frac{K\frac{Q^2}{A^2 2g}}{2g}$$

$$H = K\frac{V^2}{2g} + K\frac{V^2}{2g}$$

$$H = \frac{K\left(\frac{Q}{A}\right)^2}{2g} + \frac{K\left(\frac{Q}{A}\right)^2}{2g}$$

$$\therefore H = \frac{K\frac{Q^2}{A^2}}{2g} + \frac{K\frac{Q^2}{A^2}}{2g}$$

$$H = Q^2\left(\frac{\frac{K}{A^2}}{2g} + \frac{\frac{K}{A^2}}{2g}\right)$$

$$H = Q^2($$

northwest hydraulic consultants inc.	DATE	BY	CHK
CLIENT		JOB No.	
SUBJECT			

$$FB - AWS = H = \left(K_1 + f_1 \frac{L_1}{D_1}\right)\frac{V_1^2}{2g} + \left(K_2 + f_2 \frac{L_2}{D_2}\right)\frac{V_2^2}{2g}$$

$$H = \left(K_1 + f_1 \frac{L_1}{D_1}\right)\frac{\left(\frac{Q}{A_1}\right)^2}{2g} + \left(K_2 + f_2 \frac{L_2}{D_2}\right)\frac{\left(\frac{Q}{A_2}\right)^2}{2g}$$

$$H = Q^2\left(\left(K_1 + f_1 \frac{L_1}{D_1}\right)\frac{\frac{1}{A_1^2}}{2g} + \left(K_2 + f_2 \frac{L_2}{D_2}\right)\frac{\frac{1}{A_2^2}}{2g}\right)$$

$$H = \frac{Q^2}{2g}\left(\frac{\left(K_1 + f_1 \frac{L_1}{D_1}\right)}{A_1^2}\right) + \left(\frac{\left(K_2 + f_2 \frac{L_2}{D_2}\right)}{A_2^2}\right)$$

$$A_1 = \pi r_1^2 = \pi\left(\frac{2}{2}\right)^2 = 3.14 \qquad A_1^2 = 9.86$$

$$A_2 = \pi r_2^2 = \pi\left(\frac{1}{2}\right)^2 = 0.785 \qquad A_2^2 = 0.616$$

$$Q^2 = \frac{H}{\frac{1}{2g}\left(\left(\frac{K_1 + \frac{f_1 L_1}{D_1}}{A_1^2}\right) + \left(\frac{K_2 + \frac{f_2 L_2}{D_2}}{A_2^2}\right)\right)}$$

$$Q^2 = \frac{80}{\frac{1}{64.4}\left(\left(\frac{5.25}{9.86}\right) + \left(\frac{4.46}{0.616}\right)\right)}$$

$$Q = \left(\frac{80}{0.121}\right)^{\frac{1}{2}}$$

$$Q = 25 \text{ cfs}$$

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Units 1-14

AWS Q = 5.3 × 7 = 37.1 cfs

Diffuser Q = 2 × 14 = 28 cfs

Total Q = 65.1 cfs

JLL Review

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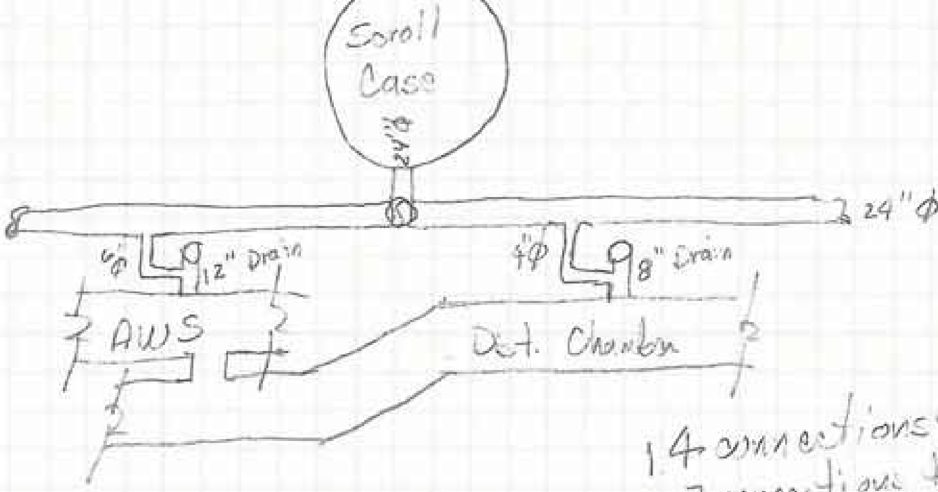
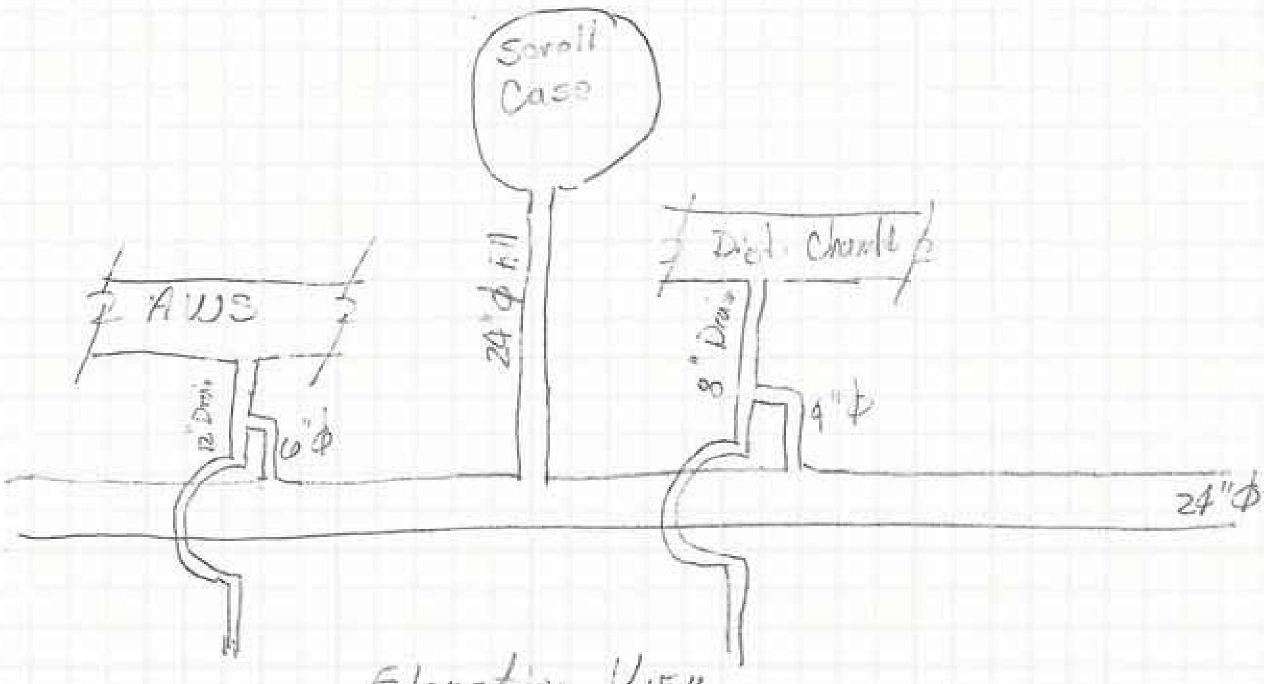
CLIENT		JOB No.	
SUBJECT			



14 connections to Dist. Ch
7 connections to AWS
∴ 7 for Dist chamber only
7 for Dist Chamber plus AWS

PLAN VIEW



Elevation VIEW

Pipe friction   k = 0.025 – 1.2 mm   Miller
= 0.001 – 0.047 ft

1. Back compute & give pipe K values
2. Check dividing flow loss for 24" - 6" T

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge through the **'AWS Drain' System.**

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := 160$

$TW := 80$

$AWS := 85$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = 75$

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := 2$ 24 inch pipe $Pipe_{1length} := 25$

$$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2 \qquad Pipe_{area1} = 3.142$$

Minor Losses Pipe 1:

$K_{1inlet} := 1.2$ entrance plus grating cover

$K_{1bends} := 7.3$ two 90 degree bends and two 't' connnections (24"-24", 24"-6")

$K_{valve1} := 0.2$ wedge valve, use gate valve, to verify later (full open)

apply contraction to smaller diameter pipe

$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1}$ $K_{1minor} = 8.7$

Friction Losses Pipe 1:

$Friction_1 := 0.04$ steel conduit, older pipe (K =)

$$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}} \qquad K_{friction1} = 0.5$$

$K_{1total} := K_{friction1} + K_{1minor}$ $K_{1total} = 9.2$

Pipe 2: 6 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.5$ 6 inch pipe $Pipe_{2length} := 15$

$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2$ $Pipe_{area2} = 0.196$

Minor Losses Pipe 2:

$K_{2contraction} := 0$ 6 inch to 12 inch, already included in Pipe 1 losses

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open, check valve type later

apply contraction to smaller diameter pipe

$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2}$ $K_{2minor} = 4.6$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia k=

$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}}$ $K_{friction2} = 1.8$

$K_{2total} := K_{friction2} + K_{2minor}$ $K_{2total} = 6.4$

Pipe 3: 12 inch pipe to AWS drain location within AWS

$Pipe_{3dia} := 1$ 12 inch drain pipe $Pipe_{3length} := 40$

$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2$ $Pipe_{area3} = 0.785$

Minor Losses Pipe 3:

$K_{3expansion} := 0.3$? think this is included as 'T' in pipe 2

$K_{3bends} := 0.2$ 90 degree bend, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := \mathbf{1}$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $\qquad K_{3minor} = \mathbf{1.7}$

Friction Losses Pipe 3:

$Friction_3 := \mathbf{0.04}$ K 3

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}} \qquad K_{friction3} = \mathbf{1.6}$$

$K_{3total} := K_{friction3} + K_{3minor}$ $\qquad K_{3total} = \mathbf{3.3}$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\dfrac{\left(\dfrac{K_{1total}}{Pipe_{area1}^{\;2}} + \dfrac{K_{2total}}{Pipe_{area2}^{\;2}} + \dfrac{K_{3total}}{Pipe_{area3}^{\;2}} \right)}{\mathbf{64.4}}} \right]^{.5} \qquad Q = \mathbf{5.295}$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = \mathbf{1.685}$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = \mathbf{26.966}$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = \mathbf{6.742}$$

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge through the **AWS 'Diffuser Chamber Drain' System**.

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := 160$

$TW := 80$

$AWS := 85$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = 75$

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := 2$ 24 inch pipe $Pipe_{1length} := 50$ 25

$$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2 \qquad Pipe_{area1} = 3.142$$

Minor Losses Pipe 1:

$K_{1inlet} := 1.2$ entrance plus grating cover

$K_{1bends} := 7.3$ two 90 degree bends and two 't' connnections

$K_{valve1} := 0.2$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1} \qquad K_{1minor} = 8.7$$

Friction Losses Pipe 1:

$Friction_1 := 0.04$ steel conduit, refine later

$$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}} \qquad K_{friction1} = ~~1~~\ 0.5$$

$$K_{1total} := K_{friction1} + K_{1minor} \qquad K_{1total} = ~~9.7~~\ 9.2$$

Pipe 2: 4 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.33$ 4 inch pipe $Pipe_{2length} := 20$

$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2$ $Pipe_{area2} = 0.086$

Minor Losses Pipe 2:

$K_{2contraction} := 0$ 6 inch to 12 inch, already included in Pipe 1 calcs

$K_{2bends} := 4.4$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open

apply contraction to smaller diameter pipe

$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2}$ $K_{2minor} = 4.6$

Friction Losses Pipe 2:

$Friction_2 := 0.06$ steel conduit, increase due to pipe dia

$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}}$ $K_{friction2} = 3.636$

$K_{2total} := K_{friction2} + K_{2minor}$ $K_{2total} = 8.236$

Pipe 3: 8 inch pipe to diffuser chamber

$Pipe_{3dia} := 0.67$ 8 inch drain pipe $Pipe_{3length} := 60$ longer than AWS drain

$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2$ $Pipe_{area3} = 0.353$

Minor Losses Pipe 3:

$K_{3expansion} := 0$ Included in 't' loss value in Pipe 2

$K_{3bends} := 0.4$ two 90 degree bends, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := 1$ Pipe Exit into Dist Well

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $K_{3minor} = 1.6$

Friction Losses Pipe 3:

$Friction_3 := 0.04$

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}}$$ $K_{friction3} = 3.582$

$K_{3total} := K_{friction3} + K_{3minor}$ $K_{3total} = 5.182$

Pipe 4: Diffuser Chamber to AWS

$Pipe_{4dia} := 64$ opening to AWS $Pipe_{4length} := 0.5$

$$Pipe_{area4} := \pi \cdot \left(\frac{Pipe_{4dia}}{2}\right)^2$$ $Pipe_{area4} = 3.217 \times 10^3$

Minor Losses Pipe 4:

$K_{4turn} := 0.5$ turning flow and turbulence

$K_{gate4} := \sout{0.2}$ ϕ fully open gate

Dist. Well to AWS Expansion loss thru 8 x 8 opening

$K_{exit4} := 1$

$K_{4minor} := K_{4turn} + K_{gate4} + K_{exit4}$

$K_{4total} := K_{4minor}$

$K_{4total} = 1.7$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\frac{\left(\frac{K_{1total}}{Pipe_{area1}^{2}}+\frac{K_{2total}}{Pipe_{area2}^{2}}+\frac{K_{3total}}{Pipe_{area3}^{2}}+\frac{K_{4total}}{Pipe_{area4}^{2}}\right)}{64.4}}\right]^{.5} \qquad Q = \mathbf{2.033}$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = \mathbf{0.647}$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = \mathbf{23.77}$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = \mathbf{5.766}$$

$$V_{pipe4} := \frac{Q}{Pipe_{area4}} \qquad V_{pipe4} = \mathbf{6.32 \times 10^{-4}}$$

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SUBJECT			

$$H = KU^2/2g$$

$$H = \frac{K_1\left(\frac{Q}{A_1}\right)^2}{2g} + \frac{K_2\left(\frac{Q}{A_2}\right)^2}{2g} + \frac{K_3\left(Q/A_3\right)^2}{2g}$$

$$H = \frac{K_1Q^2}{2gA_1^2} + \frac{K_2Q^2}{2gA_2^2} + \frac{K_3Q^2}{2gA_3^2} = \frac{Q^2}{2g}\left(\frac{K_1}{A_1^2} + \frac{K_2}{A_2^2} + \frac{K_3}{A_3^2}\right)$$

$$Q^2 = \frac{2gH}{\frac{K_1}{A_1^2} + \frac{K_2}{A_2^2} + \frac{K_3}{A_3^2}}$$

$$Q = \left[\frac{2gH}{\frac{K_1}{A_1^2} + \frac{K_2}{A_2^2} + \frac{K_3}{A_3^2}}\right]^{1/2}$$

$H = KU^2/2g = K(Q/A)^2/2g$

$Q = 10$

$A = 10$

$K = 1$

$H = U\left(\frac{10}{10}\right)^2 / 2g = 0.0155$

$H = \frac{1(10)^2}{64.4(10)^2} = 0.0155$

$A_1 = 24''\phi = 3.14$ $\quad K_1 = 9.2$ $\quad H = 75$

$A_2 = 6''\phi = 0.196$ $\quad K_2 = 6.4$

$A_3 = 12''\phi = 0.785$ $\quad K_3 = 3.3$

$$Q_{AWS} = \left[\frac{64.4 \times 75}{\frac{9.2}{9.86} + \frac{6.4}{.038} + \frac{3.3}{.616}}\right]^{1/2} = \left(\frac{4830}{.93 + 168.4 + 5.4}\right)^{1/2}$$

$$= \left(\frac{4830}{84.1}\right)^{1/2} = (27.6)^{1/2} = 5.3 \text{ cfs}$$

$$Q_{DW} = \left[\frac{64.4 \times 75}{\frac{9.2}{9.86} + \frac{8.2}{.0076} + \frac{5.2}{.117} + \frac{1.5}{4100}}\right]^{1/2} = \left[\frac{4830}{0.93 + 1079 + 44 + 0}\right]^{1/2}$$

$$= (4.3)^{1/2} = 2.1 \text{ cfs}$$

AWS Drain

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge from the equalizer header system.

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := \mathbf{160}$

$TW := \mathbf{80}$

$AWS := \mathbf{85}$ rough approx for now

$Head_{available} := FB - AWS$ $Head_{available} = \mathbf{75}$

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := \mathbf{2}$ 24 inch pipe $Pipe_{1length} :=$ ~~50~~ 27

$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2$ $Pipe_{area1} = \mathbf{3.142}$ ✓

Minor Losses Pipe 1:

$K_{1inlet} := \mathbf{1.2}$ ✓ entrance plus grating cover

~~Ex~~ Square edge entr K = 0.9 with grating 1.2 reasonable

2.1–2.6 K = 0.5–1.0

$K_{1bends} := \mathbf{2.6}$ two 90 degree bends and two 't' connnections 1.6

R/D = 1.4 K = 0.2
R/D = 1 K = 0.5

1 T's
Combining 24"-24"
Dividing 24"-6"

$K_{valve1} := \mathbf{0.2}$ ✓ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe ✓

$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1} + K_T$ (1.2, 0.5–1.0, 0.2, 1.6) $K_{1minor} = \mathbf{4}$ (3.5 – 4.0)

Friction Losses Pipe 1:

Best possible – could be as high as 0.05

$Friction_1 := \mathbf{0.02}$ steel conduit, refine later

K = .025 – 1.2 mm (new smooth – mains w/ gen'l tuberculation)
N_R = 2.7x10^5 – 4.6x10^5 (6 & 10 cfs) ~~assume~~

$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}}$ $K_{friction1} = \mathbf{0.5}$ 0.27 – 0.7

Q = 6 cfs 10 cfs
V = 1.9 3.2
N = 2.7x10^5 4.6x10^5
K = .025 – 1.2 mm
= .00098 – .047 ft
K/D = ~~.....~~ .0005 – .024
f = .018 – .055

$K_{1total} := K_{friction1} + K_{1minor}$ $K_{1total} = \mathbf{4.5}$ (3.8 – 4.7)

0.27–0.7 3.5 4.0

Q = 6 cfs
f = 0.019 – .055
Q = 10 cfs
f = .018 – .055

Pipe 2: 6 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.5$ 6 inch pipe $Pipe_{2length} := 20$ 15' DDP 1.2-3-8/42

$$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2 \qquad Pipe_{area2} = 0.196$$

Minor Losses Pipe 1: Kentrance included in Pipe 1

~~$K_{2contraction} := 0.3$ 6 inch to 12 inch~~

K=0.5-1.0 4.0

$K_{2bends} := 3$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ ✓ assume fully open, check valve type later

apply contraction to smaller diameter pipe

0.5-1.0 0.2 4.0

$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2} + K_T \quad K_{2minor} = 3.5$ 4.7 - 5.2

Friction Losses Pipe 2:

$Friction_2 := 0.02$ steel conduit, refine later

$$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}} \quad L=15 \qquad K_{friction2} = 0.8$$

0.? - 2.4

6" φ k=.00098 - .047
K/D = .00196 - .094
N = 1.1 x 10^6
f = .024 - .08

$K_{2total} := K_{friction2} + K_{2minor} \quad K_{2total} = 4.3$

Pipe 3: 12 inch pipe to AWS drain location within AWS

$Pipe_{3dia} := 1$ 12 inch drain pipe $Pipe_{3length} := 40$ ✓

$$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2 \qquad Pipe_{area3} = 0.785$$

Minor Losses Pipe 3:

~~$K_{3expansion} := 0.3$~~ → Take out, included in Pipe 2 'T' 6" → 12"

$K_{3bends} := 0.5$ 90 degree bend, tight radius K = 0.2 - 0.5

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later ✓

$K_{exit3} := 1$

0.2 1.0 0.2 - 0.5

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $K_{3minor} = 2$

1.4 - 1.7

Friction Losses Pipe 3:

$Friction_3 := 0.02$

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}}$$

$K_{friction3} = 0.8$

0.88 - 2.6

K/D = .00098 - .047

N = 5.5 X 10^5

f = .022 - .065

0.9 - 2.6 1.4 - 1.7

$K_{3total} := K_{friction3} + K_{3minor}$ $K_{3total} = 2.8$

2.3 - 4.3

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\dfrac{\left(\dfrac{K_{1total}}{Pipe_{area1}^{2}} + \dfrac{K_{2total}}{Pipe_{area2}^{2}} + \dfrac{K_{3total}}{Pipe_{area3}^{2}}\right)}{64.4}}\right]^{.5}$$

$Q = 6.438$

✓ OK

$H = K (Q/A)^2 / 64.4$

$(\frac{1}{64.4})^{1/2} Q/A = (H/K)^{1/2}$

$Q = (H/K)^{1/2} (A)(64.4)^{1/2}$

Velocities in Sections of Pipes:

$V_{pipe1} := \dfrac{Q}{Pipe_{area1}}$ $V_{pipe1} = 2.049$

$V_{pipe2} := \dfrac{Q}{Pipe_{area2}}$ $V_{pipe2} = 32.789$

$V_{pipe3} := \dfrac{Q}{Pipe_{area3}}$ $V_{pipe3} = 8.197$

Diffuser Drain

21936 The Dalles Dam - Equalizer Header November 1, 2011

Estimate potential discharge from the equalizer header system.

Use typical bay for now even though bays divided into three distinct sections

Assumptions:

$FB := \mathbf{160}$

$TW := \mathbf{80}$

$AWS := \mathbf{85}$ rough approx for now

$Head_{available} := FB - AWS$ $\quad Head_{available} = \mathbf{75}$

Q in this pipe equals AWS Q + DW Q

Pipe 1: Scroll case equalizer pipe opening to AWS 6 inch connection at El. 22

$Pipe_{1dia} := \mathbf{2}$ 24 inch pipe $\quad Pipe_{1length} := \mathbf{50}$

$$Pipe_{area1} := \pi \cdot \left(\frac{Pipe_{1dia}}{2}\right)^2 \qquad Pipe_{area1} = \mathbf{3.142}$$

Minor Losses Pipe 1:

$K_{1inlet} := \mathbf{1.2}$ entrance plus grating cover

$K_{1bends} := \mathbf{2.6}$ two 90 degree bends and two 't' connnections

$K_{valve1} := \mathbf{0.2}$ wedge valve, use gate valve, to verify later

apply contraction to smaller diameter pipe

$$K_{1minor} := K_{1inlet} + K_{1bends} + K_{valve1} \qquad K_{1minor} = \mathbf{4}$$

Friction Losses Pipe 1:

$Friction_1 := \mathbf{0.02}$ steel conduit, refine later

$$K_{friction1} := \frac{(Friction_1 \cdot Pipe_{1length})}{Pipe_{1dia}} \qquad K_{friction1} = \mathbf{0.5}$$

$$K_{1total} := K_{friction1} + K_{1minor} \qquad K_{1total} = \mathbf{4.5}$$

Pipe 2: 4 inch connector between AWS drain and 24 inch equalizer pipe

$Pipe_{2dia} := 0.33$ 4 inch pipe $Pipe_{2length} := 20$

$$Pipe_{area2} := \pi \cdot \left(\frac{Pipe_{2dia}}{2}\right)^2 \qquad Pipe_{area2} = 0.086$$

Minor Losses Pipe 1:

$K_{2contraction} := 0.3$ 6 inch to 12 inch

$K_{2bends} := 3$ two 90 degree tight radius, t connection with 12 inch

$K_{valve2} := 0.2$ assume fully open

apply contraction to smaller diameter pipe

$$K_{2minor} := K_{2contraction} + K_{2bends} + K_{valve2} \qquad K_{2minor} = 3.5$$

Friction Losses Pipe 2:

$Friction_2 := 0.02$ steel conduit, refine later

$$K_{friction2} := \frac{(Friction_2 \cdot Pipe_{2length})}{Pipe_{2dia}} \qquad K_{friction2} = 1.212$$

check 'f' for $k = 0.00098 - .0047$ ft per Miller

this may be too low

$$K_{2total} := K_{friction2} + K_{2minor} \qquad K_{2total} = 4.712$$

Pipe 3: 8 inch pipe to diffuser chamber

$Pipe_{3dia} := 0.67$ 8 inch drain pipe $Pipe_{3length} := 60$ longer than AWS drain

$$Pipe_{area3} := \pi \cdot \left(\frac{Pipe_{3dia}}{2}\right)^2 \qquad Pipe_{area3} = 0.353$$

Minor Losses Pipe 3:

~~$K_{3expansion} := 0.3$~~ K_{3exit} 1.0

$K_{3bends} := 1$ two 90 degree bends, tight radius

$K_{valve3} := 0.2$ AWS drain valve, need to verify type later

$K_{exit3} := 1$

$K_{3minor} := K_{3expansion} + K_{valve3} + K_{exit3} + K_{3bends}$ $\qquad K_{3minor} = 2.5$

Friction Losses Pipe 3:

$Friction_3 := 0.02$

$$K_{friction3} := \frac{(Friction_3 \cdot Pipe_{3length})}{Pipe_{3dia}} \qquad K_{friction3} = 1.791$$

$K_{3total} := K_{friction3} + K_{3minor}$ $\qquad K_{3total} = 4.291$

Pipe 4: Diffuser Chamber to AWS

8' x 8'

$Pipe_{4dia} := 64$ opening to AWS $\qquad Pipe_{4length} := 0.5$

$$Pipe_{area4} := \pi \cdot \left(\frac{Pipe_{4dia}}{2}\right)^2 \qquad Pipe_{area4} = 3.217 \times 10^3$$

Minor Losses Pipe 4:

$K_{4turn} := 0.5$ turning flow and turbulence ✓

$K_{gate4} := 0.2$ ~~fully open~~ gate No, ~~exit loss~~ assume no gate loss

$K_{exit4} := 1$ ✓

$K_{4minor} := K_{4turn} + K_{gate4} + K_{exit4}$

$K_{4total} := K_{4minor}$

$K_{4total} = 1.7$

Solve for Q:

$$Q := \left[\frac{Head_{available}}{\frac{\left(\frac{K_{1total}}{Pipe_{area1}^{2}} + \frac{K_{2total}}{Pipe_{area2}^{2}} + \frac{K_{3total}}{Pipe_{area3}^{2}} + \frac{K_{4total}}{Pipe_{area4}^{2}} \right)}{64.4}} \right]^{.5} \qquad Q = \mathbf{2.667}$$

Velocities in Sections of Pipes:

$$V_{pipe1} := \frac{Q}{Pipe_{area1}} \qquad V_{pipe1} = \mathbf{0.849}$$

$$V_{pipe2} := \frac{Q}{Pipe_{area2}} \qquad V_{pipe2} = \mathbf{31.181}$$

$$V_{pipe3} := \frac{Q}{Pipe_{area3}} \qquad V_{pipe3} = \mathbf{7.564}$$

$$V_{pipe4} := \frac{Q}{Pipe_{area4}} \qquad V_{pipe4} = \mathbf{8.29 \times 10^{-4}}$$

FISH LOCK APPROACH CHANNEL

FISH LOCK APPROACH CHANNEL

FINAL CALCULATIONS REFLECTING ITR COMMENTS

northwest hydraulic consultants inc.	DATE 1/12/12	BY LWL	CHK	1
CLIENT HOR/USACE		JOB No. 21936		
SUBJECT The Dalles - Fish lock/AWS Connection				

Existing Fish lock to AWS Connection

Adjust losses per ITR Comments

Pipe 102, 106, 110, 114 K=0

Pipe 103, 107, 111, 115 K=1.4

Pipe 104, 108, 112, 116 K=0.4

Pipe 105, 109, 113, 117 K=1.45

Pipe 121 K=0.1

See EPANET Results.

With ITR comments, conclusions remain same

↓

Existing connection won't pass 1,400 cfs

northwest hydraulic consultants inc.	DATE 1/12/12	BY LWL	CHK	2
CLIENT HQR / USACE		JOB No. 21936		
SUBJECT The Dalles - Fish lock / AWS Connection				

Modified fish lock to AWS connection

Adjust losses per ITR comments

Pipe 102, 106, 110, 114 K=0

Pipe 103, 107, 111, 115 K=0.5

Pipe 105, 109, 113, 117 K=0

Pipe 121 K=0.1

See EPANET Results

With ITR comments, conclusions remain same

↓

modified connection should pass 1,400 cfs

CFD model recommended

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```
**********************************************************************
*                           E P A N E T                              *
*                 Hydraulic and Water Quality                        *
*                 Analysis for Pipe Networks                         *
*                         Version 2.0                                *
**********************************************************************
```

Input File: fishlock ITR update existing.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	96
103	3	4	1	42.7
104	4	5	1	57.6
105	5	18	1	48
118	18	19	16	64
119	19	20	16	78
120	20	21	16	86
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	96
107	7	8	1	42.7
108	8	9	1	57.6
109	9	19	1	48
110	10	11	5	96
111	11	12	1	42.7
112	12	13	1	57.6
113	13	20	1	48
114	14	15	5	96
115	15	16	1	42.7
116	16	17	1	57.6
117	17	21	1	48
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

Page 2 The Dalles - Fish Lock to AWS

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	109.00	47.23	0.00	
3	0.00	109.00	47.23	0.00	
4	0.00	99.58	43.15	0.00	
5	0.00	98.76	42.79	0.00	
6	0.00	109.00	47.23	0.00	
7	0.00	109.00	47.23	0.00	
8	0.00	99.43	43.08	0.00	
9	0.00	98.60	42.72	0.00	
10	0.00	109.00	47.23	0.00	
11	0.00	109.00	47.23	0.00	
12	0.00	99.17	42.97	0.00	
13	0.00	98.32	42.60	0.00	
14	0.00	109.00	47.23	0.00	
15	0.00	109.00	47.23	0.00	
16	0.00	98.79	42.81	0.00	
17	0.00	97.90	42.42	0.00	
18	0.00	92.65	40.15	0.00	
19	0.00	92.40	40.04	0.00	
20	0.00	91.96	39.84	0.00	
21	0.00	91.29	39.55	0.00	
25	0.00	90.58	39.25	0.00	
26	0.00	90.30	39.13	0.00	
1	-841.27	109.00	0.00	0.00	Reservoir
22	841.27	85.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-841.27	2.17	0.04	Open
102	206.71	4.11	0.43	Open
103	206.71	20.79	9419.81	Open
104	206.71	11.42	816.35	Open
105	206.71	16.45	6106.91	Open
118	206.71	9.25	15.91	Open
119	415.02	12.51	27.71	Open
120	626.10	15.52	41.82	Open
201	634.56	1.64	0.02	Open
203	426.25	1.10	0.01	Open
204	215.18	0.55	0.00	Open
106	208.31	4.14	0.43	Open
107	208.31	20.95	9566.33	Open
108	208.31	11.51	829.04	Open
109	208.31	16.58	6201.90	Open
110	211.07	4.20	0.45	Open
111	211.07	21.23	9821.79	Open

Page 3 The Dalles - Fish Lock to AWS
Link Results: (continued)

Link ID	Flow CFS	VelocityUnit fps	Headloss ft/Kft	Status
112	211.07	11.66	851.18	Open
113	211.07	16.80	6367.52	Open
114	215.18	4.28	0.46	Open
115	215.18	21.64	10207.39	Open
116	215.18	11.89	884.61	Open
117	215.18	17.12	6617.51	Open
121	841.27	16.74	17.76	Open
122	841.27	16.74	6.88	Open
123	841.27	16.74	441.79	Open

```
[TITLE]
The Dalles - Fish Lock to AWS

[JUNCTIONS]
;ID              Elev            Demand          Pattern
 2               0               0                                   ;
 3               0               0                                   ;
 4               0               0                                   ;
 5               0               0                                   ;
 6               0               0                                   ;
 7               0               0                                   ;
 8               0               0                                   ;
 9               0               0                                   ;
 10              0               0                                   ;
 11              0               0                                   ;
 12              0               0                                   ;
 13              0               0                                   ;
 14              0               0                                   ;
 15              0               0                                   ;
 16              0               0                                   ;
 17              0               0                                   ;
 18              0               0                                   ;
 19              0               0                                   ;
 20              0               0                                   ;
 21              0               0                                   ;
 25              0               0                                   ;
 26              0               0                                   ;

[RESERVOIRS]
;ID              Head            Pattern
 1               109                             ;
 22              85                              ;

[TANKS]
;ID              Elevation       InitLevel       MinLevel        MaxLevel        Diameter
MinVol          VolCurve

[PIPES]
;ID              Node1                   Node2                   Length          Diameter
Roughness       MinorLoss       Status
 101             2                       1                       16              266.7           1
        0        Open     ;
 102             2                       3                       5               96              1
        0        Open     ;
 103             3                       4                       1               42.7            1
        1.4      Open     ;
 104             4                       5                       1               57.6            1
        0.4      Open     ;
 105             5                       18                      1               48              1
        1.45     Open     ;
```

118	18	19	16	64	1	0.15	Open	;
119	19	20	16	78	1	0.15	Open	;
120	20	21	16	86	1	0.15	Open	;
201	2	6	16	266.7	1	0	Open	;
203	6	10	16	266.7	1	0	Open	;
204	10	14	16	266.7	1	0	Open	;
106	6	7	5	96	1	0	Open	;
107	7	8	1	42.7	1	1.4	Open	;
108	8	9	1	57.6	1	0.4	Open	;
109	9	19	1	48	1	1.45	Open	;
110	10	11	5	96	1	0	Open	;
111	11	12	1	42.7	1	1.4	Open	;
112	12	13	1	57.6	1	0.4	Open	;
113	13	20	1	48	1	1.45	Open	;
114	14	15	5	96	1	0	Open	;
115	15	16	1	42.7	1	1.4	Open	;
116	16	17	1	57.6	1	0.4	Open	;
117	17	21	1	48	1	1.45	Open	;
121	21	25	40	96	1	0.1	Open	;
122	25	26	40	96	1	0	Open	;
123	26	22	12	96	1	1.2	Open	;

[PUMPS]

;ID	Node1	Node2	Parameters

[VALVES]

;ID	Node1	Node2	Diameter	Type	Setting

MinorLoss

```
[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
```

8

```
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 2                      -164.29                 7542.86
 3                      -164.29                 6400.00
 4                      -164.29                 5171.43
 5                      -164.29                 3885.71
 6                      1225.00                 7550.00
 7                      1191.67                 6333.33
 8                      1191.67                 5116.67
 9                      1175.00                 3850.00
 10                     2541.67                 7550.00
 11                     2521.43                 6300.00
 12                     2541.67                 5066.67
 13                     2525.00                 3800.00
 14                     3621.43                 7557.14
 15                     3635.71                 6300.00
 16                     3664.29                 5085.71
 17                     3664.29                 3771.43
```


9

```
 18               -158.33          2833.33
 19               1207.14          2871.43
 20               2608.33          2850.00
 21               3721.43          2828.57
 25               5041.67          3166.67
 26               6225.00          3466.67
 1                -2041.67         7583.33
 22               7408.33          3783.33

[VERTICES]
;Link             X-Coord          Y-Coord
 121              5008.33          3100.00

[LABELS]
;X-Coord        Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS       0.00             0.00             10000.00         10000.00
 UNITS            None
 FILE
 OFFSET           0.00             0.00

[END]
```

10

Page 1 1/6/2012 12:17:15 PM

```
**********************************************************************
*                            E P A N E T                             *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                         Version 2.0                                *
**********************************************************************
```

Input File: fishlock ITR mods to AWS.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	160
103	3	4	1	148
104	4	5	1	148
105	5	18	1	107
118	18	19	16	64
119	19	20	16	78
120	20	21	16	86
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	213
107	7	8	1	185
108	8	9	1	185
109	9	19	1	125
110	10	11	5	213
111	11	12	1	185
112	12	13	1	185
113	13	20	1	125
114	14	15	5	213
115	15	16	1	185
116	16	17	1	185
117	17	21	1	125
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	109.00	47.23	0.00	
3	0.00	109.00	47.23	0.00	
4	0.00	109.00	47.23	0.00	
5	0.00	109.00	47.23	0.00	
6	0.00	109.00	47.23	0.00	
7	0.00	109.00	47.23	0.00	
8	0.00	108.99	47.23	0.00	
9	0.00	108.99	47.23	0.00	
10	0.00	108.99	47.23	0.00	
11	0.00	108.99	47.23	0.00	
12	0.00	108.97	47.22	0.00	
13	0.00	108.97	47.22	0.00	
14	0.00	108.99	47.23	0.00	
15	0.00	108.99	47.23	0.00	
16	0.00	108.66	47.08	0.00	
17	0.00	108.60	47.05	0.00	
18	0.00	109.00	47.23	0.00	
19	0.00	108.99	47.23	0.00	
20	0.00	108.97	47.21	0.00	
21	0.00	108.59	47.05	0.00	
25	0.00	105.93	45.90	0.00	
26	0.00	104.90	45.45	0.00	
1	-1630.08	109.00	0.00	0.00	Reservoir
22	1630.08	85.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-1630.08	4.20	0.13	Open
102	20.49	0.15	0.00	Open
103	20.49	0.17	0.23	Open
104	20.49	0.17	0.05	Open
105	20.49	0.33	0.00	Open
118	20.49	0.92	0.20	Open
119	92.87	2.80	1.78	Open
120	413.91	10.26	23.40	Open
201	1609.59	4.15	0.13	Open
203	1537.21	3.96	0.12	Open
204	1216.17	3.13	0.07	Open
106	72.38	0.29	0.00	Open
107	72.38	0.39	1.17	Open
108	72.38	0.39	0.24	Open
109	72.38	0.85	0.02	Open
110	321.04	1.30	0.02	Open
111	321.04	1.72	23.00	Open

Page 3 The Dalles - Fish Lock to AWS

Link Results: (continued)

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
112	321.04	1.72	4.62	Open
113	321.04	3.77	0.27	Open
114	1216.17	4.91	0.24	Open
115	1216.17	6.52	330.00	Open
116	1216.17	6.52	66.39	Open
117	1216.17	14.27	3.66	Open
121	1630.08	32.43	66.52	Open
122	1630.08	32.43	25.70	Open
123	1630.08	32.43	1658.54	Open

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```
[TITLE]
The Dalles - Fish Lock to AWS

[JUNCTIONS]
;ID              Elev        Demand      Pattern
 2               0           0                       ;
 3               0           0                       ;
 4               0           0                       ;
 5               0           0                       ;
 6               0           0                       ;
 7               0           0                       ;
 8               0           0                       ;
 9               0           0                       ;
 10              0           0                       ;
 11              0           0                       ;
 12              0           0                       ;
 13              0           0                       ;
 14              0           0                       ;
 15              0           0                       ;
 16              0           0                       ;
 17              0           0                       ;
 18              0           0                       ;
 19              0           0                       ;
 20              0           0                       ;
 21              0           0                       ;
 25              0           0                       ;
 26              0           0                       ;

[RESERVOIRS]
;ID              Head        Pattern
 1               109                     ;
 22              85                      ;

[TANKS]
;ID              Elevation   InitLevel   MinLevel    MaxLevel    Diameter
MinVol       VolCurve

[PIPES]
;ID              Node1            Node2            Length      Diameter
Roughness    MinorLoss   Status
 101             2                1                16          266.7       1
         0       Open    ;
 102             2                3                5           160         1
         0       Open    ;
 103             3                4                1           148         1
         0.5     Open    ;
 104             4                5                1           148         1
         0.1     Open    ;
 105             5                18               1           107         1
         0       Open    ;
```

118	18	19	16	64	1	0.2	Open	;
119	19	20	16	78	1	0.2	Open	;
120	20	21	16	86	1	0.2	Open	;
201	2	6	16	266.7	1	0	Open	;
203	6	10	16	266.7	1	0	Open	;
204	10	14	16	266.7	1	0	Open	;
106	6	7	5	213	1	0	Open	;
107	7	8	1	185	1	0.5	Open	;
108	8	9	1	185	1	0.1	Open	;
109	9	19	1	125	1	0	Open	;
110	10	11	5	213	1	0	Open	;
111	11	12	1	185	1	0.5	Open	;
112	12	13	1	185	1	0.1	Open	;
113	13	20	1	125	1	0	Open	;
114	14	15	5	213	1	0	Open	;
115	15	16	1	185	1	0.5	Open	;
116	16	17	1	185	1	0.1	Open	;
117	17	21	1	125	1	0	Open	;
121	21	25	40	96	1	0.1	Open	;
122	25	26	40	96	1	0	Open	;
123	26	22	12	96	1	1.2	Open	;

[PUMPS]
;ID Node1 Node2 Parameters

[VALVES]
;ID Node1 Node2 Diameter Type Setting MinorLoss

15

```
[TAGS]

[DEMANDS]
;Junction               Demand          Pattern                 Category

[STATUS]
;ID                     Status/Setting

[PATTERNS]
;ID                     Multipliers

[CURVES]
;ID                     X-Value         Y-Value

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
```


16

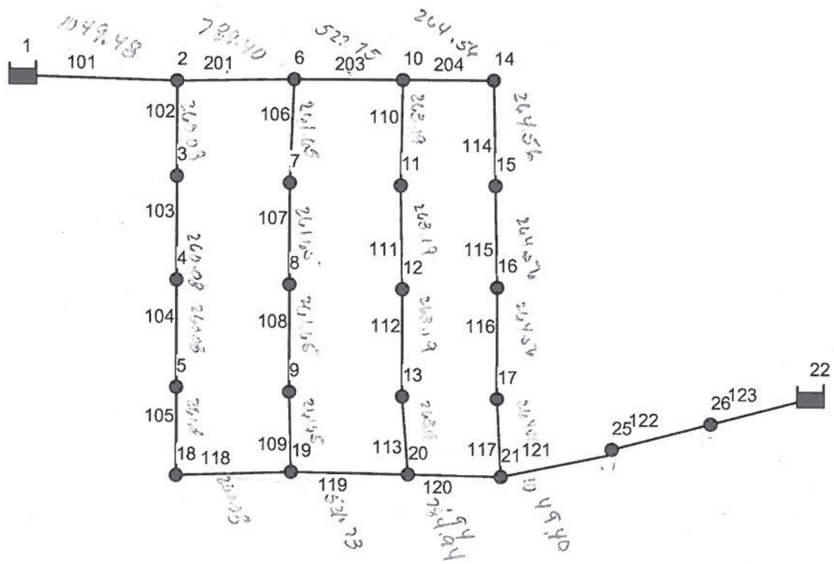
```
 Hydraulic Timestep    1:00
 Quality Timestep      0:05
 Pattern Timestep      1:00
 Pattern Start         0:00
 Report Timestep       1:00
 Report Start          0:00
 Start ClockTime       12 am
 Statistic             None

[REPORT]
 Status                No
 Summary               No
 Page                  0

[OPTIONS]
 Units                 CFS
 Headloss              D-W
 Specific Gravity      1
 Viscosity             0.00001
 Trials                40
 Accuracy              0.001
 CHECKFREQ             2
 MAXCHECK              10
 DAMPLIMIT             0
 Unbalanced            Continue 10
 Pattern               1
 Demand Multiplier     1.0
 Emitter Exponent      0.5
 Quality               None mg/L
 Diffusivity           1
 Tolerance             0.01

[COORDINATES]
;Node                  X-Coord            Y-Coord
 2                     -164.29            7542.86
 3                     -164.29            6400.00
 4                     -164.29            5171.43
 5                     -164.29            3885.71
 6                     1225.00            7550.00
 7                     1191.67            6333.33
 8                     1191.67            5116.67
 9                     1175.00            3850.00
 10                    2541.67            7550.00
 11                    2521.43            6300.00
 12                    2541.67            5066.67
 13                    2525.00            3800.00
 14                    3621.43            7557.14
 15                    3635.71            6300.00
 16                    3664.29            5085.71
 17                    3664.29            3771.43
```

```
 18                 -158.33             2833.33
 19                 1207.14             2871.43
 20                 2608.33             2850.00
 21                 3721.43             2828.57
 25                 5041.67             3166.67
 26                 6225.00             3466.67
 1                  -2041.67            7583.33
 22                 7408.33             3783.33

[VERTICES]
;Link               X-Coord             Y-Coord
 121                5008.33             3100.00

[LABELS]
;X-Coord        Y-Coord           Label & Anchor Node

[BACKDROP]
 DIMENSIONS         0.00                0.00                10000.00            10000.00
 UNITS              None
 FILE
 OFFSET             0.00                0.00

[END]
```


18

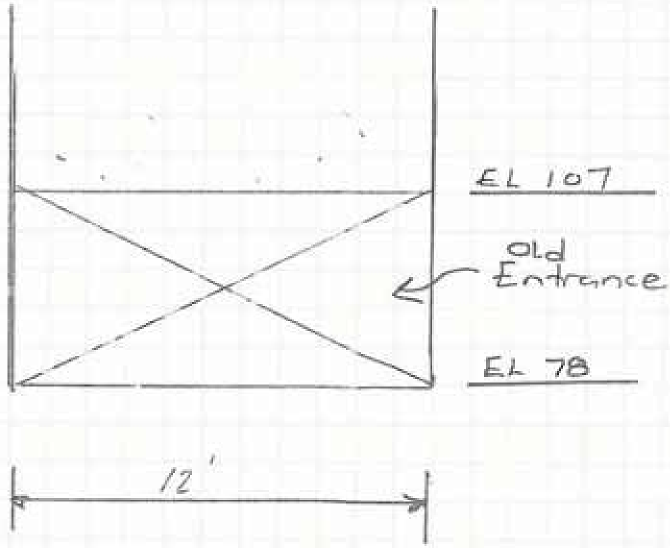
The Dalles - Fish Lock to AWS

Day 1, 12:0

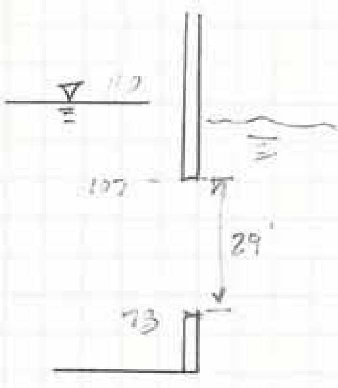


FISH ENTRANCE CALCULATIONS

Estimate Loss from fish lock channel thru old Lock entrance opening to fish lock channel



Say Fish lock WSEL = 110



Contraction

$A_1 = \pi r^2 = (3.14)\left(\frac{28}{2}\right)^2 = 615$

$A_2 = (107 - 78)(10) = 290$ (12 written above 10)

$A/A = 0.47$

Abrupt contraction
K = 0.3 – 0.5 miller P.374

Expansion

$A_1 = 290$ Entrance

$A_2 = \sim 16 \times (107 - 74)$ Fish chnl
$= 528$

$A/A = 0.55$ 1.0

K ~ 0.3 miller P.375

Total K = 0.60

northwest hydraulic consultants inc.	DATE 11/22	BY LWL	CHK	2
CLIENT HDR/USACE		JOB No. 21936		
SUBJECT The Dalles EAWS – Fish Lock				

Estimate Head loss:

K → Apply to entrance opening

$H_L = K \frac{V^2}{2g}$

Say Q = 1,400 cfs

$V = \frac{Q}{A} = \frac{1,400}{290} = 4.83$

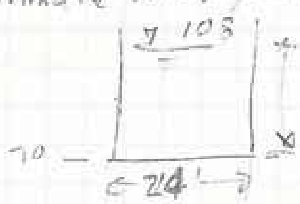
$H_L = (0.6)\frac{(4.83)^2}{2g} = 0.22$ ft relatively small

$1.5 \times \frac{4.8^2}{2g} = 0.5'$ still small

If FL WS = 109, then w.s. @ about f = 0.2 conservatively

2 = 109 − 0.5 − f(108/30)(0.04) = 108.5 − 0.03 = 108.5
6 = 109 − 0.5 − f(140/30)(0.04) = 108.5 − 0.04 = 108.5
10 = 109 − 0.5 − f(1?/30)(0.04) = 108.5 − 0.05 = 108.45
14 = 109 − 0.5 − f(183/30)(0.04) = 108.5 − 0.05 = 108.46

Estimate W.S. profile in approach:



A = 24 × 38 = 912
Q = 1400   y = 1.5 h_f = 0.04

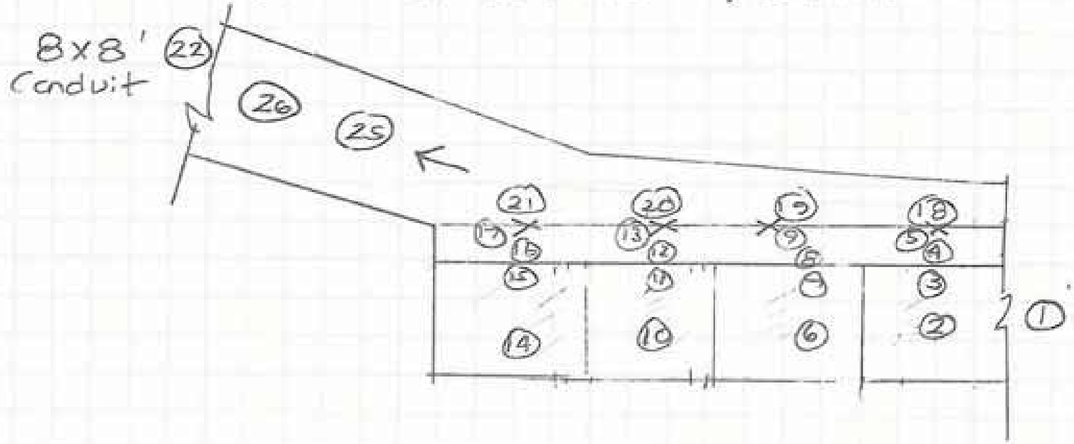
ORIGINAL FISH LOCK APPROACH CHANNEL CALCULATIONS

ITR COMMENTS

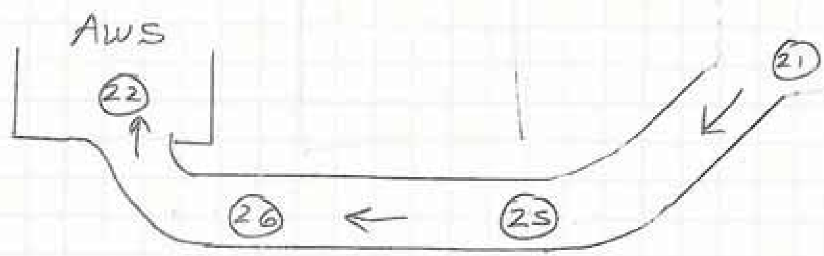
northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK JL
CLIENT HOR / USACE		JOB No. 21936	
SUBJECT Fish lock to AWS			

Fish Lock Channel to AWS via 8'x8' AWS "Culvert"

Plan view Fish Channel to AWS system



2 = Channel
3 - Thru diffuser chamber opening
4 = Chimney expansion
5 = 4x4 Gate
18 = AWS supply chnl



Flow will go "backwards" in system from fish lock to AWS.

Assume grating / bubbler beams removed

Assume 1' freeboard on fish collection chnl
Assume Fish lock WSEL = 109 ft & AWS WSEL = 85 ft

Estimate loss coefficients & use EPANET to estimate discharge

northwest hydraulic consultants inc.	DATE 11/22/11	BY LWL	CHK	1a
CLIENT USACE/HDR		JOB No. 21936		
SUBJECT The Dalles Fish lock to AWS				

Fish Lock thru Culvert to AWS

Fish lock Reservoir = 1

Basis for WS el 108? Weir ht = 5'?

Pipe 101 Fish Chnl = 20' wide
Water EL ~ 108 − 70 ~ 38 ft
W=20'
ht = 38 ft
Ln ~ 16 ft

Note: 108' assumed before 1' freeboard criteria; however, no need to modify

Pipe 102 Fish chnl → Diffuser chamber
Assume diffuser grating / bubbler beams removed

where is D/S? Think it should be vertical

W = 20' ? Ln ~ 5 ft
ht ~ 5' (diffuser ~ 5' above)

Contraction $A_1 = 700+$ $A_2/A_1 = 0.14$
$A_2 = 100$
$K = 0.4$ miller okay

Total K = 0.4 delete

Pipe 103 Diffuser Chamber thru initial opening to AWS

W = 16' ✓ Ln = 1 ft
ht = 2' ✓

Contraction $A_1 = 100$ $A_2/A_1 = 0.32$
$A_2 = 32$
$K = 0.4$ miller

Abrupt Expansion to chimney (closed) just U/S of 4'x 4' gate

Expansion: $A = 32$
K=1.0 Chimney ~ ~~12'~~ 16' x 3' = ~~36'~~ 48'
~~Neglect this~~ – include

Total K = ~~0.4~~ 1.4

northwest hydraulic consultants inc.	DATE 11/22/11	BY LWL	CHK	2
CLIENT USACE/HDR		JOB No. 21936		
SUBJECT The Dalles Fish lock to AWS				

Pipe 104 Chimney section
~ 3 X 12' 16' = 48 ft²
90°
TWO Bends K ~ 0.2 too low 0.4

see p 2a

Pipe 105 4 X 4 gate Ln=1

Contraction A=36, A=16 16/36 = 0.44

K = 0.3

Expansion/Combining Flow
Q/Q = 1.0 at u/s end

A/A = 16/~3x25 = 0.21 miller - high!
Use K=4 → Too high
K=1.0

Total K = 1.3

Pipe 118 AWS gradually expands

3 x 25 → 5 x 25

$\frac{A}{A} = \frac{75}{100} = 0.75$

K expansion = 0.15

ht & wd 4 x 25 (Avg)

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK
CLIENT USACE / HDR		JOB No. 21936	
SUBJECT The Dalles Fish lock to AWS			

Pipe 105 4 X 4 Gate Ln = 1 93.9 ft² to 16 ft²

Contraction K = 0.3 see P.2

Expansion – Try expansion + bend vs Miller combining flow

Expanded Area ~ 3 x 25 = 75 ft²
A/A = 16/75 ~ 0.21

K = 0.65 Use K = 1.0 for full velocity head loss

Flow Turning
Aspect Ratio – Use 0.5 for now
Say r/w = 1
θ = 90°

K ~ 0.16

Total K = 1.11

Could be A ⇒ 16 x 3 = 48 ft²

A/A = 16/48 = 0.33

K = 0.45 (ent) I'd use K_{exp} = 1.0

Total K = 0.91 0.3 + 1.0 + .16 = 1.46

Use 1.46

Use K = 0.9 + check, likely negligible difference

northwest hydraulic consultants inc.	DATE 11/23/11	BY LWL	CHK	3
CLIENT USACE/HOR		JOB No. 21936		
SUBJECT The Dalles Fish lock to AWS				

Pipe 121 AWS culvert 8'x8'

Ln ~ 40 ft

Large gradual bend k ~ 0.1

Entrance loss - contraction

See HTR revisions from old version ← A = 8 x ~25

A = 8 x 8

A/A = 0.32 Maybe no entrance?

K = 0.4

Total K = 0.5

pipe 122 AWS culvert

Ln ~ 40 ft

Straight section

pipe 123 AWS culvert Ln ~ 12'

Bend K = 0.2

Exit loss K = 1.0 ✓

K = 1.2 w/o manifold/baffling etc.

Total

21936 The Dalles
Estimate the equivalent diameter of rectangular conduits for EPANET
Fish Lock to AWS estimates

Pipe	Ht ~~In~~ (ft)	width (ft)	Area	equivalent dia (ft)	equivalent dia (inches)	Wetted Perimeter (ft)	Hyd Dia 4*(Area/WP) (ft)	Hyd Dia 4*(Area/WP) (in)	Hyd Area ft²
101	20 ?	25 ✓	500	24.4	292.9	90	22.2	266.7	386.9
102	20	5 ✓	100	10.3	124.1	50	8.0	96.0	50.2
103	2	16 ✓	32	5.5	66.1	36	3.6	42.7	9.9
104	3	12 ✓	36	6.2	74.4	30	4.8	57.6	18.1
105	4	4 ✓	16	4.4	52.5	16	4.0	48.0	12.5
118	4	25 ✓	100	10.0	119.5	58	6.9	82.8	37.4
119	6	25 ✓	150	12.6	151.5	62	9.7	116.1	73.4
120	8	25 ✓	200	14.9	178.5	66	12.1	145.5	115.3
	8	8 ✓	64	8.7	104.9	32	8.0	96.0	50.2

fishlock hyd dia.inp

Prior to making revisions to conduit d/s of 4'x4 Openings

28

11/28/2011

```
[TITLE]
The Dalles - Fish Lock to AWS

[JUNCTIONS]
;ID                    Elev         Demand        Pattern
 2                     0            0
          ;
 3                     0            0
          ;
 4                     0            0
          ;
 5                     0            0
          ;
 6                     0            0
          ;
 7                     0            0
          ;
 8                     0            0
          ;
 9                     0            0
          ;
 10                    0            0
          ;
 11                    0            0
          ;
 12                    0            0
          ;
 13                    0            0
          ;
 14                    0            0
          ;
 15                    0            0
          ;
 16                    0            0
          ;
 17                    0            0
          ;
 18                    0            0
          ;
 19                    0            0
          ;
 20                    0            0
          ;
 21                    0            0
          ;
 25                    0            0
          ;
 26                    0            0
          ;

[RESERVOIRS]
;ID                    Head         Pattern
 1                     109                                  ;
 22                    85                                   ;

[TANKS]
;ID                    Elevation    InitLevel     MinLevel
MaxLevel       Diameter      MinVol        VolCurve

[PIPES]
;ID                    Node1                      Node2
Length         Diameter      Roughness            MinorLoss     Status
 101                   2                          1                      16
      266.7            1 Ramersta      0                        Open    ;
 102                   2                          3                      5
      96               1 R             0.4 0                    Open    ;
 103                   3                          4                      1
      42.7             1 R             0.4 1.4                  Open    ;
```

104	4	5	1	57.6	1	~~0.2~~ 0.4	Open	;
105	5	18	1	48	1	~~0.9~~ 1.45	Open	;
118	18	19	16	82.8	1	0.15	Open	;
119	19	20	16	116.1	1	0.15	Open	;
120	20	21	16	145.5	1	0.15	Open	;
201	2	6	16	266.7	1	0 ✓	Open	;
203	6	10	16	266.7	1	0 ✓	Open	;
204	10	14	16	266.7	1	0 ✓	Open	;
106	6	7	5	96	1	0.4 9	Open	;
107	7	8	1	42.7	1	0.4 1.4	Open	;
108	8	9	1	57.6	1	0.2 0.4	Open	;
109	9	19	1	48	1	0.9 1.45	Open	;
110	10	11	5	96	1	0.4 9	Open	;
111	11	12	1	42.7	1	0.4 1.4	Open	;
112	12	13	1	57.6	1	0.2 0.4	Open	;
113	13	20	1	48	1	0.9 1.45	Open	;
114	14	15	5	96	1	0.4 9	Open	;
115	15	16	1	42.7	1	0.4 1.4	Open	;
116	16	17	1	57.6	1	~~0.2~~ 0.4	Open	;
117	17	21	1	48	1	0.9 1.45	Open	;
121	21	25	40	96	1	~~0.5~~ 0.01	Open	;
122	25	26	40	96	1	0 ✓	Open	;
123	26	22	12	96	1	1.2 ✓	Open	;

[PUMPS]
;ID Node1 Node2 Parameters

[VALVES]
;ID Node1 Node2 Diameter Type Setting MinorLoss

[TAGS]

[DEMANDS]
;Junction Demand Pattern Category

[STATUS]
;ID Status/Setting

[PATTERNS]
;ID Multipliers

[CURVES]
;ID X-Value Y-Value

```
[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01
```

```
[COORDINATES]
;Node                   X-Coord                  Y-Coord
 2                      -164.29                  7542.86
 3                      -164.29                  6400.00
 4                      -164.29                  5171.43
 5                      -164.29                  3885.71
 6                      1225.00                  7550.00
 7                      1191.67                  6333.33
 8                      1191.67                  5116.67
 9                      1175.00                  3850.00
 10                     2541.67                  7550.00
 11                     2521.43                  6300.00
 12                     2541.67                  5066.67
 13                     2525.00                  3800.00
 14                     3621.43                  7557.14
 15                     3635.71                  6300.00
 16                     3664.29                  5085.71
 17                     3664.29                  3771.43
 18                     -158.33                  2833.33
 19                     1207.14                  2871.43
 20                     2608.33                  2850.00
 21                     3721.43                  2828.57
 25                     5041.67                  3166.67
 26                     6225.00                  3466.67
 1                      -2041.67                 7583.33
 22                     7408.33                  3783.33

[VERTICES]
;Link                   X-Coord                  Y-Coord
 121                    5008.33                  3100.00

[LABELS]
;X-Coord              Y-Coord            Label & Anchor Node

[BACKDROP]
 DIMENSIONS             0.00                     0.00
       10000.00                 10000.00
 UNITS                  None
 FILE
 OFFSET                 0.00                     0.00

[END]
```

See note on "inp" file

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```
**********************************************************************
*                             E P A N E T                            *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: fishlock hyd dia.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	96
103	3	4	1	42.7
104	4	5	1	57.6
105	5	18	1	48
118	18	19	16	82.8
119	19	20	16	116.1
120	20	21	16	145.5
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	96
107	7	8	1	42.7
108	8	9	1	57.6
109	9	19	1	48
110	10	11	5	96
111	11	12	1	42.7
112	12	13	1	57.6
113	13	20	1	48
114	14	15	5	96
115	15	16	1	42.7
116	16	17	1	57.6
117	17	21	1	48
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

33

Fishlock WS 109

Page 2 The Dalles - Fish Lock to AWS

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	109.00	47.23	0.00	
3	0.00	108.83	47.16	0.00	
4	0.00	104.54	45.30	0.00	
5	0.00	103.89	45.01	0.00	
6	0.00	109.00	47.23	0.00	
7	0.00	108.83	47.15	0.00	
8	0.00	104.48	45.27	0.00	
9	0.00	103.82	44.99	0.00	
10	0.00	109.00	47.23	0.00	
11	0.00	108.82	47.15	0.00	
12	0.00	104.43	45.25	0.00	
13	0.00	103.76	44.96	0.00	
14	0.00	109.00	47.23	0.00	
15	0.00	108.82	47.15	0.00	
16	0.00	104.38	45.23	0.00	
17	0.00	103.71	44.94	0.00	
18	0.00	97.88	42.41	0.00	
19	0.00	97.74	42.35	0.00	
20	0.00	97.61	42.29	0.00	
21	0.00	97.49	42.24	0.00	
25	0.00	93.68	40.59	0.00	
26	0.00	93.25	40.41	0.00	
1	-1049.48	109.00	0.00	0.00	Reservoir
22	1049.48	85.00	0.00	0.00	Reservoir

8' loss from 26 to 22 Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-1049.48	2.71	0.06	Open
102	260.08	5.17	33.92	Open
103	260.08	26.15	4292.07	Open
104	260.08	14.37	650.81	Open
105	260.08	20.70	6009.45	Open
118	260.08	6.96	8.48	Open
119	521.73	7.10	8.33	Open
120	784.92	6.80	7.43	Open
201	789.41	2.03	0.03	Open
203	527.76	1.36	0.01	Open
204	264.56	0.68	0.00	Open
106	261.65	5.21	34.34	Open
107	261.65	26.31	4344.23	Open
108	261.65	14.46	658.72	Open
109	261.65	20.82	6082.48	Open
110	263.19	5.24	34.74	Open
111	263.19	26.47	4395.58	Open

Page 3 The Dalles - Fish Lock to AWS

Link Results: (continued)

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
112	263.19	14.54	666.50	Open
113	263.19	20.94	6154.37	Open
114	264.56	5.26	35.10	Open
115	264.56	26.60	4441.41	Open
116	264.56	14.62	673.46	Open
117	264.56	21.05	6218.56	Open
121	1049.48	20.88 16.4	95.29	Open
122	1049.48	20.88 16.4	10.69	Open
123	1049.48	20.88 164	687.51	Open

```
Page 1                                        11/28/2011 12:12:36 PM
**********************************************************************
*                            E P A N E T                             *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                         Version 2.0                                *
**********************************************************************
```

Input File: fishlock_raise WSEL.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	96
103	3	4	1	42.7
104	4	5	1	57.6
105	5	18	1	48
118	18	19	16	82.8
119	19	20	16	116.1
120	20	21	16	145.5
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	96
107	7	8	1	42.7
108	8	9	1	57.6
109	9	19	1	48
110	10	11	5	96
111	11	12	1	42.7
112	12	13	1	57.6
113	13	20	1	48
114	14	15	5	96
115	15	16	1	42.7
116	16	17	1	57.6
117	17	21	1	48
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	128.00	55.46	0.00	
3	0.00	127.69	55.33	0.00	
4	0.00	120.00	52.00	0.00	
5	0.00	118.84	51.49	0.00	
6	0.00	128.00	55.46	0.00	
7	0.00	127.69	55.33	0.00	
8	0.00	119.91	51.96	0.00	
9	0.00	118.73	51.44	0.00	
10	0.00	128.00	55.46	0.00	
11	0.00	127.69	55.33	0.00	
12	0.00	119.81	51.91	0.00	
13	0.00	118.62	51.40	0.00	
14	0.00	128.00	55.46	0.00	
15	0.00	127.68	55.32	0.00	
16	0.00	119.72	51.88	0.00	
17	0.00	118.52	51.35	0.00	
18	0.00	108.07	46.83	0.00	
19	0.00	107.83	46.72	0.00	
20	0.00	107.59	46.62	0.00	
21	0.00	107.38	46.53	0.00	
25	0.00	100.55	43.57	0.00	
26	0.00	99.78	43.24	0.00	
1	-1404.84	128.00	0.00	0.00	Reservoir
22	1404.84	85.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-1404.84	3.62	0.10	Open
102	348.14	6.93	60.78	Open
103	348.14	35.01	7690.74	Open
104	348.14	19.24	1166.12	Open
105	348.14	27.70	10768.14	Open
118	348.14	9.31	15.18	Open
119	698.39	9.50	14.92	Open
120	1050.70	9.10	13.30	Open
201	1056.70	2.72	0.06	Open
203	706.45	1.82	0.03	Open
204	354.14	0.91	0.01	Open
106	350.25	6.97	61.52	Open
107	350.25	35.22	7784.12	Open
108	350.25	19.36	1180.28	Open
109	350.25	27.87	10898.90	Open
110	352.31	7.01	62.24	Open
111	352.31	35.43	7876.07	Open

Page 3 The Dalles - Fish Lock to AWS

Link Results: (continued)

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
112	352.31	19.47	1194.23	Open
113	352.31	28.04	11027.63	Open
114	354.14	7.05	62.89	Open
115	354.14	35.61	7958.18	Open
116	354.14	19.57	1206.67	Open
117	354.14	28.18	11142.59	Open
121	1404.84	27.95	170.71	Open
122	1404.84	27.95	19.11	Open
123	1404.84	27.95	1231.88	Open

36

northwest hydraulic consultants inc.	DATE	BY LWL	CHK	4
CLIENT		JOB No. 21936		
SUBJECT				

Revise Fish lock to AWS Calculations Connection

Don't understand what is modified?

Pipe 5-18 (105) and Pipe 18-19 (118)

Pipe 5-18 (105):

Section w/ 4 X 4 gate

Note: D/S side is into the 8X8 culvert. Only gate slot goes to deck

Contraction K = 0.3 (Same as before)

Expansion ⇒ Note Difference

A = 16 ft^2 slot

D/S A = 8X 4 = 32 ft^2

$A/A = 16/32 = 0.5$

Use full h_v loss

K ~ 0.3

Flow Turning
Same as before ~ K = 0.16
may be higher, likely not lower

$K_{Total} = 0.76$ 1.45

Pipe 18-19 (118):

AWS 3X8 to 5X8 approx

Use Avg 4'X 8' Hyd dia = $\frac{4(4 \times 8)}{2(4)+2(8)}$ = 5.33

$A/A = 5/3 = 1.67$ $V = \frac{400}{5 \times 8} = 10$ $v = \frac{400}{3 \times 8} = 12.5$

$h = \frac{(V - v)^2}{2g}$ $h = \frac{(12.5-10)^2}{32.2}$ $h = 0.19$

$h = \frac{KV^2}{2g}$ $0.19 = \frac{K(10)^2}{64.4}$ K = 0.12

northwest hydraulic consultants inc.	DATE 11/29/11	BY LWL	CHK	3
CLIENT HDR / USACE		JOB No. 21936		
SUBJECT Dalles EAWS				

Pipe 18-19 (1,8) Continued

There are likely some combining flow losses. Difficult to estimate since miller is for pipe system

Use K = 0.2 as approximation
may be higher

Pipes 105, 109, 113, 117 same

Pipe

118 4 X 8 Hyd Dia = 5.33 X 12 = 64"

119 Avg 5.5 X 8 Hyd Dia = $\frac{4(5.5 \times 8)}{2(5.5)+2(8)}$ = 6.5 X 12 = 78"

120 Avg 6.5 X 8 Hyd Dia = $\frac{4(6.5 \times 8)}{2(6.5)+2(8)}$ = 7.2 X 12 = 86'

Revised to reflect actual conduit on d/s of 4x4, previously had assumed it was larger until additional drwgs reviewed

11/30/2011

fishlock 112911 existing.inp

```
[TITLE]
The Dalles - Fish Lock to AWS

[JUNCTIONS]
;ID              Elev            Demand          Pattern
 2               0               0
       ;
 3               0               0
       ;
 4               0               0
       ;
 5               0               0
       ;
 6               0               0
       ;
 7               0               0
       ;
 8               0               0
       ;
 9               0               0
       ;
 10              0               0
       ;
 11              0               0
       ;
 12              0               0
       ;
 13              0               0
       ;
 14              0               0
       ;
 15              0               0
       ;
 16              0               0
       ;
 17              0               0
       ;
 18              0               0
       ;
 19              0               0
       ;
 20              0               0
       ;
 21              0               0
       ;
 25              0               0
       ;
 26              0               0
       ;

[RESERVOIRS]
;ID              Head            Pattern
 1               109                                     ;
 22              85                                      ;

[TANKS]
;ID              Elevation       InitLevel       MinLevel
MaxLevel         Diameter        MinVol          VolCurve

[PIPES]
;ID              Node1                           Node2
Length           Diameter        Roughness       MinorLoss       Status
 101             2                               1                       16
        266.7    1               0                       Open    ;
 102             2                               3                       5
        96       1               0.4                     Open    ;
 103             3                               4                       1
        42.7     1               0.4                     Open    ;
```

104	4	5	1	57.6	1	0.2	Open	;
105	5	18	1	48	1	0.76	Open	;
118	18	19	16	64	1	0.15	Open	;
119	19	20	16	78	1	0.15	Open	;
120	20	21	16	86	1	0.15	Open	;
201	2	6	16	266.7	1	0	Open	;
203	6	10	16	266.7	1	0	Open	;
204	10	14	16	266.7	1	0	Open	;
106	6	7	5	96	1	0.4	Open	;
107	7	8	1	42.7	1	0.4	Open	;
108	8	9	1	57.6	1	0.2	Open	;
109	9	19	1	48	1	0.76	Open	;
110	10	11	5	96	1	0.4	Open	;
111	11	12	1	42.7	1	0.4	Open	;
112	12	13	1	57.6	1	0.2	Open	;
113	13	20	1	48	1	0.76	Open	;
114	14	15	5	96	1	0.4	Open	;
115	15	16	1	42.7	1	0.4	Open	;
116	16	17	1	57.6	1	0.2	Open	;
117	17	21	1	48	1	0.76	Open	;
121	21	25	40	96	1	0.5	Open	;
122	25	26	40	96	1	0	Open	;
123	26	22	12	96	1	1.2	Open	;

[PUMPS]
;ID Node1 Node2
Parameters

[VALVES]
;ID Node1 Node2
Diameter Type Setting MinorLoss

[TAGS]

[DEMANDS]
;Junction Demand Pattern Category

[STATUS]
;ID Status/Setting

[PATTERNS]
;ID Multipliers

[CURVES]
;ID X-Value Y-Value

```
[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency      75
 Global Price           0
 Demand Charge          0

[EMITTERS]
;Junction               Coefficient

[QUALITY]
;Node                   InitQual

[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  CFS
 Headloss               D-W
 Specific Gravity       1
 Viscosity              0.00001
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01
```

```
[COORDINATES]
;Node            X-Coord            Y-Coord
 2               -164.29            7542.86
 3               -164.29            6400.00
 4               -164.29            5171.43
 5               -164.29            3885.71
 6               1225.00            7550.00
 7               1191.67            6333.33
 8               1191.67            5116.67
 9               1175.00            3850.00
 10              2541.67            7550.00
 11              2521.43            6300.00
 12              2541.67            5066.67
 13              2525.00            3800.00
 14              3621.43            7557.14
 15              3635.71            6300.00
 16              3664.29            5085.71
 17              3664.29            3771.43
 18              -158.33            2833.33
 19              1207.14            2871.43
 20              2608.33            2850.00
 21              3721.43            2828.57
 25              5041.67            3166.67
 26              6225.00            3466.67
 1               -2041.67           7583.33
 22              7408.33            3783.33

[VERTICES]
;Link            X-Coord            Y-Coord
 121             5008.33            3100.00

[LABELS]
;X-Coord           Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS      0.00               0.00
     10000.00               10000.00
 UNITS           None
 FILE
 OFFSET          0.00               0.00

[END]
```

See note on 'inp' file


```
**********************************************************************
*                            E P A N E T                             *
*                  Hydraulic and Water Quality                       *
*                  Analysis for Pipe Networks                        *
*                         Version 2.0                                *
**********************************************************************
```

Input File: fishlock 112911 existing.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	96
103	3	4	1	42.7
104	4	5	1	57.6
105	5	18	1	48
118	18	19	16	64
119	19	20	16	78
120	20	21	16	86
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	96
107	7	8	1	42.7
108	8	9	1	57.6
109	9	19	1	48
110	10	11	5	96
111	11	12	1	42.7
112	12	13	1	57.6
113	13	20	1	48
114	14	15	5	96
115	15	16	1	42.7
116	16	17	1	57.6
117	17	21	1	48
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

Page 2 The Dalles - Fish Lock to AWS

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	109.00	47.23	0.00	
3	0.00	108.84	47.16	0.00	
4	0.00	104.84	45.43	0.00	
5	0.00	104.24	45.17	0.00	
6	0.00	109.00	47.23	0.00	
7	0.00	108.83	47.16	0.00	
8	0.00	104.68	45.36	0.00	
9	0.00	104.05	45.08	0.00	
10	0.00	109.00	47.23	0.00	
11	0.00	108.82	47.15	0.00	
12	0.00	104.39	45.23	0.00	
13	0.00	103.72	44.94	0.00	
14	0.00	109.00	47.23	0.00	
15	0.00	108.81	47.15	0.00	
16	0.00	103.94	45.04	0.00	
17	0.00	103.21	44.72	0.00	
18	0.00	99.51	43.12	0.00	
19	0.00	99.13	42.95	0.00	
20	0.00	98.47	42.67	0.00	
21	0.00	97.46	42.23	0.00	
25	0.00	93.65	40.58	0.00	
26	0.00	93.23	40.40	0.00	
1	-1048.05	109.00	0.00	0.00	Reservoir
22	1048.05	85.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow CFS	VelocityUnit fps	Headloss ft/Kft	Status
101	-1048.05	2.70	0.06	Open
102	251.01	4.99	31.60	Open
103	251.01	25.24	3997.91	Open
104	251.01	13.87	606.22	Open
105	251.01	19.97	4730.35	Open
118	251.01	11.24	23.44	Open
119	506.91	15.28	41.33	Open
120	771.26	19.12	63.44	Open
201	797.04	2.05	0.03	Open
203	541.14	1.39	0.02	Open
204	276.79	0.71	0.00	Open
106	255.91	5.09	32.85	Open
107	255.91	25.73	4155.66	Open
108	255.91	14.14	630.13	Open
109	255.91	20.36	4917.01	Open
110	264.34	5.26	35.05	Open
111	264.34	26.58	4434.05	Open

Page 3 The Dalles - Fish Lock to AWS
Link Results: (continued)

Link ID	Flow CFS	VelocityUnit fps	Headloss ft/Kft	Status
112	264.34	14.61	672.34	Open
113	264.34	21.04	5246.41	Open
114	276.79	5.51	38.42	Open
115	276.79	27.83	4861.53	Open
116	276.79	15.30	737.15	Open
117	276.79	22.03	5752.20	Open
121	1048.05	20.85	95.03	Open
122	1048.05	20.85	10.66	Open
123	1048.05	20.85	685.63	Open

northwest hydraulic consultants inc.	DATE 11/30/11	BY LWL	CHK JL	6a
CLIENT HPR/USACE		JOB No. 21936		
SUBJECT Fish Lock to AWS				

Maximum possible through 8x8 culvert - assuming no losses.

$$\Delta H = \frac{V^2}{2g}$$

$$V = \frac{Q}{A} = \frac{Q}{8 \times 8} = \frac{Q}{64}$$

$$\Delta H = 109 - 85 = 24$$

$$24 = \frac{\left(\frac{Q}{64}\right)^2}{64.4}$$

$$1545.6 = \frac{Q^2}{(64)^2}$$

$$Q = 2500 \text{ cfs} \checkmark$$

See calculations for option w/ diffuser Chimney + 4x4 gates completely removed

max possible through 4 - 4x4 gates w/ No Loss

$$24 = \frac{\left(\frac{Q}{16}\right)^2}{64.4} \qquad Q = 629 \checkmark$$

$$629 \times 4 \sim 2500 \text{ cfs} \checkmark$$

We have significant losses. max of 2,500 cfs isn't achievable; however, mods to reduce losses can be made.

northwest hydraulic consultants inc.	DATE 11/29/11	BY LWL	CHK	7
CLIENT HDR/USACE		JOB No. 21936		
SUBJECT Dalles EAWS				

Fish lock channel to AWS – modification to increase Q

Assume – 2'x15' opening can be expanded to 16'x15' opening (16, 17)

– 4'x4' opening can be expanded to 8'x15' opening (10', 16')

Diffuser 4 – slightly Different than 1–3

Pipe 3-4 (103)

2'x10' → 10'x16' instead (16', 17)

Hyd Dia = $\frac{4(10 \times 16)}{2(10)+2(16)}$ = 12.3' ⇒ 148" (17, 17)

K = 0.5 Entrance loss

Pipe 4-5 (104) chimney section

Say 10'x16' also K = 1.0 Exit loss

Pipe 5-18 (105)

4'x4' ⇒ 8'x10' instead K = Φ

Hyd Dia = $\frac{4(8 \times 10)}{2(8)+2(10)}$ = 8.8' ⇒ 107"

* Pipe 2-3 (102)

Say area ~ 20x10 instead

Hyd Dia = $\frac{4(20 \times 10)}{2(20)+2(10)}$ = 13.3 x12 = 160"

? What is 102?? Delete??

K = Φ

northwest hydraulic consultants inc.	DATE 11/29/11	BY LWL	CHK 8
CLIENT HDR / USACE		JOB No. 21956	
SUBJECT Dalles FAWS			

Fish lock to AWS mod (cont)

Diffuser 1-3

Pipe 6-7 (106) 110 114

Area ~ 20 X 16 K=0

$$\text{Hyd Dia} = \frac{4(20 \times 16)}{2(20)+2(16)} = 17.7 \times 12 = 213''$$

Pipe 7-8 (107) 111 115 Chimney

2'x15' → 15'x16' 17x16 K=0.5

$$\text{Hyd Dia} = \frac{4(15 \times 16)}{2(15)+2(16)} = 15.5 \times 12 = 185''$$

Pipe 8-9 (108) 10x14 K=1.0

Say 15'x16' also

Pipe 9-19 (109) K=φ

4 x 4 ⇒ 8 x 15 instead

$$\text{Hyd. Dia} = \frac{4(8 \times 15)}{2(8)+2(15)} = 10.4 \times 12 = 125''$$

Removed walls to remove diffuser chimney

fishlock 112911 mods to AWS.inp 11/30/2011

```
[TITLE]
The Dalles - Fish Lock to AWS

[JUNCTIONS]
;ID              Elev        Demand        Pattern
 2               0           0
         ;
 3               0           0
         ;
 4               0           0
         ;
 5               0           0
         ;
 6               0           0
         ;
 7               0           0
         ;
 8               0           0
         ;
 9               0           0
         ;
 10              0           0
         ;
 11              0           0
         ;
 12              0           0
         ;
 13              0           0
         ;
 14              0           0
         ;
 15              0           0
         ;
 16              0           0
         ;
 17              0           0
         ;
 18              0           0
         ;
 19              0           0
         ;
 20              0           0
         ;
 21              0           0
         ;
 25              0           0
         ;
 26              0           0
         ;

[RESERVOIRS]
;ID              Head        Pattern
 1               109                              ;
 22              85                               ;

[TANKS]
;ID                   Elevation     InitLevel     MinLevel
MaxLevel      Diameter      MinVol        VolCurve

[PIPES]
;ID                   Node1                       Node2
Length        Diameter      Roughness     MinorLoss     Status
 101                  2                           1                   16
        266.7         1             0             Open      ;
 102                  2                           3                   5
        160           1             ~~0.1~~ 0     Open      ;
 103                  3                           4                   1
        148           1             ~~0.1~~ 0.5   Open      ;
```

2 10 6 14
3 7 11 15
4 8 12 16
5 9 13 17

104	4	5	1	148	1	0.1	Open	;
105	5	18	1	107	1	0.2 ϕ	Open	;
118	18	19	16	64	1	0.2	Open	;
119	19	20	16	78	1	0.2	Open	;
120	20	21	16	86	1	0.2	Open	;
201	2	6	16	266.7	1	0	Open	;
203	6	10	16	266.7	1	0	Open	;
204	10	14	16	266.7	1	0	Open	;
106	6	7	5	213	1	~~0.1~~ ϕ	Open	;
107	7	8	1	185	1	~~0.1~~ 0.5	Open	;
108	8	9	1	185	1	~~0.1~~ 1.0	Open	;
109	9	19	1	125	1	~~0.2~~ ϕ	Open	;
110	10	11	5	213	1	0.1 ϕ	Open	;
111	11	12	1	185	1	0.1 0.5	Open	;
112	12	13	1	185	1	~~0.1~~ 1.0	Open	;
113	13	20	1	125	1	.2 ϕ	Open	;
114	14	15	5	213	1	0.1 ϕ	Open	;
115	15	16	1	185	1	0.1 0.5	Open	;
116	16	17	1	185	1	0.1 1.0	Open	;
117	17	21	1	125	1	0.2 ϕ	Open	;
121	21	25	40	96	1	~~0.5~~ 0.1	Open	;
122	25	26	40	96	1	0	Open	;
123	26	22	12	96	1	1.2	Open	;

[PUMPS]
;ID Node1 Node2 Parameters

[VALVES]
;ID Node1 Node2 Diameter Type Setting MinorLoss

[TAGS]

[DEMANDS]
;Junction Demand Pattern Category

[STATUS]
;ID Status/Setting

[PATTERNS]
;ID Multipliers

[CURVES]
;ID X-Value Y-Value

```
[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency       75
 Global Price            0
 Demand Charge           0

[EMITTERS]
;Junction                Coefficient

[QUALITY]
;Node                    InitQual

[SOURCES]
;Node                    Type              Quality           Pattern

[REACTIONS]
;Type            Pipe/Tank                 Coefficient


[REACTIONS]
 Order Bulk              1
 Order Tank              1
 Order Wall              1
 Global Bulk             0
 Global Wall             0
 Limiting Potential      0
 Roughness Correlation   0

[MIXING]
;Tank                    Model

[TIMES]
 Duration                0
 Hydraulic Timestep      1:00
 Quality Timestep        0:05
 Pattern Timestep        1:00
 Pattern Start           0:00
 Report Timestep         1:00
 Report Start            0:00
 Start ClockTime         12 am
 Statistic               None

[REPORT]
 Status                  No
 Summary                 No
 Page                    0

[OPTIONS]
 Units                   CFS
 Headloss                D-W
 Specific Gravity        1
 Viscosity               0.00001
 Trials                  40
 Accuracy                0.001
 CHECKFREQ               2
 MAXCHECK                10
 DAMPLIMIT               0
 Unbalanced              Continue 10
 Pattern                 1
 Demand Multiplier       1.0
 Emitter Exponent        0.5
 Quality                 None mg/L
 Diffusivity             1
 Tolerance               0.01
```

53

```
[COORDINATES]
;Node              X-Coord            Y-Coord
 2                 -164.29            7542.86
 3                 -164.29            6400.00
 4                 -164.29            5171.43
 5                 -164.29            3885.71
 6                 1225.00            7550.00
 7                 1191.67            6333.33
 8                 1191.67            5116.67
 9                 1175.00            3850.00
 10                2541.67            7550.00
 11                2521.43            6300.00
 12                2541.67            5066.67
 13                2525.00            3800.00
 14                3621.43            7557.14
 15                3635.71            6300.00
 16                3664.29            5085.71
 17                3664.29            3771.43
 18                -158.33            2833.33
 19                1207.14            2871.43
 20                2608.33            2850.00
 21                3721.43            2828.57
 25                5041.67            3166.67
 26                6225.00            3466.67
 1                 -2041.67           7583.33
 22                7408.33            3783.33

[VERTICES]
;Link              X-Coord            Y-Coord
 121               5008.33            3100.00

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS        0.00                      0.00
        10000.00            10000.00
 UNITS             None
 FILE
 OFFSET            0.00                      0.00

[END]
```

Page 1 11/30/2011 10:14:28 AM

```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                          Version 2.0                               *
**********************************************************************
```

Input File: fishlock 112911 mods to AWS.net

The Dalles - Fish Lock to AWS

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
101	2	1	16	266.7
102	2	3	5	160
103	3	4	1	148
104	4	5	1	148
105	5	18	1	107
118	18	19	16	64
119	19	20	16	78
120	20	21	16	86
201	2	6	16	266.7
203	6	10	16	266.7
204	10	14	16	266.7
106	6	7	5	213
107	7	8	1	185
108	8	9	1	185
109	9	19	1	125
110	10	11	5	213
111	11	12	1	185
112	12	13	1	185
113	13	20	1	125
114	14	15	5	213
115	15	16	1	185
116	16	17	1	185
117	17	21	1	125
121	21	25	40	96
122	25	26	40	96
123	26	22	12	96

Page 2 The Dalles - Fish Lock to AWS

Node Results:

Node ID	Demand CFS	Head ft	Pressure psi	Quality	
2	0.00	109.00	47.23	0.00	
3	0.00	109.00	47.23	0.00	
4	0.00	109.00	47.23	0.00	
5	0.00	109.00	47.23	0.00	
6	0.00	109.00	47.23	0.00	
7	0.00	109.00	47.23	0.00	
8	0.00	109.00	47.23	0.00	
9	0.00	109.00	47.23	0.00	
10	0.00	109.00	47.23	0.00	
11	0.00	108.99	47.23	0.00	
12	0.00	108.99	47.22	0.00	
13	0.00	108.98	47.22	0.00	
14	0.00	108.99	47.23	0.00	
15	0.00	108.97	47.22	0.00	
16	0.00	108.93	47.20	0.00	
17	0.00	108.88	47.18	0.00	
18	0.00	109.00	47.23	0.00	
19	0.00	108.99	47.23	0.00	
20	0.00	108.94	47.20	0.00	
21	0.00	108.47	47.00	0.00	
25	0.00	101.31	43.90	0.00	
26	0.00	100.51	43.55	0.00	
1	-1438.88	109.00	0.00	0.00	Reservoir
22	1438.88	85.00	0.00	0.00	Reservoir

15 ft loss 26 - 22 Is this reasonable?

Link Results:

Link ID	Flow CFS	Velocity fps	Unit Headloss ft/Kft	Status
101	-1438.88	3.71	0.10	Open
102	28.70	0.21	0.01	Open
103	28.70	0.24	0.09	Open
104	28.70	0.24	0.09	Open
105	28.70	0.46	0.66	Open
118	28.70	1.28	0.39	Open
119	129.87	3.91	3.47	Open
120	460.59	11.42	28.97	Open
201	1410.17	3.63	0.10	Open
203	1309.01	3.37	0.09	Open
204	978.29	2.52	0.05	Open
106	101.17	0.41	0.05	Open
107	101.17	0.54	0.46	Open
108	101.17	0.54	0.46	Open
109	101.17	1.19	4.41	Open
110	330.72	1.34	0.57	Open
111	330.72	1.77	4.91	Open

Page 3 The Dalles - Fish Lock to AWS
Link Results: (continued)

Link ID	Flow CFS	VelocityUnit fps	Headloss ft/Kft	Status
112	330.72	1.77	4.91	Open
113	330.72	3.88	47.04	Open
114	978.29	3.95	5.01	Open
115	978.29	5.24	42.95	Open
116	978.29	5.24	42.96	Open
117	978.29	11.48	411.58	Open
121	1438.88	28.63	179.07	Open
122	1438.88	28.63	20.04	Open
123	1438.88	28.63	1292.29	Open

northwest hydraulic consultants inc.	DATE 1/11/12	BY LWJ	CHK
CLIENT HDR USACE		JOB No. 21936	
SUBJECT The Dalles			

Fish lock approach channel hydraulics

20 ft wide
Say WSEL = 109
Floor EL ~ 60

$A = 20 \times (109 - 60)$
$= 980 \text{ ft}^2$

$V = \frac{Q}{A} = \frac{1,400}{980} = 1.4$

northwest hydraulic consultants inc.	DATE 1/11/12	BY LWL	CHK
CLIENT HDR / USACE		JOB No. 21936	
SUBJECT The Dalles			

Evaluate chamber D/s of 8'x8' culvert exit into AWS

WSEL AWS ~85'

Floor conduit ~ 57'

Depth water ~ 28'
width ~ 22'

Area x-sec ~ 616 ft^2

Appendix C

Geotechnical

The Dalles Dam

Figure G-1. Existing Ground Line Contours

The Dalles Dam, Oregon/Washington

HDR
ONE COMPANY | *Many Solutions*

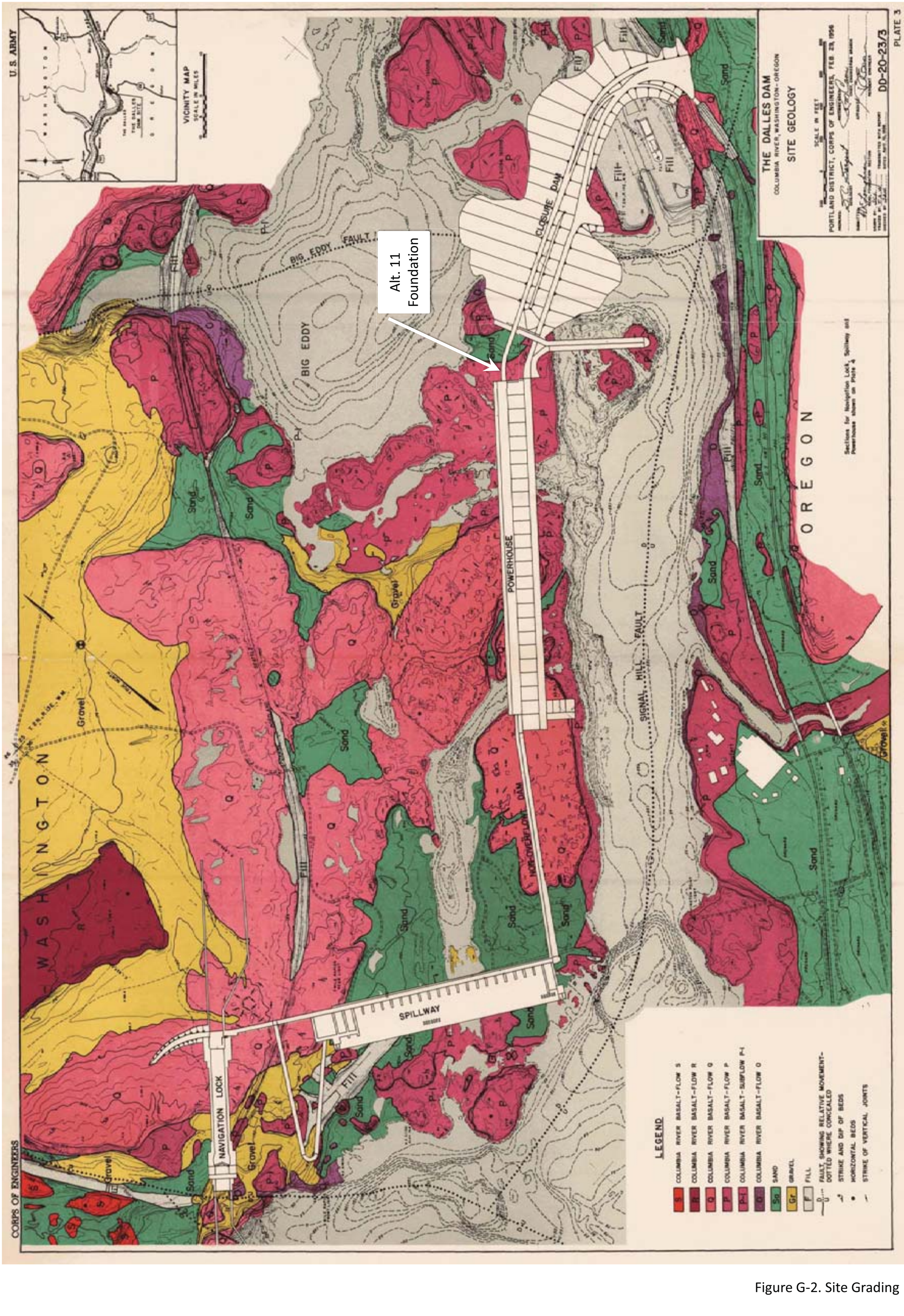


Figure G-2. Site Grading

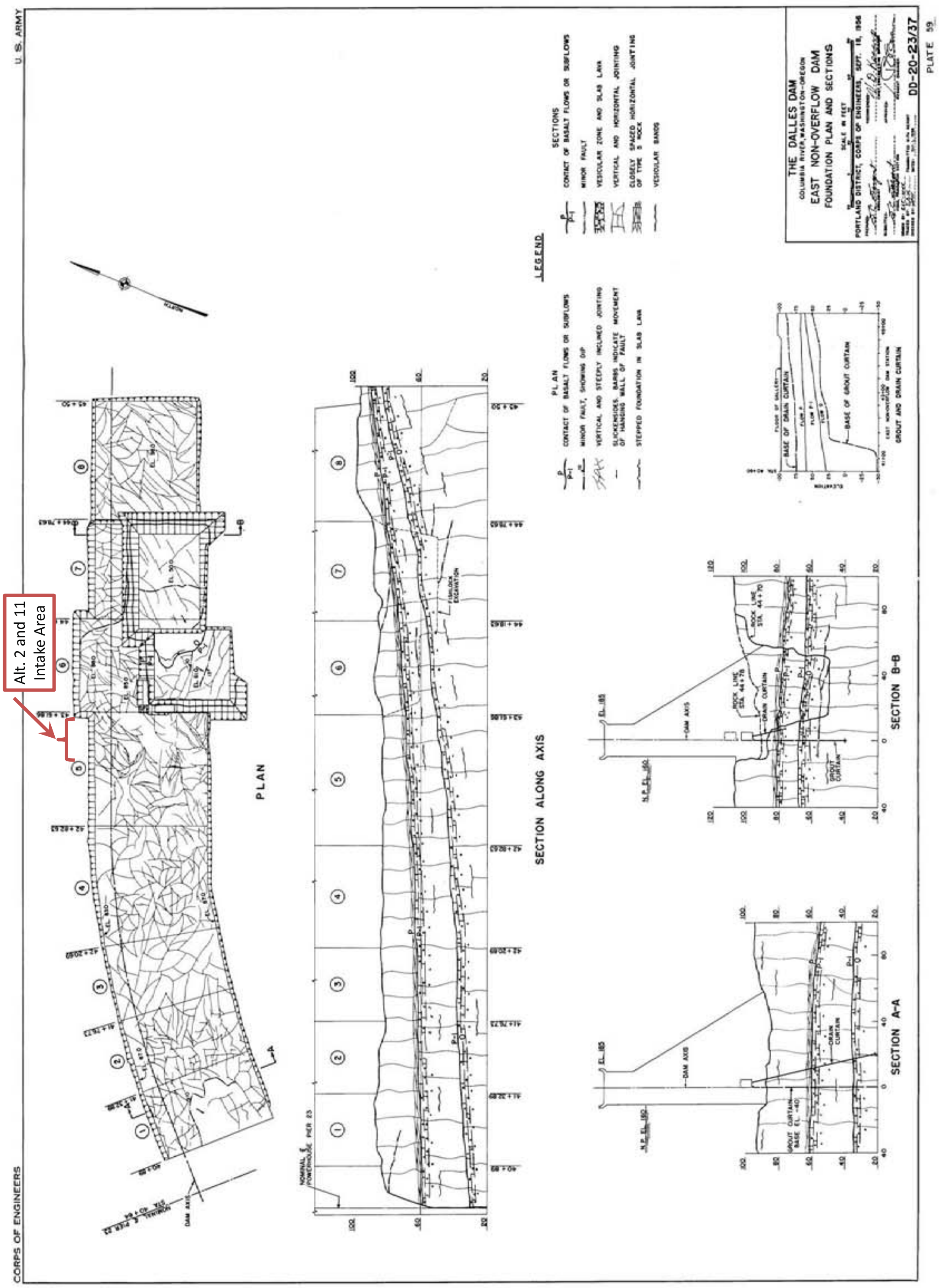


Figure G-3. Foundation Sections

Appendix D

Structural

90% EDR

Alternatives #2 and #11

Low Level Intake & Siphon from Tower

1. Quantities
2. Calculations
3. Miscellaneous Information for Costs

Alternative #2 - Low Level Intake: Concrete Quantities for Intake Structure - 90%

Concrete pipe supports (2)		192.10	sf
		7.11	cy
Concrete at pipe exit at base of dam		598	sf
		22.15	cy
Concrete thrust block at Jet Flow Valves		922	sf
Note: #7 @12 for all concrete		34.15	cy
	Total Concrete =	63.41	lbs

Alternative #2 - Low Level Intake:Trash Rack Enclosures, Trashrack Panels, and Bulkheads - 90%

Trashrack Enclosure					
HSS 14x4x1/2 vertical members				71.59	lf
	55.53	plf			
				3,975	lbs
HSS 7x4x1/2 vertical members (corners)				28.64	lf
	31.71	plf			
				908	lbs
HSS 8x4x1/2 horizontal frame members				59.14	lf
	35.11	plf			
				2,076	lbs
L 6x6x 1 Inside horizontal				50	lf
	37.40	plf			
				1,870	lbs
0.75 Plate					
Top	174.00	sf			
Bottom	174.00	sf			
Mounting Flange	74.50	sf			
Sides	94.30	sf		516.8	sf
				15,827	lbs
Trashrack Panels (5)	5				
	43,789	lbs each		218,945	lbs
Bulkheads (2)					
MC 9x25.4				41.4	lf
	248.00	plf			
				10,267	lbs
0.75 " Plate (front and back, top and bottom)					
	357	sf		10,933	lbs
1.0 " Plate (rails)					
	302	lf			
	0.33	sf		49,070	lbs
	Total Steel Weight =			302,939	lbs

Undercut Anchors

1" Diameter x 1'-6" - Williams Stainless Steel S-9 Undercut Anchor - ASTM A193 316 B8M Class II

Bulkhead Rails =	162.00	pcs
Trashrack Enclosure =	84.00	pcs
Total Quantity of Anchors =	246	pcs

Alternative #11 - Siphon; Concrete Quantities for Intake Structure - 90%

Precast Concrete Section - Postentioned

Front face width:	68.00	ft		
back face width:	73.92	ft		
out-to-out depth (face of dam to front):	29.50	ft		
Height of trapezoidal enclosure:	85.00	ft		
Area of one trash rack (11'-6" x 16'-0"):	184.00	ft^2		
Number of trash racks:	5.00			
Thickness of walls:	2.50	ft		
XS Area of 'wall' around top slab:	4.22	ft^2 (measured in CAD)		
Volume of concrete-ext walls:	24254	ft^3 =	898	yd^3
Volume of top and bottom slab:	9420	ft^3 =	349	yd^3
Volume of interior wall:	1823	ft^3 =	68	yd^3
Volume of 'wall' around top slab:	536	ft^3 =	20	yd^3
	Total Concrete Weight =		1334.5	yd^3

Alternative #11 - Siphon: Trash Rack Panels and Pipe Brackets - 90%

Trash Racks and Panels

HSS 14x4x1/2 vertical members			71.59	lf
	55.53	plf		
			3,975	lbs
HSS 7x4x1/2 vertical members (corners)			28.64	lf
	31.71	plf		
			908	lbs
L 6x6x 1 Inside horizontal			41.4	lf
	37.40	plf		
			1,548	lbs

Pipe Support Brackets (2)

HSS 8x6x5/8			42	lf
	50.60	plf		
			2,125	lbs
Trashrack Panels Weight		43789.00	lbs each	
	5		218,945	lbs
	Total Steel Weight =		227,502	lbs

HDR | ONE COMPANY *Many Solutions*	Project: DALLES AWS	Computed: JPG	Date: 03/19/12
	Subject: 90%	Checked:	Date:
	Task: TRASHRACKS	Page: 1	of: 3
	Job #: 171578-0	No:	

DETERMINE TRASHRACK SIZE

DESIGN CRITERIA (USACOE)

- APPROACH VELOCITY = 3 F/S
- MAX SPACING = 3/4"
- MAX Q = 1000 CFS

ASSUMPTIONS:

- 60% LOSS @ 15%

SO,

$$Q = VA \Rightarrow A = \frac{Q}{V} = \frac{1000}{3} = 333 \#'$$

@ 15% LOSS,

$$A_{REQ.} = 333\#' \times 1.15 = 384\#'$$

$$= 55{,}296 \#''$$

16' TALL TRASHRACK PANELS

$$\frac{55{,}296\#''}{0.75'' \times 16' \times 12} = 384 \text{ SLOTS}$$

∴ 383 - 1" WIDE BARS

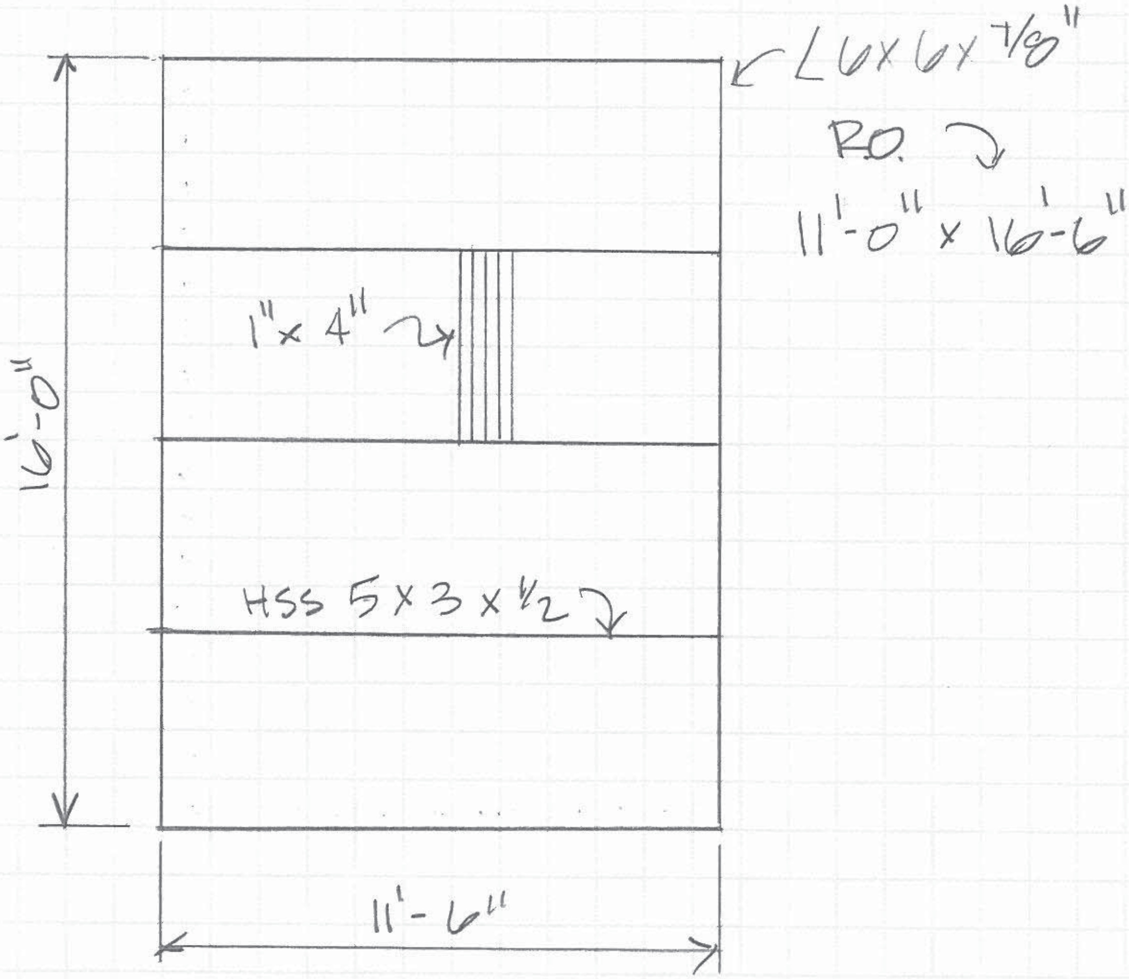
$$\text{TOTAL WIDTH} = 384 \times 0.75'' + 383 \times 1.0$$

$$= 671'' \Rightarrow 55.92'$$

5 PANELS

$= \frac{55.92'}{5} = 11.18'$

⇒ USE 11'-6" x 16'-0"



TOTAL WEIGHT

= 43,788.45

Project: DALLES AWS		Computed: JPG	Date: 3/19/12
Subject: 9090		Checked:	Date:
Task:		Page: 3	of: 3
Job #:		No:	

HDR | ONE COMPANY *Many Solutions*

QUANTITIES

L6x6x 7/8" (33.1 PLF) — lbs

57.0' x 33.1 = 1886.70

HSS 5x3x 1/2 (21.5 PLF)

34.5' x 21.5 = 741.75

1" VERTICALS x 4" (3.57 PLF)

63 x 4 x 45.75 x = 41,160

TOTAL 43,788.45

43.79 kips

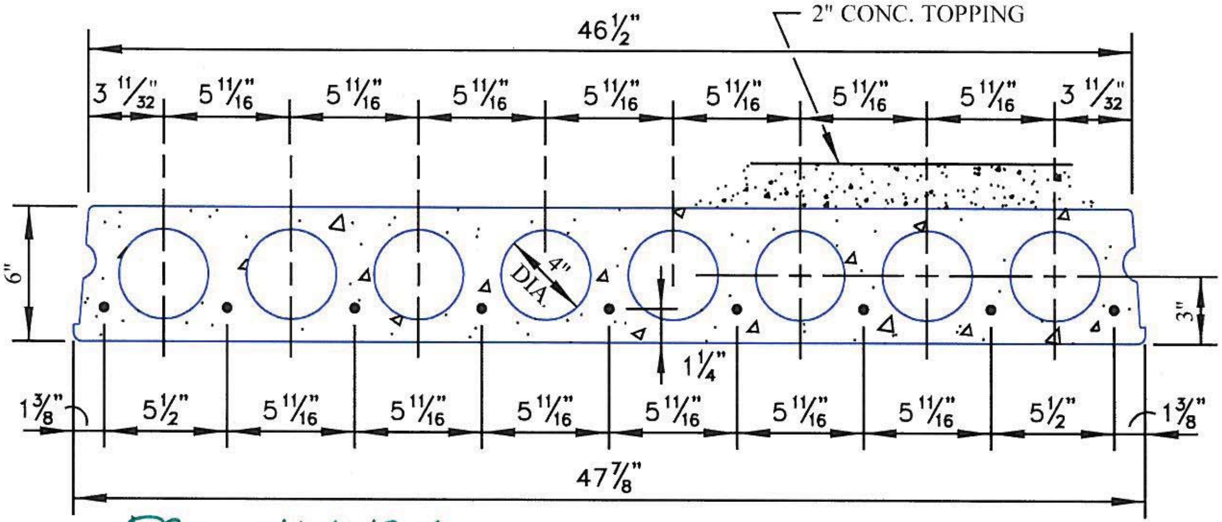
x 5

= 218.95 kips

= 218,943 lbs

6" COREFLOOR

FIGURES INDICATE SUPERIMPOSED LOADS



PRELIMINARY.

SECTION PROPERTIES

NON-COMPOSITE

$A = 188\ IN^2$ $\quad I = 764\ IN^4$

$Y_B = 3.0\ IN$ $\quad$ WT= 49 PSF

$Y_t = 3.0\ IN$

COMPOSITE

$A = 284\ IN^2$ $\quad I = 1649\ IN^4$

$Y_B = 4.14\ IN$ $\quad$ WT= 74 PSF

$Y_t = 3.86\ IN$

	SPAN IN FEET												
STRAND	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'	30'	32'	34'
6SC56	406	269	187	134	97	71	52						
6SC57		368	260	189	141	107	81	62	47				
6SC67			313	230	173	133	103	80	62	48			
6SC58				255	193	149	116	91	71	56	44		
6SC68					232	180	142	113 *	90 *	72 *	58 *	46 *	
6SC78					269	210	167	134 *	108 *	87 *	71 *	58 *	46 *
6ST56			260	185	133	97	69						
6ST57				263	195	146	110	83					
6ST67					239	182	140	107	76				
6ST58						205	159	122	89	62			
6ST68						249	195	152*	115*	85*	61*		
6ST78							229	181*	140*	106*	80*	58*	
SUPERIMPOSED LOAD CAPACITY IN POUNDS PER SQUARE FOOT													

* IMMEDIATE & LONG TERM DEFLECTION MAY LIMIT APPLICATION

f'ci= 3500 PSI

f'c= 6500 PSI

STRAND= 270 KSI L.R.

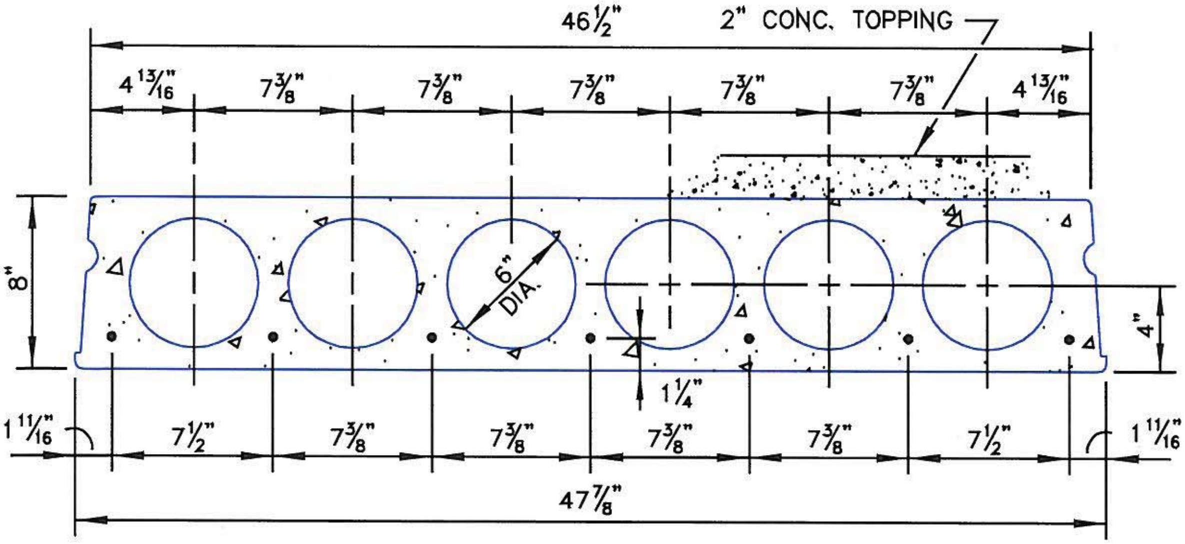
CONCRETE TOPPING= 4000 PSI

SC- UNTOPPED SECTION

ST- 2" COMPOSITE TOPPING

8" COREFLOOR

FIGURES INDICATE SUPERIMPOSED LOADS



SECTION PROPERTIES

NON-COMPOSITE

A= 214 IN ^{2} I= 1666 IN ^{4}
Y_B= 4.0 IN WT= 56 PSF
Y_t = 4.0 IN

COMPOSITE

A= 310 IN ^{2} I= 3084 IN ^{4}
Y_B= 5.30 IN WT= 80 PSF
Y_t = 4.70 IN

	SPAN IN FEET												
STRAND	18'	20'	22'	24'	26'	28'	30'	32'	34'	36'	38'	40'	42'
8SC46	116	85	62	45									
8SC47	170	129	99	76	58	43							
8SC48		182	143	112	89	70	55	43					
8SC58			185	148	120	97	78	63	51	40			
8SC68				183	149	122	100	83	68	56	45		
8SC78					179	148	123	102	85	71	59	49	40
8ST46	142	102	73										
8ST47	210	158	119	89	66								
8ST48		225	174	136	106	82	63						
8ST58			228	181	144	115	92	73					
8ST68				224	181	147	119	97	76				
8ST78				264	215	177	145	120	96	76			

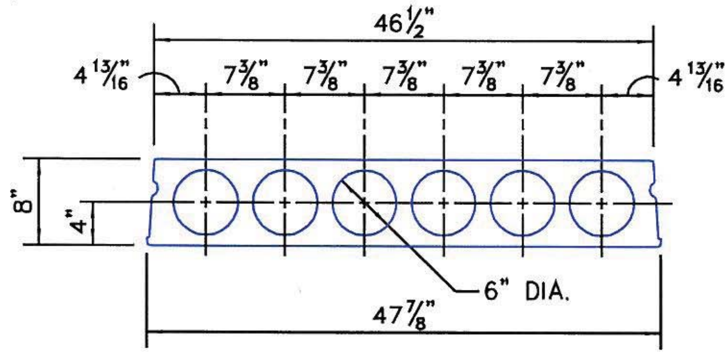
SUPERIMPOSED LOAD CAPACITY IN POUNDS PER SQUARE FOOT

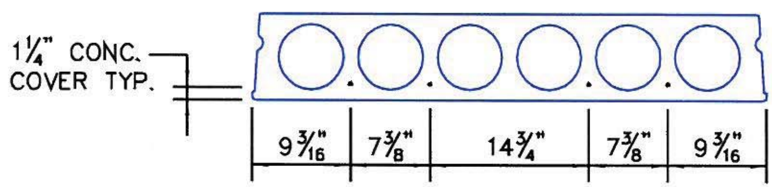
f'ci= 3500 PSI
f'c= 6500 PSI
STRAND= 270 KSI L.R.

CONCRETE TOPPING= 4000 PSI
SC- UNTOPPED SECTION
ST- 2" COMPOSITE TOPPING

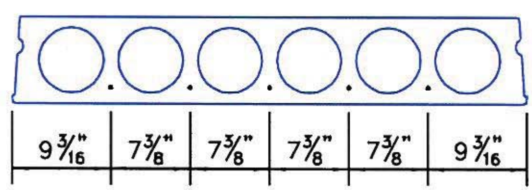
8" COREFLOOR

PHYSICAL PROPERTIES & STRAND PATTERNS

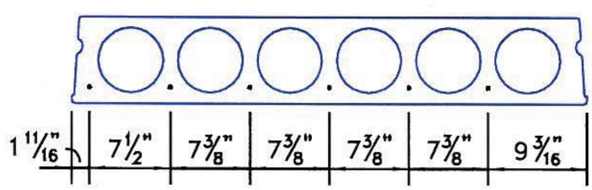




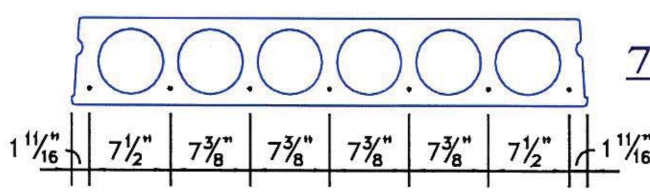
4 STRAND



5 STRAND



6 STRAND



7 STRAND

Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: Alternative #11 - Tower Top Slab

Project Notes :

Job #

Printed: 26 MAR 2012, 3:31PM

Concrete Beam

ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Lic. # : KW-06000410

Licensee : hdr engineering inc

Description : Top Slab of Tower

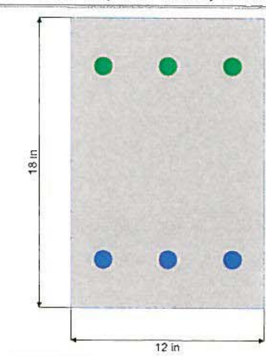
Material Properties

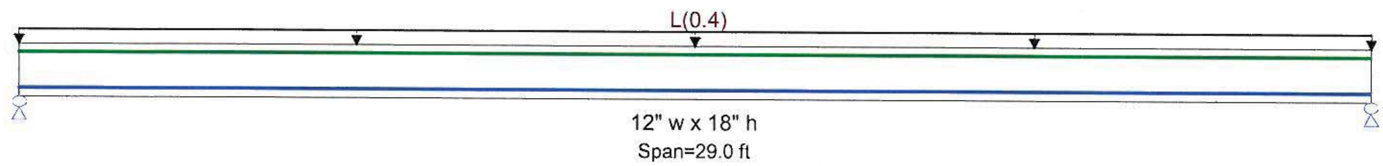
Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c	=	4.0 ksi
fr = $f'c^{1/2}$ * 7.50	=	474.34 psi
ψ Density	=	145.0 pcf
λ LtWt Factor	=	1.0
Elastic Modulus	=	3,122.0 ksi
fy - Main Rebar	=	60.0 ksi
E - Main Rebar	=	29,000.0 ksi

ϕ Phi Values Flexure :		0.90
Shear :		0.750
β_1	=	0.850
Fy - Stirrups		60.0 ksi
E - Stirrups	=	29,000.0 ksi
Stirrup Bar Size # =	#	4
Number of Resisting Legs Per Stirrup =		2

Load Combination 2009 IBC & ASCE 7-05





Cross Section & Reinforcing Details

Rectangular Section, Width = 12.0 in, Height = 18.0 in
Span #1 Reinforcing....
3-#9 at 3.0 in from Bottom, from 0.0 to 29.0 ft in this span
3-#9 at 3.0 in from Top, from 0.0 to 29.0 ft in this span

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : L = 0.40 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =		**0.539** : 1
Section used for this span		**Typical Section**
Mu : Applied		94.718 k-ft
Mn * Phi : Allowable		175.71 k-ft
Load Combination		+1.20D+0.50Lr+1.60L+1.60H
Location of maximum on span		14.500 ft
Span # where maximum occurs		Span # 1

Maximum Deflection			
Max Downward L+Lr+S Deflection	0.710 in	Ratio =	490
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.900 in	Ratio =	386
Max Upward Total Deflection	0.000 in	Ratio =	999

Cross Section Strength & Inertia

		Phi*Mn (k-ft)		Moment of Inertia (in^4)		
Cross Section	Bar Layout Description	Btm Tension	Top Tension	I gross	Icr - Btm Tension	Icr - Top Tension
Section 1	3- #9 @ d=15",3- #9 @ d=3",	175.71	175.71	5,832.00	3,332.18	3,332.18

Vertical Reactions - Unfactored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	8.954	8.954
D Only	3.154	3.154
L Only	5.800	5.800
D+L	8.954	8.954

Shear Stirrup Requirements

Between 0.00 to 2.13 ft, Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in
Between 2.19 to 3.67 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.4.5.1, use stirrups spaced at 7.000 in
Between 3.74 to 25.26 ft, Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in
Between 25.33 to 26.81 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.4.5.1, use stirrups spaced at 7.000 in
Between 26.87 to 28.94 ft, Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in

Maximum Forces & Stresses for Load Combinations

Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: Alternative #11 - Tower Top Slab

Project Notes :

Job #

Printed: 26 MAR 2012, 3:31PM

Concrete Beam

Lic. # : KW-06000410

ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Licensee : hdr engineering inc

Description : Top Slab of Tower

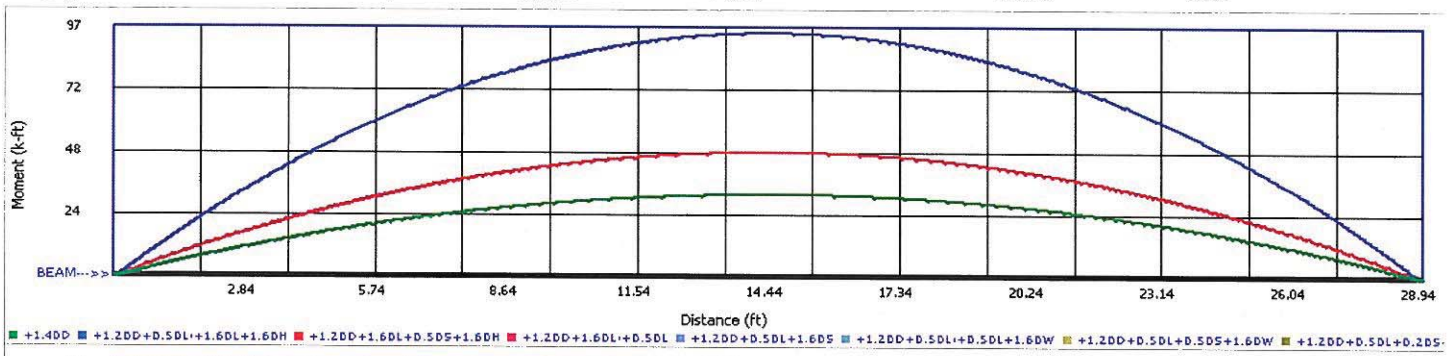
Load Combination Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	14.500	94.72	175.71	0.54
+1.40D					
Span # 1	1	14.500	32.01	175.71	0.18
+1.20D+0.50Lr+1.60L+1.60H					
Span # 1	1	14.500	94.72	175.71	0.54
+1.20D+1.60L+0.50S+1.60H					
Span # 1	1	14.500	94.72	175.71	0.54
+1.20D+1.60Lr+0.50L					
Span # 1	1	14.500	48.46	175.71	0.28
+1.20D+0.50L+1.60S					
Span # 1	1	14.500	48.46	175.71	0.28
+1.20D+0.50Lr+0.50L+1.60W					
Span # 1	1	14.500	48.46	175.71	0.28
+1.20D+0.50L+0.50S+1.60W					
Span # 1	1	14.500	48.46	175.71	0.28
+1.20D+0.50L+0.20S+E					
Span # 1	1	14.500	48.46	175.71	0.28

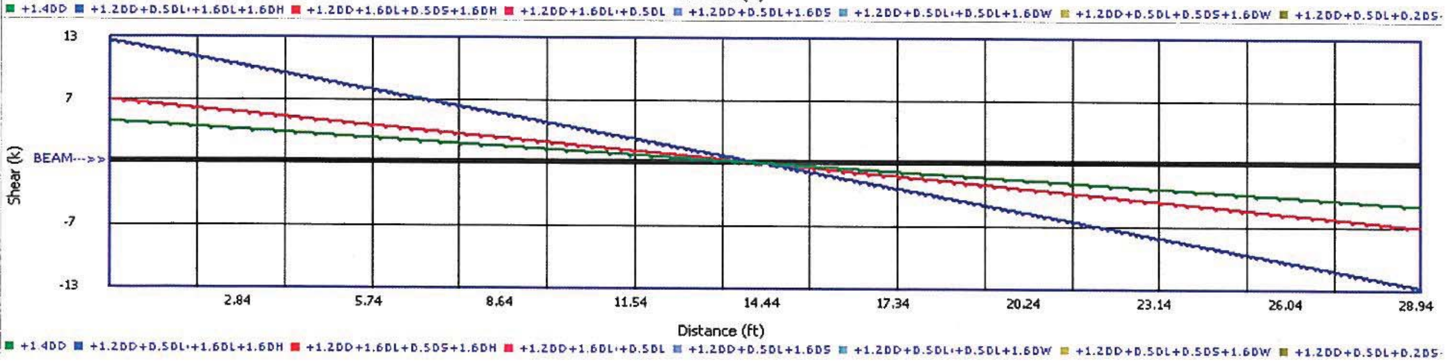
Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.8998	14.790		0.0000	0.000

Maximum Deflections for Load Combinations - Unfactored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D Only	1	0.1899	14.790	0.0000	0.000
D+L	1	0.8998	14.790	0.0000	0.000
D Only	1	0.1899	14.790	0.0000	0.000
L Only	1	0.5112	14.790	0.0000	0.000
D+L	1	0.8998	14.790	0.0000	0.000





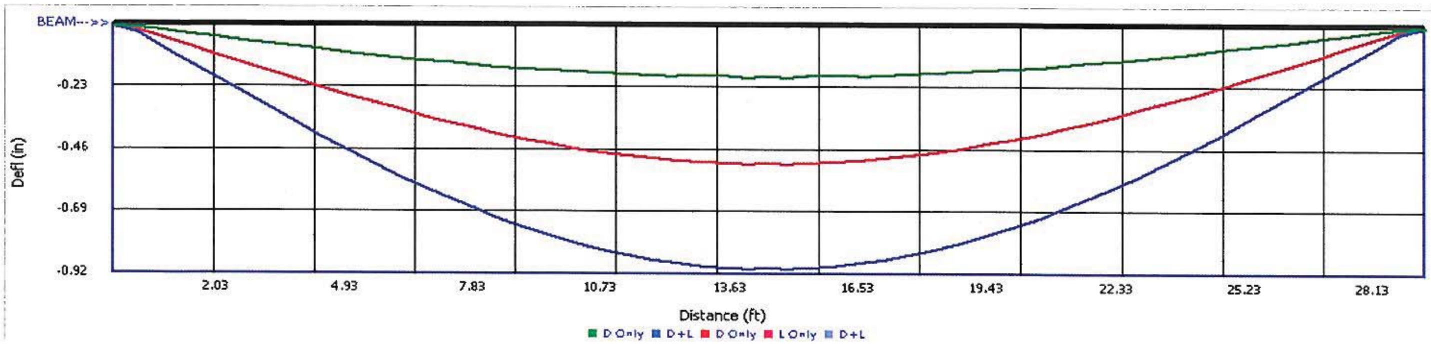
Job #

Concrete Beam

ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

Description : Top Slab of Tower



Concrete Beam

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles new tower.ec6
ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

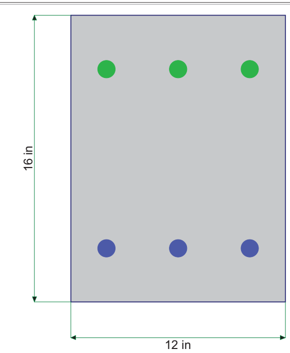
Description : Valve Maintenance Slab

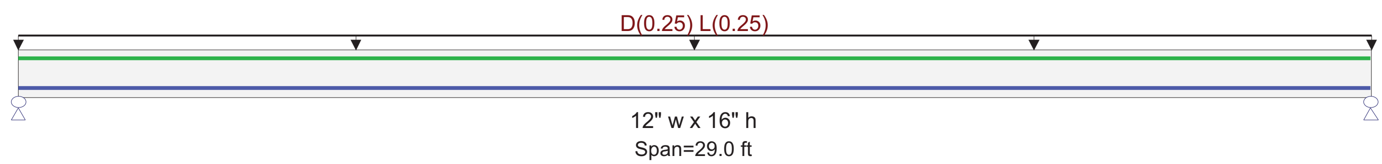
Material Properties

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c	= 4.0 ksi	φ Phi Values	Flexure :	1.0	
fr = f'c$^{1/2}$ * 7.50	= 474.34 psi		Shear :	0.750	
ψ Density	= 145.0 pcf	β_1	=	0.850	
λ LtWt Factor	= 1.0				
Elastic Modulus	= 3,122.0 ksi	Fy - Stirrups		60.0	ksi
fy - Main Rebar	= 60.0 ksi	E - Stirrups	=	29,000.0	ksi
E - Main Rebar	= 29,000.0 ksi	Stirrup Bar Size #	=	#	4
		Number of Resisting Legs Per Stirrup	=		2

Load Combination 2009 IBC & ASCE 7-05





Cross Section ein orcing Details

Rectangular Section, Width = 12.0 in, Height = 16.0 in
Span #1 Reinforcing....
3-#8 at 3.0 in from Bottom, from 0.0 to 29.0 ft in this span
3-#8 at 3.0 in from Top, from 0.0 to 29.0 ft in this span

pplied Loads

Service loads entered. Load Factors will be applied for calculations.

ea sel weig t calculated and added to loads
Load or Span u er 1
Uniform Load : D = 0.250, L = 0.250 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.732** : 1	
Section used for this span	**Typical Section**	
Mu : Applied	97.977	k-ft
Mn * Phi : Allowable	133.78	k-ft
Load Combination	+1.20D+1.60L	
Location of maximum on span	14.500	ft
Span # where maximum occurs	Span # 1	

Maximum Deflection				
Max Downward L+Lr+S Deflection	0.698 in	Ratio =	498	
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0	<360
Max Downward Total Deflection	1.741 in	Ratio =	199	
Max Upward Total Deflection	0.000 in	Ratio =	999	<180

Cross Section Strengt Inertia

		Phi*Mn (k-ft)		Moment of Inertia (in^4)		
Cross Section	Bar Layout Description	Btm Tension	Top Tension	I gross	Icr - Btm Tension	Icr - Top Tension
Section 1	3- #8 @ d=13",3- #8 @ d=3",	133.78	133.78	4,096.00	1,985.81	1,985.81

Vertical eactions n actored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	10.053	10.053
D Only	6.428	6.428
L Only	3.625	3.625
D+L	10.053	10.053

S ear Stirrup e uire ents

Between 0.00 to 6.32 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.4.5.1, use stirrups spaced at 6.000 in
Between 6.38 to 22.62 ft, Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in
Between 22.68 to 28.94 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.4.5.1, use stirrups spaced at 6.000 in

Ma i u orces Stresses or Load Co inations

Load Combination		Location (ft)	Bending Stress Results (k-ft)		
Segment Length	Span #	in Span	Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					

Title : Dalles AWS Job #
Engineer: Peter Gaby
Project Desc.: Alternative #11 - Valve Maintenance Slab

Project Notes :

Printed: 30 MAR 2012, 9:39AM

Concrete Beam

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles new tower.ec6
ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

Description : Valve Maintenance Slab

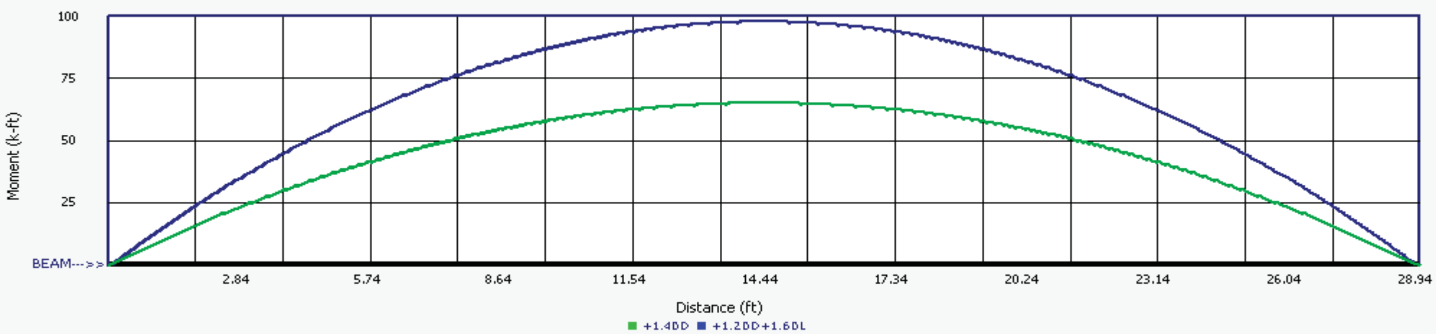
Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
Span # 1	1	14.500	97.98	133.78	0.73
+1.40D					
Span # 1	1	14.500	65.25	133.78	0.49
+1.20D+1.60L					
Span # 1	1	14.500	97.98	133.78	0.73

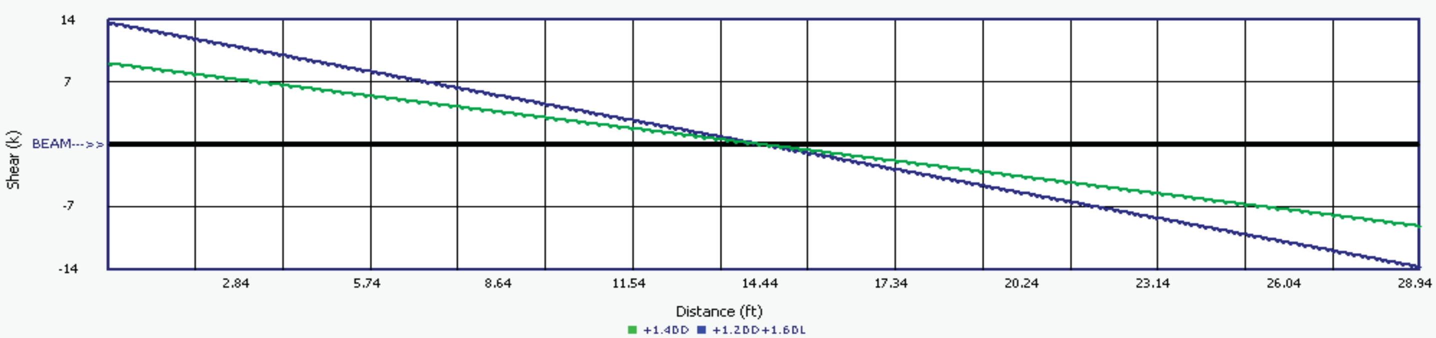
Overall Ma i u De lections n actored Loads

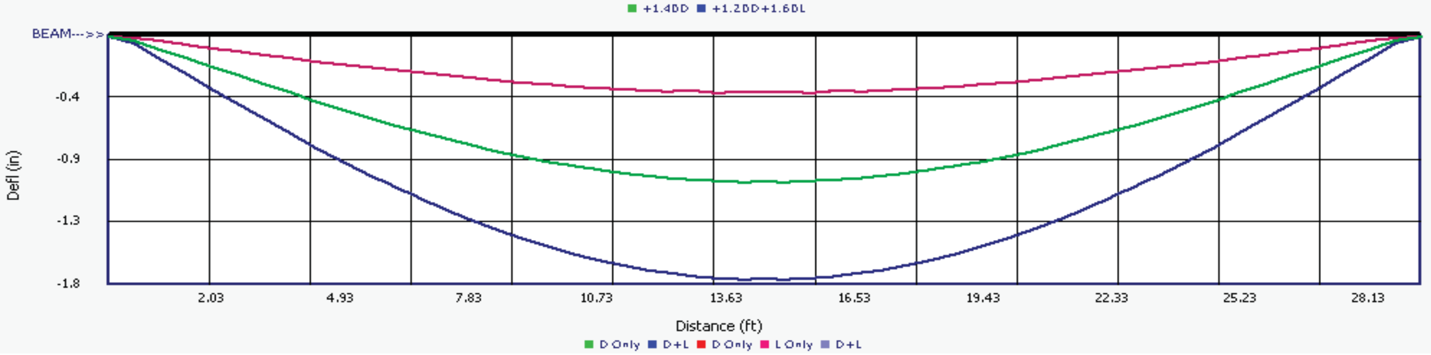
Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	1.7407	14.210		0.0000	0.000

Ma i u De lections or Load Co inations n actored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D Only	1	1.0429	14.210	0.0000	0.000
D+L	1	1.7407	14.210	0.0000	0.000
D Only	1	1.0429	14.210	0.0000	0.000
L Only	1	0.4086	14.210	0.0000	0.000
D+L	1	1.7407	14.210	0.0000	0.000







Title : Job #
Engineer:
Project Desc.:

Project Notes :

Steel Beam

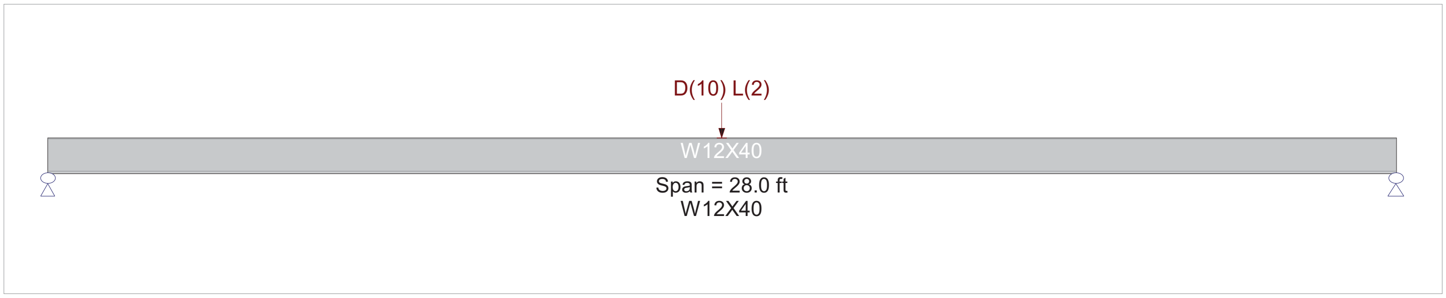
Lic. # : KW-06000410 **Licensee : hdr engineering inc**

Description : Boring Machine Temporary Structure

Material Properties

Calculations per ISC 60 0 , I C 200 , C C 2010, SCE 7 0

Analysis Method :	Load Resistance Factor Design	Fy : Steel Yield :	50.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		
Load Combination	2009 IBC & ASCE 7-05		



pplied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load(s) for Span Number 1
Point Load : D = 10.0, L = 2.0 k @ 14.0 ft, (Tunnel Boring Machine)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.912** : 1	Maximum Shear Stress Ratio =	**0.079** : 1
Section used for this span	**W12X40**	Section used for this span	**W12X40**
Mu : Applied	111.084 k-ft	Vu : Applied	8.269 k
Mn * Phi : Allowable	121.772 k-ft	Vn * Phi : Allowable	105.32 k
Load Combination	+1.20D+1.60L	Load Combination	+1.20D+1.60L
Location of maximum on span	14.000 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.179 in	Ratio =	1878
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	1.135 in	Ratio =	295
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Ma i u orces Stresses or Load Co inations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx	Phi*Vnx
+1.40D													
Dsgn. L = 28.00 ft	1	0.851	0.074	103.46		103.46	135.10	121.59	1.31	1.00	7.78	105.32	105.32
+1.20D+1.60L													
Dsgn. L = 28.00 ft	1	0.912	0.079	111.08		111.08	135.30	121.77	1.31	1.00	8.27	105.32	105.32

Overall Ma i u De lections n actored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000		0.0000	0.000

Ma i u De lections or Load Co inations n actored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D Only	1	0.9566	14.140	0.0000	0.000
L Only	1	0.1789	14.000	0.0000	0.000
D+L	1	1.1355	14.140	0.0000	0.000

Vertical eactions n actored

Support notation : Far left is #1 Values in KIPS

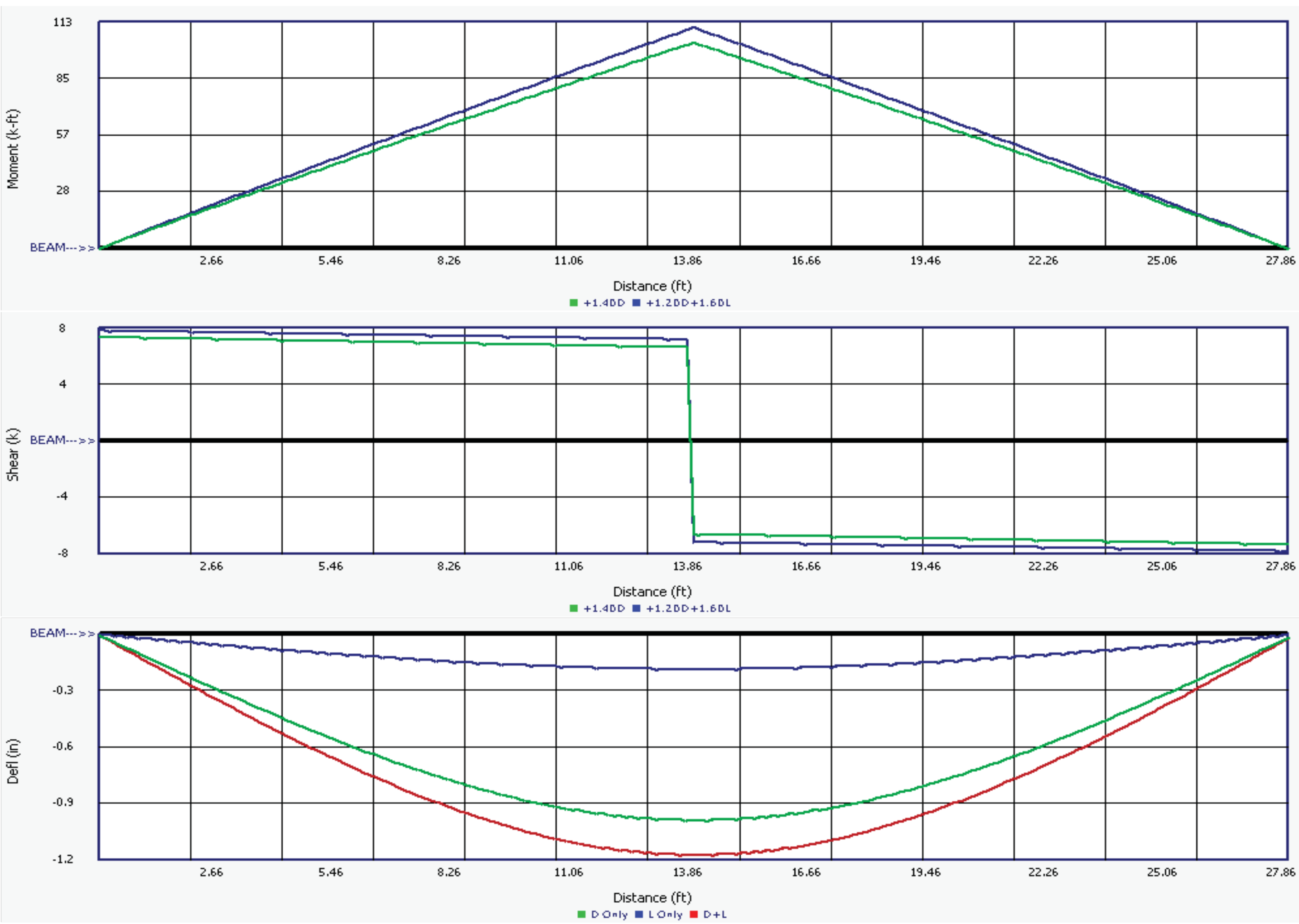
Load Combination	Support 1	Support 2
Overall MAXimum	6.558	6.558
D Only	5.558	5.558
L Only	1.000	1.000
D+L	6.558	6.558

Steel Beam

Description : Boring Machine Temporary Structure

Steel Section Properties 12 40

Depth	=	11.900 in	I xx	=	307.00 in^4	J	=	0.906 in^4
Web Thick	=	0.295 in	S xx		51.50 in^3	Cw	=	1,440.00 in^6
Flange Width	=	8.010 in	R xx	=	5.130 in			
Flange Thick	=	0.515 in	Zx	=	57.000 in^3			
Area	=	11.700 in^2	I yy	=	44.100 in^4			
Weight	=	39.827 plf	S yy	=	11.000 in^3	Wno	=	22.800 in^2
Kdesign	=	1.020 in	R yy	=	1.940 in	Sw	=	23.500 in^4
K1	=	0.875 in	Zy	=	16.800 in^3	Qf	=	11.300 in^3
rts	=	2.210 in	rT	=	2.140 in	Qw	=	27.800 in^3
Ycg	=	5.950 in						



Title : Dalles AWS Job #
Engineer: Peter Gaby
Project Desc.: Alternative #11 - Valve Maintenance Wall

Project Notes :

Printed: 30 MAR 2012, 10:03AM

Concrete Beam

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles new tower.ec6
ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

Description : Valve Maintenance Wall

Material Properties

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

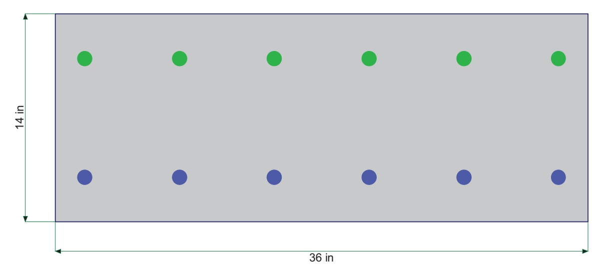
f'c = 4.0 ksi
fr = $f'c^{1/2}$ * 7.50 = 474.34 psi
ψ Density = 145.0 pcf
λ LtWt Factor = 1.0
Elastic Modulus = 3,122.0 ksi

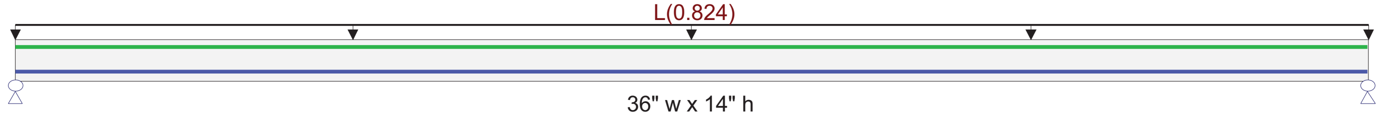
fy - Main Rebar = 60.0 ksi
E - Main Rebar = 29,000.0 ksi

φ Phi Values Flexure : 1.0
Shear : 0.750
β_1 = 0.850

Fy - Stirrups 60.0 ksi
E - Stirrups = 29,000.0 ksi
Stirrup Bar Size # = # 4
Number of Resisting Legs Per Stirrup = 2

Load Combination 2009 IBC & ASCE 7-05





Cross Section ein orcing Details

Rectangular Section, Width = 36.0 in, Height = 14.0 in
Span #1 Reinforcing....
6-#8 at 3.0 in from Bottom, from 0.0 to 29.0 ft in this span
6-#8 at 3.0 in from Top, from 0.0 to 29.0 ft in this span

pplied Loads

Service loads entered. Load Factors will be applied for calculations.

Load or Span u er 1
Uniform Load : L = 0.8240 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.592** : 1		
Section used for this span	**Typical Section**		
Mu : Applied	138.60 k-ft		
Mn * Phi : Allowable	233.98 k-ft		
Load Combination	+1.20D+1.60L		
Location of maximum on span	14.500 ft		
Span # where maximum occurs	Span # 1		

Maximum Deflection			
Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	1.103 in	Ratio =	315
Max Upward Total Deflection	0.000 in	Ratio =	999 <180

Cross Section Strengt Inertia

Cross Section	Bar Layout Description	Phi*Mn (k-ft) Btm Tension	Top Tension	Moment of Inertia (in^4) I gross	Icr - Btm Tension	Icr - Top Tension
Section 1	6- #8 @ d=11",6- #8 @ d=3",	233.98	233.98	8,232.00	2,963.12	2,963.12

Vertical eactions n actored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	11.948	11.948
L Only	11.948	11.948
D+L	11.948	11.948

S ear Stirrup e uire ents

Entire Beam Span Length : Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in

Ma i u orces Stresses or Load Co inations

Load Combination Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	14.500	138.60	233.98	0.59
+1.20D+1.60L					
Span # 1	1	14.500	138.60	233.98	0.59

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File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles new tower.ec6
ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.12.01.12

Concrete Beam

Lic. # : KW-06000410 Licensee : hdr engineering inc

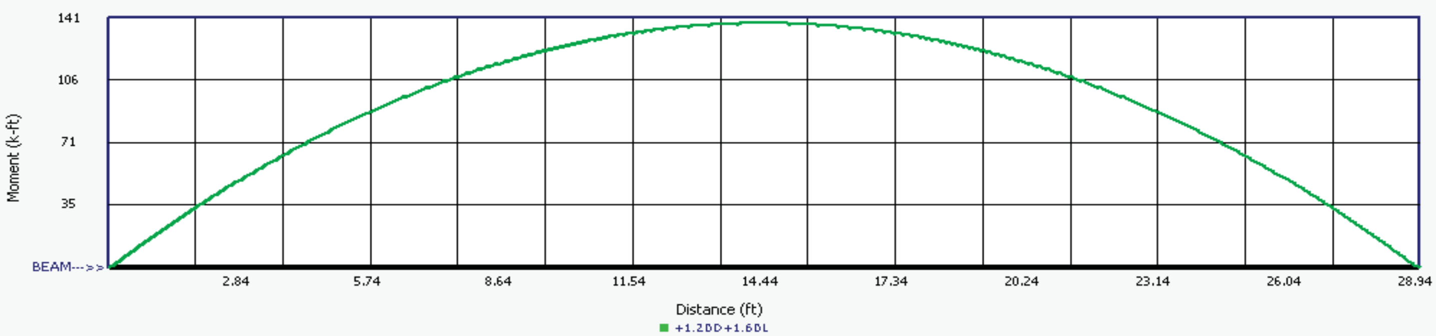
Description : Valve Maintenance Wall

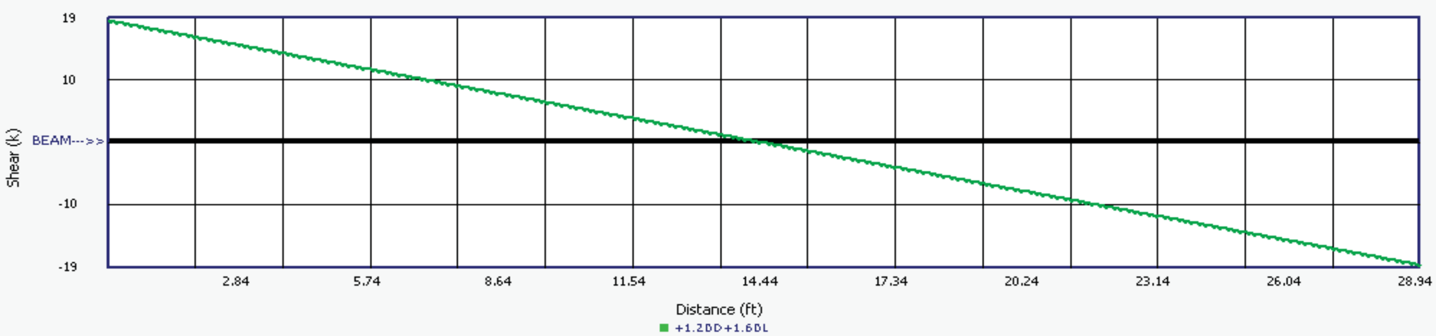
Overall Ma i u De lections n actored Loads

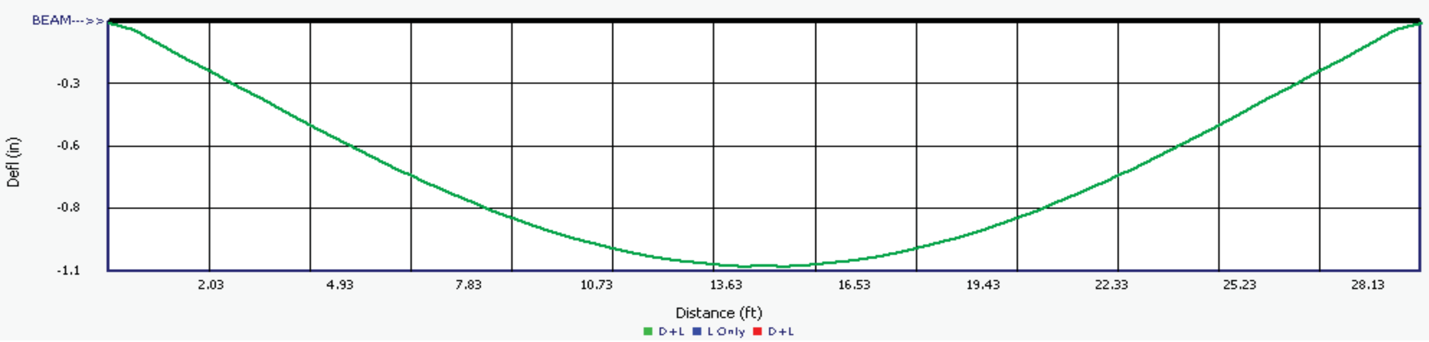
Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	1.1034	14.790		0.0000	0.000

Ma i u De lections or Load Co inations n actored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D+L	1	1.1034	14.790	0.0000	0.000
L Only	1	1.1034	14.790	0.0000	0.000
D+L	1	1.1034	14.790	0.0000	0.000







60% EDR

Low Level Intake & Trashracks

1. Quantities
2. Calculations
3. Miscellaneous Information for Costs

Project: DALLES AWS	Computed: JPG	Date: 12/19/11
HDR ONE COMPANY *Many Solutions®*	Subject: ALTERNATIVES	Checked:	Date:
	Task: TRASHRACK	Page: 1	of:
	Job #: 171518-003-007	No:	

TRASHRACK GRATING DESIGN

DESIGN CRITERIA (ACOE)

- APPROACH VELOCITY = 3 F/S
- 3/4" SPA. BETWEEN BARS
- DESIGN FOR 1000 CFS

- ASSUME FOR 60% LOSS @ 15%

SO,

$$Q = VA \Rightarrow A = \frac{Q}{V} = \frac{1000 \text{ CFS}}{3 \text{ F/S}} = 333 \text{ ft}^2$$

@ 15% LOSS,

$$A_{REQ} = 333 \text{ ft}^2 \times 1.15 = 384 \text{ ft}^2$$

$$= 55,296 \text{ in}^2$$

TRY 10' TALL TRASHRACK

- $.75'' \times 10' \times 12'' = 90 \text{ in}^2$/OPENING

$$\frac{55,296 \text{ in}^2}{90 \text{ in}^2} \doteq 615 \text{ SLOTS } \& \text{ } 616 \text{ BARS}$$

TOTAL L = 615 × 0.75" + 616 × 1"

= 1077.25" ⇒ 89' OF 10'

Project: DALLES AWS		Computed: JPG	Date: 12/19/
Subject: ALTERNATIVES		Checked:	Date:
Task: TRASH RACK		Page: 2	of:
Job #: 171578-003-007		No:	

HDR | ONE COMPANY *Many Solutions*®

TRY 12' w/ 2 HORIZONTAL MEMBERS

.75" x 12' x 12 = 108#"/SLOT

$\frac{55,296 \#"}{108 \#"}$ = 512 SLOTS & 511 BARS

L = 512 x 0.75" + 511 x 1" = 895"

≅ 75'

TRY 14' w/ 3 HORIZ. MEMBERS

$\frac{55,296 \#"}{.75 \times 14' \times 12}$ ≅ 439 SLOTS & 438 BARS

L = 439 x 0.75" x 438 x 1" = 767"

≅ 64'

USE 14'-0" TALL

- 3/4" SPACES
- 1" x 4" BARS & 2" x 6" HORIZONTALS
- MAX SPAN ≈
- PANELS: 10'-7" x 14'-0" +/-

Project:	Computed:	Date:
Subject:	Checked:	Date:
Task:	Page:	of:
Job #:	No:	

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QUANTITIES

TRASHRACK PANELS

10'-7" × 14'-0" - ALONG SLOPE 5:1

BAR 1 × 6 × 3'-4" × 288 pcs

WT/BAR = $\frac{1 \times 6}{144} \times 490 \frac{lb}{FT^3} = 20.42 \frac{lb}{FT}$

288 pcs × 3.33' × 20.42 lb/FT

= 19,603.20 lbs

HSS 8 × 4 × 1/2 (42.10 PLF)

50 LF × 42.10 $\frac{lb}{FT}$ = 2105.00 lbs

= 21,708.20 lbs

× 1.10

= 23,879 lbs

LL COFFERDAM

$A = \pi \frac{(11.083'^2 - 11.0'^2)}{4}$

= 1.439 ft²/FT × 10' = 14.395 FT³

WT = 14.395 × 490 = 7,053.8 lbs

Trash Rack for Alternative #1

Linear feet of HSS 8x4x1/2					
Corners		8	37.5	300	
Perimeter		4	33	132	
		2	3	6	
Perimeter braces		14	37.5	525	
Top support		11	23.5	258.5	
TOTAL				1221.5	LF
		42.10 plf			
				51,425	lbs
3/4" plate					
Top		690		690	
Corners		8	45	360	
				1050	SF
TOTAL				42,875	lbs
Concrete base					
	3	1156		128	CY
Trashrack Panels Weight			23879.00	lbs each	
		6		143,274	lbs
		Total Weight =		237574.15	lbs

Trash Rack, Bulkhead, and Cofferdam for Low Level Inlet

Linear feet of HSS 8x4x1/2					
				561.4	LF
		42.10 plf			
				23,635	lbs
3/4" plate				40.59	cf
		490 pcf			
				19,889	lbs
Trashrack Panels Weight			23879.00	lbs each	
		6		143,274	lbs
Cofferdam					
Linear feet of HSS 3x2 X3/8 ribs					
Ribs		7	16.71	116.97	LF
		14.65 lf			
				1,799	lbs
Half of a 11' diameter x 1/2" pipe					
				10.0	LF
		1.44 plf			
				7,404	lbs
3/4" plate					
Back of cofferdam		10.77	1.67	18.0	SF
halfpipe covers		99.40		99.4	
TOTAL				117.4	
				5,033	LBS
Bulkheads					
Bulkheads and Sliding Tracks for two (2) (see handcalcs)					
				7,477	lbs
		Total Weight =		208,511	lbs

Project: PAHES AWS	Computed: JPG	Date: 1/12/12
Subject: ALTERNATIVES	Checked:	Date:
Task: QUANTITIES	Page: 1	of: 3
Job #: 171578-003-007	No:	

HDR | ONE COMPANY *Many Solutions*

QUANTITIES FOR LOW LEVEL INLET

BULK HEADS - (2)

1/2" THICK STIFFENED PLATE

$8.5' \times 8.5' \times \frac{0.5}{12} \times 490$ PCF $= 1,475.1$ lbs

ASSUME RIBS $\frac{1" \times 4"}{144} \times 8.34' \times 8$ PCS $\times 490$ PCF $= 907.4$ lbs

PERIMETER L = 33.67'

$\frac{1" \times 4"}{144} \times 33.67' \times 490$ PCF = 458.3 lbs

RAILS: A = 11.75 □" L = 18.0'

FOR 1, $\frac{11.75 □"}{144} \times 18.0' \times 490$ PCF

= 719.7 lbs

SUB-TOTAL 3560.5 lbs

× 2 = 7121.0 lbs

× 1.05 ≅ 7477. lbs ⇐

BOLTS: 20 - 1" φ - 8" SS 316 BOLTS

Project: DALLES AWS		Computed: JPG	Date: 1/12/12
Subject:		Checked:	Date:
Task: QUANTITIES		Page: 2	of: 3
Job #:		No:	

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TRASHRACK STRUCTURES (2)

4 pcs HSS 8 x 4 x 1/2 x 38.75'
(155 LF) x 42.1 PLF = 6,525.50 lbs

4 SIDE PANELS - 3/4" PLATE

A = 56.4 ft²

$4 \times 56.4\, ft^2 \times \frac{0.75''}{12} \times 490\, pcf = 1{,}727.25\ lbs$

CENTER FRAMES - BTWN

4 pcs HSS 8 x 4 x 1/2 x 22.25'
(89.0) x 42.1 PLF = 3,746.90 lbs

FRONT PANELS - 3/4" PL (2)

A = 188.42 ft² (FOR BOTH)

$1 \times 188.42\, ft^2 \times \frac{0.75''}{12} \times 490\, pcf = 5770.26\ lbs$

TOP PANELS - 2

A = 105.29 ft² (BOTH)

$1 \times 105.29\, ft^2 \times \frac{0.75''}{12} \times 490\, pcf = 3224.56\ lbs$

Project: DALLES AWS		Computed: JPG	Date: 1/16/12
Subject:		Checked:	Date:
Task: QUANTITIES		Page: 3	of: 3
Job #:		No:	

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BOTTOM PANELS - 2

A = 299.25 ft²

1 × 299.25 ft² × $\frac{0.75''}{12}$ × 490 pcf = 9,164.53 lbs

LONGITUDINAL HSS 8×4×½

[5 pcs × 3(10.58')] × 2 × 42.1 pcf

(317.4)

= 13,366.75 lbs

SUB-TOTAL = 43,525.75 lbs

BOLTS: 100 - 1"Φ - 8" SS316

Single Pump – Pump House

1. Quantities
2. Calculations
3. Miscellaneous Information for Costs

PUMP HOUSE TRASH RACKS

TRY 16' TALL

$0.75'' \times (16' - 3(3''/12)) \times 12'' = 137.25$ #"/OPENING

L = 4' (1" BAR)

$\frac{55{,}296 \text{ \#''}}{137} \approx 403.6 \Rightarrow 404$ SLOTS 3/4"

404 SLOTS + 403 BARS

= 404 (.75") + 403 (1.0") = 706"

= 58.83'

4 PANEL @ 14' WIDE

= 4 x 14 = 56' ≈ OK

⟹ -ASSUME 16'-6" x 14'-0 x 4 PANELS

1" BAR L = 4'-1½" ℄ to ℄

Project: DALLES AWS	Computed: JPG	Date: 1/15/12
Subject:	Checked:	Date:
Task: QUANTITIES	Page:	of:
Job #: 171578-003	No:	

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QUANTITIES

PUMPSTATION TRASHRACK PANELS (4)

14'-0" x 16'-6"

BAR 1" x 6" x 4.125'

380 pcs x 4.125' x 20.42 lb/FT

= 32,009 lbs

HSS 8 x 4 x 1/2 (42.10)

62'-4" ⇒ 62.33' x 42.1 lb/FT

= 2,624.3 lbs

= 34,633.30 lbs

4 - PANELS

4 x 34,633.30 x 1.05 ← MISC

= 145,459.68 lbs

+10,000 lbs FOR SUPPORTING STRUCTURE

USE 155,500 lbs

Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: East Fish Ladder Aux. Water
Job # 171578-005

Project Notes :

Printed 11 JAN 2012 11:27AM

Concrete Beam

ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

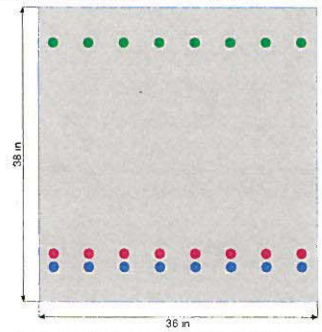
Description : Pump Support Beams in Pump House

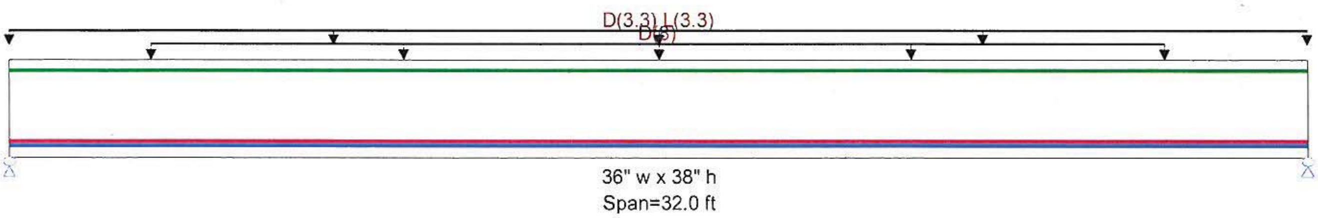
Material Properties

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c	=	4.50 ksi	ϕ Phi Values	Flexure :		0.90
$fr = f'c^{1/2} * 7.50$	=	503.12 psi		Shear :		0.750
ψ Density	=	145.0 pcf	β_1		=	0.8250
λ LtWt Factor	=	1.0				
Elastic Modulus	=	3,865.20 ksi	Fy - Stirrups			40.0 ksi
fy - Main Rebar	=	60.0 ksi	E - Stirrups		=	29,000.0 ksi
E - Main Rebar	=	29,000.0 ksi	Stirrup Bar Size # =		#	5
			Number of Resisting Legs Per Stirrup =			2.0

Load Combination 2009 IBC & ASCE 7-05





Cross Section & Reinforcing Details

Rectangular Section, Width = 36.0 in, Height = 38.0 in
Span #1 Reinforcing....
8-#10 at 4.50 in from Bottom, from 0.0 to 32.0 ft in this span
8-#10 at 6.250 in from Bottom, from 0.0 to 32.0 ft in this span
8-#10 at 4.50 in from Top, from 0.0 to 32.0 ft in this span

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : D = 8.0 k/ft, Extent = 3.50 -->> 28.50 ft, Tributary Width = 1.0 ft, (Pump Weight)
Uniform Load : D = 3.30, L = 3.30 k/ft, Tributary Width = 1.0 ft, (Top Slab)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.965** : 1	Maximum Deflection			
Section used for this span	**Typical Section**	Max Downward L+Lr+S Deflection	0.228 in	Ratio =	1681
Mu : Applied	2,564.30 k-ft	Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Mn * Phi : Allowable	2,658.55 k-ft	Max Downward Total Deflection	1.053 in	Ratio =	364
Load Combination	+1.20D+1.60L	Max Upward Total Deflection	0.000 in	Ratio =	999
Location of maximum on span	16.000 ft				
Span # where maximum occurs	Span # 1				

Cross Section Strength & Inertia

Cross Section	Bar Layout Description	Phi*Mn (k-ft) Btm Tension	Top Tension	Moment of Inertia (in^4) I gross	Icr - Btm Tension	Icr - Top Tension
Section 1	8- #10 @ d=33.5",8- #10 @ d=4.5",8- #10 @ d=31.75",	2,658.55	1,449.37	164616.00	89,418.26	56,332.88

Vertical Reactions - Unfactored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	227.640	227.640
D Only	174.840	174.840
L Only	52.800	52.800
D+L	227.640	227.640

Shear Stirrup Requirements

Between 0.00 to 9.88 ft, PhiVc < Vu, Req'd Vs = Min 11.5.6.3, use stirrups spaced at 5.000 in
Between 9.96 to 13.08 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.5.6.3, use stirrups spaced at 13.000 in
Between 13.16 to 18.84 ft, Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in
Between 18.92 to 22.04 ft, PhiVc/2 < Vu <= PhiVc, Req'd Vs = Min 11.5.6.3, use stirrups spaced at 13.000 in
Between 22.12 to 31.93 ft, PhiVc < Vu, Req'd Vs = 121.85, use stirrups spaced at 5.000 in

Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: East Fish Ladder Aux. Water

Job # 171578-005

Project Notes :

Printed: 11 JAN 2012, 11:27AM

Concrete Beam

ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410

Licensee : hdr engineering inc

Description : Pump Support Beams in Pump House

Maximum Forces & Stresses for Load Combinations

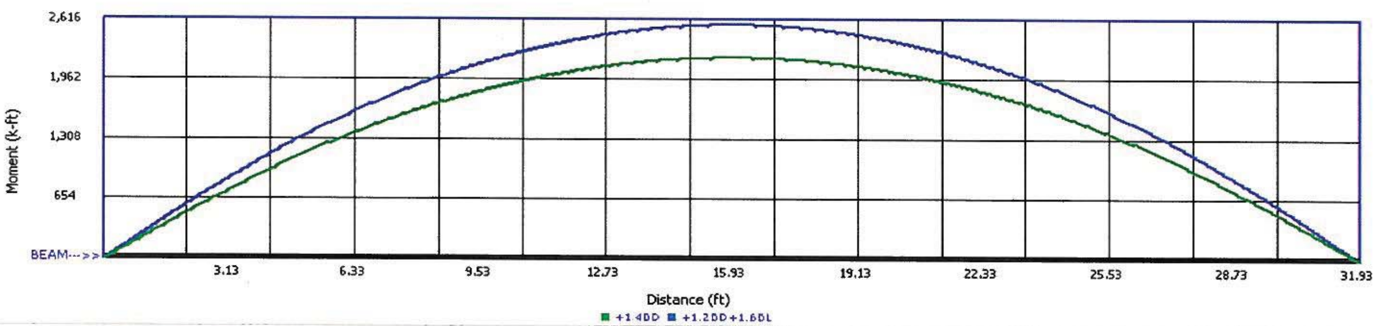
Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	16.000	2,564.30	2,658.55	0.96
+1.40D					
Span # 1	1	16.000	2,203.21	2,658.55	0.83
+1.20D+1.60L					
Span # 1	1	16.000	2,564.30	2,658.55	0.96

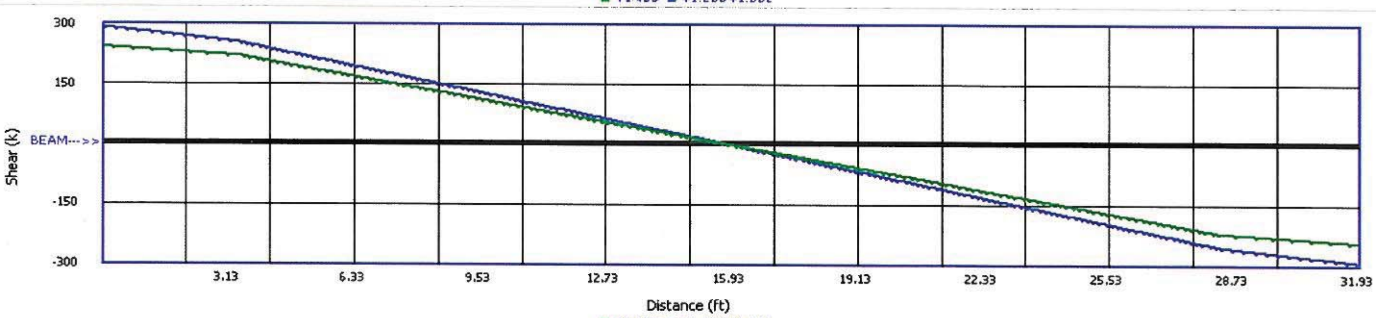
Overall Maximum Deflections - Unfactored Loads

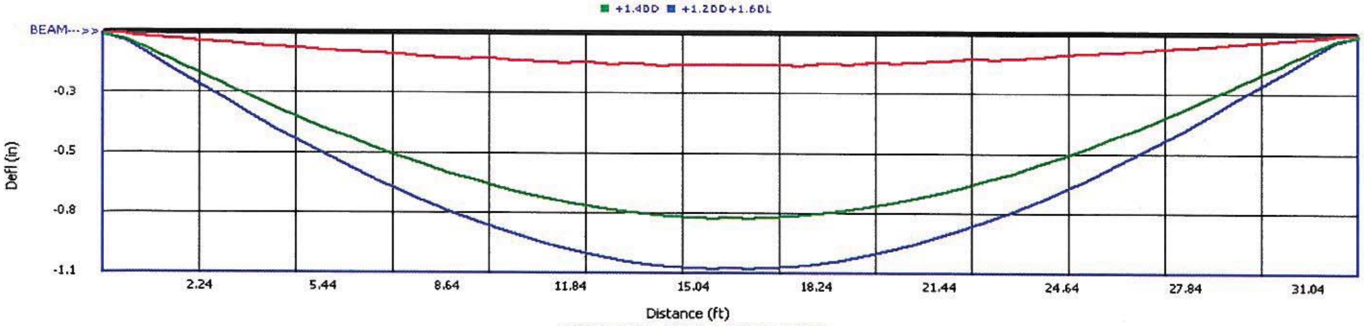
Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	1.0534	16.320		0.0000	0.000

Maximum Deflections for Load Combinations - Unfactored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D Only	1	0.8250	16.320	0.0000	0.000
D+L	1	1.0534	16.320	0.0000	0.000
D Only	1	0.8250	16.320	0.0000	0.000
L Only	1	0.1386	16.320	0.0000	0.000
D+L	1	1.0534	16.320	0.0000	0.000







Concrete Beam

Lic. # : KW-06000410 ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0 **Licensee : hdr engineering inc**

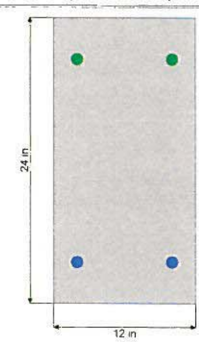
Description : Top Slab in Pump House

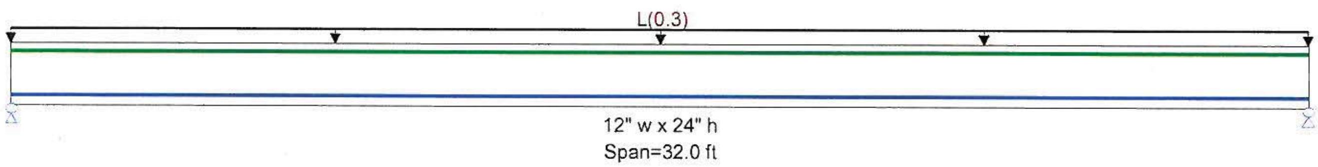
Material Properties

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c =	4.50 ksi	ϕ Phi Values Flexure :	0.90
$fr = f'c^{1/2} * 7.50$ =	503.12 psi	Shear :	0.750
ψ Density =	145.0 pcf	β_1 =	0.8250
λ LtWt Factor =	1.0		
Elastic Modulus =	3,865.20 ksi	Fy - Stirrups	40.0 ksi
fy - Main Rebar =	60.0 ksi	E - Stirrups =	29,000.0 ksi
E - Main Rebar =	29,000.0 ksi	Stirrup Bar Size # =	# 5
		Number of Resisting Legs Per Stirrup =	2.0

Load Combination 2009 IBC & ASCE 7-05





Cross Section & Reinforcing Details

Rectangular Section, Width = 12.0 in, Height = 24.0 in
Span #1 Reinforcing....
2-#8 at 3.50 in from Bottom, from 0.0 to 32.0 ft in this span
2-#8 at 3.50 in from Top, from 0.0 to 32.0 ft in this span

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
Uniform Load : L = 0.30 k/ft, Tributary Width = 1.0 ft, (300 psf)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.756** : 1	Maximum Deflection				
Section used for this span	**Typical Section**	Max Downward L+Lr+S Deflection	0.450 in	Ratio =	854	
Mu : Applied	105.98 k-ft	Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0	<360
Mn * Phi : Allowable	140.28 k-ft	Max Downward Total Deflection	0.577 in	Ratio =	664	
Load Combination	+1.20D+1.60L	Max Upward Total Deflection	0.000 in	Ratio =	999	
Location of maximum on span	16.000 ft					
Span # where maximum occurs	Span # 1					

Cross Section Strength & Inertia

Cross Section	Bar Layout Description	Phi*Mn (k-ft) Btm Tension	Top Tension	Moment of Inertia (in^4) I gross	Icr - Btm Tension	Icr - Top Tension
Section 1	2- #8 @ d=20.5",2- #8 @ d=3.5",	140.28	140.28	13,824.00	3,367.12	3,367.12

Vertical Reactions - Unfactored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	9.440	9.440
D Only	4.640	4.640
L Only	4.800	4.800
D+L	9.440	9.440

Shear Stirrup Requirements

Entire Beam Span Length : Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Location (ft) in Span	Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	16.000	105.98	140.28	0.76
+1.40D					

Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: East Fish Ladder Aux. Water

Job # 171578-005

Project Notes :

Printed: 11 JAN 2012, 11:13AM

Concrete Beam

ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410

Licensee : hdr engineering inc

Description : Top Slab in Pump House

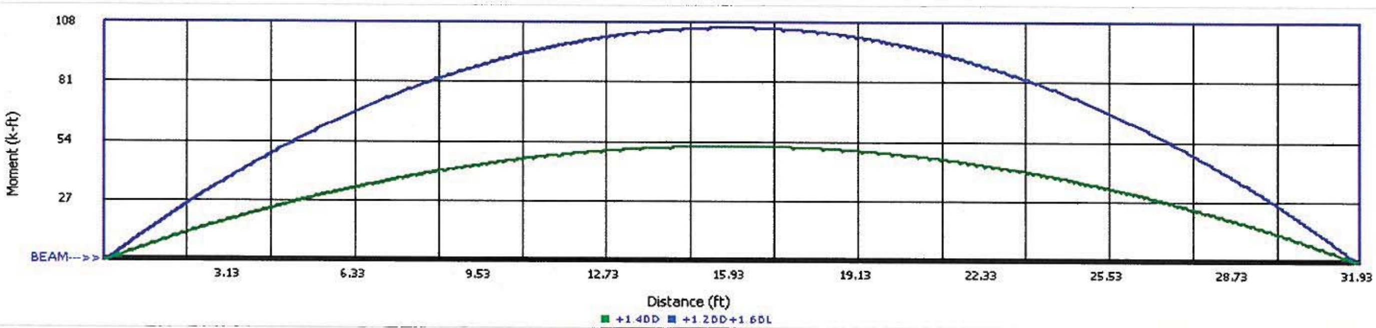
Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
Span # 1	1	16.000	51.97	140.28	0.37
+1.20D+1.60L					
Span # 1	1	16.000	105.98	140.28	0.76

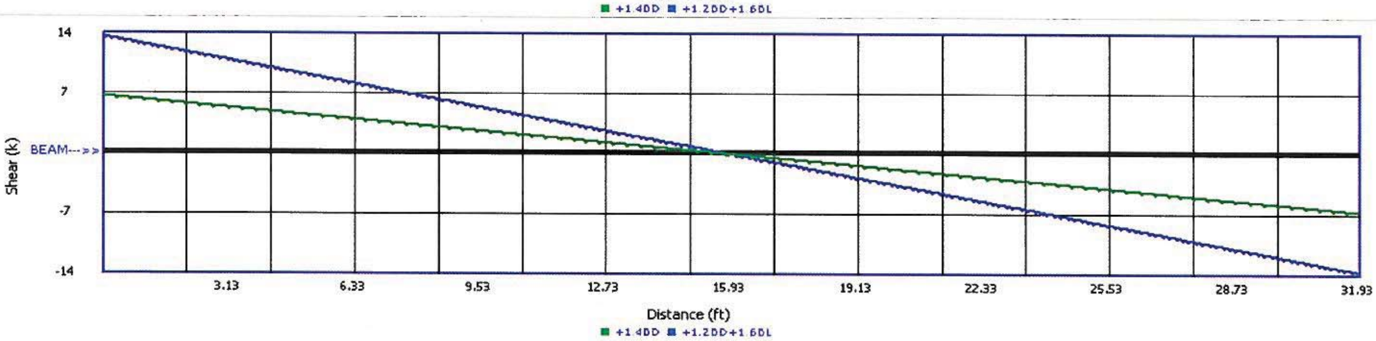
Overall Maximum Deflections - Unfactored Loads

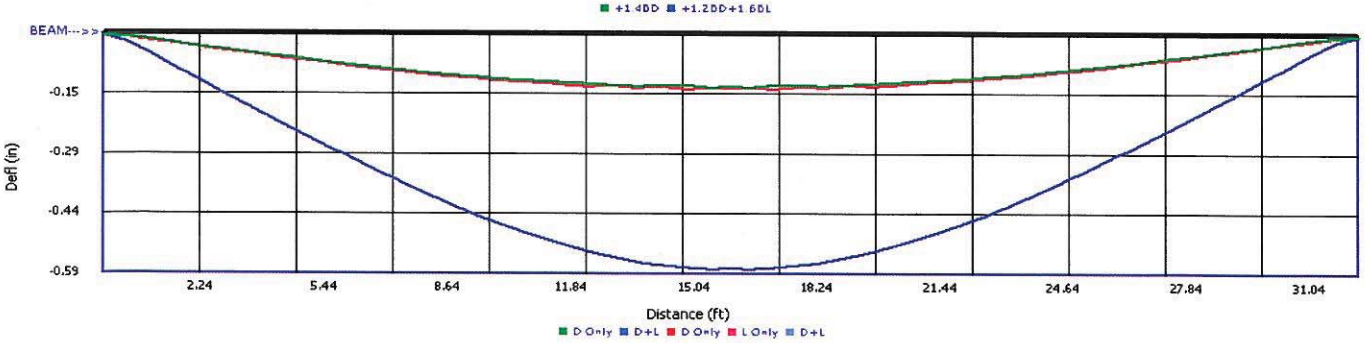
Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.5775	16.320		0.0000	0.000

Maximum Deflections for Load Combinations - Unfactored Loads

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
D Only	1	0.1279	16.320	0.0000	0.000
D+L	1	0.5775	16.320	0.0000	0.000
D Only	1	0.1279	16.320	0.0000	0.000
L Only	1	0.1323	16.320	0.0000	0.000
D+L	1	0.5775	16.320	0.0000	0.000







Title : Dalles AWS | Job # 171578-005
Engineer: Peter Gaby
Project Desc.: East Fish Ladder Aux. Water

Project Notes :

Printed: 11 JAN 2012 12:10PM

Concrete Column

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles pump house.ec6
ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410 | **Licensee : hdr engineering inc**

Description : Columns supporting Pump Beams

General Information

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

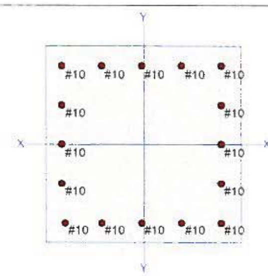
f'c : Concrete 28 day strength = 4.50 ksi
E = 3,865.20 ksi
Density = 145.0 pcf
β = 0.8250
fy - Main Rebar = 60.0 ksi
E - Main Rebar = 29,000.0 ksi
Allow. Reinforcing Limits — *ASTM A615 Bars Used*
Min. Reinf. = 1.0 %
Max. Reinf. = 8.0 %
Load Combination :2009 IBC & ASCE 7-05

Overall Column Height = 50.0 ft
End Fixity: Top & Bottom Pinned
ACI Code Year: ACI 318-05
Brace condition for deflection (buckling) along columns :
X-X (width) axis : Fully braced against buckling along X-X Axis
Y-Y (depth) axis : Fully braced against buckling along Y-Y Axis

Column Cross Section

Column Dimensions :36.0in Square Column, Column Edge to Rebar Edge Cover = 3.0in

Column Reinforcing : 4 - #10 bars @ corners,, 3 - #10 bars top & bottom between corner bars, 3 - #10 bars left & right between corner bars



Applied Loads

Entered loads are factored per load combinations specified by user.

Column self weight included : 65,250.0 lbs * Dead Load Factor
AXIAL LOADS . . .
Pump Beam Reactions: Axial Load at 50.0 ft above base, Xecc = 6.0in, Yecc = 6.0in, D = 174.84, L = 52.80 k

DESIGN SUMMARY

Load Combination: +1.20D+1.60L
Location of max.above base: 49.664 ft

Maximum Stress Ratio **0.1513 : 1**
Ratio = (Pu^2+Mu^2)^.5 / (PhiPn^2+PhiMn^2)^.5

Pu = 372.59 k | φ * Pn = 2,464.29 k
Mu-x = -146.16 k-ft | φ * Mn-x = 0.0 k-ft
Mu-y = -146.16 k-ft | φ * Mn-y = 0.0 k-ft

Mu Angle = 45.0 deg
Mu at Angle = 206.70 k-ft | φMn at Angle = 1,366.23 k-ft

Pn & Mn values located at Pu-Mu vector intersection with capacity curve

Column Capacities . . .
Pnmax : Nominal Max. Compressive Axial Capacity 6,098.68 k
Pnmin : Nominal Min. Tension Axial Capacity -1,219.20 k
φ Pn, max : Usable Compressive Axial Capacity 3,171.31 k
φ Pn, min : Usable Tension Axial Capacity -792.48 k

Maximum SERVICE Load Reactions . .
Top along Y-Y k | Bottom along Y-Y k
Top along X-X k | Bottom along X-X k

Maximum SERVICE Load Deflections . . .
Along Y-Y -0.05881 in at 29.195 ft above base
for load combination : D+L
Along X-X -0.05881 in at 29.195 ft above base
for load combination : D+L

General Section Information . φ = 0.650 β = 0.8250 θ = 0.80
ρ : % Reinforcing 1.568 % Rebar % Ok
Reinforcing Area 20.320 in^2
Concrete Area 1,296.0 in^2

Governing Load Combination Results

Governing Factored Load Combination	Dist. from base ft	Axial Load k Pu	φ * Pn	δx	δx * Mux	δy	δy * Muy	Bending Analysis k-ft Alpha (deg)	δ Mu	φ Mn	Utilization Ratio
+1.40D	49.66	336.13	2,579.32	1.000	-121.57	1.000	-121.57	45.000	171.92	1,312.16	**0.131**
+1.20D+1.60L	49.66	372.59	2,464.29	1.000	-146.16	1.000	-146.16	45.000	206.70	1,366.23	**0.151**

Concrete Column

Description : Columns supporting Pump Beams

Maximum Reactions - Unfactored

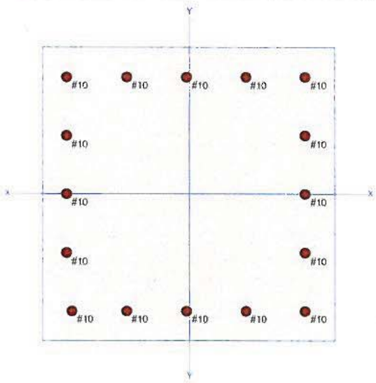
Note: Only non-zero reactions are listed.

Load Combination	Reaction along X-X Axis @ Base	Reaction along X-X Axis @ Top	Reaction along Y-Y Axis @ Base	Reaction along Y-Y Axis @ Top	Axial Reaction @ Base
D Only	1.748	1.748 k	1.748	1.748 k	240.090 k
L Only	0.528	0.528 k	0.528	0.528 k	52.800 k
D+L	2.276	2.276 k	2.276	2.276 k	292.890 k

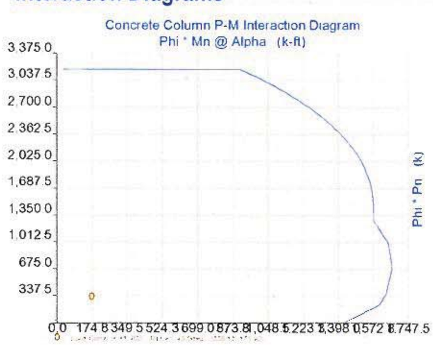
Maximum Deflections for Load Combinations - Unfactored Loads

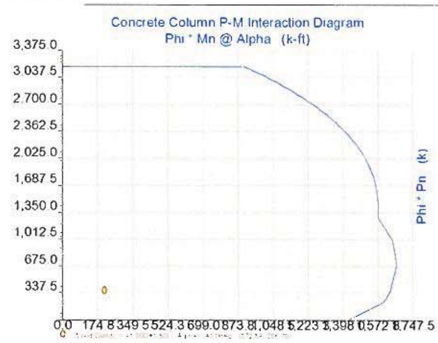
Load Combination	Max. X-X Deflection		Distance		Max. Y-Y Deflection		Distance	
D Only	-0.0452	in	29.195	ft	-0.045	in	29.195	ft
L Only	-0.0136	in	29.195	ft	-0.014	in	29.195	ft
D+L	-0.0588	in	29.195	ft	-0.059	in	29.195	ft

Sketches



Interaction Diagrams





Title : Dalles AWS
Engineer: Peter Gaby
Project Desc.: East Fish Ladder Aux. Water

Job # 171578-005

Project Notes :

Printed: 11 JAN 2012 12:19PM

Concrete Column

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles pump house.ec6
ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410 **Licensee : hdr engineering inc**

Description : Drilled Shafts

General Information

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c : Concrete 28 day strength	=	3.0 ksi
E =	=	3,865.20 ksi
Density	=	145.0 pcf
β	=	0.850
fy - Main Rebar	=	60.0 ksi
E - Main Rebar	=	29,000.0 ksi
Allow. Reinforcing Limits	ASTM A615 Bars Used	
Min. Reinf.	=	1.0 %
Max. Reinf.	=	4.0 %

Load Combination :2009 IBC & ASCE 7-05

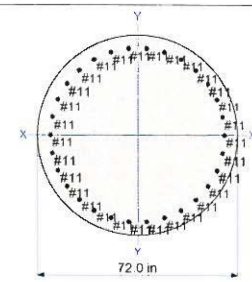
Overall Column Height	=	25.0 ft
End Fixity		Top Fixed, Bottom Fixed
ACI Code Year		ACI 318-05

Brace condition for deflection (buckling) along columns :
X-X (width) axis : Unbraced Length for X-X Axis buckling = 20 ft, K = 0.65
Y-Y (depth) axis : Unbraced Length for Y-Y Axis buckling = 20 ft, K = 1.0

Column Cross Section

Column Dimensions :72.0in Diameter, Column Edge to Rebar Edge Cover = 4.0in

Column Reinforcing : 30 - #11 bars



Applied Loads

Entered loads are factored per load combinations specified by user.

Column self weight included : 102,494 lbs * Dead Load Factor
AXIAL LOADS . . .
Pump Beam Reactions: Axial Load at 25.0 ft above base, Xecc = 6.0in, Yecc = 6.0in, D = 300.0, L = 300.0 k

DESIGN SUMMARY

Load Combination	+1.20D+1.60L
Location of max.above base	24.832 ft
Maximum Stress Ratio	**0.1156 : 1**

Ratio = (Pu^2+Mu^2)^.5 / (PhiPn^2+PhiMn^2)^.5

Pu =	962.99 k	φ * Pn =	8,332.76 k
Mu-x =	0.0 k-ft	φ * Mn-x =	0.0 k-ft
Mu-y =	0.0 k-ft	φ * Mn-y =	0.0 k-ft
Mu Angle =	0.0 deg		
Mu at Angle =	0.0 k-ft	φMn at Angle =	0.0 k-ft

Pn & Mn values located at Pu-Mu vector intersection with capacity curve

Column Capacities . . .

Pnmax : Nominal Max. Compressive Axial Capacity	13,071.0 k
Pnmin : Nominal Min. Tension Axial Capacity	-2,808.0 k
φ Pn, max : Usable Compressive Axial Capacity	8,332.76 k
φ Pn, min : Usable Tension Axial Capacity	-2,106.0 k

Maximum SERVICE Load Reactions . .

Top along Y-Y	k	Bottom along Y-Y	k
Top along X-X	k	Bottom along X-X	k

Maximum SERVICE Load Deflections . . .

Along Y-Y 0.0 in at 0.0 ft above base
for load combination :

Along X-X 0.0 in at 0.0 ft above base
for load combination :

General Section Information . φ = 0.750 β = 0.850 θ = 0.850

ρ : % Reinforcing	1.149 %	Rebar % Ok
Reinforcing Area	46.80 in^2	
Concrete Area	4,071.50 in^2	

Governing Load Combination Results

Governing Factored Load Combination	Dist. from base ft	Axial Load k Pu	φ * Pn	δ x	δ x * Mux	δ y	δ y * Muy	Bending Analysis k-ft Alpha (deg)	δ Mu	φ Mn	Utilization Ratio
+1.40D	24.83	563.49	8,332.76					0.000			**0.068**
+1.20D+1.60L	24.83	962.99	8,332.76					0.000			**0.116**

Concrete Column

File: c:\Documents and Settings\jgaby\My Documents\ENERCALC Data Files\dalles pump house.ec6
ENERCALC, INC. 1983-2011, Build:6.11.11.11, Ver:6.2.00.0

Lic. # : KW-06000410 | Licensee : hdr engineering inc

Description : Drilled Shafts

Maximum Reactions - Unfactored

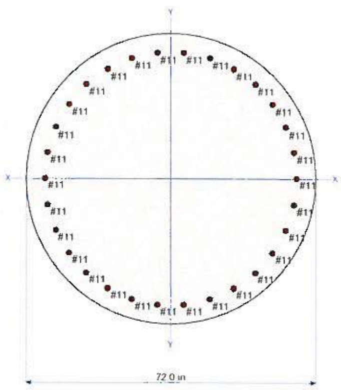
Note: Only non-zero reactions are listed.

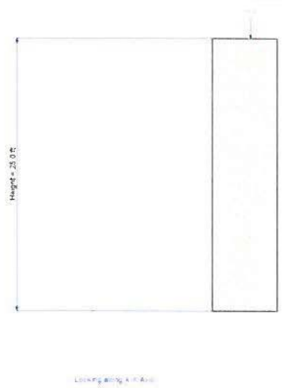
Load Combination	Reaction along X-X Axis @ Base	Reaction along X-X Axis @ Top	Reaction along Y-Y Axis @ Base	Reaction along Y-Y Axis @ Top	Axial Reaction @ Base
D Only		k		k	402.494 k
L Only		k		k	300.000 k
D+L		k		k	702.494 k

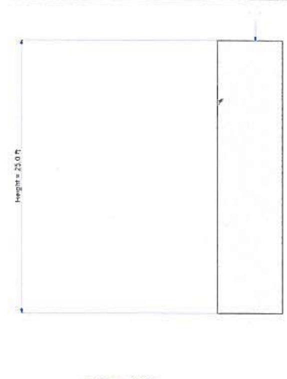
Maximum Deflections for Load Combinations - Unfactored Loads

Load Combination	Max. X-X Deflection		Distance		Max. Y-Y Deflection		Distance	
D Only	0.0000	in	0.000	ft	0.000	in	0.000	ft
L Only	0.0000	in	0.000	ft	0.000	in	0.000	ft
D+L	0.0000	in	0.000	ft	0.000	in	0.000	ft

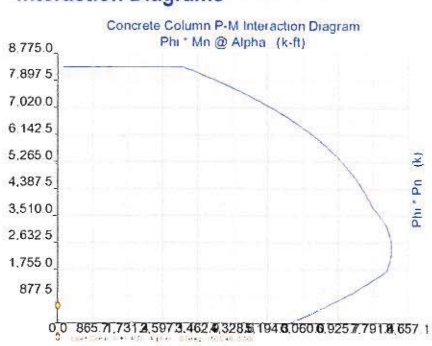
Sketches

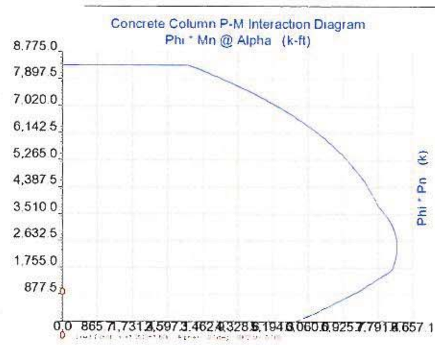






Interaction Diagrams





Concrete Column

Description : Columns supporting Pump Beams

General Information

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05

f'c : Concrete 28 day strength	=	4.50 ksi
E =	=	3,865.20 ksi
Density	=	145.0 pcf
β	=	0.8250
fy - Main Rebar	=	60.0 ksi
E - Main Rebar	=	29,000.0 ksi
Allow. Reinforcing Limits	*ASTM A615 Bars Used*	
Min. Reinf.	=	1.0 %
Max. Reinf.	=	8.0 %

Load Combination : 2009 IBC & ASCE 7-05

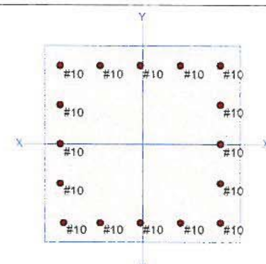
Overall Column Height = 50.0 ft
End Fixity: Top & Bottom Pinned
ACI Code Year: ACI 318-05

Brace condition for deflection (buckling) along columns :
X-X (width) axis : Fully braced against buckling along X-X Axis
Y-Y (depth) axis : Fully braced against buckling along Y-Y Axis

Column Cross Section

Column Dimensions : 36.0in Square Column, Column Edge to Rebar Edge Cover = 3.0in

Column Reinforcing : 4 - #10 bars @ corners,, 3 - #10 bars top & bottom between corner bars, 3 - #10 bars left & right between corner bars



Applied Loads

Entered loads are factored per load combinations specified by user.

Column self weight included : 65,250.0 lbs * Dead Load Factor
AXIAL LOADS . . .
Pump Beam Reactions: Axial Load at 50.0 ft above base, Xecc = 6.0in, Yecc = 6.0in, D = 174.84, L = 52.80 k

DESIGN SUMMARY

Load Combination: +1.20D+1.60L
Location of max.above base: 49.664 ft

Maximum Stress Ratio **0.1513 : 1**
Ratio = (Pu^2+Mu^2)^.5 / (PhiPn^2+PhiMn^2)^.5

Pu =	372.59 k	φ * Pn =	2,464.29 k
Mu-x =	-146.16 k-ft	φ * Mn-x =	0.0 k-ft
Mu-y =	-146.16 k-ft	φ * Mn-y =	0.0 k-ft
Mu Angle =	45.0 deg		
Mu at Angle =	206.70 k-ft	φMn at Angle =	1,366.23 k-ft

Pn & Mn values located at Pu-Mu vector intersection with capacity curve

Column Capacities . . .

Pnmax : Nominal Max. Compressive Axial Capacity	6,098.68 k
Pnmin : Nominal Min. Tension Axial Capacity	-1,219.20 k
φ Pn, max : Usable Compressive Axial Capacity	3,171.31 k
φ Pn, min : Usable Tension Axial Capacity	-792.48 k

Maximum SERVICE Load Reactions . .

Top along Y-Y	k	Bottom along Y-Y	k
Top along X-X	k	Bottom along X-X	k

Maximum SERVICE Load Deflections . . .

Along Y-Y -0.05881 in at 29.195 ft above base
for load combination : D+L
Along X-X -0.05881 in at 29.195 ft above base
for load combination : D+L

General Section Information . φ = 0.650 β = 0.8250 θ = 0.80

ρ : % Reinforcing 1.568 % Rebar % Ok
Reinforcing Area 20.320 in^2
Concrete Area 1,296.0 in^2

Governing Load Combination Results

Governing Factored Load Combination	Dist. from base ft	Axial Load k Pu	φ * Pn	δ x	δ x * Mux	δ y	δ y * Muy	Bending Analysis k-ft Alpha (deg)	δ Mu	φ Mn	Utilization Ratio
+1.40D	49.66	336.13	2,579.32	1.000	-121.57	1.000	-121.57	45.000	171.92	1,312.16	**0.131**
+1.20D+1.60L	49.66	372.59	2,464.29	1.000	-146.16	1.000	-146.16	45.000	206.70	1,366.23	**0.151**

Concrete Column

Description : Columns supporting Pump Beams

Maximum Reactions - Unfactored

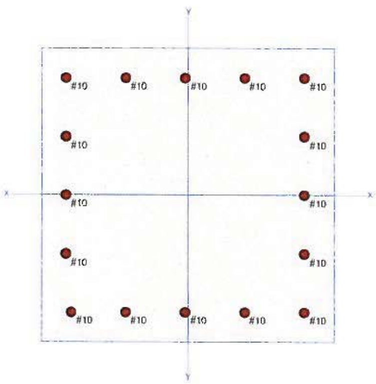
Note: Only non-zero reactions are listed.

Load Combination	Reaction along X-X Axis @ Base	Reaction along X-X Axis @ Top	Reaction along Y-Y Axis @ Base	Reaction along Y-Y Axis @ Top	Axial Reaction @ Base
D Only	1.748	1.748 k	1.748	1.748 k	240.090 k
L Only	0.528	0.528 k	0.528	0.528 k	52.800 k
D+L	2.276	2.276 k	2.276	2.276 k	292.890 k

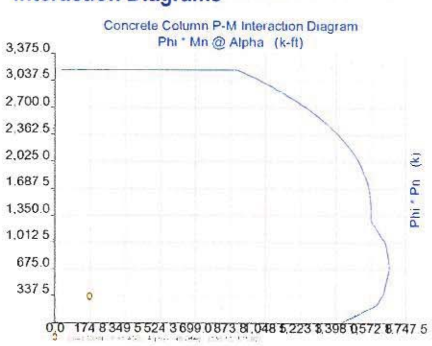
Maximum Deflections for Load Combinations - Unfactored Loads

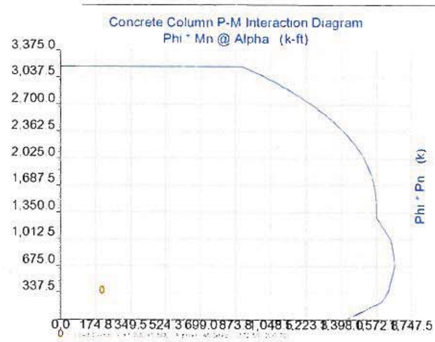
Load Combination	Max. X-X Deflection		Distance		Max. Y-Y Deflection		Distance	
D Only	-0.0452	in	29.195	ft	-0.045	in	29.195	ft
L Only	-0.0136	in	29.195	ft	-0.014	in	29.195	ft
D+L	-0.0588	in	29.195	ft	-0.059	in	29.195	ft

Sketches



Interaction Diagrams

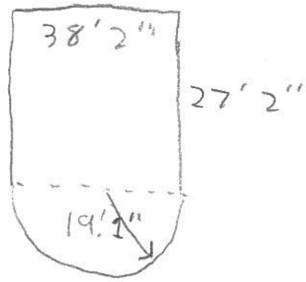




Project: The Dalles Dam East Fish Ladder	Computed: S.S.	Date: 1/16/11	
Subject: Siphon Tower Alternative II	Checked:	Date:	
Task: Quanity Calculations	Page:	of:	
Job #:	No:		

Intake Tower Volume of Concrete

Top Slab -

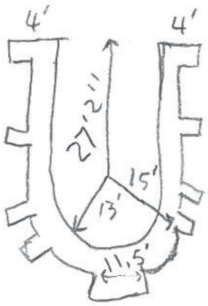


1'6" Thick

Volume $= \left(\tfrac{1}{2}(19'1")^2 \pi + (38'2" \times 27'2")\right) \times 1.5'$

2421 ft³

Body -



Height = 83.5'

Includes 6 Trashracks

10'7" × 14'0"

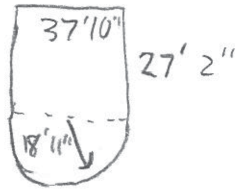
Area $= \left(\tfrac{1}{2}(15')^2 \pi - \tfrac{1}{2}(13')^2 \pi\right) + (27'2" \times 2' \times 2') + (2' \times 2' \times 8) + (11.5' \times 2') = 251.6\ ft^2$

Volume $= 251.6 \times 83.5 = 21{,}012\ ft^3$

Minus Volume of trashracks

$21{,}012 - (10'7" \times 14' \times 2' \times 6) =$ **19,234 ft³**

Base -



3 ft Thick

Volume $= \tfrac{1}{2}(18'11")^2 \pi + (37'10" \times 27'2") \times 3'$

4770 ft³

Total Volume = 2421 + 19,234 + 4770 = 26,425 ft³

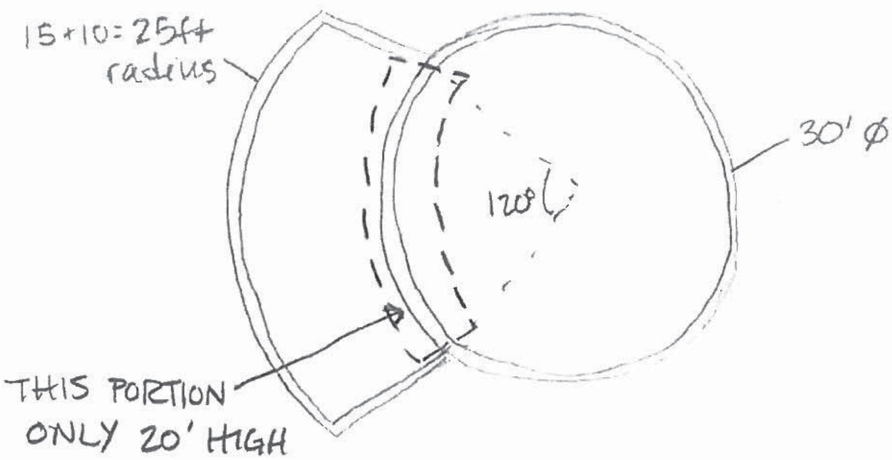
Plus 10% Buffer = 29,067 ft³ or **1077 cubic yards**

Project: USACE Dalles Dam EFL	Computed: NLS	Date: 1/16/12
Subject:	Checked:	Date:
Task: QUANTITIES	Page: 1	of:
Job #:	No:	

HDR ONE COMPANY *Many Solutions*

JUNCTION BOX QUATITIES

STEEL → ASSUME ½" THICK



ext. of discharge box: $\pi\left((25ft)^2 - (24ft + 11\tfrac{1}{2}in)^2\right)(30ft)\left(\tfrac{1}{3}\right)$

$= 65.395 ft^3$

$(2)(10ft)(30ft)\left(\frac{\tfrac{1}{2}in}{12}\right) = + 25.00 ft^3$

$\underline{\underline{90.395 ft^3}}$

ext. of cylinder: $\frac{\pi}{4}\left((30ft)^2 - (29ft + 11in)^2\right)(30ft)\left(\tfrac{2}{3}\right) = \underline{\underline{78.43 ft^3}}$

20' high wall: $\frac{\pi}{4}\left((30ft)^2 - (29ft + 11in)^2\right)(20ft)\left(\tfrac{1}{3}\right) = \underline{\underline{26.14 ft^3}}$

base plate: $\frac{\pi}{4}\left((30ft)^2 + \frac{1}{3}(50ft)^2\right)\left(\frac{\tfrac{1}{2}in}{12}\right) = \underline{\underline{56.72 ft^3}}$

TOTAL STEEL WEIGHT (ASSUMING NO CAP):

$W = (490\ lb/ft^3)(90.395 + 78.43 + 26.14 + 56.72)ft^3$

$= \boxed{123,326\ lbs}$

Project:	Computed:	Date:	
Subject:	Checked:	Date	
Task:	Page: 2	of:	
Job #:	No:		

HDR | ONE COMPANY *Many Solutions*

JXN BOX FOUNDATION:

CONCRETE: ASSUME A 3' THICK SLAB UNDERNEATH JXN BOX STRUCTURE

ASSUME 40' × 40' AREA OF SLAB

$$CONC = (40ft)(40ft)(3ft)\left(\frac{1yd^3}{27ft^3}\right) = \boxed{178 yd^3}$$

BRIDGE ABUTMENT CONCRETE

$$(18.5ft)(8ft)(2ft) + (4ft + 14.5ft + 4ft)(1ft)(4ft + 2in) + (2ft)(14.5ft)(3ft)) = 476.75ft^3 = \boxed{17.66 yd^3}$$

WET WELL CONCRETE

FND SLAB: $(99.5FT)(41ft)(4ft)/27 = 604 yd^3$

BACK WALL: $(50FT)(30FT)(2FT)(1.10) = 122 yd^3$

Adding 10% for corbel

SIDE WALLS: $(80.5FT)(2FT)(50FT)(2) = 596.3 yd^3$

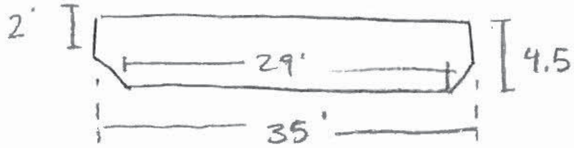
mid-height length

FLOOR SLAB: $(87.5FT)(47.5FT)(2FT) - \pi\left(\frac{(12ft)^2}{4}\right) \times 2' + 3(30ft)(1'+2")(3ft)) = 311.2 yd^3$

measured length in MICROSTATION; width of floor slab

TOTAL = $\boxed{1634 yd^3}$

Bridge Pier concrete



depth = 5 ft
or 5' → avg = 4.75'

$35\,ft\,(4.75\,ft) - 2\left(\tfrac{1}{2}\right)(2.75\,ft)(3\,ft) = 158\,ft^2$

$Vol = 2 \times (158\,ft^2)(5\,ft) = 1580\,ft^3 = \underline{58.5\,yd^3}$

concrete pipe support:

$A = 49.62\,ft^2 + 17.49\,ft^2 = 67.11\,ft^2$
(measured in Microstation)

$V = 2 \times (67.11\,ft^2)(3\,ft \text{ depth}) = 402.7\,ft^3 = \underline{15\,yd^3}$

$58.5\,yd^3 + 15\,yd^3 = \boxed{73.4\ CY}$

Single Pump – Pump House

1. ODOT Bridge Information
2. AWWA Pipe Weights

PUMPHOUSE BRIDGE

1.1.2.3 Structure Layout: Spans and Proportions

(1) Column Locations - Column locations, which of course affect span lengths, are subject to clearance requirements of Section 1.4.8.1, AASHTO standard clearances, or by hydraulic considerations. After these conditions are met, spans lengths may also be governed by environmental issues, economics and aesthetics. Consider alternate structure types to best fit the needs of the site.

If columns are located in the median of a divided highway and within the clear zone as determined by the Roadway Designer, they must be protected from traffic by a guardrail or concrete barrier. See Section 1.6 for column loading criteria for vehicular impact, depending on type and location of barrier used (ODOT Instructions for AASHTO LRFD 3.6.5).

Check with the Roadway Designer about which barrier will be used. It will affect the bridge's appearance and may influence the type of column selected.

Earth Mounds are no longer an acceptable method of column protection. At this time, however, existing earth mounds do not need to be removed.

When locating columns and span configurations, consider the effects of columns in waterways. Consider the possibility for scour or difficulty in inspecting a column that is in the highest flow area of a river. Avoid placing the column directly in the middle of the river.

(2) Structure Depth - Structure depth, also referred to as superstructure depth, is generally controlled by span length and clearance limitations. Although a minimum depth structure may be aesthetically appealing, it may not be the optimal solution for the site.

For steel superstructures, use the minimum depth recommended in AASHTO LRFD Table 2.5.2.6.3-1 for estimating purposes. For concrete superstructures, use the minimum depths given below:

Reinforced Concrete Superstructures:

Balanced 3-span cast-in-place slabs with main reinforcement parallel to traffic	d = .542 + S/48
T-Beams	d = S/19
Box Girders, constant depth	d = S/21
Box Girders, with haunch = 1.5 d to 1.75 D	d = S/25

d = depth of constant depth members or depth at midspan of haunched member.

S = length c -c of bents or longest span of a continuous bridge.

Depths shown for slabs and T-beams are for constant-depth sections. Depth may be reduced 15 percent for beams with continuous parabolic haunches or with straight haunches equal to 1/4 the span where the total depth at the haunch is 1.5d.

Increase depths for simple span bridges by 10 percent.

1.1.2.3 Structure Layout: Spans and Proportions - (continued)

(2) Structure Depth – (continued)

Post Tensioned Box Girders:

Use the following minimum depths in place of those recommended by AASHTO LRFD Table 2.5.2.6.3-1:

simple span	d = S/26
continuous, uniform depth	d = S/29
cont with min. haunch = 1.5d	d = S/35

≈ 50'x12 / 33 = 18"

Precast Prestressed Concrete Superstructures:

Slabs and Boxes	d = S/33
Bulb-I and Bulb-T girders	d = S/23

Depths shown for Bulb-I and Bulb-T girders may be reduced up to 15% for haunched girders made continuous. If so, provide either continuous parabolic haunches or straight haunches equal to ¼ the span with a total depth at the haunch at least 1.5d.

Where minimum depth requirements, given above, are satisfied, the optional live load deflection criteria in AASHTO LRFD Section 2.5.2.6.2 will not be required. When minimum depth requirements are not satisfied, verify the live load deflection does not exceed the limits recommended in AASHTO LRFD Section 2.5.2.6.2.

When both minimum depth and live load deflection requirements are not satisfied, submit a request for a design deviation to the State Bridge Engineer. As justification for the request, document girder and deck service stress levels, live load deflection, and provide evidence of similar structures already in service with satisfactory performance.

(3) Girder Spacing - Girder spacing is normally dependent on girder capacity. As span length increases, girder spacing should decrease. Limit deck overhangs to no more than one-half the girder spacing. Long deck overhangs, even if the deck is post-tensioned transversely, tend to sag over time.

1.1.2.4 Structure Types and Economics

(1) General - Structure type is generally the most important factor influencing bridge costs. (Substructure considerations are typically second, although there can be exceptions.) Each project site is unique and should be evaluated for conditions that alter the usual cost expectations. For the following discussion, structure type generally means classification of superstructure spans by construction material and method of construction.

As can be determined from the Bridge Section's annual *Structure Cost Data* books, structure types in order of increasing costs are as follows:

Structure Type	Span Range
Precast concrete slabs	up to 83 feet
Precast concrete box beams	up to 120 feet
Cast-in-place concrete slabs	up to 50-66-50 feet
Precast integral deck concrete girder	up to 130 feet
Precast concrete girder, BT72	up to 140 feet
Precast concrete girder, BT84	up to 160 feet
Precast concrete girder, BT90 & BT96	up to 183 feet **
Cast-in-place box girder	*
Cast-in-place post-tensioned box girder	*
Steel girder	*
Steel truss	*

*Normally used for longer, multi-span continuous bridges.
** Length for BT90 & 96 is limited by prestressing bed capacity for Oregon precasters.

When using precast or prefabricated girders, verify that there is an acceptable route for shipping. As girder lengths increase, shipping becomes more difficult on roadways with sharp curves, high superelevation and/or load-restricted bridges.

Timber bridges up to 30' of length may be considered for special situations. (See Section 1.3.1, 'Timber Bridge Locations".) The cost of a timber bridge may be more than a concrete bridge of the same length.

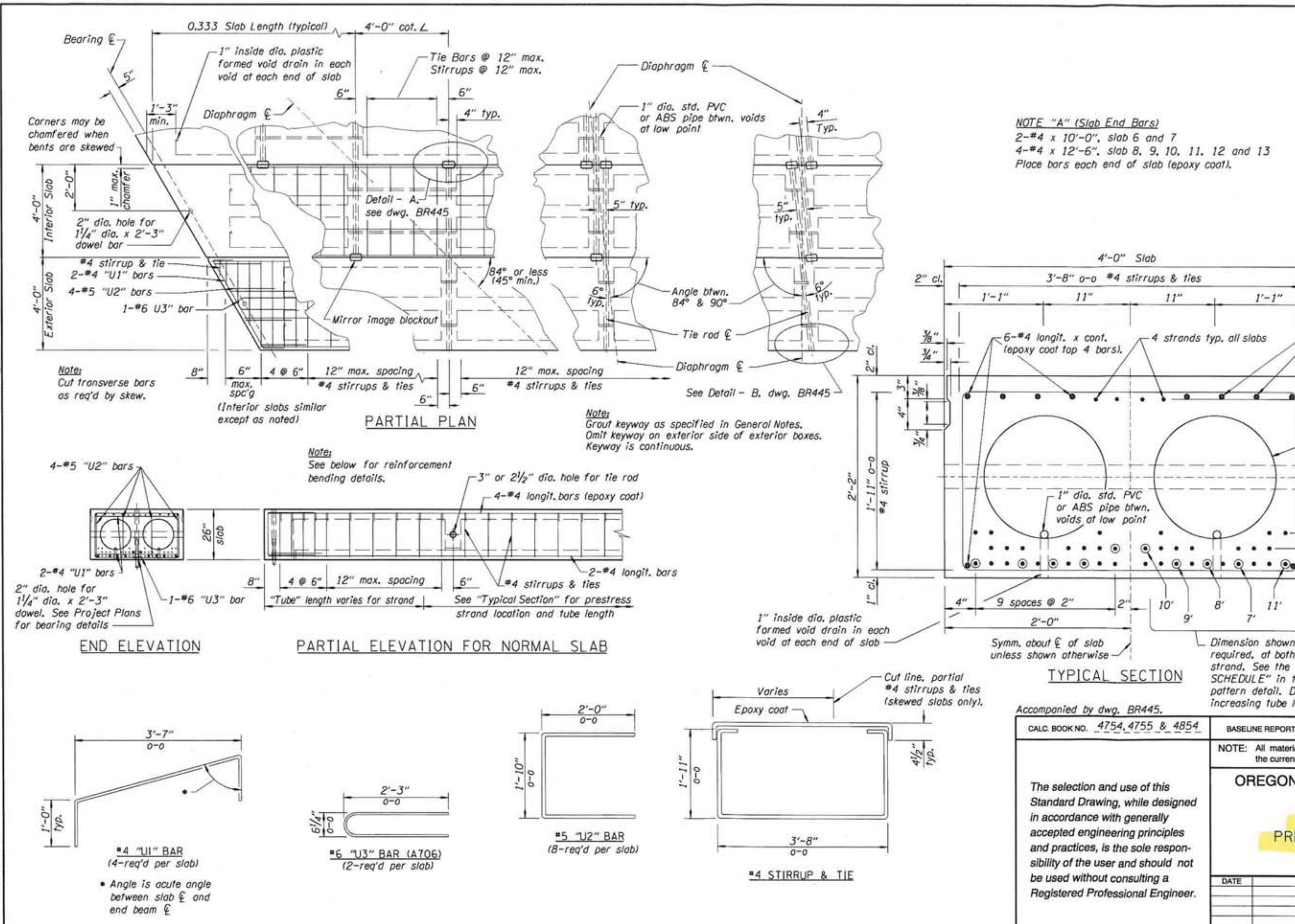
Do not use cast-in-place concrete slabs with any span greater than 66 ft. Cast-in-place concrete slab superstructures have significant dead load deflections. Even if actual deflections match estimated deflections, it will likely take 10 to 15 years for creep deflection to diminish. For longer span lengths, the ride quality would be unacceptable while waiting for the creep deflection to happen.

Do not use voids in cast-in-place concrete slab superstructures. Although such designs are effective at reducing the structure weight and dead load deflections, it is very difficult to secure the voids in the field. The potential for failure is unacceptably high.

When cast-in-place slabs are used, ensure the edge beam requirements given in sections 4.6.2.1.4, 5.14.4.1 and 9.7.1.4 in the LRFD Bridge Design Specifications are met.

Where a design deviation is approved by the State Bridge Engineer for use of voids in a cast-in-place concrete slab superstructure, apply the edge beam requirements listed above to this type of structure.

Use HPC concrete in cast-in-place concrete slab superstructures. Place concrete full-depth of the slab (i.e., no horizontal construction joints). For cast-in-place slab superstructures having any span greater than 40 ft, apply a deck sealer product (from the QPL) at least 60 days after placement of the slab.



SECTION PROPERTIES

Area = 851 in.²
c.g. = 12.92 in.
I = 63,596 in.⁴
St = 4862 in.³
Sb = 4923 in.³
Weight = 916 lbs/ft
J = 128,800 in.⁴
K = 0.77
V/S = 5.75
Form wt = 20 lbs/ft (tubes)
Total wt w/forms = 936 lbs/ft

Diaphragm Weight

Skew	Weight
No Skew	430 lb
15°	710 lb
30°	1230 lb
45°	1940 lb

NOTE "A" (Slab End Bars)

2-#4 x 10'-0", slab 6 and 7
4-#4 x 12'-6", slab 8, 9, 10, 11, 12 and 13
Place bars each end of slab (epoxy coat).

CALC. BOOK NO. 4754, 4755 & 4854

BASELINE REPORT DATE 01-JAN-2009

NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications

The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.

OREGON STANDARD DRAWINGS

26" PRECAST PRESTRESSED SLAB

2008

DATE	REVISION DESCRIPTION

Effective Date: June 1, 2011 - November 30, 2011

Table 7-2 Values of Moment of Inertia and Section Modulus of Steel Pipe (continued)

Nominal Size* in.	Wall Thickness in.	Weight of Pipe and Water lb/ft	Moment of Inertia $in.^4$	Section Modulus $in.^3$
114	0.625	5188	369 669.79	6 415.09
	0.750	5345	445 062.21	7 706.71
120	0.500	5545	343 575.02	5 678.93
	0.625	5706	430 810.89	7 106.16
	0.750	5869	518 588.23	8 536.43
126	0.500	6079	397 494.49	6 259.76
	0.625	6249	498 346.95	7 832.57
	0.750	6419	559 795.37	9 408.56
132	0.500	6638	456 779.50	6 868.87
	0.625	6816	572 596.56	8 594.32
	0.750	6994	689 067.49	10 323.11
138	0.500	7221	521 684.34	7 506.25
	0.625	7407	653 877.33	9 391.42
	0.750	7593	786 784.58	11 280.07
144	0.500	7829	592 463.77	8 171.91
	0.625	8023	742 507.85	10 223.86
	0.750	8217	893 329.02	12 279.44

*Sizes under 45 in. are outside diameter sizes; those 45 in. and over are inside diameter sizes.

References

1. ROARK, R. J. *Formulas for Stress and Strain*. McGraw-Hill Book Co., New York (1954).
2. SCHORER, HERMAN. Design of Large Pipelines. *Trans. ASCE,* 98:101 (1933).
3. ARRIAGA, P.M. The Influence of Circumferential Tension on the Transverse Bending of a Pressure Conduit on Concrete Masonry Supports (Saddle Supports) in the Vicinity of the Support. Technical Library, US BUREC, Denver, Colo.
4. WILSON, W.M. & NEWMARK, N.M. The Strength of Thin Cylindrical Shells as Columns. Bull. 255, Engrg. Exp. Stn., Univ. of Illinois, Urbana, Ill. (1933).
5. FOSTER, H.A. Formulas Indicate Earthquake Forces in Design of Ring Girder-Supported Pipes. *Civ. Engrg.,* 19:697 (1949).
6. Penstock Analysis and Stiffener Design. Bull. 5, Part V. Tech. Invest., Final Rept., Boulder Canyon Project, US BUREC, Denver, Colo. (1944).
7. CATES, W.H. Design Standards for Large-Diameter Steel Water Pipe. *Jour. AWWA,* 42:860 (Sept. 1950).
8. BIER, P.J. Welded Steel Penstocks—Design and Construction. Engrg. Monograph 3, US BUREC, Washington, D.C. (July 1949).
9. — — — Siphon Self-Supporting in Long Spans. *Engineering News-Record,* 124:852 (1940).
10. FOSTER, H.A. Formulas Facilitate Design of Ring-Supported Pipes. *Civ. Engrg.,* 19:629 (1949).
11. GARRETT, G.H. Design of Long-Span Self-Supporting Steel Pipe. *Jour. AWWA,* 40:1197 (Nov. 1948).
12. BARNARD, R.E. Design Standards for Steel Water Pipe. *Jour.* AWWA, 40:24 (Jan. 1948).
13. CROCKER, SABIN, ed. *Piping Handbook.* McGraw-Hill Book Co., New York (4th ed., 1954).
14. TIMOSHENKO, *S. Theory of Elastic Stability.* Engrg. Soc. Monographs. McGraw-Hill Book Co., New York (1st ed., 1936).

The following references are not cited in the text.

— Steel Penstocks and Tunnel Liners. AISI. Steel Plate Engineering Data Vol. 4, (1982).

— YOUNGER, J.E. *Structural Design of Metal Airplanes.* McGraw-Hill Book Co., New York (1935).

Appendix E

Electrical

8998DB0201R5/06
06/2006
Seneca, SC, USA

Data Bulletin

Replaces 8998DB0201R5/02 dated 05/2002

ENGLISH

Application of NEMA 3R Low Voltage Motor Control Centers with AC Drives and Soft Starts

Class 8998

Retain for future use.

INTRODUCTION

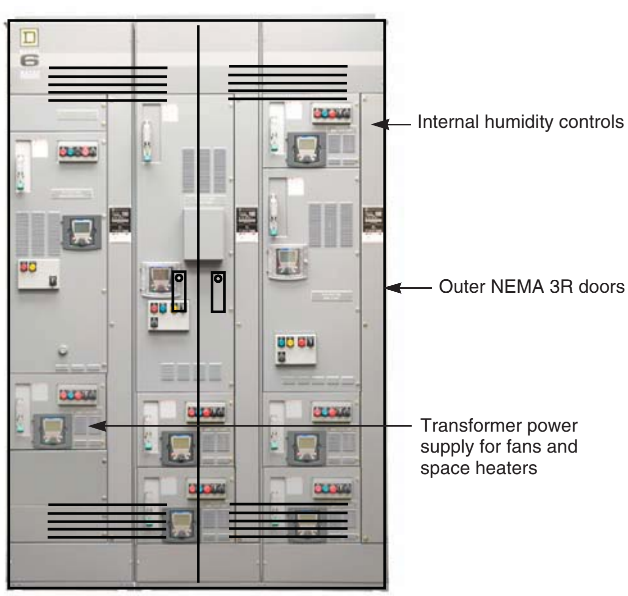
Square D® Motor Control Centers (MCCs), designed and manufactured by Schneider Electric, provide a convenient, versatile package that can be used in various environments. MCCs are frequently used in NEMA 3R applications to provide a free-standing, rainproof enclosure for municipal pumping and industrial processes. NEMA 3R MCCs may contain AC drives and soft starts, which require additional provisions to ensure they operate reliably in an outdoor environment. Until now, outdoor MCC packages containing drives and soft starts were designed as specially-engineered solutions that included air conditioners or other cooling systems.

Schneider Electric now provides a pre-engineered, force-ventilated NEMA 3R MCC with AC drives and soft starts. A specified range of these drives and soft starts can be shipped from the factory for outdoor applications (see "Ratings" on page 3). Due to its force-ventilated design and humidity control, the NEMA 3R MCC package can continuously operate within the range of ambient conditions specified in this bulletin.

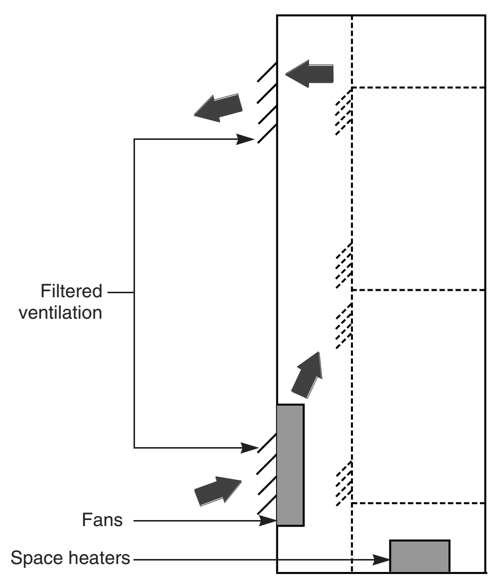
PRODUCT DESCRIPTION

NEMA 3R MCCs are non-walk-in enclosures with a design based on the standard NEMA 1 MCC. Additional housing and gasketing provide protection from rain, sleet, and ice. The NEMA 3R MCC for AC drives and soft starts features louvered and filtered openings on the front doors, along with humidity controls inside the enclosure (see Figure 1). The MCC enclosure is further modified to include fan-forced ventilation while continuing to meet NEMA 3R enclosure requirements and the UL 845 MCC standard.

Figure 1: Square D® Ventilated NEMA 3R Low Voltage Motor Control Center



Front View of NEMA 3R MCC



Side View of NEMA 3R MCC

ENVIRONMENTAL CONTROL

The ventilated NEMA 3R MCC manages the internal MCC environment to maintain the required temperature and humidity levels for the drive and soft start controls in outside environments from -10 to 40 °C (14 to 104 °F). The following features are included:

Dual Door Fans

Dual door fans force fresh air into the enclosure and move air out of the enclosure. The centrifugal impeller fans use highly reliable ball bearing rotors. A factory-preset thermostat controls the fans, based on the MCC's internal temperature. Door interlock switches turn the fans off when the outer NEMA 3R door is opened.

Positive Pressure Ventilation

The intake fans, mounted at the lower vents, blow air into the cabinet. This air increases the cabinet's internal air pressure relative to the air pressure outside the cabinet. The "positive" air pressure created inside the cabinet helps force out dirt and contaminants. This positive pressure ventilation method is common practice for industrial atmospheres. It provides a cleaner environment for drive and soft start electronics than one that would be created by exhaust fans mounted at the upper vents.

Space Heaters

Space heaters add heat to prevent condensation during cooler periods, overnight, and in winter weather.

NOTE: Space heaters do not allow application of the MCC in temperatures below -10 °C (14 °F).

Humidity Controls

It is crucial to maintain a level of dryness in or around the electronic controls for drives and soft starts. Condensation must be avoided. The space heaters will supply the MCC with heat when necessary to reduce condensation. A factory-preset thermostat and humidistat monitor humidity levels and turn on the space heaters to dry the internal MCC ambient air.

Self-Contained Power Supply

The fused control transformer(s) supplied in each MCC line-up provide power for space heaters and fans. There is no need for external power once the main 3-phase power is connected. The power supply is pre-wired at the factory to fans, space heaters, and environmental controls through protected wiring provisions. Each transformer is able to supply power to three sections and should be mounted at the bottom of the MCC section.

Filtered Louvers

Each NEMA 3R MCC door contains top and bottom louvers for ventilation. Behind each louver is a coarse rubber filter that helps protect against debris entering the MCC.

NOTE: All drives and soft starts include internal thermal protection switches to shut down the drive or soft start unit before damage occurs.

ENGLISH

RATINGS

- -10 to 40 °C (14 to 104 °F)

  NOTE: In hotter climates, Schneider Electric suggests installing a shed for shading the MCC as a best practice, since high temperatures are not always consistent.
- Up to 2000 A horizontal bus
- Up to 600 A vertical bus
- Outdoor, rainproof, sleet-resistant enclosure (NEMA 3R)
- UL 845 Listed
- 0–600 Vac, 3-phase, 3-wire or 4-wire
- Non-walk-in
- The following table shows the drive and soft start units available for mounting in a NEMA 3R MCC.

Table 1: Drive and Soft Start Units Available for NEMA 3R MCC

Device	Horsepower
Altistart® soft starters	1–200 hp, 208 V 1–200 hp, 240 V 1–500 hp, 480 V 1–600 hp, 600 V
Altivar® AC drives[1] (constant torque)[2]	1–40 hp, 480 V 1–15 hp, 208/230 V

[1] A maximum of four Altivar drives are allowed in a single section. Mount drive units starting at the top of the section.

[2] Use constant torque ratings for variable torque applications. For information on drive space requirements, refer to Square D document no. 8998CT9701__.

Schneider Electric USA
1990 Sandifer Blvd.
Seneca, SC 29678 USA
1-888-SquareD (1-888-778-2733)
www.us.SquareD.com

Appendix F

Mechanical

Pump Station

Hydraulic Calculations

The Dalles Dam AWS Pump Station Hydraulic Calculations - Gravity Flow Section

Calculations by:	K. Nelson	1/19/2012	Checked by:	A. Petrasek	1/24/2012

Elevations	
Fishlock WS Elev	109

Pipe Information	
C - Low	110
C - High	145
Pipe Diameter	132.0 in
Pipe Length	170.0 ft

Flow	
Total system flow	1,000 cfs
Total system flow	448,000 gpm
Velocity	10.50

Friction Losses	
Sum of fitting losses (K)	1.9
Minor losses (ft)	0.26 ft water
High C Friction (ft)	0.40 ft water

Junction Box Elevations	
Downstream WS Elev =	109.7
Downstream WS Elev Rounded =	110.0
Crest Height above DS WS =	5
Crest Elev =	115.0
Junction Box Diameter	30
Percentage of Box = Weir	0.33
Weir Length =	31.10
Weir Height =	4.53
Upstream WS Elev =	119.5

Minor Losses (H_m) Pipe 1

Item	**Fittings**	**No.**	**K factor**	**K**
1	Entrance	1	0.50	0.5
2	Gate Valves	0	0.10	0
3	Ball Valves	0	0.04	0
4	Butterfly Valves	1	0.35	0.35
5	Plug Valves	0	0.23	0
6	Basket Strainer	0	1.30	0
7	90^o Elbow	0	0.39	0
8	45^o Elbow	0	0.21	0
9	Flow thru Tee	0	0.26	0
10	Branch Tee	0	0.78	0
11	Increaser/Reducer	0	0.04	0
12	Exit	1	1.00	1
			Sum (ΣnK)	**1.85**

The Dalles Dam AWS Pump Station Hydraulic Calculations - Pressure Section

Calculations by:	K. Nelson	1/19/2012	Checked by:	A. Petrasek	1/24/2012

Elevations	
Intake WS Elev - low	72.5
Intake WS Elev - high	90
JB WS Elev	120.0
CL of Pipe Elev	100

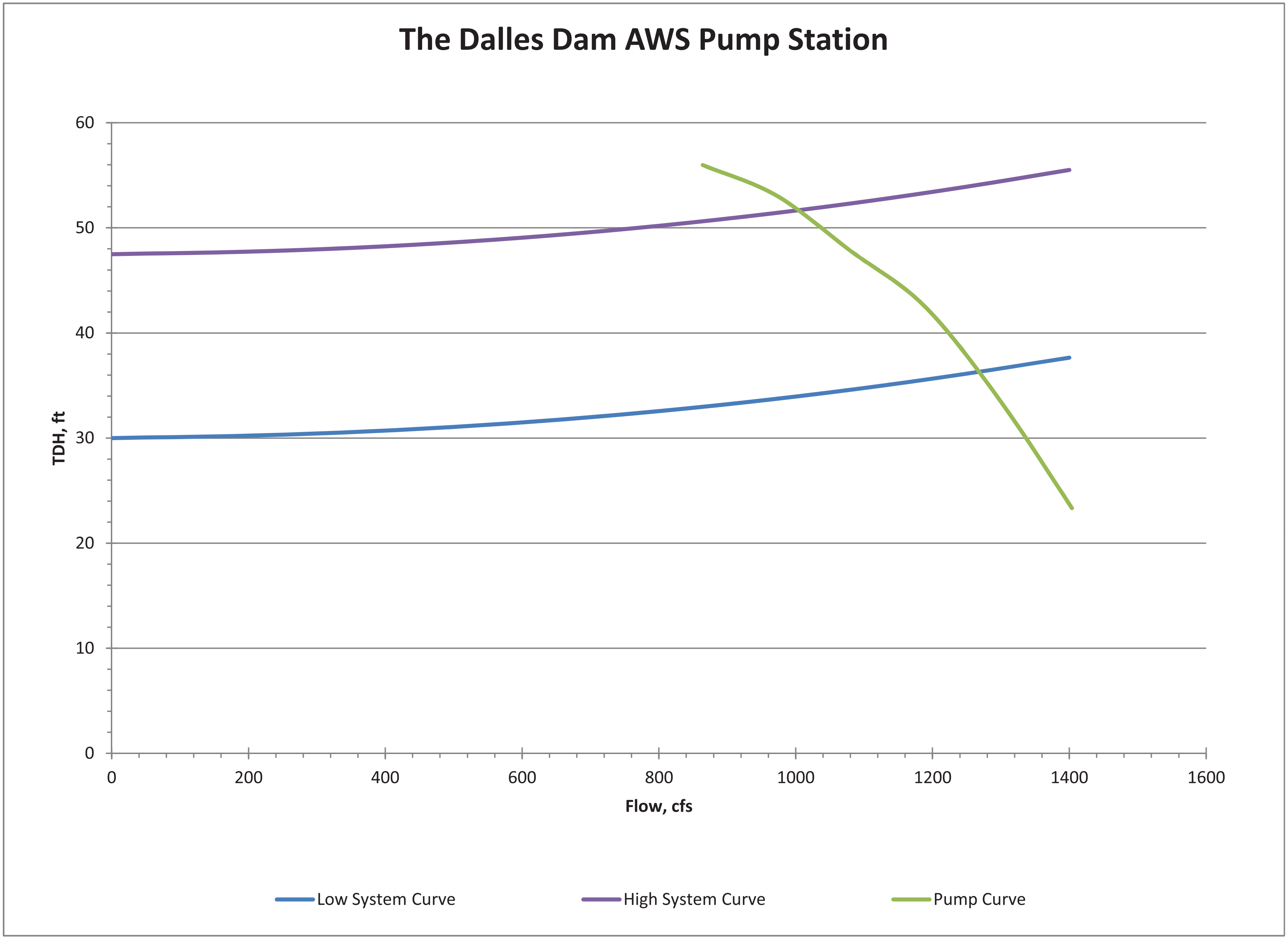
Pipe Information	
C - Low	110
C - High	145
Pipe Diameter	132.0 in
Pipe Length	200.0 ft

Minor Losses	
Trash rack loss	1.0 in
Sum of fitting losses (K)	2.1

Minor Losses (H_m) Pipe 1				
Item	**Fittings**	**No.**	**K factor**	**K**
1	Entrance	1	0.50	0.5
2	Gate Valves	0	0.10	0
3	Ball Valves	0	0.04	0
4	Butterfly Valves	0	0.35	0
5	Plug Valves	0	0.23	0
6	Basket Strainer	0	1.30	0
7	90^o Elbow	1	0.39	0.39
8	45^o Elbow	1	0.21	0.21
9	Flow thru Tee	0	0.26	0
10	Branch Tee	0	0.78	0
11	Increaser/Reducer	0	0.04	0
12	Exit	1	1.00	1
			Sum (ΣnK)	**2.1**

High System Curve						HP @ 1000 cfs, 85% eff =	6,874 hp
		Static Head	Velocity	Dynamic Losses			Total Discharge
Flow (cfs)	Flow (gpm)	(ft)	(ft/sec)	Friction (ft)	Minor (ft)	Total (ft)	Head (ft)
0	0	47.5	0.00	0.00	0	0.00	47.50
200	89600	47.5	2.10	0.02	0.23	0.25	47.75
400	179200	47.5	4.20	0.09	0.66	0.75	48.25
600	268800	47.5	6.30	0.18	1.38	1.56	49.06
800	358400	47.5	8.40	0.31	2.39	2.70	50.20
1000	448000	47.5	10.50	0.47	3.68	4.15	51.65
1200	537600	47.5	12.60	0.66	5.26	5.92	53.42
1400	627200	47.5	14.71	0.87	7.13	8.01	55.51

Low System Curve						HP @ 1000 cfs, 85% eff =	4,520 hp
		Static Head	Velocity	Dynamic Losses			Total Discharge
Flow (cfs)	Flow (gpm)	(ft)	(ft/sec)	Friction (ft)	Minor (ft)	Total (ft)	Head (ft)
0	0	30.0	0.00	0.00	0	0.00	30.00
200	89600	30.0	2.10	0.01	0.23	0.24	30.24
400	179200	30.0	4.20	0.05	0.66	0.71	30.71
600	268800	30.0	6.30	0.11	1.38	1.49	31.49
800	358400	30.0	8.40	0.19	2.39	2.57	32.57
1000	448000	30.0	10.50	0.28	3.68	3.96	33.96
1200	537600	30.0	12.60	0.39	5.26	5.66	35.66
1400	627200	30.0	14.71	0.52	7.13	7.66	37.66


The Dalles Dam AWS Pump Station
TDH, ft
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
Flow, cfs
Low System Curve
High System Curve
Pump Curve

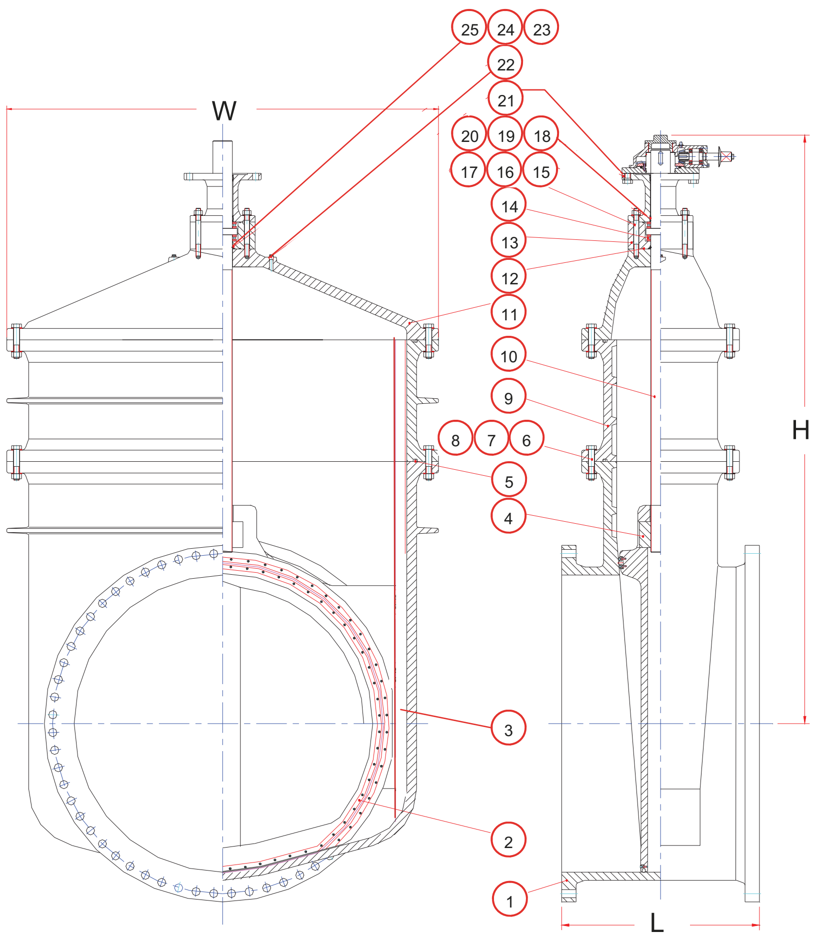
The Dalles Dam EFL AWS - Pump Station Intake Calculations		
Based on HI 9.8-1998		
Intake Design Parameter	**Equation/Basis**	**Result**
Flow (Q)		1,000 cfs
Inlet Velocity (V)		5.5 ft/s
Suction Inlet (D)	D = SQRT((4*Q)/(PI*V))	15.0 ft
Bell Floor Clearance (C)	C = 0.5*D	7.5 ft
Froude # (Fd)	Fd = (V)/((32.2*D)^0.5)	0.250
Req'd Submergence (S)	S = D*(1+2.3*Fd)	23.7 ft
Water Depth (H)	H = C + S	31.2 ft
Pump Bay Width (W)	W = 2*D	30.0 ft
Approach Velocity	Vapp = Q/(W*H)	1.1 ft/s
Pump Bay Length (X)	X = 3*D	45.0 ft
Back Wall Dimension (B)	B = 0.75*D	11.25 ft

Mechanical Equipment

Cut Sheets

Resilient Seated Solid Wedge Gate Valve with Bevel Gear Operator - Series 6800

AWWA C509 & C515 ▪ NRS Type ▪ FL x FL ▪ Sizes 54"- 72"



Spur gear configuration, available.
Gears can be rotated in90° increments.

No.	Part Name	Materials
1	Body	Ductile Iron ASTM A536 65-45-12
2	Wedge	Ductile Iron With EPDM seat
3	Wedge Nut	Bronze
4	Track	Stainless Steel ANSI 316
5	Gasket	EPDM
6	Bolts	ASTM 307B Zinc Plated
7	Nuts	ASTM 307B Zinc Plated
8	Washer	ASTM 307B Zinc Plated
9	Body Adaptor	Ductile Iron ASTM A536 65-45-12
10	Stem	Stainless Steel, Bronze Available
11	Bonnet	Ductile Iron ASTM A536 65-45-12
12	O-Ring	EPDM
13	Bearing Housing	Ductile Iron ASTM A536 65-45-12
14	Bearing	Stainless Steel AISI 304
15	Stud	ASTM 307B Zinc Plated
16	Nuts	ASTM 307B Zinc Plated
17	Washer	ASTM 307B Zinc Plated
18	Stem Bushing	Brass ASTM B16
19	O-Ring	EPDM
20	O-Ring	EPDM
21	Gear Adaptor	Ductile Iron ASTM A536 65-45-12
22	Pug	Brass ASTM B16
23	Bushing	Brass ASTM B16
24	O-Ring	EPDM
25	O-Ring	EPDM

Features:

- Design and Materials in Accordance With AWWA C509, C515 & C550.
- Flanges Conform to ANSI B16.1, Class 125.
- Ductile Iron, Body, Bonnet, Wedge, and Gland.
- Coated in accordance with AWWA C550.
- Stainless Steel Stem, Bronze Available.
- Ductile Iron Wedge with Mechanically Retained EPDM Seat.
- EPDM Gaskets and O-Rings.
- Available with Bypass.
- Handwheel Operator, 2" AWWA Ductile Iron Nut Operator, or Automatic Actuators Available.

Dimensions:

Size	Model	L	H	W	Approx. Weight
54"	6854	42"	124"	83"	24,300#
60"	6860	44"	132"	89"	30,900#
72"	6872	48"	198"	104"	59,500#

Larger Sizes Available Upon Request Thru 96"

2323 1st Street ▪ Huffman, TX 77336 ▪ Phone: 866.498.GATE (4283)
Fax: 281.324.6879 ▪ Email: sales@JandSValve.com ▪ www.JandSValve.com

RODNEY HUNT

Rodney Hunt

A ZURN *Company*

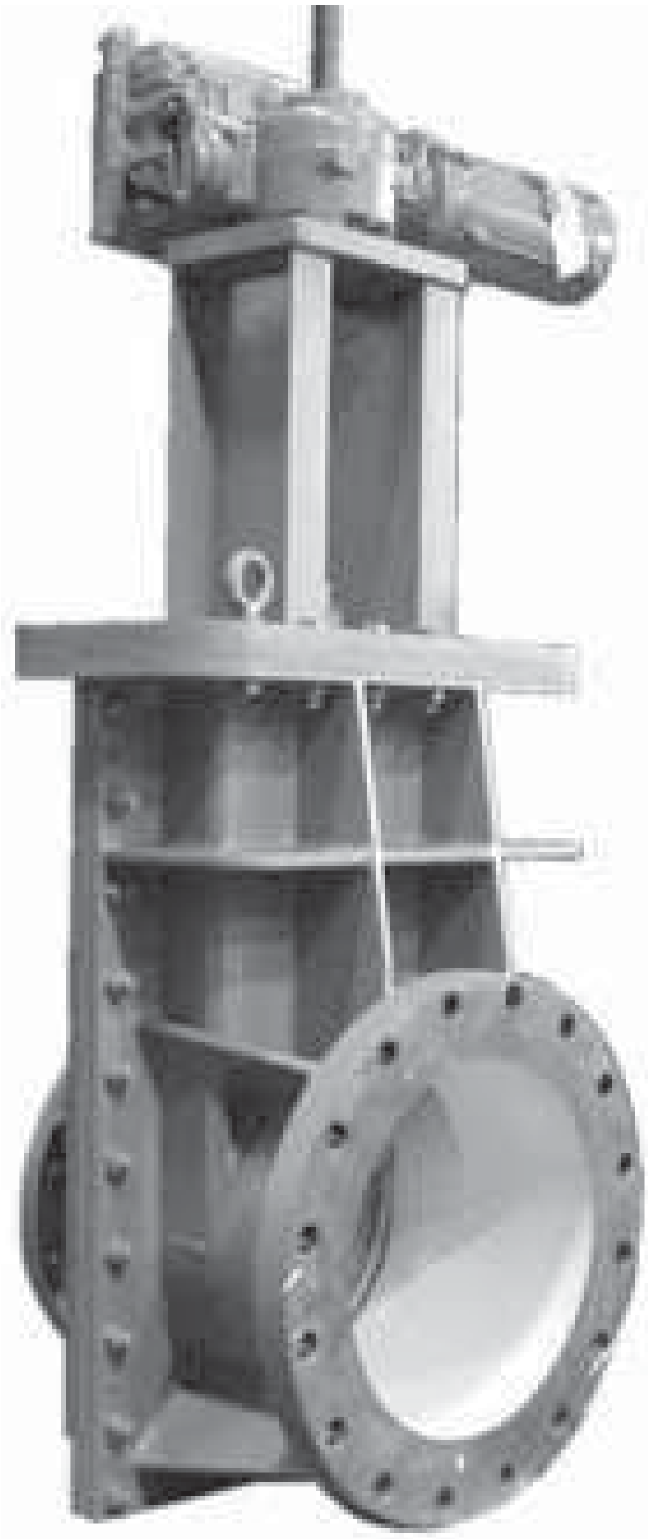
Jet Flow Gates

Jet Flow

Gates

RODNEY HUNT

Rodney Hunt Jet Flow Gates:



The Jet Flow gate is a fabricated valve that has the appearance of a bonneted gate valve. It is used in special applications for the modulation, occasionally at extreme low degrees of opening, of high flows and high pressures.

The Jet Flow gets its name in that immediately upstream of the gate leaf the waterway slopes conically inward. This conical section concentrates the flow into a jet. Hence the name *Jet Flow*.

The Jet Flow gate is used for flow modulation and energy dissipation. Normally, the Jet Flow gate discharges either freely or into an enlarged non-pressurized conduit. When discharging into a conduit it is necessary to vent air into the area immediately downstream of the gate leaf to stabilize the jet.

The Jet Flow gate was developed in the mid-1940's by the United States Bureau of Reclamation as a solution to the problem of cavitation damage in bonneted slide gates at low degrees of opening.

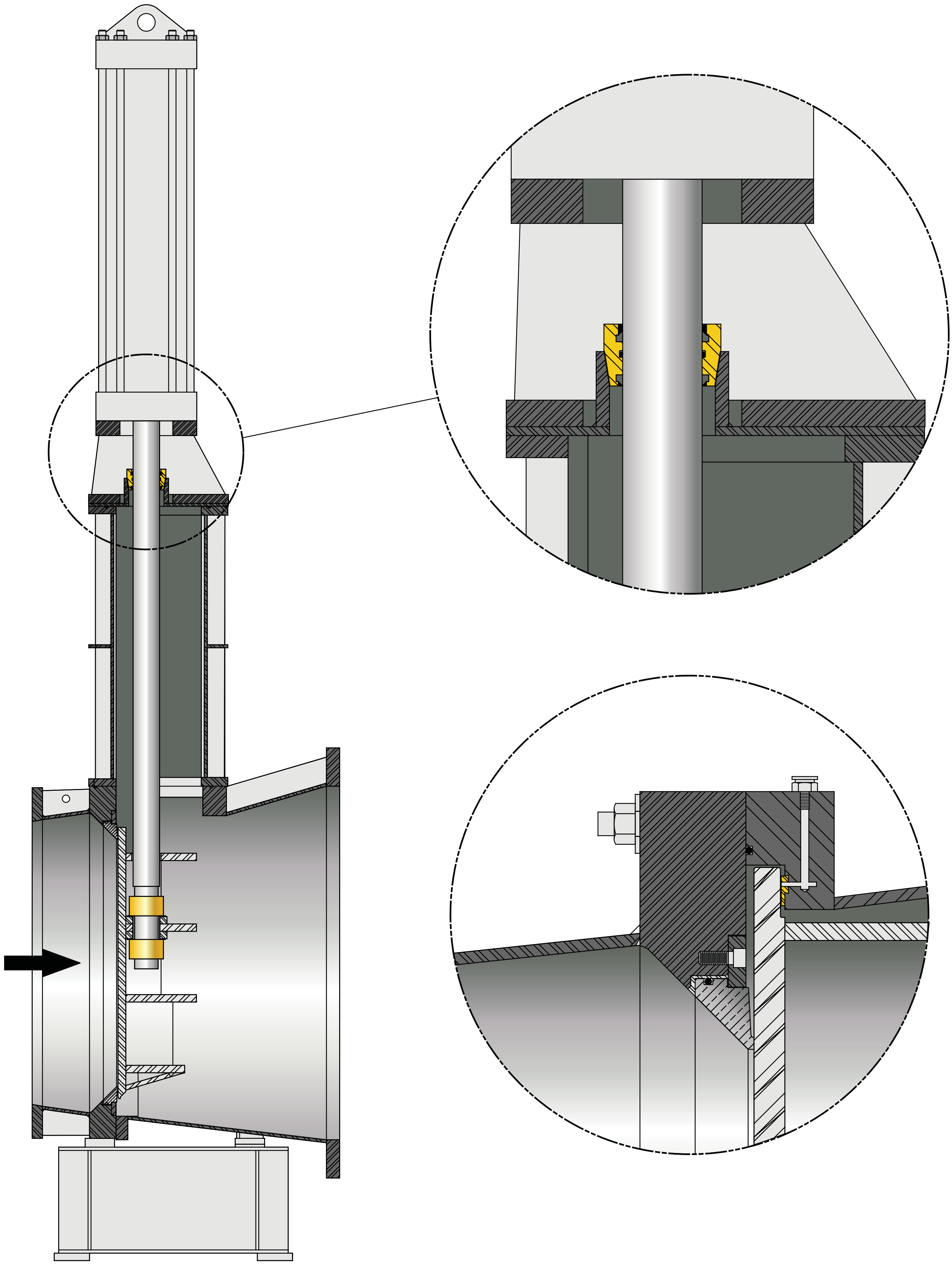
Jet Flow gates are used in similar applications to Howell-Bunger valves. The difference in the two types is the discharge pattern. The discharge from a Howell-Bunger valve is an energy dissipating spray whereas the Jet Flow gate is a high velocity jet.

The Jet Flow gate has a maximum head of approximately 500 feet, while the Howell-Bunger valve has a maximum head of about 1000 feet. There are a number of 95", 90" and 84", as well as smaller sizes, at various dams throughout the world. The simplicity and excellent flow regulation characteristics of Jet Flow gates have resulted in the development of standard designs in 10", 12" and 14" sizes by the Bureau of Reclamation.

Jet Flow gates operate smoothly without vibration or serious cavitation damage at any opening. However, under free discharge conditions there is considerable air demand at partial openings on the discharge side.

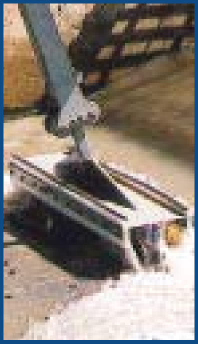
Jet Flow Gates:

RODNEY HUNT®



Atlas Polar Hydrorake Atlas Polar Hydrobrush Atlas Polar Log Lifter

Keeping the water flowing!



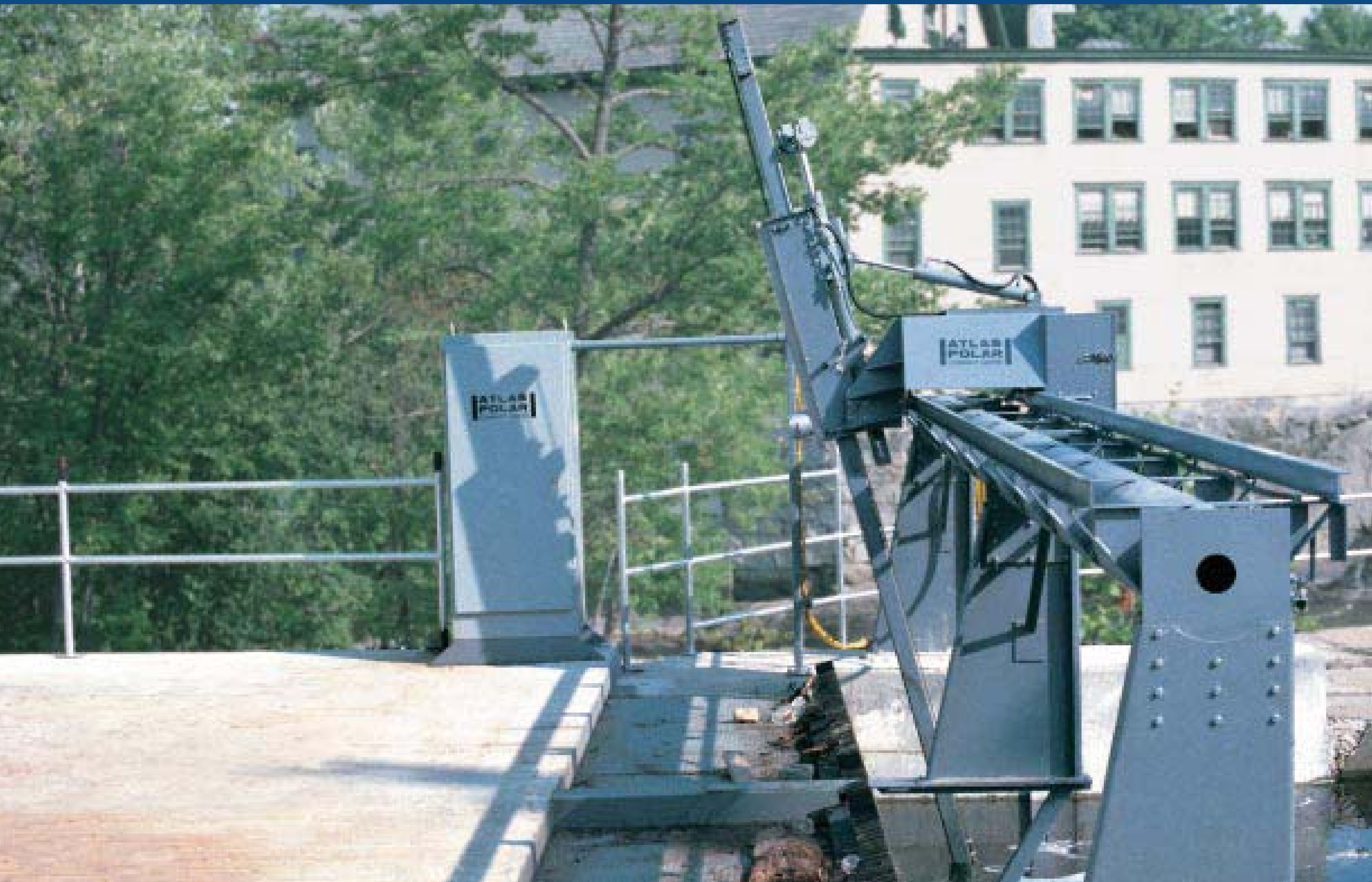
ATLAS POLAR

Delivering Customer Solutions Since 1938

Save time, labour and increase flow!

The Atlas Polar trash raking system cleans any gauge screen or bar rack. Installation upstream provides space for trash removal and deck access for personnel. The fully automatic system replaces handraking, which is still the most common method of rack maintenance. The Hydrorake imitates this action automatically 24 hours a day even in the coldest weather.

The Atlas Polar ST8000 Hydrorake System
The PLC control system permits tailoring the operational sequencing to any flow or debris conditions at each intake.



Put all the logs in their place... every time!

The Atlas Polar Stop Log Lifter is now established as an effective and efficient way to secure and remove logs, stack logs and retrieve and replace logs in the sluiceway. It replaces hand cranked winches that have their lifting hooks manually engaged.

The Atlas Polar LP2040 Stop Log Lifting Unit

Capable of engaging a log while a full head of water is passing over it. All operation is from a central console area with both gains visible to the operator.

Pressure and performance

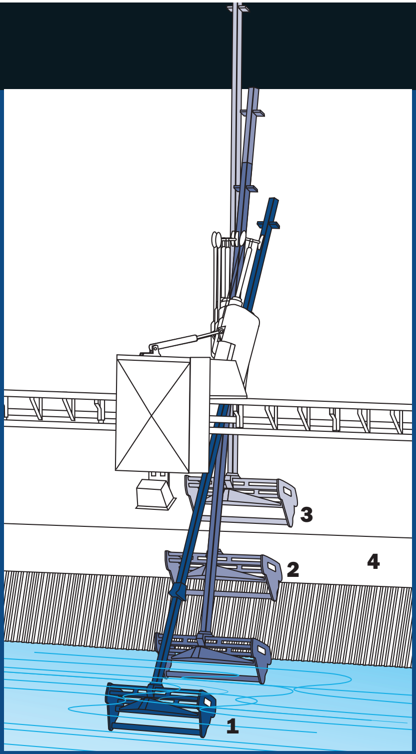
The lifting force of the unit is 20,000 lbs and the compacting force (jacking down) is 40,000 lbs. The unit will remove logs from any sluice and stack them on the deck.

Provide clean and friendly waterways!

Our latest innovation and an example of our commitment to respond to customer needs, the Atlas Polar Hydrobrush is ideal for fish monitoring or transfer facilities where keeping a constant flow through screens is essential.

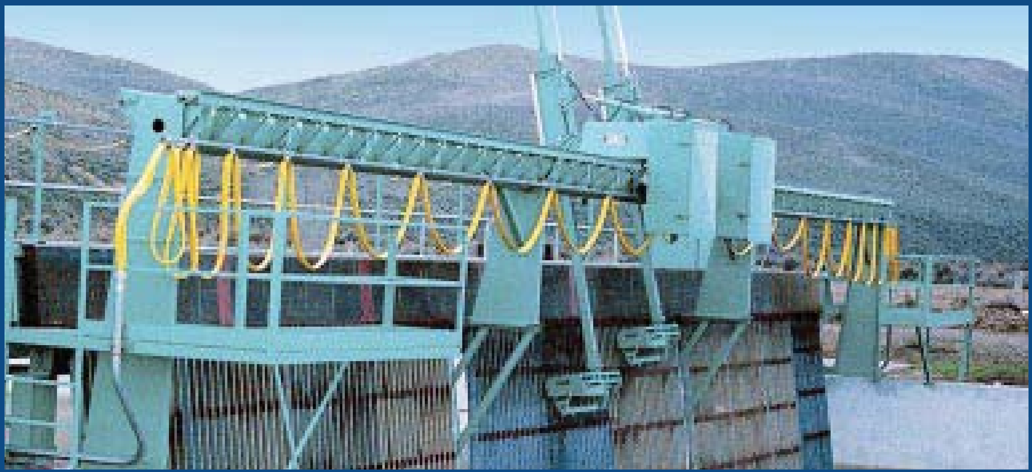
The Atlas Polar ST8100 Hydrobrush System

The specially designed Hydrobrush automatically cleans stainless steel screens travelling horizontally. The Atlas Polar Hydrobrush is ideal for water pump, fish monitoring, or transfer facilities. Any screen angle from vertical to 30 degrees can be brushed automatically.



How the Atlas Polar ST8000 Hydrorake System works

1. A telescopic boom with rake head extends into the water by means of a hydraulic/ mechanical boom system.
2. A hydraulic cylinder tilts the boom to hold the rake against the racks at a constant pressure while a second cylinder lifts the boom.
3. When the rake reaches the top of the racks it automatically dumps the debris into a spillway that runs the length of the intake.
4. The optional transporter/ spillway system then moves the debris to a collection area on either side of the intake.



The Atlas Polar ST8000 Hydrorake System

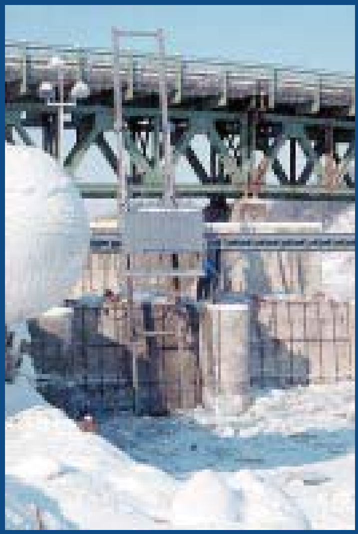
Multiple units can be used on the same rail system for intakes with large masses of debris such as the USBR fish screen protection barrier in central Washington state.

Twice the workload? ...Think twin boom!

A fast payback on your investment is ensured as facilities protected by the Hydrorake show increased flow efficiency, and reduced operation and maintenance costs. Also, crew moral and safety increase dramatically with this automatic system.

The Atlas Polar DT8300 Hydrorake System

The DT8300 twin-boom trash raking system is capable of lifting 4,000 lbs of debris and can reach to a depth of over 70 feet.



The Atlas Polar DT8300 Hydrorake System

As with the ST8000 model the DT8300 system cleans any gauge screen or bar rack. Installation upstream provides space for trash removal and deck access for personnel. The installation above and lower left utilized a conveyor system for debris removal.

Hand Held Remote Control

All Hydrorake systems come standard with a hand-held pendant station for manual operation.

Atlas Polar's Hydrorake Division has more than three decades of experience in the field. During that time we have built a reputation as the principal supplier of totally automated trashraking systems to the Hydropower and Water Management industries across North America.

Hydrorake

	Model ST8000	Model DT8300
Lift capacity	1,250 lbs. debris	4,000 lbs. debris
Raking depth	34 ft. below deck elevation	70 ft. below deck elevation
Rake boom design	Single and telescopic staging available	Double and telescopic staging available
PLC control	Auto control panel available with alternate hand-held controller. Control installation available in motor control center or in outdoor weather proof enclosure.	Auto control panel available with alternate hand-held controller. Control installation available in motor control center or in outdoor weather proof enclosure.
Power supply	240/480/575V, 3 phase, 60 HZ	240/480/575V, 3 phase, 60 HZ
Parts	Standard production items, hi-interchangeability of parts	Standard production items, hi-interchangeability of parts
Hydraulic system	2,250 PSI	2,500 PSI
Inward rake pressure	Rake exerts an adjustable 200–300 lbs. pressure on trashracks during upward raking motion	Rake exerts an adjustable 300–500 lbs. pressure on trashracks during upward raking motion
Rakehead width	4 feet/custom	6 feet

Hydrobrush

	Model ST8100
Stainless steel wire orientation	Vertical
Brush/length	Double bristle/5 feet/custom
Brushing depth	40 feet
Screen angle	0° - 30° from vertical
Boom design	Single/double
PLC control	Auto control panel available with alternate hand-held controller. Control installation available in motor control centre or in outdoor weather proof enclosure.
Power supply	240/480/575V, 3 phase, 60 HZ
Side-travel speed	0 - 1.25 ft/sec.
Parts	Standard production items, hi-interchangeability of parts
Hydraulic system	Maximum 2,250 PSI
Inward brush pressure	Variable

Stop Log Lifter

	Model LP2040
Log size	12 or 14 inches wide, up to 29 ft. long
Rail centers	To suit
Sluice depth	30 feet
Boom system	Double telescopic
Power supply	240/480/575V, 3 phase, 60 HZ
Control station	Center console
Boom speed	25 ft./min. average
Side-travel speed	Variable to 50 ft./min.
Breakaway force	10,000 lbs. per boom
Compaction force	20,000 lbs. per boom
Iron style	Hook or spud
Log contact indication	Compactor plate mounted
Hydraulic system	3,000 PSI

Specifications subject to change

ATLAS POLAR

Delivering Customer Solutions Since 1938

Atlas Polar Company Limited 60 Northline Road Toronto ON M4B 3E5

Toll Free: 1 888 799-4422 Local: (416) 751-7740 Fax: (416) 751-2094 E-mail: mfg@atlaspolar.com Web: www.atlaspolar.com

BAILEY VALVE INC

moving water forward

B10 SLEEVE VALVE

Model B-10 Sleeve Valve
Inline Configuration

B10
SLEEVE VALVE
Model B-10 Sleeve Valve
Inline Configuration

"focused valve solutions for water applications"

BAILEY VALVE MODEL B-10
CV VERSUS STROKE

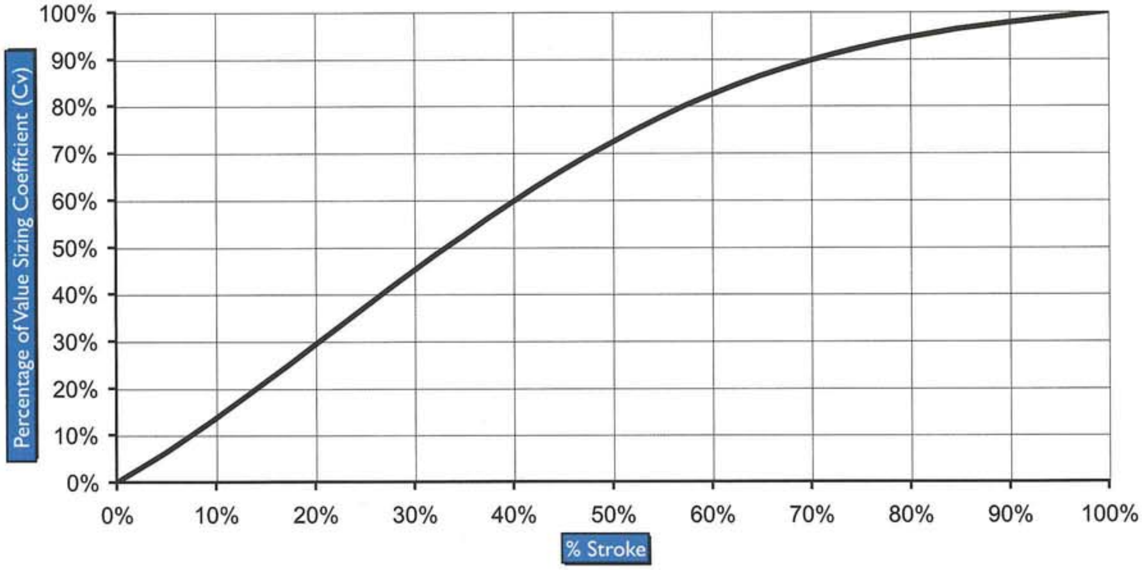


Table 1

Valve Size		Flow Rate (Based on 30 ft/sec port velocity)			
(in)	(mm)	gpm	cfs	mgd	cms
8	200	4698	10.47	6.76	0.30
10	250	7340	16.35	10.57	0.46
12	300	10570	23.55	15.22	0.67
14	350	14387	32.05	20.72	0.91
16	400	18791	41.87	27.06	1.19
18	450	23782	52.99	34.25	1.50
20	500	29361	65.42	42.28	1.85
24	600	42280	94.20	60.88	2.67
30	450	66062	147.19	95.13	4.17
36	900	95130	211.95	136.99	6.00
42	1000	129482	288.49	186.46	8.17
48	1200	169120	376.80	243.53	10.67
54	1400	214042	476.89	308.22	13.51
60	1500	264249	588.75	380.52	16.67
66	1670	319742	712.39	460.43	20.17
72	1820	380519	847.80	547.95	24.01

Table 2

Valve Size		Flow Coefficient (Cv)*						
(in)	(mm)	gpm/√psi	cfs/√psi	mgd/√psi	gpm/√ft	cfs/√ft	mgd/√ft	cms/√m
8	200	987	2.20	1.42	650	1.45	0.94	0.07
10	250	1548	3.45	2.23	1019	2.27	1.47	0.12
12	300	2232	4.97	3.21	1469	3.27	2.12	0.17
14	350	3040	6.77	4.38	2001	4.46	2.88	0.23
16	400	3973	8.85	5.72	2615	5.83	3.76	0.30
18	450	5029	11.21	7.24	3310	7.37	4.77	0.38
20	500	6210	13.84	8.94	4087	9.10	5.88	0.47
24	600	8942	19.92	12.88	5885	13.11	8.47	0.67
30	450	13972	31.13	20.12	9195	20.49	13.24	1.05
36	900	20117	44.82	28.97	13239	29.50	19.06	1.51
42	1000	27379	61.00	39.43	18018	40.14	25.95	2.06
48	1200	35756	79.66	51.49	23531	52.43	33.88	2.69
54	1400	45250	100.82	65.16	29779	66.35	42.88	3.40
60	1500	55860	124.46	80.44	36761	81.90	52.94	4.20
66	1670	67585	150.58	97.32	44478	99.10	64.05	5.08
72	1820	80427	179.19	115.82	52929	117.93	76.22	6.05

** Cv values are not guaranteed. They are typical and within 5%*

FEATURES:

1:1 Stroke To Diameter Ratio:

- Provides better flow control over short stroke configuration by increasing the sleeve nozzle spacing
- Reduces the risk of oscillating on the seat under low flow and high delta P condition
- Allows for more cavitation dissipation inside valve compared to shorter stroke valves
- Reduces vibration by spreading discharge energy over broader range compared to shorter stroke valves
- High flow turndown allows the use of one valve in lieu of multiple parallel valves.

Stellite Hardfaced Valve Gate:

- Provides superior hard surface edge to reduce high velocity erosion of the seating and wear surfaces
- Creates dissimilar hardness in non-bound mating materials
- Provides leading edge hardness sufficient to shear debris within the nozzle

Custom Valve Configuration:

- Allows for flange matching between valve and associated piping
- Multiple access options
- Valve material options (Carbon Steel, Stainless Steel)

Actuation Configurations:

- Electric Motor Operated
- Oil Hydraulic Operated w/ Hydraulic Power unit
- Water Hydraulic Operated from pipeline pressure

Valve Function:

- Pressure reduction
- Pressure sustaining
- Flow control

SLEEVE VALVE SIZING

Once the Bailey valve configuration (Inline, Y-Pattern, submerged, angle or non-modulating) has been selected, the next step in choosing the best solution for the application is sizing the valve for the operating conditions. This is first done by collecting key data, which will be used to determine the severity of cavitation as indicated by the cavitation index sigma (σ), velocity flow and flow capacities (Cv).

Step 1 - Data

Maximum Flow Rate → Qmax
Inlet Pressure at Qmax → Pi @ Qmax
Outlet Pressure at Qmax → Po @ Qmax
Minimum Flow Rate → Qmin
Inlet Pressure at Qmin → Pi @ Qmin
Outlet Pressure at Qmin → Po @ Qmin

Step 2 - Sigma

The sigma value or cavitation index is calculated and used to configure the performance class of sleeve valve or to determine if alternate options such as ball valves or butterfly valves are acceptable for the application conditions. The following equation is used to calculate the sigma value:

$$\sigma = Po - Pv / Pi - Po$$

Where:
Pi = Inlet Pressure (psig)
Po = Outlet Pressure (psig)
Pv = Vapor pressure (-14.6 psig for 60°F water at sea level)

** Contact Factory for assistance if σ is less than 0.15*

Step 3 - Velocity Flow

The maximum flow rate (Qmax) is compared to Table 1 to determine the corresponding valve size based on an allowable continuous velocity of 30 ft/sec through the valve port. Higher velocities can be attained for intermittent operating conditions and it is recommended that you contact the factory for sizing. Your flow rate should be rounded up to the next table corresponding valve size noted (or recorded). Various units are provided for simplicity.

Step 4 - Flow Capacities (Cv)

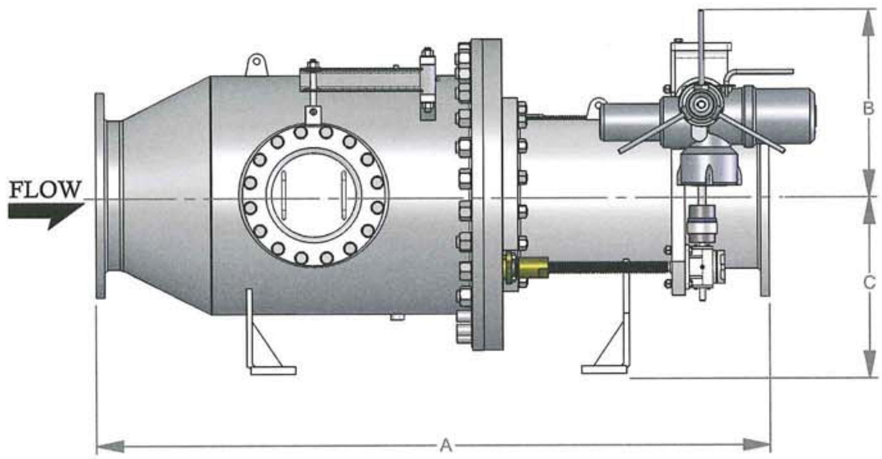
The maximum flow rate (Qmax) and associated inlet pressure (Pi) and outlet pressure (Po) are used to calculate the required Flow Capacity of Cv of the application. The Cv equation is as follows:

$$Cv = Q / \sqrt{(Pi-Po)}$$

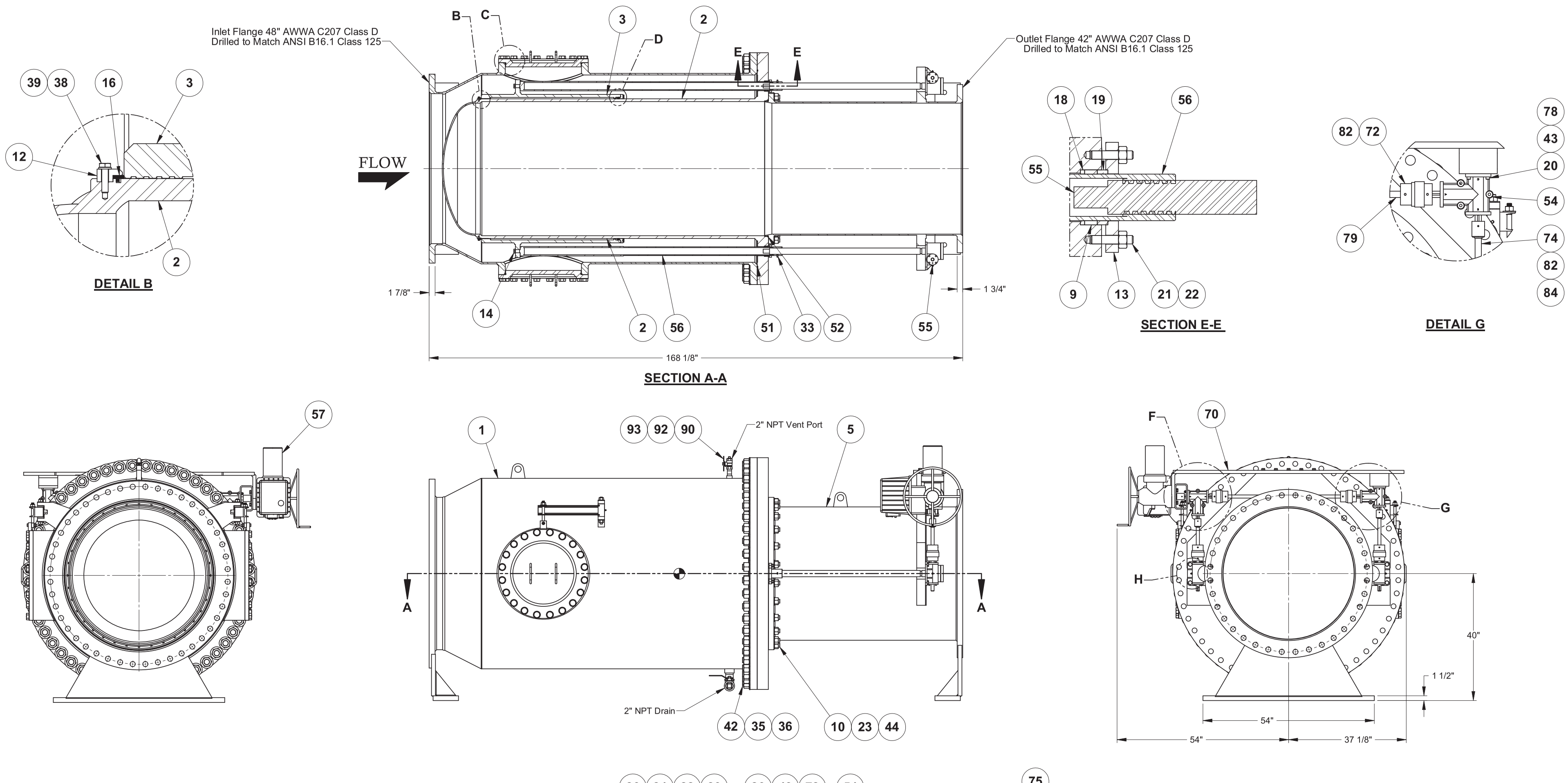
Once the application Cv is calculated from the above equation, a safety factor of 20% is added to the value for valve Cv deviation and potentional nozzle fouling from entrapped debris within the flow media. The Cv plus 20% value (C20) is compared to table 2 to determine the appropriate valve size for the application. The chosen valve size must have a higher capacity than the C20 calculated from the operating conditions. The valve size chosen from the Cv table is then compared to the valve size chosen from the previous table1 and the larger of the two valves is the correct size for the application coditions.

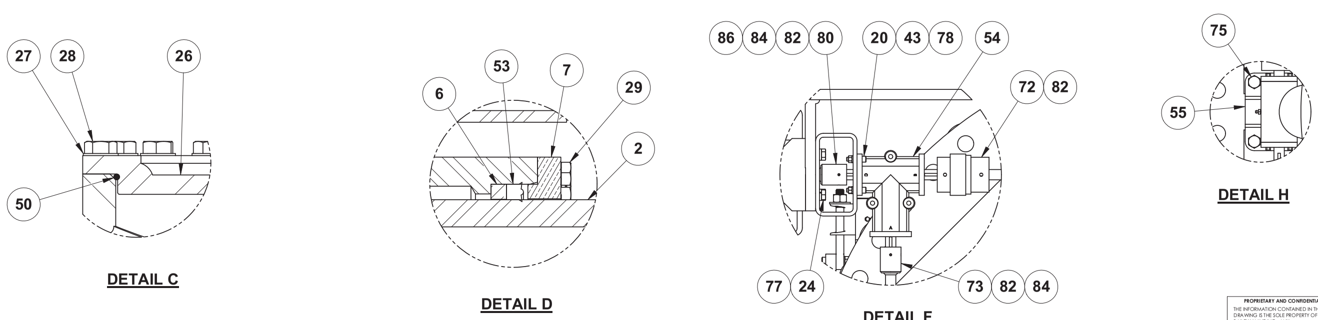
"focused valve solutions for water applications"

DIMENSIONS



Valve Size		A		B		C	
(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)
8	200	70	1778	18	457	15	381
10	250	76	1930	20	508	17	432
12	300	82	2083	22	559	19	483
14	350	88	2235	23	584	20	508
16	400	94	2388	24	610	21	533
18	450	100	2540	24	610	22	559
20	500	106	2692	25	635	24	610
24	600	118	2997	27	686	26	660
30	750	136	3454	30	762	29	737
36	900	152	3861	34	864	36	914
42	1000	170	4318	37	940	39	991
48	1200	188	4775	40	1016	43	1092
54	1400	206	5232	44	1118	47	1194
60	1500	224	5690	50	1270	53	1346
72	1800	260	6604	56	1422	60	1524





NOTES:

1. Valve pressure rating by flanges - 150 psig.
2. Valve is coated with System #44 Amerlock 400 Epoxy in accordance with Specfication 09900.
3. Items 14, 29 and 38 are safety wired with 0.032 diameter stainless steel wire.
4. All O-rings and Polypak Seals are lubricated with FDA white food grade grease.
5. Items 38 are assembled using Loctite #242. All other fasteners are assembled using Loctite Food Grade Anti-Sieze compound.

REV	DATE	BY	APPROVED
F	2008 10-17	KAF	JDE
E	2008 03-11	KAF	JDE
D	2008 02-07	KAF	JDE
C	2007 09-13	KAF	JDE
B	2007 09-12	KAF	JDE
A	2007 06-19	KAF	JDE
2	2007 05-30	JDE	JDE

APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±1/16
TWO PLACE DECIMAL ±.02
THREE PLACE DECIMAL ±.005

LAST REVISION
Item 1 was p/n 123-001 in error

MATERIAL - AS NOTED

	NAME	DATE
DRAWN	JDE	05-01-07
APPROVED	JDE	05-01-07

COMMENTS:
Carter Lake

BAILEY VALVE INC
FRESNO, CA. USA

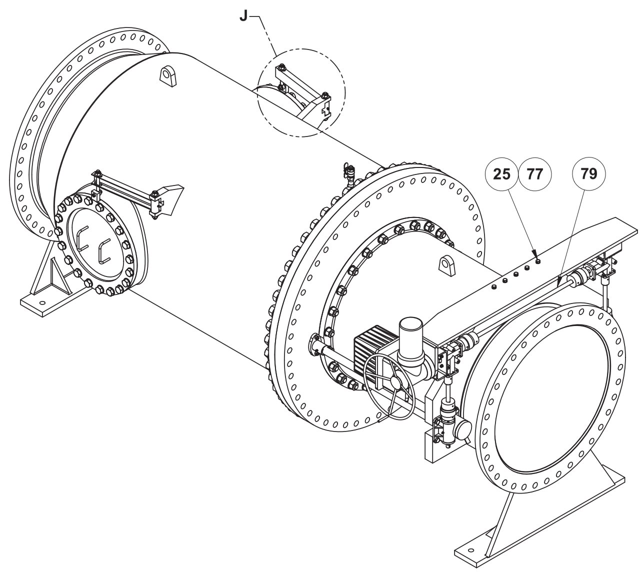
TITLE:
Assembly Drawing
B10 - 48 x 42"

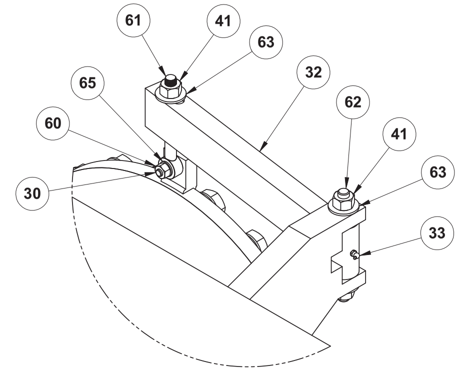
SIZE D | DWG. NO. 125-000 | REV F

SCALE: 1:16 | Weight: 15000.00 | SHEET 1 OF 2

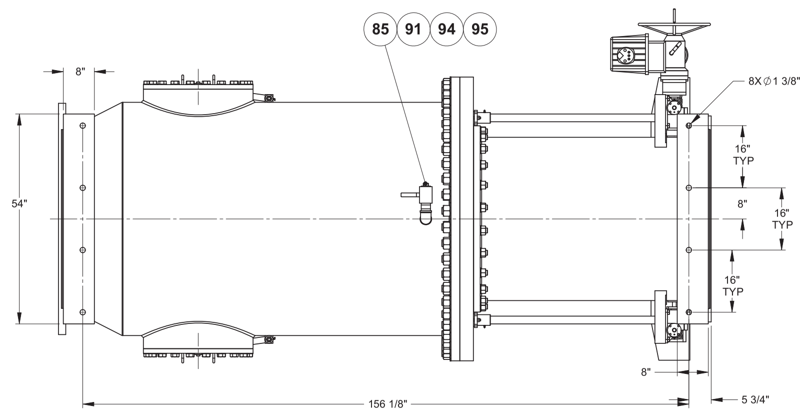
D 125-000 REV F

ITEM NO.	PART NUMBER	QTY.	DESCRIPTION	MATERIAL
1	125-001	1	Inlet Body	ASTM-A516 Gr 70, ASTM-A36
2	125-002	1	Sleeve	ASTM-A182 Gr 304L, A240 Type 304L, ASTM-A516 Gr 70
3	125-003	1	Gate	ASTM-A240 Type 304L
5	123-005	1	Outlet Body	ASTM-A516 Gr 70, A-36,
6	125-006	1	Scraper Ring	ASTM-B148 Alloy 95200
7	125-007	1	Gland	ASTM-B148 Alloy 95200
9	125-009	2	Packing 2.75 ID x .25 w, 4 Rings + Top & Bottom	Garlock #432
10	125-010	24	Tap-end Stud, 1-1/4-8 UN x 5 " Lg	ASTM-A193 Grade B7
12	125-012	1	Seat Ring	ASTM-A240/A276 Type 304L
13	125-013	2	Gland	ASTM-A240 Type 304L
14	125-014	4	Hex Bolt-Drilled, 3/4"-10 UNCx 2-1/2 Lg	304 SS
16	125-016	1	Seat Seal - 140" Lg	Buna-N, 70 Durometer
18	125-018	2	Drive Tube Scraper Ring	ASTM-B139 Alloy 51000
19	125-019	2	Drive Tube Gland Ring	ASTM B139 Alloy 51000
20	104-0050	8	Socket Head Cap Screw, 3/8-16 x 1-1/2 Lg	304 SS
21	109-0021	4	Tap-end Stud, 1/2-13 UNC-2B x 2-1/2 " Lg	18/8 SS
22	123-022	4	Elastic Stop Nut, 1/2-13 UNC	18-8 SS
23	101-0035	24	Heavy Hex Nut, 1-1/4-8 UN	ASTM-A194 Gr 2H
24	124-031	4	Hex Head Cap Screw, 5/8"-11 UNCx 2-1/2 Lg	18/8 SS
25	109-0025	5	Hex Bolt, 5/8-11 UNC x 2 Lg	18-8 SS
26	125-026	2	Clean-out	ASTM-A516 Gr. 70
27	125-027	40	Flat Washer, 1 1/8" Type A Narrow	Steel
28	125-028	40	Hex Bolt, 1 1/8-7 UNC x 3-1/4" Lg	ASTM-A193 Gr B7
29	125-029	40	Hex Bolt,Drilled, 1/2-13 UNC x 1.50 Lg	304 SS
30	110-0030	2	Shoulder Screw, 5/8 Dia x 1-3/4 Lg, 1/2-13	18/8 SS
32	125-032	2	Davit Arm	ASTM A36
33	101-0033	4	Grease Fitting, 1/8" angle	Plated Steel
35	125-035	52	Hex Nut, 1 3/4 - 8	ASTM B194 Grade 2H
36	125-036	52	Flat Washer, 1-3/4" Type B Reg., 1.88 ID x 4.0 OD x .25 Thk	Plated Steel
38	127-038	36	Hex Bolt-Drilled, 1/4-20 x 1 lg	316 SS
39	101-0039	36	Flat Washer, 1/4, Type B Narrow	304 SS
41	101-0041	6	Elastic Stop Nut, 3/4-10UNC	18/8 SS
42	125-042	52	Tap-end Stud, 1-3/4-8UN x 6.5 Lg	ASTM-A193 Grade B7
43	102-0043	8	Hex Nut, 3/8 -16 UNC	316 SS
44	105-0019	24	Washer, 1-1/4 Type A Narrow, 1.375 ID x 2.5 OD x .165 Thk	18/8 SS
50	125-050	2	O-Ring, 23-1/2 ID x .375 Dia	70 Durameter Buna-N
51	125-051	1	O-Ring, 61-5/16 ID x .275 Dia	70 Durameter Buna-N
52	125-052	1	O-Ring, 42.25 ID x .375 Dia	70 Durameter Buna-N
53	125-053	1	Polypak, 1/2 x 44 ID	Molythane
54	109-0054	2	Angle Gear	Andantex R3590
55	125-055	2	Lift Jack - 10 Ton	Duff Norton DM9011
56	125-056	2	Drive Screw Tube	ASTM A240/276/312 304L SS
57	125-057	1	Actuator	Limitorque L120-40
60	110-0060	2	Hex Nut, 1/2-13 UNC	18/8 SS
61	110-0061	2	Rod End	Type 304 Stainless Steel
62	101-0062	2	Davit Pivot	ASTM-A276 Type 304L
63	117-0063	6	Flat Washer, 3/4 Dia Type "A" Wide	304 SS
65	102-0045	2	Flat Washer, 1/2" SAE	316 SS
70	125-070	1	Actuator Mounting Plate	Steel
72	125-072	4	U-Joint/Coupling Assy	Steel
73	125-073	1	Stem Adapter, 1" Shaft x 8-1/2" L	ASTM A276 Type 304 L
74	125-074	1	Stem Adapter, 1" Shaft x 11-1/4" L	ASTM A276 Type 304 L
75	125-075	8	Hex Cap Screw, 3/4-10 x 1-3/4 Lg	304 SS
77	110-0077	9	Lock Washer, Spring Type, 5/8	18/8, 304 or 316 SS
78	110-0078	8	3/8" Lock Washer, Heavy Duty	18/8, 304, or 316 SS
79	125-079	1	Shaft, 1 OD x 1/4 Key x 39-1/2 L	ASTM-A276 Type 304
80	125-080	1	Stem Adapter, 1" Shaft x 5-1/4" L	ASTM A276 Type 304 L
82	110-0082	12	Key - Square, 1/4" x 1-1/2" L	18-8 SS
84	110-0084	6	Set Screw - Cup Pt. SCHD, 1/4-20 x 3/8" L	18-8 SS
85	125-085	1	Pipe Plug - 3000#, 2" NPT Sq Hd	Brass
86	110-0086	1	Retaining Ring-External, 1" Shaft	SS
90	125-090	1	Ball Valve, 1" NPT - 600 PSI, FEBCO	Bronze
91	125-091	1	Elbow - 90 deg, 2" NPT Class 125	Brass
92	117-0080	1	Nipple, 1 x 3" lg	Brass
93	125-093	1	Pipe Plug - 3000#, 1" NPT Sq Hd	Brass
94	117-0081	2	Nipple, 2 x 3" lg	Brass
95	117-0084	1	2" Ball Valve, 600 PSI, FEBCO	Brass





DETAIL J



FOUNDATION MOUNTING DETAIL

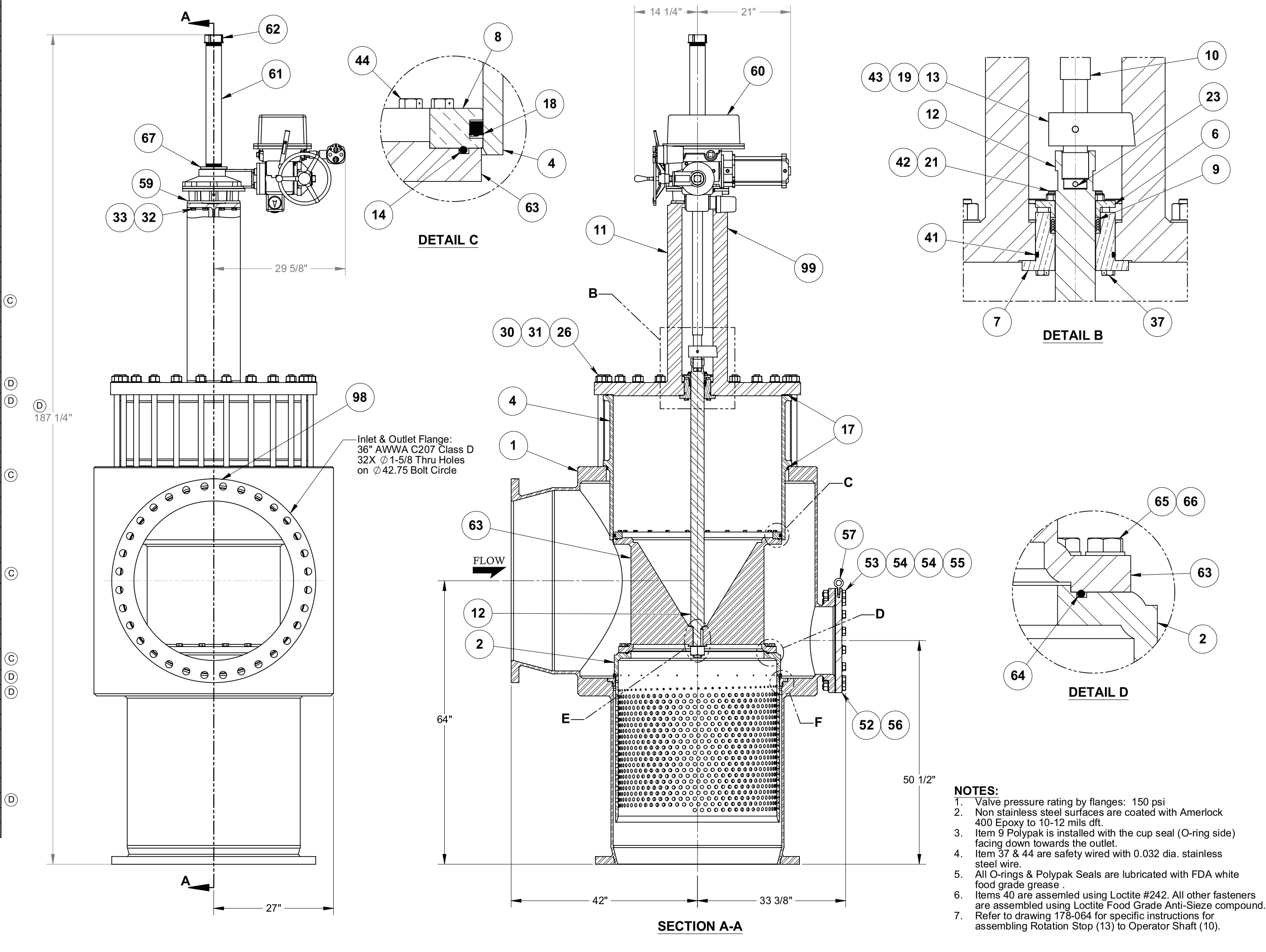
BAILEY VALVE INC
FRESNO, CA. USA

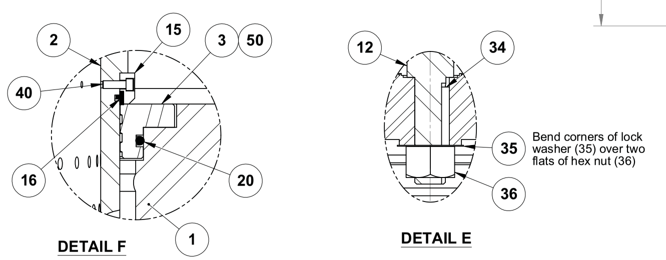
TITLE: Assembly Drawing
B10 - 48 x 42"

SIZE	DWG. NO.	REV
D	125-000	F

SCALE: 1:12 | SHEET 2 OF 2

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	MATERIAL	
1	1	178-001	Body	ASTM A516 Gr 70/A53 Type E Gr B/A105	
2	1	178-002	Sleeve	ASTM A240 Type 304L	
3	1	178-003	Seat Ring	ASTM A240 Type 304L/Stellite	
4	1	178-004	Cylinder	ASTM A240 Type 304L	
6	1	23194	Gland	ASTM-B584 Alloy-C92200	
7	1	24216	Stuffing Box	ASTM-B584 Alloy-C92200	
8	1	39558	Piston Liner	ASTM-B584 Alloy 92200	
9	1	69862488	Packing, 3/8 W x 3 ID (4 Rings)	Garlock #432	
10	1	39560	Operator Stem	ASTM-A276 Type 304	
11	1	178-011	Stem Housing	ASTM A516 Gr 70, A36, A240 Type 304L	
12	1	178-012	Lower Stem	ASTM-A276 Type 304	
13	1	32605	Rotation Stop	ASTM B584-C86300	
14	1	33956272	O-Ring, 36-1/4 ID x .275 Dia	Buna-N, Parker Compound N674-70	
15	1	178-015	Seat Holder	ASTM A240/A276 Type 304L	
16	1	33182872	T-Seal, 10 Feet	Buna-N (70 Duro)	
17	2	33386872	O-Ring, 40-1/2 ID x .275 W	Buna-N, Parker Compound N674-70	
18	1	38370008	Polypak, Urethane, 37 ID x 1/2 W	#4615-50037000 or Eq	
19	1	32590	Taper Pin	AISI 4140 Steel	
20	1	33313472	O-Ring, 38 ID x .275W	Buna-N	
21	4	178-021	Tap-end Stud, 1/2-13 x 2-1/4 " Lg	ASTM A193 Gr B8	C
23	1	1R060027	Pin, 3/8" OD x 3	ASTM-B98 Alloy-C65500	
26	24	178-026	Stud Tap-End, 1 1/4-8 x 22 L	AISI 4140 Steel	
30	24	532124AN	Flat Washer, 1-1/4 Type SAE, 1.375 ID x 2.50 OD x .165 T	Steel	
31	24	52128200	Heavy Hex Nut, 1-1/4-8	ASTM-A194 Gr 2H	
32	8	124-031	Hex Head Cap Screw, 5/8"-11 UNCx 2-1/2 Lg	18/8 SS	D
33	8	178-033	Lock Washer - Spring Type, 5/8"	18-8 SS	D
34	1	178-034	Sq Key, 1/2" x 3-3/4" Lg	316 SS	
35	1	154-022	Lock Washer	ASTM-A276 Type 316	
36	1	154-086	Heavy Hex Nut, 2-8 UN	ASTM-A194 Gr B8	
37	4	51061710	Capscrew -Drilled, 1/2-13 x 1-1/4 L	ASTM F593 Alloy 304 CW	
40	24	178-040	Hex Sckt Hd CS, 1/4-28 x 3/4" L	316 SS	C
41	1	39843372	O-Ring, 5-1/2 ID x .275 Dia (-433)	70 Durometer Buna-N	
42	4	52351700	Nut -Elastic Stop, 1/2-13 UNC	18-8 SS	
43	1	52351500	Elastic Stop-Nut, 3/8-16	18-8 Stainless Steel	
44	24	51061718	Hex Head Cap Screw-Drilled, 1/2-13 x 2-1/4L	ASTM A593 Alloy 304 CW	
50	20	178-050	Hex Sckt Hd CS, 1/2-13 x 1" Lg	ASTM A593 Alloy 304CW	
52	1	178-052	Blind Flange. 16" ANSI Class 150 FF w/Eyebolt Tap	ASTM-A36	C
53	16	51172236	Hex Head Cap Screw, 1-8 UNC x 4-1/2 L	ASTM F593 Alloy 316 CW	
54	32	532022AN	Flat Washer, 1", Type "SAE"	Plated Steel	
55	16	521222HH	Heavy Hex Nut, 1-8	ASTM A194 Grade 2H	
56	1	43786681	Gasket, 16" Class 125/150, Full Faced	1/8" Non-Asbestos	
57	1	178-057	Lifting Eyebolt -2400#, 1/2-13 x 1-1/2" Lg Thd	Forged Plain Steel, McMaster #3013T491	C
59	1	178-059	Actuator Adapter	ASTM-A516 Gr 70	D
60	1	178-060	Actuator	Limitorque SMB-00/B320-50	D
61	1	163-061	3" NPT Nipple x 30" L	Galvanized Steel	
62	1	113-063	Pipe Cap, 3" NPT	Galv Malleable Iron	
63	1	178-063	Piston	ASTM-A516 Gr 70/A36/A276 Gr 304L	
64	1	32494072	O-Ring, 31-1/2 ID x .275 Dia	Buna-N	
65	20	51062018	Hex Bolt, 3/4-10 x 2-1/4 L	ASTM-B193 Grade B8	
66	20	532520AN	Flat Washer, 3/4, Type "SAE"	316 SS McMaster #91950A036	
67	1	178-067	Pipe Bushing, 5" x 3" NPT	Galv Malleable Iron	D
98	1	31980	Nameplate - Inlet	304 SS	
99	1	900-0004	Nameplate - Bailey	304 SS	





NOTES:

1. Valve pressure rating by flanges: 150 psi
2. Non stainless steel surfaces are coated with Amerlock 400 Epoxy to 10-12 mils dft.
3. Item 9 Polypak is installed with the cup seal (O-ring side) facing down towards the outlet.
4. Item 37 & 44 are safety wired with 0.032 dia. stainless steel wire.
5. All O-rings & Polypak Seals are lubricated with FDA white food grade grease .
6. Items 40 are assemled using Loctite #242. All other fasteners are assembled using Loctite Food Grade Anti-Sieze compound.
7. Refer to drawing 178-064 for specific instructions for assembling Rotation Stop (13) to Operator Shaft (10).

THIRD ANGLE PROJECTION

REV	DATE	BY	APPROVED
D	2011 11-14	KAF	JDE
C	2011 09-02	KAF	JDE
B	2011 05-24	KAF	JDE
A	2011 05-24	KAF	JDE
1	2011 04-06	KAF	JDE

APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
DIMENSIONS IN [ ] ARE IN MILLIMETERS
TOLERANCES:
FRACTIONAL ±1/16"
TWO PLACE DECIMAL ±.020
THREE PLACE DECIMAL ±.002
INTERPRET GEOMETRIC TOLERANCING PER: ANSI Y14.1

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF BAILEY VALVE INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF BAILEY VALVE INC. IS PROHIBITED.

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	KAF	04-06-11
CHECKED	JDE	

LAST REVISION
Item32 & 33 were size 3/4" - qty. 4, Item 60 gear was B320-40, added Items 59 & 67; dim 187 1/4" was 184 3/4"

COMMENTS:
San Joaquin Pipeline No's. 3 & 4 Throttling Station

BAILEY VALVE

TITLE:
Assembly Drawing
B12 - 36"

SIZE: D | DWG. NO.: 178-000 | REV: D
SCALE: 1:1 | WEIGHT:10,500 lbs | SHEET 1 OF 1

HILTON VALVE, INCORPORATED

Parts List

FIGURE: H-200-B

30" - 72" Bonneted Knife Gate Valve

ITEM #	QTY	DESCRIPTION	MATERIAL
1	1	VALVE BODY	CS/SS
2	1	BONNET	CS/SS
3	1	GATE	STAINLESS STEEL
4	1	STEM	STAINLESS STEEL
5	SET	PACKING	TFE/SYN FIBER
6	1	PACKING FOLLOWER	STAINLESS STEEL
7	1	YOKE	CARBON STEEL
8	1	BONNET GASKET	SYNTHETIC FIBER
9	1	STEM NUT	BRONZE
10	1	BEVEL GEAR OPERATOR	MFG. STD. [5]
11	1	HANDWHEEL	STEEL [5]
12	1	SEAL RING	VITON [3]

NOTES:

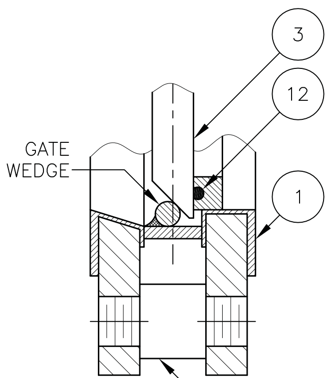
1) VALVE IS SHOWN WITH STANDARD STAINLESS STEEL WETTED PARTS, BUT IS AVAILABLE WITH ANY WELDABLE ALLOY. ALSO AVAILABLE IN SOLID ALLOY CONSTRUCTION.

[2] BOLT HOLES LOCATED IN CHEST AREA ARE THREADED BLIND.

[3] SEAL RING IS AVAILABLE IN VITON, TEFLON, BUNA N, NEOPRENE, POLYURETHANE, OR OTHER ELASTOMERS.

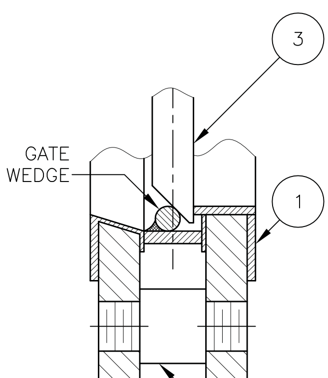
[4] STANDARD FLOW SHUT-OFF IS SHOWN. IF REVERSE FLOW SHUT-OFF IS REQUIRED, IT SHOULD BE SPECIFIED. SOME APPLICATIONS MAY REQUIRE SPECIAL GATE WEDGING.

[5] BEVEL GEARS WITH HANDWHEELS ARE FURNISHED STANDARD. A WIDE VARIETY OF MANUAL AND POWERED OPERATORS ARE AVAILABLE AS SHOWN IN THE OPERATORS SECTION.



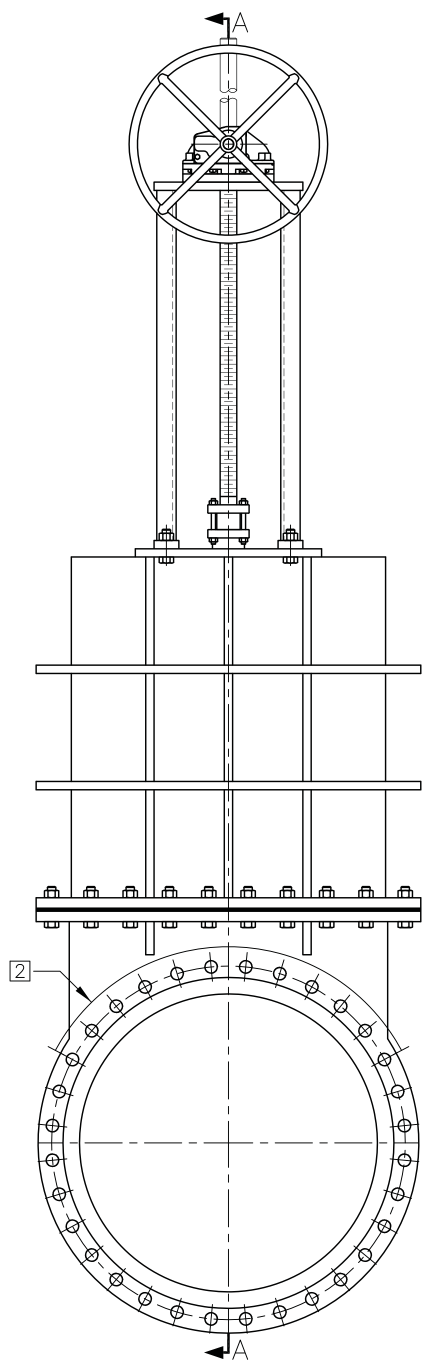
DETAIL B

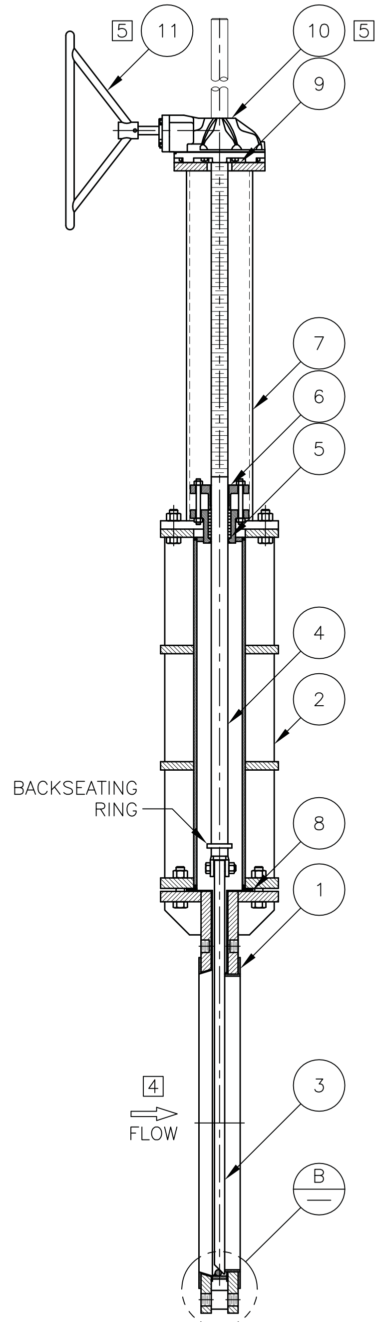
H-201-B
(OPTIONAL RESILIENT SEAT)



DETAIL B

H-200-B
(OPTIONAL METAL SEAT)





SECTION A-A

REVISED: 07/09/04

HILTON VALVE, INCORPORATED

Dimension List

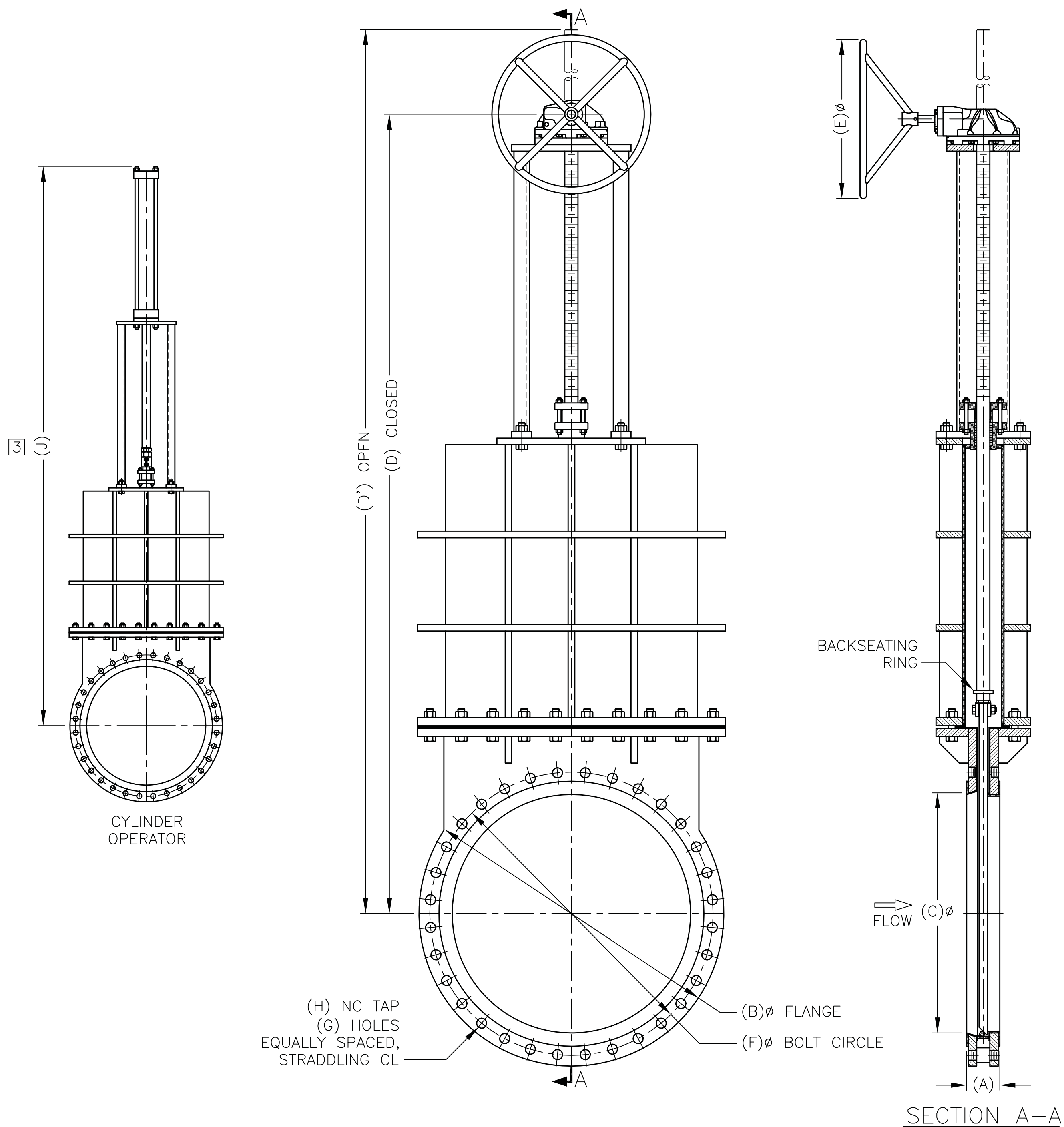
FIGURE: H-200-B

30" - 72" Bonneted Knife Gate Valve

	30"ø	36"ø	42"ø	48"ø	54"ø	60"ø	72"ø
A	4 1/2	5	5	5 1/2	7	7 1/2	8 1/2
B	38 3/4	46	53	59 1/2	66 1/4	73	86 1/2
C	30	36	42	48	54	60	72
D	88	114	130	146	161	176	207
D'	128	150	172	194	215	236	279
E	24	24	30	30	30	30	30
F	36	42 3/4	49 1/2	56	62 3/4	69 1/4	82 1/2
G	28	32	36	44	44	52	60
H	1 1/4-7	1 1/2-6	1 1/2-6	1 1/2-6	1 3/4-5	1 3/4-5	1 3/4-5
J	139	–	–	–	–	–	–

NOTES:

1) DESIGN PRESSURE: 50 PSIG CWP
DESIGN TEMPERATURE: 400°F
2) FLANGE DRILLING: ANSI B16.1 CLASS 125
3) DIMENSION (J) IS FOR REFERENCE PURPOSES ONLY, ACTUAL DIMENSION MAY VARY SLIGHTLY DEPENDING ON DIAMETER OF CYLINDER.
4) SMALLER SIZES ARE AVAILABLE.
5) ADDITIONAL PRESSURE AND TEMPERATURE RATINGS AVAILABLE.
6) ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.



REVISED: 10/31/07

ppendi

Cost Esti ates

- 60 Cost Esti ates
- 0 Cost Esti ates

60 Cost Esti ates

The Dalles East Fish Latter - Alternative Water System
Cost Summary Sheet

Alternative	Alt 1-Siphon	Alt 2-Lowlevel Intake	Alt 10-Single Pump	Alt 11- Siphon with Intake	Fishlock Improvements
Cost	$4,771,220	$4,151,543	$22,208,230	$3,826,139	$817,256

Estimate is for cost of contstruction, including contingency to account for uncertainty in the development of the design and the unit prices. Costs for operation and maintenance have been included.

Alternative 1 - Siphon for Additional Water to the Fishlock (2012 cost)

The following is an estimate of contstruction cost, including contingency to account for uncertainty in the development of the design and the unit prices. Costs for operation and maintenance have been included.

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Intake					
	Foundation and Intake Preparation					
1	Rock Fill	CY	$35	500		$17,500.00
2	Barge	DAY	$8,100	7		$56,700.00
3	Concrete Tremie	CY	$185	43		$7,955.00
4	Diver Support	DAY	$7,020	3		$21,060.00
5	Trash Rack Steel (installation in item 2 & 4)	LBS	$4.00	237,574		$950,296.00
6	Trash Removal System (Bubbler System)	LS	$300,000	1		$300,000.00
					Subtotal	**$1,353,511.00**
	Piping System					
	Concrete Mining					
7	Monolith	CY	$800	83.0		$66,400.00
8	Fishlock	CY	$800	12.0		$9,600.00
9	Pipe Fabrication - (2 @ 6 ft diam)	LF	$315.15	445		$140,241.75
	Pipe Installation					$0.00
10	In-water	LF	$378	182		$68,644.80
11	Through Monolith (with grouting)	LF	$947	42.6		$40,320.90
12	Land Side includes inside Fishlock	LF	$80	131		$10,496.00
13	Through Fishlock (with grouting)	LF	$947	11.0		$10,411.50
14	Water Side Valve and Control - installed	Each	$252,560	2		$505,120.00
15	Land Side Valve and Control - Installed	Each	$401,200	2		$802,400.00
					Subtotal	**$1,653,634.95**
	Filling System					
16	Pump	LS	$5,000	1		$5,000.00
17	Piping and valves	LS	$5,000	1		$5,000.00
18	Electrical and Controls (pump and valves)	LS	$146,000	1		$146,000.00
					Subtotal	**$156,000.00**
				Subtotal (Capital Cost)		**$3,163,145.95**
19	**Mobilization / Demobilization**	LS	10% Construction Cost			**$316,314.60**
20	**Contingency (on capital Cost + m&dm)**				***28.90%***	**$1,005,564.10**
				Total (Capital Cost)		**$4,485,024.64**
	Operations and Maintenance - Design - Construction Management					
21	Operation (one year total)	LS	$ 40,500	1	0	$48,195.00
22	Maintenance (per year)	LS	$ 4,000	50	0	$238,000.00
23	Engineering and Design	LS	to be included at the 90% level			
24	Construction Management and Engr. During Construction	LS	to be included at the 90% level			
					Subtotal	**$286,195.00**
				Total Cost		**$4,771,219.64**

Abbreviated Risk Analysis

The Dalles EFL AWS Alt 1 Siphon
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	Gaby
Cost Engineering:	hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles EFL AWS Alt 1 Siphon**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = **$ 4,838,726**

	WBS	Potential Risk Areas	Contract Cost		% Contingency	$ Contingency	Total
1	04 03 OUTLET WORKS	**foundation prep**	**$ 140,372**		35.42%	$ 49,715	$ 190,087
2	04 03 OUTLET WORKS	**trash rack Alt #1**	**$ 1,635,390**		29.17%	$ 476,989	$ 2,112,379
3	04 03 OUTLET WORKS	**Trash rake Alt #1**	**$ 300,000**		31.25%	$ 93,750	$ 393,750
4	04 03 OUTLET WORKS	**Concrete Mining**	**$ 100,370**		31.25%	$ 31,366	$ 131,736
5	04 03 OUTLET WORKS	**72" pipe**	**$ 175,302**		25.00%	$ 43,826	$ 219,128
6	04 03 OUTLET WORKS	**Pipe Installation**	**$ 168,835**		29.17%	$ 49,244	$ 218,079
7	04 03 OUTLET WORKS	**Valves**	**$ 1,725,926**		31.25%	$ 539,352	$ 2,265,278
8	04 03 OUTLET WORKS	**Pipe filling system**	**$ 179,400**		14.58%	$ 26,163	$ 205,563
9	04 03 OUTLET WORKS	**Operations & Maint**	**$ 300,625**		18.75%	$ 56,367	$ 356,992
10	04 03 OUTLET WORKS		**$ 1**		0.00%	$ -	$ 1
11			**$ 1**		0.00%	$ -	$ 1
12			**$ 1**	*1.0%*	0.00%	$ -	$ 1
13	**30 PLANNING, ENGINEERING, AND DESIGN**		**$ -**		0.00%	$ -	$ -
14	**31 CONSTRUCTION MANAGEMENT**	**Construction Management**	**$ -**		0.00%	$ -	$ -

Totals				
Total Construction Estimate	$ 4,726,223	28.92%	$ 1,366,770	$ 6,092,993
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 4,726,223		$ 1,366,770	$ 6,092,993

The Dalles EFL AWS Alt 1 Siphon
EDR - Pre Feasibility
Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	foundation prep	Foundation condition - equipment costs - weather issues	Properties of embankment unknown - In-water work period during worst part of year.	LIKELY	Marginal	2
PS-2	trash rack Alt #1	Preliminary Design based on assumptions related to enviromental constraint - design work still required	Just an initial set of assumptions	Unlikely	Significant	3
PS-3	Trash rake Alt #1	No known supplier used cost form different system	Cost not well known	Very LIKELY	Marginal	3
PS-4	Concrete Mining	method on mining not known - Properties of Concrete have been assumed	demolition or support of control building may be required. Streangth of aggregated maybe a concern	Very LIKELY	Marginal	3
PS-5	72" pipe	Pipe cost can change - availability unknown	No contact with suppliers since 2010	LIKELY	Marginal	2
PS-6	Pipe Installation	Several problems may arrise that have not been identified	Access - man hrs required for in-water installation	Very LIKELY	Marginal	3
PS-7	Valves	Preliminary Design - valves still need design work	Final design not known but probably will not change much - quote from supplier received.	Unlikely	Critical	3
PS-8	Pipe filling system	No design - Just a guess	Not sure what this looks like yet	Very LIKELY	Marginal	3
PS-9	Operations & Maint	discussions with Operations		Very Unlikely	Negligible	0
PS-10				Very Unlikely	Negligible	0
PS-11				Very Unlikely	Negligible	0
PS-12				Very Unlikely	Negligible	0
PS-13				Very Unlikely	Negligible	0
PS-14	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy						
AS-1	foundation prep	Design/bid/build		Unlikely	Marginal	1
AS-2	trash rack Alt #1	Design/bid/build		Unlikely	Marginal	1
AS-3	Trash rake Alt #1	Design/bid/build		Unlikely	Marginal	1
AS-4	Concrete Mining	Design/bid/build		Unlikely	Marginal	1
AS-5	72" pipe	Design/bid/build		Unlikely	Marginal	1
AS-6	Pipe Installation	Design/bid/build		Unlikely	Marginal	1
AS-7	Valves	Design/bid/build		Unlikely	Marginal	1
AS-8	Pipe filling system	Design/bid/build		Unlikely	Marginal	1
AS-9	Operations & Maint	Design/bid/build		Very Unlikely	Negligible	0
AS-10				Very Unlikely	Negligible	0
AS-11				Very Unlikely	Negligible	0
AS-12				Very Unlikely	Negligible	0
AS-13				Very Unlikely	Negligible	0
AS-14	Construction Management			Very Unlikely	Negligible	0

Construction Complexity

CC-1	foundation prep	In-Water work	lots of unknowns - weather	Very LIKELY	Critical	5
CC-2	trash rack Alt #1	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-3	Trash rake Alt #1	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
CC-4	Concrete Mining	specialty sub contractor needed		LIKELY	Critical	5
CC-5	72" pipe			LIKELY	Marginal	2
CC-6	Pipe Installation	In-Water work required and pipe grouting		LIKELY	Significant	4
CC-7	Valves			Very Unlikely	Significant	1
CC-8	Pipe filling system			LIKELY	Marginal	2
CC-9	Operations & Maint			Unlikely	Negligible	0
CC-10				Very Unlikely	Negligible	0
CC-11				Very Unlikely	Negligible	0
CC-12				Very Unlikely	Negligible	0
CC-13				Very Unlikely	Negligible	0
CC-14	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities

VC-1	foundation prep			Unlikely	Negligible	0
VC-2	trash rack Alt #1	price of steel	price of steel can change	Unlikely	Significant	3
VC-3	Trash rake Alt #1	No design	No design used estimate from different system	Unlikely	Marginal	1
VC-4	Concrete Mining			Unlikely	Marginal	1
VC-5	72" pipe	price of steel	price of steel can change	LIKELY	Marginal	2
VC-6	Pipe Installation			Unlikely	Marginal	1
VC-7	Valves	price of steel	price of steel can change	Unlikely	Critical	3
VC-8	Pipe filling system			Unlikely	Negligible	0
VC-9	Operations & Maint			Very Unlikely	Negligible	0
VC-10				Very Unlikely	Negligible	0
VC-11				Very Unlikely	Negligible	0
VC-12				Very Unlikely	Negligible	0
VC-13				Very Unlikely	Negligible	0
VC-14	Construction Management			Very Unlikely	Negligible	0

Quantities

Q-1	foundation prep	Not well defined at this time		LIKELY	Marginal	2
Q-2	trash rack Alt #1	Prelininary design	wt should not change much	Unlikely	Marginal	1
Q-3	Trash rake Alt #1			Very LIKELY	Marginal	3
Q-4	Concrete Mining	quantity well know unless pipe size changes		Very Unlikely	Marginal	0
Q-5	72" pipe	quantity well know unless pipe size changes		Very Unlikely	Negligible	0
Q-6	Pipe Installation	length of pipe should not change much		Very Unlikely	Marginal	0
Q-7	Valves	Number of valves defined		Very Unlikely	Critical	2
Q-8	Pipe filling system	No design - Just a guess		Unlikely	Negligible	0
Q-9	Operations & Maint			Very LIKELY	Marginal	3
Q-10				Very Unlikely	Negligible	0
Q-11				Very Unlikely	Negligible	0
Q-12				Very Unlikely	Negligible	0
Q-13				Very Unlikely	Negligible	0
Q-14	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment						
FI-1	foundation prep	Need better definition of requirements		Very Unlikely	Negligible	0
FI-2	trash rack Alt #1	Preliminary design		Unlikely	Marginal	1
FI-3	Trash rake Alt #1	No design - Just a guess		Very LIKELY	Marginal	3
FI-4	Concrete Mining			Very Unlikely	Negligible	0
FI-5	72" pipe	reasonably well understood		Unlikely	Significant	3
FI-6	Pipe Installation	reasonably well understood		Very Unlikely	Negligible	0
FI-7	Valves	factory supplied - well defined product		Unlikely	Significant	3
FI-8	Pipe filling system	No design - Just a guess		LIKELY	Negligible	1
FI-9	Operations & Maint			LIKELY	Marginal	2
FI-10				Very Unlikely	Negligible	0
FI-11				Very Unlikely	Negligible	0
FI-12				Very Unlikely	Negligible	0
FI-13				Very Unlikely	Negligible	0
FI-14	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method						
CE-1	foundation prep	values from previous estimates and preliminary supplier quotes		LIKELY	Marginal	2
CE-2	trash rack Alt #1	based on cost of steel and fabrication		Unlikely	Marginal	1
CE-3	Trash rake Alt #1	based on different design		Very LIKELY	Negligible	2
CE-4	Concrete Mining	values from previous estimates and preliminary supplier quotes		Unlikely	Marginal	1
CE-5	72" pipe	values from previous estimates and preliminary supplier quotes		Unlikely	Marginal	1
CE-6	Pipe Installation	values from previous estimates and preliminary supplier quotes		Very LIKELY	Significant	4
CE-7	Valves	values from previous estimates and preliminary supplier quotes		Very Unlikely	Significant	1
CE-8	Pipe filling system	values from previous estimates and preliminary supplier quotes		Very Unlikely	Marginal	0
CE-9	Operations & Maint			LIKELY	Marginal	2
CE-10				Very Unlikely	Negligible	0
CE-11				Very Unlikely	Negligible	0
CE-12				Very Unlikely	Negligible	0
CE-13				Very Unlikely	Negligible	0
CE-14	Construction Management			Very Unlikely	Negligible	0

External Project Risks						
EX-1	foundation prep	in-water work		Very LIKELY	Significant	4
EX-2	trash rack Alt #1	in-water work		Unlikely	Negligible	0
EX-3	Trash rake Alt #1	in-water work		Unlikely	Negligible	0
EX-4	Concrete Mining			Unlikely	Significant	3
EX-5	72" pipe	availability and shipping		Unlikely	Marginal	1
EX-6	Pipe Installation			LIKELY	Negligible	1
EX-7	Valves	availability and shipping		Very Unlikely	Significant	1
EX-8	Pipe filling system			Unlikely	Negligible	0
EX-9	Operations & Maint			LIKELY	Marginal	2
EX-10				Very Unlikely	Negligible	0
EX-11				Very Unlikely	Negligible	0
EX-12				Very Unlikely	Negligible	0
EX-13				Very Unlikely	Negligible	0
EX-14	Construction Management			Very Unlikely	Negligible	0

The Dalles EFL AWS Alt 1 Siphon

EDR - Pre Feasibility

Abbreviated Risk Analysis

Typical Risk Elements	Potential Risk Areas													
	foundation prep	trash rack Alt #1	Trash rake Alt #1	Concrete Mining	72" pipe	Pipe Installation	Valves	Pipe filling system	Operations & Maint					Construction Management
Project Scope	2	3	3	3	2	3	3	3	-	-	-	-	-	-
Acquisition Strategy	1	1	1	1	1	1	1	1	-	-	-	-	-	-
Construction Complexity	5	4	2	5	2	4	1	2	-	-	-	-	-	-
Volatile Commodities	-	3	1	1	2	1	3	-	-	-	-	-	-	-
Quantities	2	1	3	-	-	-	2	-	3	-	-	-	-	-
Fabrication & Project Installed Equipment	-	1	3	-	3	-	3	1	2	-	-	-	-	-
Cost Estimating Method	2	1	2	1	1	4	1	-	2	-	-	-	-	-
External Project Risks	4	-	-	3	1	1	1	-	2	-	-	-	-	-

Alternative 2 - Low Level Intake(2012 cost)

The following is an estimate of contstruction cost, including contingency to account for uncertainty in the development of the design and the unit prices. Costs for operation and maintenance have been included.

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Intake					
1	Monolith U/S Face Preparation	LS	$3,556	1		$ 3,556
2	Cofferdam (Steel and installation)	LS	$61,954.00	1		$ 61,954
3	Trash Rack (Steel and Installation)	LS	$554,802	1		$ 554,802
4	Trash Removal System (Bubbler System)	LS	$300,000	1		$ 300,000
					Subtotal	**$ 920,312**
	Piping System					
5	Concrete Mining					
6	Monolith	CY	$800	114		$ 91,200
7	Fishlock	CY	$800	8.6		$ 6,880
8	Pipe Fabrication - (2 @ 6 ft diam)	LF	$315.15	450		$ 141,818
9	Pipe Installation					
10	Through Monolith (with grouting)	LF	$946.50	108		$ 102,222
11	Land Side includes saddles and thrust blocks	LF	$380	326		$ 123,880
12	Through Fishlock (with grouting)	LF	$946.50	8		$ 7,572
13	Inside Fishlock	LF	$80.00	8		$ 640
14	Isolation Valve (located at D/S face of dam)	Each	$252,560	2		$ 505,120
15	Land Side Valve and Control	Each	$401,200	2		$ 802,400
16	Power Supply	LS	$15,000	1		$ 15,000
					Subtotal	**$ 1,796,732**
				Subtotal (Capital Cost)		**$ 2,717,044**
17	**Mobilization / Demobilization**	LS	at 10% of Construction cost			**$ 271,704**
18	**Contingency (on capital Cost + m&dm)**				29.33%	**$876,599.74**
				Total (Capital Cost)		**$ 3,865,348**
	rations and Maintenance - Design - Construction Management					
19	Operation (one year total)	LS	$ 40,500	1	19%	$ 48,195
20	Maintenance (per year)	LS	$ 4,000	50	19%	$ 238,000
21	Engineering and Design	LS	to be included at 90% level			
22	Construction Management and EDC	LS	to be included at 90% level			
					Subtotal	**$ 286,195**
				Total (Lifespan)		**$ 4,151,543**

Abbreviated Risk Analysis

The Dalles EFL AWS - Alt 2 low level intake
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	NAME
Cost Engineering:	hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles EFL AWS - Alt 2 low level intake**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = $ 4,194,148

	WBS	Potential Risk Areas	Contract Cost		% Contingency	$ Contingency	Total
1	04 03 OUTLET WORKS	**monolith prep**	**$ 4,620**		20.83%	$ 963	$ 5,583
2	04 03 OUTLET WORKS	**Cofferdam**	**$ 61,554**		29.17%	$ 17,953	$ 79,507
3	04 03 OUTLET WORKS	**trash rack Alt # 2**	**$ 716,618**		29.17%	$ 209,014	$ 925,632
4	04 03 OUTLET WORKS	**Trash rake Alt # 2**	**$ 300,000**		31.25%	$ 93,750	$ 393,750
5	04 03 OUTLET WORKS	**Concrete Mining**	**$ 127,504**		27.08%	$ 34,532	$ 162,036
6	04 03 OUTLET WORKS	**72" pipe**	**$ 184,363**		25.00%	$ 46,091	$ 230,454
7	04 03 OUTLET WORKS	**Pipe Installation**	**$ 304,609**		29.17%	$ 88,844	$ 393,453
8	04 03 OUTLET WORKS	**Valves**	**$ 1,706,172**		31.25%	$ 533,179	$ 2,239,351
10	04 03 OUTLET WORKS	**Operations & Maint**	**$ 240,500**		18.75%	$ 45,094	$ 285,594
11			**$ -**		0.00%	$ -	$ -
12			**$ -**	*1.0%*	0.00%	$ -	$ -
13	**30 PLANNING, ENGINEERING, AND DESIGN**		**$ -**		0.00%	$ -	$ -
14	**31 CONSTRUCTION MANAGEMENT**	**Construction Management**	**$ -**		0.00%	$ -	$ -

Totals	Contract Cost	% Contingency	$ Contingency	Total
Total Construction Estimate	$ 3,645,940	29.33%	$ 1,069,419	$ 4,715,359
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 3,645,940		$ 1,069,419	$ 4,715,359

The Dalles EFL AWS - Alt 2 low level intake

EDR - Pre Feasibility
Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	monolith prep	IN-water work		LIKELY	Marginal	2
PS-2	Cofferdam	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-3	trash rack Alt # 2	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-4	Trash rake Alt # 2	supplier used cost form	Cost not well known	Unlikely	Significant	3
PS-5	Concrete Mining	not well defined yet	support of control building may	LIKELY	Marginal	2
PS-6	72" pipe	can change - availability	No contact with suppliers since 2010	LIKELY	Marginal	2
PS-7	Pipe Installation	problems may arrise that have	hrs required for in-water installation	Very LIKELY	Marginal	3
PS-8	Valves	y Design - valves still need	not known but probably will not change	Unlikely	Critical	3
PS-9				Very Unlikely	Negligible	0
PS-10	Operations & Maint			Very Unlikely	Marginal	0
PS-11				Very Unlikely	Negligible	0
PS-12				Very Unlikely	Negligible	0
PS-13				Very Unlikely	Negligible	0
PS-14	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy						
AS-1	monolith prep	Design/bid/build		Unlikely	Marginal	1
AS-2	Cofferdam	Design/bid/build		Unlikely	Marginal	1
AS-3	trash rack Alt # 2	Design/bid/build		Unlikely	Marginal	1
AS-4	Trash rake Alt # 2	Design/bid/build		Unlikely	Marginal	1
AS-5	Concrete Mining	Design/bid/build		LIKELY	Marginal	2
AS-6	72" pipe	Design/bid/build		Unlikely	Marginal	1
AS-7	Pipe Installation	Design/bid/build		Unlikely	Marginal	1
AS-8	Valves	Design/bid/build		Unlikely	Marginal	1
AS-9	#REF!			Very Unlikely	Negligible	0
AS-10	Operations & Maint			Very Unlikely	Negligible	0
AS-11				Very Unlikely	Negligible	0
AS-12				Very Unlikely	Negligible	0
AS-13				Very Unlikely	Negligible	0
AS-14	Construction Management			Very Unlikely	Negligible	0

Construction Complexity

CC-1	monolith prep	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
CC-2	Cofferdam	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-3	trash rack Alt # 2	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-4	Trash rake Alt # 2			LIKELY	Marginal	2
CC-5	Concrete Mining	specialty sub contractor needed		LIKELY	Critical	5
CC-6	72" pipe	In-Water work required and pipe grouting		LIKELY	Marginal	2
CC-7	Pipe Installation			LIKELY	Significant	4
CC-8	Valves			Very Unlikely	Significant	1
CC-9	#REF!			Very Unlikely	Negligible	0
CC-10	Operations & Maint			Unlikely	Negligible	0
CC-11				Very Unlikely	Negligible	0
CC-12				Very Unlikely	Negligible	0
CC-13				Very Unlikely	Negligible	0
CC-14	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities

VC-1	monolith prep			LIKELY	Negligible	1
VC-2	Cofferdam			Unlikely	Significant	3
VC-3	trash rack Alt # 2			Unlikely	Significant	3
VC-4	Trash rake Alt # 2			Unlikely	Marginal	1
VC-5	Concrete Mining			Unlikely	Marginal	1
VC-6	72" pipe			LIKELY	Marginal	2
VC-7	Pipe Installation			Unlikely	Marginal	1
VC-8	Valves			Unlikely	Critical	3
VC-9	#REF!			Very Unlikely	Negligible	0
VC-10	Operations & Maint			Very Unlikely	Negligible	0
VC-11				Very Unlikely	Negligible	0
VC-12				Very Unlikely	Negligible	0
VC-13				Very Unlikely	Negligible	0
VC-14	Construction Management			Very Unlikely	Negligible	0

Quantities

Q-1	monolith prep			Unlikely	Marginal	1
Q-2	Cofferdam			Unlikely	Marginal	1
Q-3	trash rack Alt # 2			Unlikely	Marginal	1
Q-4	Trash rake Alt # 2			Very LIKELY	Marginal	3
Q-5	Concrete Mining			Very Unlikely	Marginal	0
Q-6	72" pipe			Very Unlikely	Negligible	0
Q-7	Pipe Installation			Very Unlikely	Marginal	0
Q-8	Valves			Very Unlikely	Critical	2
Q-9	#REF!			Very Unlikely	Negligible	0
Q-10	Operations & Maint			Very LIKELY	Marginal	3
Q-11				Very Unlikely	Negligible	0
Q-12				Very Unlikely	Negligible	0
Q-13				Very Unlikely	Negligible	0
Q-14	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment						
FI-1	monolith prep			Unlikely	Marginal	1
FI-2	Cofferdam			Unlikely	Marginal	1
FI-3	trash rack Alt # 2			Unlikely	Marginal	1
FI-4	Trash rake Alt # 2			Very LIKELY	Marginal	3
FI-5	Concrete Mining			Very Unlikely	Negligible	0
FI-6	72" pipe			Unlikely	Significant	3
FI-7	Pipe Installation			Very Unlikely	Negligible	0
FI-8	Valves			Unlikely	Significant	3
FI-9	#REF!			Very Unlikely	Negligible	0
FI-10	Operations & Maint			LIKELY	Marginal	2
FI-11				Very Unlikely	Negligible	0
FI-12				Very Unlikely	Negligible	0
FI-13				Very Unlikely	Negligible	0
FI-14	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method

CE-1	monolith prep			Unlikely	Marginal	1
CE-2	Cofferdam			Unlikely	Marginal	1
CE-3	trash rack Alt # 2			Unlikely	Marginal	1
CE-4	Trash rake Alt # 2			Very LIKELY	Negligible	2
CE-5	Concrete Mining			Unlikely	Marginal	1
CE-6	72" pipe			Unlikely	Marginal	1
CE-7	Pipe Installation			Very LIKELY	Significant	4
CE-8	Valves			Very Unlikely	Significant	1
CE-9	#REF!			Very Unlikely	Negligible	0
CE-10	Operations & Maint			LIKELY	Marginal	2
CE-11				Very Unlikely	Negligible	0
CE-12				Very Unlikely	Negligible	0
CE-13				Very Unlikely	Negligible	0
CE-14	Construction Management			Very Unlikely	Negligible	0

External Project Risks

EX-1	monolith prep			Unlikely	Marginal	1
EX-2	Cofferdam			Unlikely	Negligible	0
EX-3	trash rack Alt # 2			Unlikely	Negligible	0
EX-4	Trash rake Alt # 2			Unlikely	Negligible	0
EX-5	Concrete Mining			Unlikely	Marginal	1
EX-6	72" pipe			Unlikely	Marginal	1
EX-7	Pipe Installation			LIKELY	Negligible	1
EX-8	Valves			Very Unlikely	Significant	1
EX-9	#REF!			Very Unlikely	Negligible	0
EX-10	Operations & Maint			LIKELY	Marginal	2
EX-11				Very Unlikely	Negligible	0
EX-12				Very Unlikely	Negligible	0
EX-13				Very Unlikely	Negligible	0
EX-14	Construction Management			Very Unlikely	Negligible	0

The Dalles EFL AWS - Alt 2 low level intake
EDR - Pre Feasibility
Abbreviated Risk Analysis

		Potential Risk Areas													
		monolith prep	Cofferdam	trash rack Alt # 2	Trash rake Alt # 2	Concrete Mining	72" pipe	Pipe Installation	Valves	#REF!	Operations & Maint				Construction Management
Typical Risk Elements	Project Scope	2	3	3	3	2	2	3	3	-	-	-	-	-	-
	Acquisition Strategy	1	1	1	1	2	1	1	1	-	-	-	-	-	-
	Construction Complexity	2	4	4	2	5	2	4	1	-	-	-	-	-	-
	Volatile Commodities	1	3	3	1	1	2	1	3	-	-	-	-	-	-
	Quantities	1	1	1	3	-	-	-	2	-	3	-	-	-	-
	Fabrication & Project Installed Equipment	1	1	1	3	-	3	-	3	-	2	-	-	-	-
	Cost Estimating Method	1	1	1	2	1	1	4	1	-	2	-	-	-	-
	External Project Risks	1	-	-	-	1	1	1	1	-	2	-	-	-	-

Alternative 10 - Pump (2012 Cost)

The following is an estimate of contstruction cost, including contingency to account for uncertainty in the development of the design and the unit prices.

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Intake					
1	Piles for Pump House	FT	$600	280		$ 168,000
2	Piles for Bridge	FT	$210	200		$ 42,000
3	Type "F" Bridge Rail	FT	$93	300		$ 27,900
4	26" Precast Prestressed Slabs	FT	$200	450		$ 90,000
5	Bridge Abutment and Pier Concrete	CY	$300	91		$ 27,318
	Pumphouse					$ -
6	Concrete (Wet well & floor slab)	CY	$300	1,643		$ 492,900
7	Concrete Masonry Units	CY	$447	311		$ 139,017
8	Trash Rack Steel	LBS	$3.67	155,500		$ 570,685
9	Trash Rack Rake System	LS	$300,000	1		$ 300,000
10	Misc. Building Costs	LS	$500,000	1		$ 500,000
	Junction Structure					$ -
11	Steel	LBS	$3.67	123,326		$ 452,606
12	Concrete (Foundation Pad)	CY	$300	178		$ 53,400
13	Pumps / Motors/and installation	LS	$5,100,000	1		$ 5,100,000
14	Pumphouse Piping	LS	$118,912	1		$ 118,912
15	Isolation Valves	EA	$600,000	2		$ 1,200,000
16	Station Primary Power Feed	LS	$1,101,000	1		$ 1,101,000
17	Station Electrical Power	LS	$394,000	1		$ 394,000
					Subtotal	**$ 10,777,738**
	Piping System					
18	Concrete Mining (Fish Ladder)	CY	$800	6		$ 4,720
19	Pipe Fabrication and Installation	LF	$4,488	297		$ 1,332,936
					Subtotal	**$ 1,337,656**
				Subtotal (Capital Cost)		**$ 12,115,394**
20	**Mobilization / Demobilization**	LS	at 10% of Construction cost			**$ 1,211,539**
21	**Contingency (on capital Cost + m&dm)**				54.69%	**$7,288,500.13**
				Total (Capital Cost)		**$ 20,615,434**
	Operations and Maintenance - Design - Construction Management					
22	Operation	Mo	$12,733	12		$ 152,796
23	Maintenance	YR	$28,800	50		$ 1,440,000
24	Engineering and Design	LS	to be included at 90% level			
25	Construction Management and EDC	LS	to be included at 90% level			
					Subtotal	**1592796**
				Total (Lifespan)		**$ 22,208,230**

Abbreviated Risk Analysis

The Dalles East Fish Ladder Aux Water Supply Alt 10 Pump
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	NAME
Cost Engineering:	hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles East Fish Ladder Aux Water Supply Alt 10 Pump**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = **$ 14,799,646**

	WBS	Potential Risk Areas	Contract Cost		% Contingency	$ Contingency	Total
1	08 01 ROADS	**Piles and bridge**	**$ 461,783**		29.17%	$ 134,687	$ 596,470
2	13 PUMPING PLANT	**Pump House**	**$ 2,215,983**		33.33%	$ 738,661	$ 2,954,644
3	13 PUMPING PLANT	**Junction Structure**	**$ 657,808**		39.58%	$ 260,382	$ 918,190
4	13 PUMPING PLANT	**Pump/motor/installation**	**$ 4,785,000**		87.50%	$ 4,186,875	$ 8,971,875
5	13 PUMPING PLANT	**pump house piping**	**$ 154,586**		45.83%	$ 70,852	$ 225,438
6	13 PUMPING PLANT	**Check Valves**	**$ 1,560,000**		43.75%	$ 682,500	$ 2,242,500
7	13 PUMPING PLANT	**Station Power Feed**	**$ 1,101,000**		43.75%	$ 481,688	$ 1,582,688
8	13 PUMPING PLANT	**Station Electrical Power**	**$ 394,000**		33.33%	$ 131,333	$ 525,333
9	04 03 OUTLET WORKS	**Concrete Mining**	**$ 6,136**		16.67%	$ 1,023	$ 7,159
10	04 03 OUTLET WORKS	**Pipe Fabrication & Installation**	**$ 1,732,817**		29.17%	$ 505,405	$ 2,238,222
11	**04 03 OUTLET WORKS**	**Operations and Maintenance**	**$ 235,872**		35.42%	$ 83,538	$ 319,410
12			**$ 1**	*1.0%*	0.00%	$ -	$ 1

Totals	Contract Cost	% Contingency	$ Contingency	Total
Total Construction Estimate	$ 13,304,986	54.69%	$ 7,276,943	$ 20,581,929
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 13,304,986		$ 7,276,943	$ 20,581,929

The Dalles East Fish Ladder Aux Water Supply Alt 10 Pump
EDR - Pre Feasibility
Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	Piles and bridge	Designed to 60%		LIKELY	Marginal	2
PS-2	Pump House	Design not completed	Just an initial set of assumptions	LIKELY	Marginal	2
PS-3	Junction Structure	Design not completed	Cost not well known	LIKELY	Marginal	2
PS-4	Pump/motor/installation	Specifications from supplier	Cost not well known	Very LIKELY	Critical	5
PS-5	pump house piping	Design not completed	quantity and cost not defined	Very LIKELY	Significant	4
PS-6	Check Valves	Specifications from supplier		Unlikely	Marginal	1
PS-7	Station Power Feed	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
PS-8	Station Electrical Power	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
PS-9	Concrete Mining	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
PS-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
PS-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	Very LIKELY	Significant	4
PS-12				Very Unlikely	Negligible	0
PS-13				Very Unlikely	Negligible	0
PS-14	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy

AS-1	Piles and bridge	Design/bid/build		Unlikely	Marginal	1
AS-2	Pump House	Design/bid/build		Unlikely	Marginal	1
AS-3	Junction Structure	Design/bid/build		Unlikely	Marginal	1
AS-4	Pump/motor/installation	Design/bid/build		LIKELY	Significant	4
AS-5	pump house piping	Design/bid/build		Unlikely	Marginal	1
AS-6	Check Valves	Design/bid/build		Unlikely	Marginal	1
AS-7	Station Power Feed	Design/bid/build		Unlikely	Marginal	1
AS-8	Station Electrical Power	Design/bid/build		Unlikely	Marginal	1
AS-9	Concrete Mining	Design/bid/build		Unlikely	Marginal	1
AS-10	Pipe Fabrication & Installation			Very Unlikely	Negligible	0
AS-11	Operations and Maintenance			Very Unlikely	Negligible	0
AS-12				Very Unlikely	Negligible	0
AS-13				Very Unlikely	Negligible	0
AS-14	Construction Management			Very Unlikely	Negligible	0

Construction Complexity

CC-1	Piles and bridge	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
CC-2	Pump House	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
CC-3	Junction Structure	Electrical	Significant skill required	Very LIKELY	Marginal	3
CC-4	Pump/motor/installation	Off the shelf	Installation may be difficult	LIKELY	Marginal	2
CC-5	pump house piping	not detailed		Very LIKELY	Marginal	3
CC-6	Check Valves	have specifications and cost		Unlikely	Marginal	1
CC-7	Station Power Feed	Preliminary Design	Preliminary Design	LIKELY	Significant	4
CC-8	Station Electrical Power	Preliminary Design	Preliminary Design	LIKELY	Significant	4
CC-9	Concrete Mining	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
CC-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	Very Unlikely	Negligible	0
CC-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	Very LIKELY	Marginal	3
CC-12				Very Unlikely	Negligible	0
CC-13				Very Unlikely	Negligible	0
CC-14	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities						
VC-1	Piles and bridge	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
VC-2	Pump House	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
VC-3	Junction Structure	Electrical	Significant skill required	Very LIKELY	Significant	4
VC-4	Pump/motor/installation	Off the shelf	Installation may be difficult	LIKELY	Critical	5
VC-5	pump house piping	not detailed		LIKELY	Significant	4
VC-6	Check Valves	have specifications and cost		LIKELY	Significant	4
VC-7	Station Power Feed	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
VC-8	Station Electrical Power	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
VC-9	Concrete Mining	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
VC-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	LIKELY	Significant	4
VC-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	LIKELY	Marginal	2
VC-12				Very Unlikely	Negligible	0
VC-13				Very Unlikely	Negligible	0
VC-14	Construction Management			Very Unlikely	Negligible	0

Quantities

Q-1	Piles and bridge	In-Water work	lots of unknowns - weather	Unlikely	Marginal	1
Q-2	Pump House	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
Q-3	Junction Structure	Electrical	Significant skill required	LIKELY	Marginal	2
Q-4	Pump/motor/installation	Off the shelf	Installation may be difficult	Very LIKELY	Critical	5
Q-5	pump house piping	not detailed		LIKELY	Marginal	2
Q-6	Check Valves	have specifications and cost		Unlikely	Significant	3
Q-7	Station Power Feed	Preliminary Design	Preliminary Design	Unlikely	Significant	3
Q-8	Station Electrical Power	Preliminary Design	Preliminary Design	Unlikely	Significant	3
Q-9	Concrete Mining	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
Q-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	Unlikely	Negligible	0
Q-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	Very LIKELY	Negligible	2
Q-12				Very Unlikely	Negligible	0
Q-13				Very Unlikely	Negligible	0
Q-14	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment						
FI-1	Piles and bridge	In-Water work	lots of unknowns - weather	Unlikely	Negligible	0
FI-2	Pump House	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
FI-3	Junction Structure	Electrical	Significant skill required	Very LIKELY	Significant	4
FI-4	Pump/motor/installation	Off the shelf	Installation may be difficult	Very LIKELY	Critical	5
FI-5	pump house piping	not detailed		LIKELY	Marginal	2
FI-6	Check Valves	have specifications and cost		LIKELY	Significant	4
FI-7	Station Power Feed	Preliminary Design	Preliminary Design	LIKELY	Significant	4
FI-8	Station Electrical Power	Preliminary Design	Preliminary Design	LIKELY	Negligible	1
FI-9	Concrete Mining	Preliminary Design	Preliminary Design	Very Unlikely	Negligible	0
FI-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	Very Unlikely	Negligible	0
FI-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	LIKELY	Marginal	2
FI-12				Very Unlikely	Negligible	0
FI-13				Very Unlikely	Negligible	0
FI-14	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method

CE-1	Piles and bridge	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
CE-2	Pump House	In-Water work	lots of unknowns - weather	Very LIKELY	Marginal	3
CE-3	Junction Structure	Electrical	Significant skill required	Very LIKELY	Marginal	3
CE-4	Pump/motor/installation	Off the shelf	Installation may be difficult	Very LIKELY	Critical	5
CE-5	pump house piping	not detailed		LIKELY	Significant	4
CE-6	Check Valves	have specifications and cost		Unlikely	Significant	3
CE-7	Station Power Feed	Preliminary Design	Preliminary Design	LIKELY	Significant	4
CE-8	Station Electrical Power	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
CE-9	Concrete Mining	Preliminary Design	Preliminary Design	LIKELY	Marginal	2
CE-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design	LIKELY	Significant	4
CE-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	LIKELY	Marginal	2
CE-12				Very Unlikely	Negligible	0
CE-13				Very Unlikely	Negligible	0
CE-14	Construction Management			Very Unlikely	Negligible	0

External Project Risks

EX-1	Piles and bridge	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
EX-2	Pump House	In-Water work	lots of unknowns - weather	LIKELY	Marginal	2
EX-3	Junction Structure	Electrical	Significant skill required	Unlikely	Negligible	0
EX-4	Pump/motor/installation	Off the shelf	Installation may be difficult	LIKELY	Critical	5
EX-5	pump house piping	not detailed		LIKELY	Marginal	2
EX-6	Check Valves	have specifications and cost		LIKELY	Significant	4
EX-7	Station Power Feed	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
EX-8	Station Electrical Power	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
EX-9	Concrete Mining	Preliminary Design	Preliminary Design	Unlikely	Marginal	1
EX-10	Pipe Fabrication & Installation	Preliminary Design	Preliminary Design availability and shipping	LIKELY	Significant	4
EX-11	Operations and Maintenance	Requirements not well defined	Data needed from operations	LIKELY	Marginal	2
EX-12				Very Unlikely	Negligible	0
EX-13				Very Unlikely	Negligible	0
EX-14	Construction Management			Very Unlikely	Negligible	0

The Dalles East Fish Ladder Aux Water Supply Alt 10 Pump

EDR - Pre Feasibility

Abbreviated Risk Analysis

		Potential Risk Areas													
		Piles and bridge	Pump House	Junction Structure	Pump/motor/installat ion	pump house piping	Check Valves	Station Power Feed	Station Electrical Power	Concrete Mining	Pipe Fabrication & Installation	Operations and Maintenance			Construction Management
Typical Risk Elements	Project Scope	2	2	2	5	4	1	2	2	1	2	4	-	-	-
	Acquisition Strategy	1	1	1	4	1	1	1	1	1	-	-	-	-	-
	Construction Complexity	2	2	3	2	3	1	4	4	1	-	3	-	-	-
	Volatile Commodities	2	2	4	5	4	4	2	2	1	4	2	-	-	-
	Quantities	1	2	2	5	2	3	3	3	1	-	2	-	-	-
	Fabrication & Project Installed Equipment	-	2	4	5	2	4	4	1	-	-	2	-	-	-
	Cost Estimating Method	2	3	3	5	4	3	4	2	2	4	2	-	-	-
	External Project Risks	4	2	-	5	2	4	1	1	1	4	2	-	-	-

Alternative 11 - Siphon with Intake Structure (2012 cost)

The following is an estimate of contstruction cost, including contingency to account for uncertainty in the development of the design and the unit prices. Costs for operation and maintenance have been included.

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Intake					
1	Foundation Preparation (Excavation)	LS	$42,765	1		$ 42,765
2	Intake Structure Construction	LS	$1,037,227	1		$ 1,037,227
3	Intake Structure Trash Rack (Steel)	LBS	$4.00	25,000		$ 100,000
4	Trash Removal System (Bubbler System)	LS	$300,000	1		$ 300,000
					Subtotal	**$ 1,479,992**

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Piping System					
4	Concrete Mining	CY	$800	97		$ 77,600
5	Pipe Fabrication - (2 @ 6.5 ft diam)	LF	$341.50	492		$ 167,847
6	Pipe Installation					
7	In-water	LS	$10,020	1		$ 10,020
8	Through Monolith (with grouting)	LF	$947	42.6		$ 40,321
9	Land Side includes inside Fishlock	LF	$80	63		$ 5,040
10	Through Fishlock (with grouting)	LF	$947	11		$ 10,412
11	Water Side Valve and Control	EA	$255,020	2		$ 510,040
12	Land Side Valve and Control	EA	$401,200	2		$ 802,400
					Subtotal	**$ 1,623,680**

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Filling System					
13	Pump	LS	$5,000	1		$ 5,000
14	Piping and valves	LS	$5,000	1		$ 5,000
15	Electrical and Controls	LS	$146,000	1		$ 146,000
					Subtotal	**$ 156,000**

Subtotal (Capital Cost)	**$ 3,259,672**

Item	Description	Unit	Unit Price	Qty	Contingency	Total
16	**Mobilization / Demobilization**	LS	at 10% of Construction cost			**$ 325,967**
20	**Contingency (on capital Cost + m&dm)**				***33.95%***	**$1,217,324.38**

Total (Capital Cost)	**$ 3,585,639**

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	tions and Maintenance - Design - Construction Management					
17	Operation (one year total)	LS	$ 40,500	1		$ 40,500
18	Maintenance (per year)	LS	$ 4,000	50		$ 200,000
19	Engineering and Design	LS	to be included at 90% level			
20	Construction Management and EDC	LS	to be included at 90% level			
					Subtotal	**$ 240,500**

Total (Lifespan)	**$ 3,826,139**

Abbreviated Risk Analysis

The Dalles EFL AWS Alt. 11 Siphon w intake tower
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	Ron Mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	Pete Gaby
Cost Engineering:	R Hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles EFL AWS Alt. 11 Siphon w intake tower**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = $ 3,536,914

	WBS	Potential Risk Areas	Contract Cost		% Contingency	$ Contingency	Total
1	04 03 OUTLET WORKS	**foundation prep**	$ 55,595		31.25%	$ 17,373	$ 72,968
2	04 03 OUTLET WORKS	**Intake Tower**	$ 1,033,935		50.00%	$ 516,968	$ 1,550,903
3	04 03 OUTLET WORKS	**Trash rack Alt #11**	$ 119,275		29.17%	$ 34,789	$ 154,064
4	04 03 OUTLET WORKS	**Trash removal system Alt #11**	$ 390,000		31.25%	$ 121,875	$ 511,875
5	04 03 OUTLET WORKS	**Concrete Mining**	$ 100,880		31.25%	$ 31,525	$ 132,405
6	04 03 OUTLET WORKS	**72" pipe**	$ 218,201		25.00%	$ 54,550	$ 272,751
7	04 03 OUTLET WORKS	**Pipe Installation**	$ 85,530		29.17%	$ 24,946	$ 110,476
8	04 03 OUTLET WORKS	**Valves**	$ 1,699,776		31.25%	$ 531,180	$ 2,230,956
9	04 03 OUTLET WORKS	**Pipe filling system**	$ 202,800		14.58%	$ 29,575	$ 232,375
10	04 03 OUTLET WORKS	**Operations & Maint**	$ 240,500		18.75%	$ 45,094	$ 285,594
11			$ 1		0.00%	$ -	$ 1
12			**$ 1**	*0.0%*	0.00%	$ -	$ 1
13	30 PLANNING, ENGINEERING, AND DESIGN		$ -		0.00%	$ -	$ -
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	$ -		0.00%	$ -	$ -

Totals	Contract Cost	% Contingency	$ Contingency	Total
Total Construction Estimate	$ 4,146,494	33.95%	$ 1,407,875	$ 5,554,369
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 4,146,494		$ 1,407,875	$ 5,554,369

The Dalles EFL AWS Alt. 11 Siphon w intake tower

EDR - Pre Feasibility

Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	foundation prep	Foundation condition - equipment costs - weather issues	Properties of embankment unknown - In-water work period during worst part of year.	LIKELY	Marginal	2
PS-2	Intake Tower	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-3	Trash rack Alt #11	No known supplier used cost form different system	Cost not well known	Unlikely	Significant	3
PS-4	Trash removal system Alt #11	Criterial not well defined yet	demolition or support of control building may be required	Unlikely	Significant	3
PS-5	Concrete Mining	Pipe cost can change - availability unknown	No contact with suppliers since 2010	Very LIKELY	Marginal	3
PS-6	72" pipe	Several problems may arrise that have not been identified	Access - man hrs required for in-water installation	LIKELY	Marginal	2
PS-7	Pipe Installation	Preliminary Design - valves still need design work	Final design not known but probably will not change much	Very LIKELY	Marginal	3
PS-8	Valves	No design - Just a guess	Not sure what this looks like yet	Unlikely	Critical	3
PS-9	Pipe filling system	No information on how this is done	No information	Very LIKELY	Marginal	3
PS-10	Operations & Maint			Very Unlikely	Negligible	0
PS-11				Very Unlikely	Negligible	0
PS-12				Very Unlikely	Negligible	0
PS-13				Very Unlikely	Negligible	0
PS-14	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy

AS-1	foundation prep	Design/bid/build		Unlikely	Marginal	1
AS-2	Intake Tower	Design/bid/build		Unlikely	Marginal	1
AS-3	Trash rack Alt #11	Design/bid/build		Unlikely	Marginal	1
AS-4	Trash removal system Alt #11	Design/bid/build		Unlikely	Marginal	1
AS-5	Concrete Mining	Design/bid/build		Unlikely	Marginal	1
AS-6	72" pipe	Design/bid/build		Unlikely	Marginal	1
AS-7	Pipe Installation	Design/bid/build		Unlikely	Marginal	1
AS-8	Valves	Design/bid/build		Unlikely	Marginal	1
AS-9	Pipe filling system	Design/bid/build		Unlikely	Marginal	1
AS-10	Operations & Maint			Very Unlikely	Negligible	0
AS-11				Very Unlikely	Negligible	0
AS-12				Very Unlikely	Negligible	0
AS-13				Very Unlikely	Negligible	0
AS-14	Construction Management			Very Unlikely	Negligible	0

Construction Complexity						
CC-1	foundation prep	In-Water work	lots of unknowns - weather	LIKELY	Critical	5
CC-2	Intake Tower	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-3	Trash rack Alt #11	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-4	Trash removal system Alt #11	specialty sub contractor needed		LIKELY	Marginal	2
CC-5	Concrete Mining			LIKELY	Critical	5
CC-6	72" pipe	In-Water work required and pipe grouting		LIKELY	Marginal	2
CC-7	Pipe Installation			LIKELY	Significant	4
CC-8	Valves			Very Unlikely	Significant	1
CC-9	Pipe filling system			LIKELY	Marginal	2
CC-10	Operations & Maint			Very Unlikely	Negligible	0
CC-11				Very Unlikely	Negligible	0
CC-12				Very Unlikely	Negligible	0
CC-13				Very Unlikely	Negligible	0
CC-14	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities

VC-1	foundation prep			Unlikely	Negligible	0
VC-2	Intake Tower			Unlikely	Significant	3
VC-3	Trash rack Alt #11			Unlikely	Significant	3
VC-4	Trash removal system Alt #11			Unlikely	Marginal	1
VC-5	Concrete Mining			Unlikely	Marginal	1
VC-6	72" pipe			LIKELY	Marginal	2
VC-7	Pipe Installation			Unlikely	Marginal	1
VC-8	Valves			Unlikely	Critical	3
VC-9	Pipe filling system			Unlikely	Negligible	0
VC-10	Operations & Maint			Very Unlikely	Negligible	0
VC-11				Very Unlikely	Negligible	0
VC-12				Very Unlikely	Negligible	0
VC-13				Very Unlikely	Negligible	0
VC-14	Construction Management			Very Unlikely	Negligible	0

Quantities

Q-1	foundation prep			LIKELY	Marginal	2
Q-2	Intake Tower			Unlikely	Significant	3
Q-3	Trash rack Alt #11			Unlikely	Marginal	1
Q-4	Trash removal system Alt #11			Very LIKELY	Marginal	3
Q-5	Concrete Mining			Very Unlikely	Marginal	0
Q-6	72" pipe			Very Unlikely	Negligible	0
Q-7	Pipe Installation			Very Unlikely	Marginal	0
Q-8	Valves			Very Unlikely	Critical	2
Q-9	Pipe filling system			Unlikely	Negligible	0
Q-10	Operations & Maint			Very LIKELY	Marginal	3
Q-11				Very Unlikely	Negligible	0
Q-12				Very Unlikely	Negligible	0
Q-13				Very Unlikely	Negligible	0
Q-14	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment						
FI-1	foundation prep			Very Unlikely	Negligible	0
FI-2	Intake Tower			Unlikely	Significant	3
FI-3	Trash rack Alt #11			Unlikely	Marginal	1
FI-4	Trash removal system Alt #11			Very LIKELY	Marginal	3
FI-5	Concrete Mining			Very Unlikely	Negligible	0
FI-6	72" pipe			Unlikely	Significant	3
FI-7	Pipe Installation			Very Unlikely	Negligible	0
FI-8	Valves			Unlikely	Significant	3
FI-9	Pipe filling system			LIKELY	Negligible	1
FI-10	Operations & Maint			LIKELY	Marginal	2
FI-11				Very Unlikely	Negligible	0
FI-12				Very Unlikely	Negligible	0
FI-13				Very Unlikely	Negligible	0
FI-14	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method						
CE-1	foundation prep			LIKELY	Marginal	2
CE-2	Intake Tower			LIKELY	Significant	4
CE-3	Trash rack Alt #11			Unlikely	Marginal	1
CE-4	Trash removal system Alt #11			Very LIKELY	Negligible	2
CE-5	Concrete Mining			Unlikely	Marginal	1
CE-6	72" pipe			Unlikely	Marginal	1
CE-7	Pipe Installation			Very LIKELY	Significant	4
CE-8	Valves			Very Unlikely	Significant	1
CE-9	Pipe filling system			Very Unlikely	Marginal	0
CE-10	Operations & Maint			LIKELY	Marginal	2
CE-11				Very Unlikely	Negligible	0
CE-12				Very Unlikely	Negligible	0
CE-13				Very Unlikely	Negligible	0
CE-14	Construction Management			Very Unlikely	Negligible	0

External Project Risks

EX-1	foundation prep			LIKELY	Marginal	2
EX-2	Intake Tower			Unlikely	Significant	3
EX-3	Trash rack Alt #11			Unlikely	Negligible	0
EX-4	Trash removal system Alt #11			Unlikely	Negligible	0
EX-5	Concrete Mining			Unlikely	Significant	3
EX-6	72" pipe			Unlikely	Marginal	1
EX-7	Pipe Installation			LIKELY	Negligible	1
EX-8	Valves			Very Unlikely	Significant	1
EX-9	Pipe filling system			Unlikely	Negligible	0
EX-10	Operations & Maint			LIKELY	Marginal	2
EX-11				Very Unlikely	Negligible	0
EX-12				Very Unlikely	Negligible	0
EX-13				Very Unlikely	Negligible	0
EX-14	Construction Management			Very Unlikely	Negligible	0

The Dalles EFL AWS Alt. 11 Siphon w intake tower

EDR - Pre Feasibility

Abbreviated Risk Analysis

		Potential Risk Areas													
		foundation prep	Intake Tower	Trash rack Alt #11	Trash removal system Alt #11	Concrete Mining	72" pipe	Pipe Installation	Valves	Pipe filling system	Operations & Maint				Construction Management
Typical Risk Elements	Project Scope	2	3	3	3	3	2	3	3	3	-	-	-	-	-
	Acquisition Strategy	1	1	1	1	1	1	1	1	1	-	-	-	-	-
	Construction Complexity	5	4	4	2	5	2	4	1	2	-	-	-	-	-
	Volatile Commodities	-	3	3	1	1	2	1	3	-	-	-	-	-	-
	Quantities	2	3	1	3	-	-	-	2	-	3	-	-	-	-
	Fabrication & Project Installed Equipment	-	3	1	3	-	3	-	3	1	2	-	-	-	-
	Cost Estimating Method	2	4	1	2	1	1	4	1	-	2	-	-	-	-
	External Project Risks	2	3	-	-	3	1	1	1	-	2	-	-	-	-

Fish Lock Improvements (2012 Cost)

The following is an estimate of contstruction cost, including contingency to account for uncertainty in the development of the design and the unit prices. Costs for operation and maintenance have been included.

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Improvement					
1	Fishlock	CY	No Work Planned			
2	Valve Room - Replace two valves	each	350000	2		$ 700,000
	Labor	LS	10000	2		$ 20,000
3	Approach Channel					
4	Removal of Concrete, Gates and Frames	CY	800	28.7		$ 22,960
					Subtotal (Capital Cost)	**$ 742,960**
5	**Mobilization / Demobilization**	at 10% of construction cost				**$ 74,296**
20	**Contingency (on capital Cost + m&dm)**				***31.50%***	**$257,435.64**
					Total (Capital Cost)	**$ 1,074,692**

Item	Description	Unit	Unit Price	Qty	Contingency	Total
	Operations and Maintenance - Design - Construction Management					
6	Operation	Mo	12733	12		
7	Maintenance	Yr	28800	50		
8	Engineering and Design	LS	to be included at 90% level			
9	Construction Management and EDC	LS	to be included at 90% level			
					Total (Capital Cost)	**$ 817,256**

0 Cost Esti ates

LIFE CYCLE COST ANALYSIS
The Dalles EFL AWS

3/29/2012

Cost Component	Alternatives	
	Alt. #2	Alt. #11
Initial Construction Costs	**$7,650,836**	**$10,084,991**
Replacement Costs	**$0**	**$0**
Maintenance Costs		
1. First Year Cost	$104,580	$109,560
2. Annual Maintenance Costs	$71,380	$43,160
P/A Discount Factor (50-yrs)	31.424	31.424
Present-Worth Annual Maintenance Costs	$2,243,017	$1,356,243
3. Cost every 10th Year	$177,462	$207,337
P/F Discount Factor (at 10+20+30+40+50-yrs)	2.870	2.870
Present-Worth Cost every 10th Year	$509,282	$595,018
4. Cost @ 5th Year	$88,810	$92,130
P/F Discount Factor (at 5-yrs)	0.906	0.906
Present-Worth Annual Maintenance Costs	$80,438	$83,445
Total Maintenance Costs	**$2,937,317**	**$2,144,265**
Annual Energy Costs	**$0**	**$0**
Total Life-Cycle Costs	**$10,588,153**	**$12,229,256**

Overall Life-Cycle Costs

The total life-cycle costs were determined for each system alternative. As described above, all future and annual costs over the 50-year analysis period were converted to a present-day cost to allow comparison. The interest rate used was 2.0% as recommended in the current Office of Management and Budget (OMB) Circular A-94 Appendix C (December 2010). This represents a real discount rate from which the inflation premium has been removed. Real discount rates are used for discounting constant-dollar flows as is required for cost-effectiveness analyses. Appendix B includes the interest factor spreadsheet for these life cycle cost factors calculated using the 2.0% rate.

The Dales EFW -AWS Backup System O&M hours

	First year cost	annual cost	cost every 10th years	cost for 1-year of operation @ Year 5
Alternative 2	$63,080	$69,720	$58,100	$47,310
Material Cost 5%			$102,762	
Alternative 11	$68,060	$41,500	$58,100	$50,630
Material Cost 5%			$132,637	
Valve Room	$41,500	$1,660	$16,600	$41,500
Alt 2 + Valve Room	**$104,580**	**$71,380**	**$177,462**	**$88,810**
Alt 11 + Valve Room	**$109,560**	**$43,160**	**$207,337**	**$92,130**

First year cost - hours during construction
Annual cost- hours per year for normal O&M
cost every tenth year - for periodic reconditioning of operating equipment
Material cost 5% of Rake, Crane, pumps, 72" valves and Valve room valves
Cost to operate for one year - Assume this occurs at year 5 after construction
O&M Labor Rate = $83.00/hr burdened

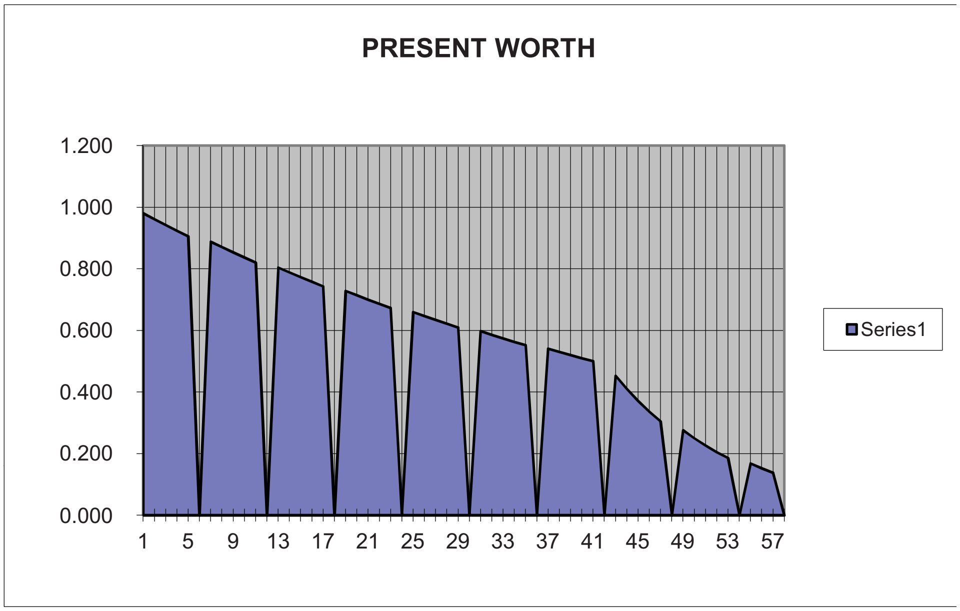
U.S. Cost Incorporated

2.00% 2.00%

Compound Interest Factors

N u m b e r (N)	SINGLE PAYMENT		UNIFORM PAYMENT SERIES			
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor
	Find R Given P *F/P*	Find P Given F *P/F*	Find A Given G *A/F*	Find A Given P *A/P*	Find F Given A *F/A*	Find P Given A *P/A*
1	1.020	**0.980**	1.000	1.020	1.000	**0.980**
2	1.040	**0.961**	0.495	0.515	2.020	**1.942**
3	1.061	**0.942**	0.327	0.347	3.060	**2.884**
4	1.082	**0.924**	0.243	0.263	4.122	**3.808**
5	1.104	**0.906**	0.192	0.212	5.204	**4.713**
6	1.126	**0.888**	0.159	0.179	6.308	**5.601**
7	1.149	**0.871**	0.135	0.155	7.434	**6.472**
8	1.172	**0.853**	0.117	0.137	8.583	**7.325**
9	1.195	**0.837**	0.103	0.123	9.755	**8.162**
10	1.219	**0.820**	0.091	0.111	10.950	**8.983**
11	1.243	**0.804**	0.082	0.102	12.169	**9.787**
12	1.268	**0.788**	0.075	0.095	13.412	**10.575**
13	1.294	**0.773**	0.068	0.088	14.680	**11.348**
14	1.319	**0.758**	0.063	0.083	15.974	**12.106**
15	1.346	**0.743**	0.058	0.078	17.293	**12.849**
16	1.373	**0.728**	0.054	0.074	18.639	**13.578**
17	1.400	**0.714**	0.050	0.070	20.012	**14.292**
18	1.428	**0.700**	0.047	0.067	21.412	**14.992**
19	1.457	**0.686**	0.044	0.064	22.841	**15.678**
20	1.486	**0.673**	0.041	0.061	24.297	**16.351**
21	1.516	**0.660**	0.039	0.059	25.783	**17.011**
22	1.546	**0.647**	0.037	0.057	27.299	**17.658**
23	1.577	**0.634**	0.035	0.055	28.845	**18.292**
24	1.608	**0.622**	0.033	0.053	30.422	**18.914**
25	1.641	**0.610**	0.031	0.051	32.030	**19.523**
26	1.673	**0.598**	0.030	0.050	33.671	**20.121**
27	1.707	**0.586**	0.028	0.048	35.344	**20.707**
28	1.741	**0.574**	0.027	0.047	37.051	**21.281**
29	1.776	**0.563**	0.026	0.046	38.792	**21.844**
30	1.811	**0.552**	0.025	0.045	40.568	**22.396**
31	1.848	**0.541**	0.024	0.044	42.379	**22.938**
32	1.885	**0.531**	0.023	0.043	44.227	**23.468**
33	1.922	**0.520**	0.022	0.042	46.112	**23.989**
34	1.961	**0.510**	0.021	0.041	48.034	**24.499**
35	2.000	**0.500**	0.020	0.040	49.994	**24.999**
40	2.208	**0.453**	0.017	0.037	60.402	**27.355**
45	2.438	**0.410**	0.014	0.034	71.893	**29.490**
50	2.692	**0.372**	0.012	0.032	84.579	**31.424**
55	2.972	**0.337**	0.010	0.030	98.587	**33.175**
60	3.281	**0.305**	0.009	0.029	114.052	**34.761**
65	3.623	**0.276**	0.008	0.028	131.126	**36.197**
70	4.000	**0.250**	0.007	0.027	149.978	**37.499**
75	4.416	**0.226**	0.006	0.026	170.792	**38.677**
80	4.875	**0.205**	0.005	0.025	193.772	**39.745**
85	5.383	**0.186**	0.005	0.025	219.144	**40.711**
90	5.943	**0.168**	0.004	0.024	247.157	**41.587**
95	6.562	**0.152**	0.004	0.024	278.085	**42.380**
100	7.245	**0.138**	0.003	0.023	312.232	**43.098**

Compound Interest Factors



**** TOTAL PROJECT COST SUMMARY ****

PROJECT: The Dalles E Fish Ladder AWS - Alt 2
LOCATION: The Dalles, OR.

DISTRICT: NWP Portland PREPARED: 3/29/2012
POC: CHIEF, COST ENGINEERING, Michael R. Moran

This Estimate reflects the scope and schedule in report; The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 2 - 032912

WBS NUMBER	Civil Works Feature & Sub-Feature Description	ESTIMATED COST: COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	PROJECT FIRST COST (Program Year (Budget EC): 2014; Effective Price Level Date: 1 OCT 13): ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	TOTAL PROJECT COST (FULLY FUNDED): Spent Thru: 29-Mar-12 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
03	RESERVOIRS			-		-								
04	DAMS			-		-								
05	LOCKS			-		-								
06	FISH & WILDLIFE FACILITIES	$7,650,836	$2,653,310	35%	$10,304,146	5.1%	$8,040,249	$2,788,358	**$10,828,608**			$8,040,249	$2,788,358	$10,828,608
07	POWER PLANT			-		-								
	CONSTRUCTION ESTIMATE TOTALS:	$7,650,836	$2,653,310		**$10,304,146**	5.1%	$8,040,249	$2,788,358	**$10,828,608**			$8,040,249	$2,788,358	$10,828,608
01	LANDS AND DAMAGES			-		-								
30	PLANNING, ENGINEERING & DESIGN	$3,060,334	$1,061,324	35%	$4,121,658	11.8%	$3,421,251	$1,186,490	**$4,607,740**			$3,421,251	$1,186,490	$4,607,740
31	CONSTRUCTION MANAGEMENT	$765,084	$265,331	35%	$1,030,415	11.8%	$855,313	$296,623	**$1,151,936**			$855,313	$296,623	$1,151,936
	PROJECT COST TOTALS:	$11,476,254	$3,979,965	35%	**$15,456,219**	7.3%	$12,316,813	$4,271,471	**$16,588,284**			$12,316,813	$4,271,471	$16,588,284

________ CHIEF, COST ENGINEERING, Michael R. Moran

________ PROJECT MANAGER, George J. Medina

________ CHIEF, REAL ESTATE, xxx

________ CHIEF, PLANNING,xxx

________ CHIEF, ENGINEERING, Lance A. Helwig

________ CHIEF, OPERATIONS, xxx

________ CHIEF, CONSTRUCTION, Karen L. Garmire

________ CHIEF, CONTRACTING, Ralph Banse-Fay

________ CHIEF, PM-PB, xxxx

________ CHIEF, DPM, xxx

ESTIMATED FEDERAL COST:	100%	**$16,588,284**
ESTIMATED NON-FEDERAL COST:		
ESTIMATED TOTAL PROJECT COST:		**$16,588,284**
O&M OUTSIDE OF TOTAL PROJECT COST:		**$2,937,317**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: The Dalles E Fish Ladder AWS - Alt 2
LOCATION: The Dalles, OR.
This Estimate reflects the scope & schedule in report; The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 2 - 032912

DISTRICT: NWP Portland PREPARED: 3/29/2012
POC: CHIEF, COST ENGINEERING, Michael R. Moran

Estimate Prepared: 29-Mar-12
Effective Price Level: 29-Mar-12

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		PHASE 1													
03		RESERVOIRS													
04		DAMS													
05		LOCKS													
06		FISH & WILDLIFE FACILITIES	$7,650,836	$2,653,310	34.68%	$10,304,146	5.1%	$8,040,249	$2,788,358	$10,828,608	2015Q2		$8,040,249	$2,788,358	$10,828,608
07		POWER PLANT													
		CONSTRUCTION ESTIMATE TOTALS:	$7,650,836	$2,653,310	34.68%	**$10,304,146**		$8,040,249	$2,788,358	$10,828,608			$8,040,249	$2,788,358	$10,828,608
01		LANDS AND DAMAGES			34.68%										
30		PLANNING, ENGINEERING & DESIGN													
	5.0%	Project Management	$382,542	$132,666	34.68%	$515,208	11.8%	$427,657	$148,311	$575,968	2015Q2		$427,657	$148,311	$575,968
		Planning & Environmental Compliance			34.68%										
	25.0%	Engineering & Design	$1,912,709	$663,327	34.68%	$2,576,036	11.8%	$2,138,282	$741,556	$2,879,838	2015Q2		$2,138,282	$741,556	$2,879,838
	3.0%	Engineering Tech Review ITR & VE	$229,525	$79,599	34.68%	$309,124	11.8%	$256,594	$88,987	$345,580	2015Q2		$256,594	$88,987	$345,580
	3.0%	Contracting & Reprographics	$229,525	$79,599	34.68%	$309,124	11.8%	$256,594	$88,987	$345,580	2015Q2		$256,594	$88,987	$345,580
	4.0%	Engineering During Construction	$306,033	$106,132	34.68%	$412,165	11.8%	$342,125	$118,649	$460,773	2015Q2		$342,125	$118,649	$460,773
		Planning During Construction			34.68%										
		Project Operations			34.68%										
31		CONSTRUCTION MANAGEMENT													
	8.0%	Construction Management	$612,067	$212,265	34.68%	$824,332	11.8%	$684,250	$237,298	$921,548	2015Q2		$684,250	$237,298	$921,548
		Project Operation:			34.68%										
	2.0%	Project Management	$153,017	$53,066	34.68%	$206,083	11.8%	$171,063	$59,325	$230,387	2015Q2		$171,063	$59,325	$230,387
		CONTRACT COST TOTALS:	$11,476,254	$3,979,965		**$15,456,219**		$12,316,813	$4,271,471	$16,588,284			$12,316,813	$4,271,471	**$16,588,284**

90% EDR Cost Estimate

US Army Corps of Engineers®
Portland District

The Dalles East Fish Ladder Auxiliary Water Backup System
Alternative No. 2

The Dalles Dam, Oregon

March 29, 2012

HDR

U.S. COST

7800 North Stemmons Freeway, Suite 650
Dallas, Texas 75247
214-630-3994 Fax 214-631-1352

The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 2 - 032912

Estimated by	U.S.COST Inc.
Designed by	HDR Engineering Inc.
Prepared by	Howard Campbell
Preparation Date	3/29/2012
Effective Date of Pricing	3/29/2012
Estimated Construction Time	365 Days

Table of Contents

Description — **Page**

Designed by
HDR Engineering Inc.
Estimated by
U.S.COST Inc.
Prepared by
Howard Campbell

Design Document	90% EDR Drawings
Document Date	3/29/2012
District	Portland
Contact	Howard Campbell
Budget Year	2012
UOM System	Original

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost
PED
CM

Timeline/Currency

Preparation Date	3/29/2012
Escalation Date	3/29/2012
Eff. Pricing Date	3/29/2012
Estimated Duration	365 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB10EB: MII English Cost Book 2010

Labor : Wasco County OR Labor 032012

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP09R08: MII Equipment Region 8 2009

08 NORTHWEST

Sales Tax	6.00
Working Hours per Year	1,540
Labor Adjustment Factor	1.01
Cost of Money	4.88
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.067
Gas	4.231
Diesel Off-Road	3.737
Diesel On-Road	4.440

Shipping Rates

Over 0 CWT	27.78
Over 240 CWT	26.06
Over 300 CWT	23.69
Over 400 CWT	21.52
Over 500 CWT	11.26
Over 700 CWT	9.51
Over 800 CWT	6.48

Date	Author	Note
3/28/2012		Project NoteProject Description: This project requires the construction of two 72" diameter pipes with two valves routhed through the concrete dam monilith and along the base of the concrete non-overflow section of the dam to the existing fishlock, the existing piping and valves within the valve room will be removed and six new valves with associated piping and meters installed in the valve room. The existing fish elevator, equipment, gates and fish lock approach channel shall be removed. Some concrete within the fish lock approach channed shall be demolished and one wall of the fish lock approach channel height will be raised to elevation 111.0. The joints in the existing auxiliary conduit. shall be repaired and one set of new stop logs shall be provided for the fish lock approach channel. A new intake screen, trash rake system, intake bulkheads with guides and a jib hoist shall be installed. Temporary construction cofferdams shall be required for the concrete mining.Project Location: The Dalles Dam, Oregon.Documents Used as the Basis for this Estimate: 90% EDR documents received March 2012.Volatile Cost Items: Two categories of volatile cost items are fuel (gasoline, on-road diesel and off-road diesel) and materials (e.g., steel pipe, valves).Construction is scheduled to begin July 1, 2014 and end June 2015 lasting 12 months. Mid-point of construction would be at 6 months, or January 2015.Construction Windows: In- water work shall only be allowed in the period starting December 1 and ending January 31.Escalation: 0% - Will be included in the TPCS..1. Taxes: Sales tax is applied at 0.0%.2. FOOH: 10.0% of running costs.3. HOOH: 5.0% of running costs.4. Profit: 8.02% calculated per tables.5. Bond: 0.84% calculated per tables.6. Design/Estimating Contingency: 0.0%7. Price Level: March 20128. Productivity: 100%9. Overtime Usage: N/A.10. Contingency: 0% - Will be included in the TPCS.11. PED costs: 0% - Will be included in the TPCS..12. Owner's Supervision & Inspection costs: 0% - Will be included in the TPCS.Adjustments To Equipment Database:1: Gasoline: 4.2312: Diesel (Off-Road): 3.7373: Diesel (On-Road): 4.440Deployment Site Access: The project construction site is accessible via major highway/local roads/improved roadways.Unusual Conditions (Soil, Water, and Weather): Oregon's season rainy season is October to March. Unique Construction Techniques: It is anticipated that a prudent, well-equipped contractor can perform the construction. Equipment and Labor Availability and Distance Traveled: This estimate assumes equipment and labor availability of a prudent and well-equipped joint venture contractor/fabricator in Eugene, OR., as indicated in Engineer Instructions 01D010, 1 Sep 1997 (Unified Facilities Criteria 3-700-02A, 01 March 2005). This estimate assumes the vessel fabrication and initial assemble will occur at the joint venture contractor's Eugene facility .Environmental Concerns During Construction: Concrete mining, over water work and in- water work shall only be allowed in the period starting December 1 and ending January 31.Acquisition Plan: Competitive Bid. Sub-contracting Plan: The prime contractor will be a heavy mechanical/piping contractor who will selfperform all piping, valve, equipment installation and valve room piping/valve demolition. The concrete demolition, fish elevator & fish elevator equipment, fencing, dam concrete mining, diving and work activites requiring marine equipment will be subcontracted.Databases used: MII English Cost Book 2010, MII Equipment Region 8 2009 & Wasco County OR Labor J032012.Effective Dates for Labor, Equipment and Material Pricing: March 2012Effective Dates for Labor, Equipment and Material Pricing: March 2012

Description	UOM	Quantity	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report A - Summary Bid Items			**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
06 Fish and Wildlife Facilities	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
0601 Fish Facilities at Dams	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
060144 Fishways and Fish Ladders	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**

Description	UOM	Quantity	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report B - Summary System			**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
06 Fish and Wildlife Facilities	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
0601 Fish Facilities at Dams	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
060144 Fishways and Fish Ladders	**EA**	**1.00**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			279,649.81		*351,838.85*				*351,838.85*
06014401 Cofferdam	**EA**	**1.00**	**279,649.81**	**72,189.04**	**351,838.85**	**0.00**	**0.00**	**0.00**	**351,838.85**
			1,247,321.77		*1,569,306.47*				*1,569,306.47*
06014403 Trash Rack	**EA**	**1.00**	**1,247,321.77**	**321,984.71**	**1,569,306.47**	**0.00**	**0.00**	**0.00**	**1,569,306.47**
			290,968.26		*366,079.05*				*366,079.05*
06014404 Trash Rake	**EA**	**1.00**	**290,968.26**	**75,110.79**	**366,079.05**	**0.00**	**0.00**	**0.00**	**366,079.05**
			186,481.58		*234,620.10*				*234,620.10*
06014405 Concrete Mining	**EA**	**1.00**	**186,481.58**	**48,138.51**	**234,620.10**	**0.00**	**0.00**	**0.00**	**234,620.10**
			608.00		*764.95*				*764.95*
06014406 72" Pipe Material	**LF**	**448.00**	**272,384.00**	**70,313.44**	**342,697.44**	**0.00**	**0.00**	**0.00**	**342,697.44**
			619,495.86		*779,413.05*				*779,413.05*
06014407 72" Pipe Installation	**EA**	**1.00**	**619,495.86**	**159,917.19**	**779,413.05**	**0.00**	**0.00**	**0.00**	**779,413.05**
			834,283.54		*1,049,646.21*				*1,049,646.21*
06014408 72" Valves	**EA**	**1.00**	**834,283.54**	**215,362.67**	**1,049,646.21**	**0.00**	**0.00**	**0.00**	**1,049,646.21**
			1,329,718.11		*1,672,972.68*				*1,672,972.68*
06014410 Valve Room Modification	**EA**	**1.00**	**1,329,718.11**	**343,254.57**	**1,672,972.68**	**0.00**	**0.00**	**0.00**	**1,672,972.68**
			805,000.57		*1,012,804.10*				*1,012,804.10*
06014411 Approach Channel & Fish Lock Mod.	**EA**	**1.00**	**805,000.57**	**207,803.53**	**1,012,804.10**	**0.00**	**0.00**	**0.00**	**1,012,804.10**
			215,761.43		*271,458.27*				*271,458.27*
06014413 Electrical	**EA**	**1.00**	**215,761.43**	**55,696.84**	**271,458.27**	**0.00**	**0.00**	**0.00**	**271,458.27**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report C - Summary All Level			**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
06 Fish and Wildlife Facilities	**1.00**	**EA**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
0601 Fish Facilities at Dams	**1.00**	**EA**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			6,081,064.93		*7,650,836.23*				*7,650,836.23*
060144 Fishways and Fish Ladders	**1.00**	**EA**	**6,081,064.93**	**1,569,771.29**	**7,650,836.23**	**0.00**	**0.00**	**0.00**	**7,650,836.23**
			279,649.81		*351,838.85*				*351,838.85*
06014401 Cofferdam	**1.00**	**EA**	**279,649.81**	**72,189.04**	**351,838.85**	**0.00**	**0.00**	**0.00**	**351,838.85**
			95,203.86		*119,779.87*				*119,779.87*
0601440101 Shop Fabricate Tempory Construction Cofferdam #2	**2.00**	**EA**	**190,407.73**	**49,152.01**	**239,559.74**	**0.00**	**0.00**	**0.00**	**239,559.74**
			25,304.06		*31,836.07*				*31,836.07*
0601440102 Install & Remove Tempory Construction Cofferdam #2	**2.00**	**EA**	**50,608.12**	**13,064.02**	**63,672.14**	**0.00**	**0.00**	**0.00**	**63,672.14**
			38,633.96		*48,606.97*				*48,606.97*
0601440103 Marine Work Platform #2	**1.00**	**MO**	**38,633.96**	**9,973.00**	**48,606.97**	**0.00**	**0.00**	**0.00**	**48,606.97**
			1,247,321.77		*1,569,306.47*				*1,569,306.47*
06014403 Trash Rack	**1.00**	**EA**	**1,247,321.77**	**321,984.71**	**1,569,306.47**	**0.00**	**0.00**	**0.00**	**1,569,306.47**
			157,529.81		*198,194.69*				*198,194.69*
0601440301 Install 72" Dia Bulkhead #2	**2.00**	**EA**	**315,059.62**	**81,329.76**	**396,389.38**	**0.00**	**0.00**	**0.00**	**396,389.38**
			920,406.38		*1,158,000.87*				*1,158,000.87*
0601440302 Intake Screen #2	**1.00**	**EA**	**920,406.38**	**237,594.49**	**1,158,000.87**	**0.00**	**0.00**	**0.00**	**1,158,000.87**
			11,855.77		*14,916.23*				*14,916.23*
0601440303 Jib Crane & Hoist #2	**1.00**	**EA**	**11,855.77**	**3,060.46**	**14,916.23**	**0.00**	**0.00**	**0.00**	**14,916.23**
			290,968.26		*366,079.05*				*366,079.05*
06014404 Trash Rake	**1.00**	**EA**	**290,968.26**	**75,110.79**	**366,079.05**	**0.00**	**0.00**	**0.00**	**366,079.05**
			290,968.26		*366,079.05*				*366,079.05*
0601440401 Trash Rake System #2	**1.00**	**EA**	**290,968.26**	**75,110.79**	**366,079.05**	**0.00**	**0.00**	**0.00**	**366,079.05**
			186,481.58		*234,620.10*				*234,620.10*
06014405 Concrete Mining	**1.00**	**EA**	**186,481.58**	**48,138.51**	**234,620.10**	**0.00**	**0.00**	**0.00**	**234,620.10**
			1,500.00		*1,887.21*				*1,887.21*
0601440501 84" Dia Dam Mass Concrete Mining #2	**106.00**	**LF**	**159,000.00**	**41,044.40**	**200,044.40**	**0.00**	**0.00**	**0.00**	**200,044.40**
			3,435.20		*4,321.96*				*4,321.96*
0601440502 84" Dia Fishlock Reinforced Concrete Mining #2	**8.00**	**LF**	**27,481.58**	**7,094.12**	**34,575.70**	**0.00**	**0.00**	**0.00**	**34,575.70**
			608.00		*764.95*				*764.95*

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
06014406 72" Pipe Material	**448.00**	**LF**	**272,384.00**	**70,313.44**	**342,697.44**	**0.00**	**0.00**	**0.00**	**342,697.44**
			608.00		*764.95*				*764.95*
0601440601 72" Pipe Material #2	**448.00**	**LF**	**272,384.00**	**70,313.44**	**342,697.44**	**0.00**	**0.00**	**0.00**	**342,697.44**
			619,495.86		*779,413.05*				*779,413.05*
06014407 72" Pipe Installation	**1.00**	**EA**	**619,495.86**	**159,917.19**	**779,413.05**	**0.00**	**0.00**	**0.00**	**779,413.05**
			222.78		*280.29*				*280.29*
0601440701 Install 72" Dia. Intake Piping in Tunnels #2	**218.00**	**LF**	**48,566.04**	**12,536.88**	**61,102.92**	**0.00**	**0.00**	**0.00**	**61,102.92**
			140.23		*176.42*				*176.42*
0601440702 Grout 11" Annular Space #2	**1,223.00**	**CF**	**171,495.64**	**44,270.03**	**215,765.67**	**0.00**	**0.00**	**0.00**	**215,765.67**
			10,539.81		*13,260.56*				*13,260.56*
0601440703 Concrete Saddle #2	**2.00**	**EA**	**21,079.61**	**5,441.51**	**26,521.12**	**0.00**	**0.00**	**0.00**	**26,521.12**
			29,637.32		*37,287.93*				*37,287.93*
0601440704 Concrete Thrust Block #2	**1.00**	**EA**	**29,637.32**	**7,650.60**	**37,287.93**	**0.00**	**0.00**	**0.00**	**37,287.93**
			29,834.97		*37,536.60*				*37,536.60*
0601440705 Field Fabricate & Install 72" Dia x 90 Deg Short R. Bend #2	**1.00**	**EA**	**29,834.97**	**7,701.63**	**37,536.60**	**0.00**	**0.00**	**0.00**	**37,536.60**
			55,637.33		*69,999.59*				*69,999.59*
0601440706 Field Fabricate & Install 72" Dia x 90 Deg Long R. Bend #2	**1.00**	**EA**	**55,637.33**	**14,362.27**	**69,999.59**	**0.00**	**0.00**	**0.00**	**69,999.59**
			29,834.97		*37,536.60*				*37,536.60*
0601440707 Field Fabricate & Install 72" Dia x 45 Deg Bend #2	**2.00**	**EA**	**59,669.95**	**15,403.25**	**75,073.20**	**0.00**	**0.00**	**0.00**	**75,073.20**
			708.24		*891.07*				*891.07*
0601440708 Install 72" Dia. Intake Piping On Saddles #2	**281.00**	**LF**	**199,016.75**	**51,374.35**	**250,391.10**	**0.00**	**0.00**	**0.00**	**250,391.10**
			656.48		*825.94*				*825.94*
0601440709 Relocate Existing Sliding Gate	**1.00**	**EA**	**656.48**	**169.46**	**825.94**	**0.00**	**0.00**	**0.00**	**825.94**
			47.20		*59.39*				*59.39*
0601440710 Install 6' Chainlink Security Fence	**80.00**	**LF**	**3,776.38**	**974.84**	**4,751.21**	**0.00**	**0.00**	**0.00**	**4,751.21**
			125.38		*157.75*				*157.75*
0601440711 Demolish Existing Fencing #2	**1.00**	**EA**	**125.38**	**32.37**	**157.75**	**0.00**	**0.00**	**0.00**	**157.75**
			834,283.54		*1,049,646.21*				*1,049,646.21*
06014408 72" Valves	**1.00**	**EA**	**834,283.54**	**215,362.67**	**1,049,646.21**	**0.00**	**0.00**	**0.00**	**1,049,646.21**
			834,283.54		*1,049,646.21*				*1,049,646.21*
0601440801 Intake Pipe Valves #2	**1.00**	**EA**	**834,283.54**	**215,362.67**	**1,049,646.21**	**0.00**	**0.00**	**0.00**	**1,049,646.21**
			1,329,718.11		*1,672,972.68*				*1,672,972.68*
06014410 Valve Room Modification	**1.00**	**EA**	**1,329,718.11**	**343,254.57**	**1,672,972.68**	**0.00**	**0.00**	**0.00**	**1,672,972.68**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
			49,410.97		*62,165.95*				*62,165.95*
0601441001 Demolish Valve Room Piping	**1.00**	**EA**	**49,410.97**	**12,754.99**	**62,165.95**	**0.00**	**0.00**	**0.00**	**62,165.95**
			16,515.45		*20,778.76*				*20,778.76*
0601441002 Field Fabricate & Install 48" Dia. Bend	**1.00**	**EA**	**16,515.45**	**4,263.31**	**20,778.76**	**0.00**	**0.00**	**0.00**	**20,778.76**
0601441003 Field Fabricate & Install Valve Vault Piping	**1.00**	**LS**	**176,815.37**	**45,643.27**	**222,458.64**	**0.00**	**0.00**	**0.00**	**222,458.64**
0601441004 Install Valve Vault Valves	**1.00**	**LS**	**1,086,976.33**	**280,593.00**	**1,367,569.33**	**0.00**	**0.00**	**0.00**	**1,367,569.33**
			805,000.57		*1,012,804.10*				*1,012,804.10*
06014411 Approach Channel & Fish Lock Mod.	**1.00**	**EA**	**805,000.57**	**207,803.53**	**1,012,804.10**	**0.00**	**0.00**	**0.00**	**1,012,804.10**
			25,469.97		*32,044.81*				*32,044.81*
0601441101 Demolish Control House	**1.00**	**EA**	**25,469.97**	**6,574.84**	**32,044.81**	**0.00**	**0.00**	**0.00**	**32,044.81**
			22,210.52		*27,943.97*				*27,943.97*
0601441102 Demolish Fishlock Equipment	**1.00**	**EA**	**22,210.52**	**5,733.44**	**27,943.97**	**0.00**	**0.00**	**0.00**	**27,943.97**
			49,908.51		*62,791.94*				*62,791.94*
0601441103 Demolition at Fishlock Approach Channel	**1.00**	**EA**	**49,908.51**	**12,883.43**	**62,791.94**	**0.00**	**0.00**	**0.00**	**62,791.94**
			25,541.25		*32,134.49*				*32,134.49*
0601441104 7' x 7' x 9' deep Cutout to Fishlock Approach Channel base slab	**1.00**	**EA**	**25,541.25**	**6,593.24**	**32,134.49**	**0.00**	**0.00**	**0.00**	**32,134.49**
			613.86		*772.32*				*772.32*
0601441105 Concrete Repair to 7' x 7' x 9' deep Cutout	**13.00**	**CY**	**7,980.16**	**2,060.01**	**10,040.16**	**0.00**	**0.00**	**0.00**	**10,040.16**
			1,506.45		*1,895.33*				*1,895.33*
0601441106 15" Thick CIP Wall Height Extension	**25.00**	**CY**	**37,661.24**	**9,721.91**	**47,383.15**	**0.00**	**0.00**	**0.00**	**47,383.15**
			148,228.91		*186,492.85*				*186,492.85*
0601441107 Seal 8' x 8' Culvert Joints	**1.00**	**EA**	**148,228.91**	**38,263.94**	**186,492.85**	**0.00**	**0.00**	**0.00**	**186,492.85**
			488,000.00		*613,972.74*				*613,972.74*
0601441108 Stop Logs	**1.00**	**EA**	**488,000.00**	**125,972.74**	**613,972.74**	**0.00**	**0.00**	**0.00**	**613,972.74**
			215,761.43		*271,458.27*				*271,458.27*
06014413 Electrical	**1.00**	**EA**	**215,761.43**	**55,696.84**	**271,458.27**	**0.00**	**0.00**	**0.00**	**271,458.27**
			85,062.91		*107,021.13*				*107,021.13*
0601441301 Power From Existing Unit Substation	**1.00**	**EA**	**85,062.91**	**21,958.21**	**107,021.13**	**0.00**	**0.00**	**0.00**	**107,021.13**
			25,059.93		*31,528.92*				*31,528.92*
0601441302 Power for Trash Rake	**1.00**	**EA**	**25,059.93**	**6,468.99**	**31,528.92**	**0.00**	**0.00**	**0.00**	**31,528.92**
			33,578.04		*42,245.90*				*42,245.90*
0601441303 Power for Valve Operators	**1.00**	**EA**	**33,578.04**	**8,667.86**	**42,245.90**	**0.00**	**0.00**	**0.00**	**42,245.90**
			25,161.41		*31,656.60*				*31,656.60*
0601441304 Power for Hydraulic Power Units	**1.00**	**EA**	**25,161.41**	**6,495.19**	**31,656.60**	**0.00**	**0.00**	**0.00**	**31,656.60**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
			23,702.21		*29,820.72*				*29,820.72*
0601441305 Power for Bulkhead Crane	**1.00**	**EA**	**23,702.21**	**6,118.51**	**29,820.72**	**0.00**	**0.00**	**0.00**	**29,820.72**
			10,974.29		*13,807.20*				*13,807.20*
0601441306 Relocate Electrical Panel at Fence	**1.00**	**EA**	**10,974.29**	**2,832.91**	**13,807.20**	**0.00**	**0.00**	**0.00**	**13,807.20**
			6,564.01		*8,258.45*				*8,258.45*
0601441307 Modify Electrical Security System at Fence	**1.00**	**EA**	**6,564.01**	**1,694.44**	**8,258.45**	**0.00**	**0.00**	**0.00**	**8,258.45**
			4,920.55		*6,190.74*				*6,190.74*
0601441308 Demo Existing Electrical at Existing FCQ7 - MCC	**1.00**	**EA**	**4,920.55**	**1,270.19**	**6,190.74**	**0.00**	**0.00**	**0.00**	**6,190.74**
			738.08		*928.61*				*928.61*
0601441308 Disconnect/Demo Electrical circuits to Control House	**1.00**	**EA**	**738.08**	**190.53**	**928.61**	**0.00**	**0.00**	**0.00**	**928.61**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
Detail Report			**1,179,102.04**	**172,712.26**	**4,337,013.88**	**273,000.00**	**119,236.75**	**0.00**	**6,081,064.93**
			1,179,102.04	*172,712.26*	*4,337,013.88*	*273,000.00*		*0.00*	*6,081,064.93*
06 Fish and Wildlife Facilities	**1.00**	**EA**	**1,179,102.04**	**172,712.26**	**4,337,013.88**	**273,000.00**	**119,236.75**	**0.00**	**6,081,064.93**
			1,179,102.04	*172,712.26*	*4,337,013.88*	*273,000.00*		*0.00*	*6,081,064.93*
0601 Fish Facilities at Dams	**1.00**	**EA**	**1,179,102.04**	**172,712.26**	**4,337,013.88**	**273,000.00**	**119,236.75**	**0.00**	**6,081,064.93**
			1,179,102.04	*172,712.26*	*4,337,013.88*	*273,000.00*		*0.00*	*6,081,064.93*
060144 Fishways and Fish Ladders	**1.00**	**EA**	**1,179,102.04**	**172,712.26**	**4,337,013.88**	**273,000.00**	**119,236.75**	**0.00**	**6,081,064.93**
			87,415.65	*14,565.28*	*148,076.32*	*0.00*		*0.00*	*279,649.81*
06014401 Cofferdam	**1.00**	**EA**	**87,415.65**	**14,565.28**	**148,076.32**	**0.00**	**29,592.56**	**0.00**	**279,649.81**
			8,251.62	*1,923.44*	*73,778.96*	*0.00*		*0.00*	*95,203.86*
0601440101 Shop Fabricate Tempory Construction Cofferdam #2	**2.00**	**EA**	**16,503.25**	**3,846.88**	**147,557.92**	**0.00**	**22,499.68**	**0.00**	**190,407.73**
			0.53	*0.02*	*1.47*	*0.00*		*0.00*	*2.29*
RSM 051223600020 Pipe support framing, structural, under 10 plf, shop fabricated	1,600.00	LB	842.84	36.63	2,352.00	0.00	433.02	0.00	3,664.48
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 051223650400 Steel plate, structural, for connections & stiffeners, 1/2" T, shop fabricated, incl shop primer	0.00	SF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*33.50*	*0.00*		*0.00*	*37.99*
RSM 051223650450 Steel plate, structural, for connections & stiffeners, 3/4" T, shop fabricated, incl shop primer	3,600.00	SF	0.00	0.00	120,600.00	0.00	16,160.40	0.00	136,760.40
			2.03	*0.06*	*0.00*	*0.00*		*0.00*	*2.37*
RSM 050521100150 Cutting, steel, to 3/4" thick, by hand, incl prep, torch cutting & grinding, excl staging	296.00	LF	601.62	16.58	0.00	0.00	82.84	0.00	701.03
			24.02	*4.06*	*1.66*	*0.00*		*0.00*	*33.72*
RSM 050521902010 Welding structural steel in field, 4 passes, 0.7 Lb/LF, 1/2" thick, continuous fillet, type 6011	158.00	LF	3,795.22	641.17	262.28	0.00	629.62	0.00	5,328.30
			307.41	*114.42*	*1,200.00*	*0.00*		*0.00*	*1,839.15*
USR 331113401180x1 Pipe, black steel, plain end, welded, 1/2" wall thickness, 96" diameter, excludes excavation or backfill	20.00	LF	6,148.19	2,288.30	24,000.00	0.00	4,346.49	0.00	36,782.98
			10.57	*1.79*	*0.71*	*0.00*		*0.00*	*14.82*
RSM 050521901500 Welding structural steel in field, single pass, 0.3 Lb/LF, 1/4" thick, continuous fillet, type 6011	484.00	LF	5,115.38	864.20	343.64	0.00	847.31	0.00	7,170.54
			24,341.21	*703.65*	*259.20*	*0.00*		*0.00*	*25,304.06*
0601440102 Install & Remove Tempory Construction Cofferdam #2	**2.00**	**EA**	**48,682.41**	**1,407.31**	**518.40**	**0.00**	**0.00**	**0.00**	**50,608.12**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,818.68	*703.65*	*0.00*	*0.00*		*0.00*	*2,522.34*
USR 331113401180x2 Hoist & Install Temporary Cofferdam at Tunnel Locations	2.00	EA	3,637.37	1,407.31	0.00	0.00	0.00	0.00	5,044.67
			15,015.02	*0.00*	*0.00*	*0.00*		*0.00*	*15,015.02*
USR 3500000001 Diver support - Drill 24 ea anchor holes in the concrete Dam face, install anchors and temporary cofferdam, excludes cost of anchors and hoisting cost.	2.00	EA	30,030.03	0.00	0.00	0.00	0.00	0.00	30,030.03
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 331113401180x2 Relocate Temporary Cofferdam to 2nd Tunnel Location	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			7,507.51	*0.00*	*0.00*	*0.00*		*0.00*	*7,507.51*
USR 3500000002 Diver support - Unbolt anchors and remove temporary cofferdam, , excludes hoisting cost.	2.00	EA	15,015.02	0.00	0.00	0.00	0.00	0.00	15,015.02
			0.00	*0.00*	*10.80*	*0.00*		*0.00*	*10.80*
USR 050523208600x2 Williams Stainless Steel Undercut Anchor, 1" dia x 18" long installed below waterline by divers	48.00	EA	0.00	0.00	518.40	0.00	0.00	0.00	518.40
			22,229.99	*9,311.09*	*0.00*	*0.00*		*0.00*	*38,633.96*
0601440103 Marine Work Platform #2	**1.00**	**MO**	**22,229.99**	**9,311.09**	**0.00**	**0.00**	**7,092.88**	**0.00**	**38,633.96**
			0.00	*4,281.22*	*0.00*	*0.00*		*0.00*	*5,243.97*
EP M10MZ010 MARINE EQUIPMENT, BOATS & LAUNCHES, TRUCKABLE WORKBOAT W/PILOT HOUSE & PUSH KNEES, INBOARD, 20.25' X 8' X 3'	1.00	MO	0.00	4,281.22	0.00	0.00	962.75	0.00	5,243.97
			0.00	*3,497.82*	*0.00*	*0.00*		*0.00*	*4,284.40*
EP M10XX012 MARINE EQUIPMENT, BOATS & LAUNCHES, 16', SHALLOW DRAFT, INLAND TUG	1.00	MO	0.00	3,497.82	0.00	0.00	786.58	0.00	4,284.40
			0.00	*327.31*	*0.00*	*0.00*		*0.00*	*400.91*
EP M10MZ005 MARINE EQUIPMENT, WORK BARGE, SECTIONAL, MEDIUM DUTY', W/ONE BUCKHEAD AND SPUDS, 40' X 12' X 4', 36 TON	4.00	MO	0.00	1,309.24	0.00	0.00	294.42	0.00	1,603.65
			0.00	*222.81*	*0.00*	*0.00*		*0.00*	*272.92*
EP M10XX002 MARINE EQUIPMENT, WORK BARGE, SECTIONAL, LOADING RAMPS	1.00	MO	0.00	222.81	0.00	0.00	50.11	0.00	272.92
			12,000.43	*0.00*	*0.00*	*0.00*		*0.00*	*14,699.05*
USR MD&BL0020 Licensed Boat Captain Class C, Tender Tug	1.00	MO	12,000.43	0.00	0.00	0.00	2,698.63	0.00	14,699.05
			10,229.56	*0.00*	*0.00*	*0.00*		*0.00*	*12,529.96*
USR MD&BL0021 Deckhand Tender Tug	1.00	MO	10,229.56	0.00	0.00	0.00	2,300.40	0.00	12,529.96
			119,626.50	*3,919.97*	*1,123,775.30*	*0.00*		*0.00*	*1,247,321.77*
06014403 Trash Rack	**1.00**	**EA**	**119,626.50**	**3,919.97**	**1,123,775.30**	**0.00**	**0.00**	**0.00**	**1,247,321.77**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			32,192.89	*1,298.52*	*124,038.40*	*0.00*		*0.00*	*157,529.81*
0601440301 Install 72" Dia Bulkhead #2	**2.00**	**EA**	**64,385.79**	**2,597.03**	**248,076.80**	**0.00**	**0.00**	**0.00**	**315,059.62**
			1,934.77	*579.05*	*122,980.00*	*0.00*		*0.00*	*125,493.82*
USR 352016730190x1 Hoist and hold 72" x 72" double steel bulkhead & guide, hold until above water anchor bolts have been installed	2.00	EA	3,869.53	1,158.11	245,960.00	0.00	0.00	0.00	250,987.64
			5.70	*0.00*	*10.80*	*0.00*		*0.00*	*16.50*
USR 050523208600 Install Williams Stainless Steel Undercut Anchor above water line, 1" dia x 18" long , in concrete, excl layout & drilling	80.00	EA	456.19	0.00	864.00	0.00	0.00	0.00	1,320.19
			0.00	*239.82*	*0.00*	*0.00*		*0.00*	*239.82*
EP P40TE004 MAN-LIFT, ARTICULATED BOOM, 66' HEIGHT, 500 LBS, 33' REACH, 4X4, SELF PROPELLED, 3' X 6' PLATFROM	6.00	DAY	0.00	1,438.93	0.00	0.00	0.00	0.00	1,438.93
			30,030.03	*0.00*	*0.00*	*0.00*		*0.00*	*30,030.03*
USR 3500000003 Diver support - Drill 58 ea anchor holes in the concrete Dam face, install anchors and permanent Bulkhead guide, excludes cost of anchors and hoisting cost.	2.00	EA	60,060.06	0.00	0.00	0.00	0.00	0.00	60,060.06
			0.00	*0.00*	*10.80*	*0.00*		*0.00*	*10.80*
USR 050523208600x2 Williams Stainless Steel Undercut Anchor above water line, 1" dia x 18" long installed below waterline by divers	116.00	EA	0.00	0.00	1,252.80	0.00	0.00	0.00	1,252.80
			52,004.31	*1,302.87*	*867,099.20*	*0.00*		*0.00*	*920,406.38*
0601440302 Intake Screen #2	**1.00**	**EA**	**52,004.31**	**1,302.87**	**867,099.20**	**0.00**	**0.00**	**0.00**	**920,406.38**
			0.00	*0.00*	*91,300.00*	*0.00*		*0.00*	*91,300.00*
USR 051223650450x4 Shop fabricated Trashrack Enclosure, 66'-2" x 18'-8", incl Delivery to site	1.00	EA	0.00	0.00	91,300.00	0.00	0.00	0.00	91,300.00
			0.00	*0.00*	*155,000.00*	*0.00*		*0.00*	*155,000.00*
USR 051223650450x4 Shop fabricated Trashrack Panel, 11'-6" x 18'-0", incl Delivery to site	5.00	EA	0.00	0.00	775,000.00	0.00	0.00	0.00	775,000.00
			35,026.27	*0.00*	*0.00*	*0.00*		*0.00*	*35,026.27*
USR 3500000004 Diver support - Drill 74 ea anchor holes in the concrete Dam face, install anchors and Trash Rack Frame, excludes cost of anchors and hoisting cost.	1.00	EA	35,026.27	0.00	0.00	0.00	0.00	0.00	35,026.27
			1,990.24	*579.05*	*0.00*	*0.00*		*0.00*	*2,569.29*
USR 034105101700x1 Install Trashrack Enclosure	1.00	EA	1,990.24	579.05	0.00	0.00	0.00	0.00	2,569.29
			497.56	*144.76*	*0.00*	*0.00*		*0.00*	*642.32*
USR 034105101700 Install Trash Rack Panel	5.00	EA	2,487.80	723.82	0.00	0.00	0.00	0.00	3,211.62
			2,500.00	*0.00*	*0.00*	*0.00*		*0.00*	*2,500.00*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
USR 3500000005 Diver support - Install Trash Rack Screen, excludes hoisting cost.	5.00	EA	12,500.00	0.00	0.00	0.00	0.00	0.00	12,500.00
			0.00	*0.00*	*10.80*	*0.00*		*0.00*	*10.80*
USR 050523208600x2 Williams Stainless Steel Undercut Anchor, 1" dia x 18" long installed below waterline by divers	74.00	EA	0.00	0.00	799.20	0.00	0.00	0.00	799.20
			3,236.41	*20.06*	*8,599.30*	*0.00*		*0.00*	*11,855.77*
0601440303 Jib Crane & Hoist #2	**1.00**	**EA**	**3,236.41**	**20.06**	**8,599.30**	**0.00**	**0.00**	**0.00**	**11,855.77**
			3,037.53	*0.00*	*8,500.00*	*0.00*		*0.00*	*11,537.53*
RSM 144510102200 Hydraulic Lifts, hoists, swivel arms, single post, 8,000 lb capacity	1.00	EA	3,037.53	0.00	8,500.00	0.00	0.00	0.00	11,537.53
			33.15	*3.34*	*16.55*	*0.00*		*0.00*	*53.04*
RSM 050523151435 Chemical anchor, 1" dia x 11-3/4" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	6.00	EA	198.88	20.06	99.30	0.00	0.00	0.00	318.24
			30,237.43	*9,936.42*	*250,794.40*	*0.00*		*0.00*	*290,968.26*
06014404 Trash Rake	**1.00**	**EA**	**30,237.43**	**9,936.42**	**250,794.40**	**0.00**	**0.00**	**0.00**	**290,968.26**
			30,237.43	*9,936.42*	*250,794.40*	*0.00*		*0.00*	*290,968.26*
0601440401 Trash Rake System #2	**1.00**	**EA**	**30,237.43**	**9,936.42**	**250,794.40**	**0.00**	**0.00**	**0.00**	**290,968.26**
			33.15	*3.34*	*16.55*	*0.00*		*0.00*	*53.04*
RSM 050523151435 Chemical anchor, 1" dia x 11-3/4" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	48.00	EA	1,591.03	160.48	794.40	0.00	0.00	0.00	2,545.91
			28,646.40	*9,775.95*	*250,000.00*	*0.00*		*0.00*	*288,422.35*
USR 412123160450x1 Trashraking System, twinboom DT8300 model, material cost includes PLC auto/manual controls.	1.00	EA	28,646.40	9,775.95	250,000.00	0.00	0.00	0.00	288,422.35
			2,481.58	*0.00*	*0.00*	*184,000.00*		*0.00*	*186,481.58*
06014405 Concrete Mining	**1.00**	**EA**	**2,481.58**	**0.00**	**0.00**	**184,000.00**	**0.00**	**0.00**	**186,481.58**
			0.00	*0.00*	*0.00*	*1,500.00*		*0.00*	*1,500.00*
0601440501 84" Dia Dam Mass Concrete Mining #2	**106.00**	**LF**	**0.00**	**0.00**	**0.00**	**159,000.00**	**0.00**	**0.00**	**159,000.00**
			0.00	*0.00*	*0.00*	*1,500.00*		*0.00*	*1,500.00*
USR 317119100120x Dam unreinforced mass concrete mining, 84" Dia diameter bored tunnel, includes mobilization/de-mobilization, 2 setups, mucking (Note: Two budget price obtained.)	106.00	LF	0.00	0.00	0.00	159,000.00	0.00	0.00	159,000.00
			310.20	*0.00*	*0.00*	*3,125.00*		*0.00*	*3,435.20*
0601440502 84" Dia Fishlock Reinforced Concrete Mining #2	**8.00**	**LF**	**2,481.58**	**0.00**	**0.00**	**25,000.00**	**0.00**	**0.00**	**27,481.58**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*3,125.00*		*0.00*	*3,125.00*
USR 317119100120xx Fishlock reinforced concrete mining, 84" Dia diameter NON-bored tunnel, not including mobilization/de-mobilization.	8.00	LF	0.00	0.00	0.00	25,000.00	0.00	0.00	25,000.00
(Note: Budget price obtained.)									
			56.40	*0.00*	*0.00*	*0.00*		*0.00*	*56.40*
RSM 024119271080 Selective demolition, torch cutting, steel, reinforced concrete walls, 24" thick, oxygen lance cutting	44.00	LF	2,481.58	0.00	0.00	0.00	0.00	0.00	2,481.58
			0.00	*0.00*	*608.00*	*0.00*		*0.00*	*608.00*
06014406 72" Pipe Material	**448.00**	**LF**	**0.00**	**0.00**	**272,384.00**	**0.00**	**0.00**	**0.00**	**272,384.00**
			0.00	*0.00*	*608.00*	*0.00*		*0.00*	*608.00*
0601440601 72" Pipe Material #2	**448.00**	**LF**	**0.00**	**0.00**	**272,384.00**	**0.00**	**0.00**	**0.00**	**272,384.00**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*380.00*
USR 331113401130x Material Cost ONLY - 72" diameter Pipe, black steel, plain end, welded, A-36, 1/2" wall thickness	448.00	LF	0.00	0.00	170,240.00	0.00	0.00	0.00	170,240.00
			0.00	*0.00*	*228.00*	*0.00*		*0.00*	*228.00*
USR 331113401645 Interior Polyurethane paint & exterior epoxy pipe coating to 72" Dia., material add only	448.00	LF	0.00	0.00	102,144.00	0.00	0.00	0.00	102,144.00
			475,106.02	*77,882.68*	*58,017.01*	*0.00*		*0.00*	*619,495.86*
06014407 72" Pipe Installation	**1.00**	**EA**	**475,106.02**	**77,882.68**	**58,017.01**	**0.00**	**8,490.15**	**0.00**	**619,495.86**
			168.07	*54.11*	*0.61*	*0.00*		*0.00*	*222.78*
0601440701 Install 72" Dia. Intake Piping in Tunnels #2	**218.00**	**LF**	**36,638.91**	**11,795.05**	**132.08**	**0.00**	**0.00**	**0.00**	**48,566.04**
			286.41	*110.81*	*0.00*	*0.00*		*0.00*	*397.22*
HNC 331113401130 Pipe, black steel, plain end, welded, 1/2" wall thickness, 72" diameter, excludes excavation or backfill	106.00	LF	30,359.13	11,746.02	0.00	0.00	0.00	0.00	42,105.15
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	2.00	EA	5,755.25	49.03	0.00	0.00	0.00	0.00	5,804.28
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	2.00	EA	524.53	0.00	132.08	0.00	0.00	0.00	656.61
			117.92	*12.30*	*10.00*	*0.00*		*0.00*	*140.23*
0601440702 Grout 11" Annular Space #2	**1,223.00**	**CF**	**144,220.51**	**15,045.13**	**12,230.00**	**0.00**	**0.00**	**0.00**	**171,495.64**
			117.92	*12.30*	*10.00*	*0.00*		*0.00*	*140.23*
USR 314313130100x1 Concrete pressure grouting to annular space, cement and sand, 1:1 mix	1,223.00	CF	144,220.51	15,045.13	12,230.00	0.00	0.00	0.00	171,495.64

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			3,636.62	*58.13*	*5,239.56*	*0.00*		*0.00*	*10,539.81*
0601440703 Concrete Saddle #2	**2.00**	**EA**	**7,273.24**	**116.26**	**10,479.12**	**0.00**	**3,210.99**	**0.00**	**21,079.61**
			8.21	*0.00*	*2.24*	*0.00*		*0.00*	*12.33*
USR 031113852000x1 C.I.P. concrete forms, Pipe Saddle, job built, plywood, to 8' high, 1 use, includes erecting, bracing, stripping and cleaning	535.00	SFC	4,394.65	0.00	1,198.40	0.00	1,005.07	0.00	6,598.13
			987.81	*0.00*	*760.00*	*0.00*		*0.00*	*2,061.89*
RSM 032110600500 Reinforcing Steel, in place, footings, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.50	TON	2,469.52	0.00	1,900.00	0.00	785.20	0.00	5,154.72
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	2.50	TON	86.89	11.08	0.00	0.00	17.60	0.00	115.57
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	2.50	TON	0.00	0.00	950.00	0.00	170.72	0.00	1,120.72
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	15.00	CY	0.00	0.00	1,627.50	0.00	292.46	0.00	1,919.96
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350400 Structural concrete, ready mix, normal weight, 5000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350411 Structural concrete, ready mix, normal weight, 6000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			11.17	*0.00*	*16.93*	*0.00*		*0.00*	*33.15*
HNC 033923230205 Curing, burlap/poly blanket, 2 ply	0.19	CSF	2.12	0.00	3.22	0.00	0.96	0.00	6.30
			18.18	*6.21*	*0.00*	*0.00*		*0.00*	*28.77*
RSM 033105703250 Structural concrete, placing, grade beam, pumped, includes strike off & consolidation, excludes material	15.00	CY	272.65	93.12	0.00	0.00	65.73	0.00	431.50
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113500020 C.I.P. concrete forms, grade beam, plywood, 1 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			4.31	*1.10*	*0.00*	*0.00*		*0.00*	*6.38*
RSM 312316130060 Excavating, trench or continuous footing, common earth, 1/2 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	11.00	BCY	47.41	12.06	0.00	0.00	10.69	0.00	70.16
			0.00	*0.00*	*1,200.00*	*0.00*		*0.00*	*1,415.64*
USR Allowance for Fabricated Steel Saddle Support	4.00	EA	0.00	0.00	4,800.00	0.00	862.56	0.00	5,662.56
			10,559.45	*545.34*	*14,017.97*	*0.00*		*0.00*	*29,637.32*
0601440704 Concrete Thrust Block #2	**1.00**	**EA**	**10,559.45**	**545.34**	**14,017.97**	**0.00**	**4,514.56**	**0.00**	**29,637.32**
			10.95	*0.00*	*2.51*	*0.00*		*0.00*	*15.88*
USR 031113852400 C.I.P. concrete forms, Thrust Block, job built, plywood, over 8' to 16' high, 1 use, includes erecting, bracing, stripping and cleaning	587.00	SFC	6,429.06	0.00	1,473.37	0.00	1,420.07	0.00	9,322.50
			987.81	*0.00*	*760.00*	*0.00*		*0.00*	*2,061.89*
RSM 032110600500 Reinforcing Steel, in place, footings, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.50	TON	2,469.52	0.00	1,900.00	0.00	785.20	0.00	5,154.72
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	2.50	TON	86.89	11.08	0.00	0.00	17.60	0.00	115.57
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	2.50	TON	0.00	0.00	950.00	0.00	170.72	0.00	1,120.72
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	89.00	CY	0.00	0.00	9,656.50	0.00	1,735.27	0.00	11,391.77
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350400 Structural concrete, ready mix, normal weight, 5000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350411 Structural concrete, ready mix, normal weight, 6000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.49	*0.00*	*0.00*	*0.00*		*0.00*	*0.58*
HNC 033529300010 Concrete finishing, floors, monolithic, screed finish	225.00	SF	111.35	0.00	0.00	0.00	20.01	0.00	131.36

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			11.17	*0.00*	*16.93*	*0.00*		*0.00*	*33.15*
HNC 033923230205 Curing, burlap/poly blanket, 2 ply	2.25	CSF	25.13	0.00	38.10	0.00	11.36	0.00	74.59
			13.63	*4.66*	*0.00*	*0.00*		*0.00*	*21.57*
RSM 033105704050 Structural concrete, placing, pile caps, pumped, over 10 CY, includes strike off & consolidation, excludes material	89.00	CY	1,213.28	414.39	0.00	0.00	292.49	0.00	1,920.17
			8.97	*4.79*	*0.00*	*0.00*		*0.00*	*16.24*
RSM 312316166120 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, clay,till or blasted rock, 1 C.Y. bucket, machine excavation, hydraulic backhoe	25.00	BCY	224.22	119.87	0.00	0.00	61.83	0.00	405.93
			25,658.18	*3,846.59*	*330.20*	*0.00*		*0.00*	*29,834.97*
0601440705 Field Fabricate & Install 72" Dia x 90 Deg Short R. Bend #2	**1.00**	**EA**	**25,658.18**	**3,846.59**	**330.20**	**0.00**	**0.00**	**0.00**	**29,834.97**
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	226.00	LF	360.11	10.28	0.00	0.00	0.00	0.00	370.40
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	6.00	EA	8,083.04	3,127.35	0.00	0.00	0.00	0.00	11,210.38
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	1.00	EA	1,515.57	586.38	0.00	0.00	0.00	0.00	2,101.95
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	5.00	EA	14,388.13	122.58	0.00	0.00	0.00	0.00	14,510.71
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	5.00	EA	1,311.34	0.00	330.20	0.00	0.00	0.00	1,641.54
			48,393.08	*6,583.85*	*660.40*	*0.00*		*0.00*	*55,637.33*
0601440706 Field Fabricate & Install 72" Dia x 90 Deg Long R. Bend #2	**1.00**	**EA**	**48,393.08**	**6,583.85**	**660.40**	**0.00**	**0.00**	**0.00**	**55,637.33**
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	414.00	LF	659.68	18.84	0.00	0.00	0.00	0.00	678.51

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	11.00	EA	14,818.90	5,733.47	0.00	0.00	0.00	0.00	20,552.37
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	1.00	EA	1,515.57	586.38	0.00	0.00	0.00	0.00	2,101.95
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	10.00	EA	28,776.25	245.17	0.00	0.00	0.00	0.00	29,021.42
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	10.00	EA	2,622.67	0.00	660.40	0.00	0.00	0.00	3,283.07
			25,658.18	*3,846.59*	*330.20*	*0.00*		*0.00*	*29,834.97*
0601440707 Field Fabricate & Install 72" Dia x 45 Deg Bend #2	**2.00**	**EA**	**51,316.37**	**7,693.18**	**660.40**	**0.00**	**0.00**	**0.00**	**59,669.95**
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	452.00	LF	720.23	20.57	0.00	0.00	0.00	0.00	740.79
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	12.00	EA	16,166.08	6,254.69	0.00	0.00	0.00	0.00	22,420.77
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	2.00	EA	3,031.14	1,172.76	0.00	0.00	0.00	0.00	4,203.89
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	10.00	EA	28,776.25	245.17	0.00	0.00	0.00	0.00	29,021.42
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	10.00	EA	2,622.67	0.00	660.40	0.00	0.00	0.00	3,283.07
			534.65	*114.57*	*59.03*	*0.00*		*0.00*	*708.24*
0601440708 Install 72" Dia. Intake Piping On Saddles #2	**281.00**	**LF**	**150,236.33**	**32,193.58**	**16,586.84**	**0.00**	**0.00**	**0.00**	**199,016.75**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			286.41	*110.81*	*0.00*	*0.00*		*0.00*	*397.22*
HNC 331113401130 Pipe, black steel, plain end, welded, 1/2" wall thickness, 72" diameter, excludes excavation or backfill	281.00	LF	80,480.32	31,138.03	0.00	0.00	0.00	0.00	111,618.36
			954.56	*135.17*	*3,800.00*	*0.00*		*0.00*	*4,889.74*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 72" pipe size, includes 1 weld per joint and weld machine	4.00	EA	3,818.26	540.70	15,200.00	0.00	0.00	0.00	19,558.96
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	21.00	EA	60,430.13	514.85	0.00	0.00	0.00	0.00	60,944.98
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	21.00	EA	5,507.62	0.00	1,386.84	0.00	0.00	0.00	6,894.46
			546.36	*0.00*	*0.00*	*0.00*		*0.00*	*656.48*
0601440709 Relocate Existing Sliding Gate	**1.00**	**EA**	**546.36**	**0.00**	**0.00**	**0.00**	**110.12**	**0.00**	**656.48**
			546.36	*0.00*	*0.00*	*0.00*		*0.00*	*656.48*
USR 323113307820x1 Relocate existing motor operator for 32' sliding gate	1.00	EA	546.36	0.00	0.00	0.00	110.12	0.00	656.48
			2.16	*0.63*	*36.50*	*0.00*		*0.00*	*47.20*
0601440710 Install 6' Chainlink Security Fence	**80.00**	**LF**	**172.46**	**50.47**	**2,920.00**	**0.00**	**633.45**	**0.00**	**3,776.38**
			2.16	*0.63*	*36.50*	*0.00*		*0.00*	*47.20*
HNC 323113534620 Fence, metal, security, 6' high, standard FE-6, includes excavation and posts	80.00	LF	172.46	50.47	2,920.00	0.00	633.45	0.00	3,776.38
			91.13	*13.22*	*0.00*	*0.00*		*0.00*	*125.38*
0601440711 Demolish Existing Fencing #2	**1.00**	**EA**	**91.13**	**13.22**	**0.00**	**0.00**	**21.03**	**0.00**	**125.38**
			1.52	*0.22*	*0.00*	*0.00*		*0.00*	*2.09*
RSM 024113621100 Selective demolition, chain link fences & gates, fence, fabric & accessories, fabric, to 8' high	60.00	LF	91.13	13.22	0.00	0.00	21.03	0.00	125.38
			12,848.27	*2,895.27*	*818,540.00*	*0.00*		*0.00*	*834,283.54*
06014408 72" Valves	**1.00**	**EA**	**12,848.27**	**2,895.27**	**818,540.00**	**0.00**	**0.00**	**0.00**	**834,283.54**
			12,848.27	*2,895.27*	*818,540.00*	*0.00*		*0.00*	*834,283.54*
0601440801 Intake Pipe Valves #2	**1.00**	**EA**	**12,848.27**	**2,895.27**	**818,540.00**	**0.00**	**0.00**	**0.00**	**834,283.54**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 352016630200x4 Lift and position 72" dia. Gate Valve, includes material cost	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			4,836.92	*1,447.64*	*400,000.00*	*0.00*		*0.00*	*406,284.55*
USR 352016630200x4 Lift and position 72" dia. Jet Flow Valve, includes material cost	2.00	EA	9,673.83	2,895.27	800,000.00	0.00	0.00	0.00	812,569.10

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			415.43	*0.00*	*3,650.00*	*0.00*		*0.00*	*4,065.43*
USR 110505000001 Hydraulic power unit, 5 H.P.	2.00	EA	830.87	0.00	7,300.00	0.00	0.00	0.00	8,130.87
			218.47	*0.00*	*2,820.00*	*0.00*		*0.00*	*3,038.47*
USR 221119141220h1 Hydraulic hose allowance, carbon steel ends, threaded, 1" diameter	2.00	EA	436.94	0.00	5,640.00	0.00	0.00	0.00	6,076.94
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 72" pipe size, includes 1 weld per joint and weld machine	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			476.66	*0.00*	*1,400.00*	*0.00*		*0.00*	*1,876.66*
USR 221113470830x4 Gasket and bolt set, for flanges, 150 lb., 72" pipe size	4.00	EA	1,906.64	0.00	5,600.00	0.00	0.00	0.00	7,506.64
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			184,975.69	*19,635.42*	*1,045,107.00*	*80,000.00*		*0.00*	*1,329,718.11*
06014410 Valve Room Modification	**1.00**	**EA**	**184,975.69**	**19,635.42**	**1,045,107.00**	**80,000.00**	**0.00**	**0.00**	**1,329,718.11**
			43,482.23	*5,928.73*	*0.00*	*0.00*		*0.00*	*49,410.97*
0601441001 Demolish Valve Room Piping	**1.00**	**EA**	**43,482.23**	**5,928.73**	**0.00**	**0.00**	**0.00**	**0.00**	**49,410.97**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 331216103832 Water Utility distribution Valves, gate valves, cast iron, mechanical joint, with boxes, 250 PSI, 36" diameter, includes valve box and mechanical joint, excludes excavation and backfill	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 221113470730 Gasket and bolt set, for flanges, 150 lb., 14" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 18" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting	29.00	LF	46.21	1.32	0.00	0.00	0.00	0.00	47.53
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 36" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	20.00	LF	31.87	0.91	0.00	0.00	0.00	0.00	32.78

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 42" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	22.00	LF	35.06	1.00	0.00	0.00	0.00	0.00	36.06
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113470750x Remove bolt set for flanges & Valves, 18" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			394.89	*46.95*	*0.00*	*0.00*		*0.00*	*441.84*
USR 221113470780x Remove bolt set for flanges & Valves, 24" pipe size	2.00	EA	789.78	93.91	0.00	0.00	0.00	0.00	883.68
			535.92	*63.72*	*0.00*	*0.00*		*0.00*	*599.64*
USR 221113470810x Remove bolt set for flanges & Valves, 30" pipe size	1.00	EA	535.92	63.72	0.00	0.00	0.00	0.00	599.64
			682.08	*81.10*	*0.00*	*0.00*		*0.00*	*763.18*
USR 221113470830x Remove bolt set for flanges & Valves, 36" pipe size	1.00	EA	682.08	81.10	0.00	0.00	0.00	0.00	763.18
			937.86	*111.51*	*0.00*	*0.00*		*0.00*	*1,049.37*
USR 221113470810x Remove bolt set for flanges & Valves, 42" pipe size	8.00	EA	7,502.88	892.12	0.00	0.00	0.00	0.00	8,395.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113470810x Remove bolt set for flanges & Valves, 48" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			895.38	*126.79*	*0.00*	*0.00*		*0.00*	*1,022.18*
USR 220505109150x Lift and remove valves previously unbolted, 42" diameter, selective demolition	2.00	EA	1,790.76	253.59	0.00	0.00	0.00	0.00	2,044.35
			61.41	*8.70*	*0.00*	*0.00*		*0.00*	*70.11*
USR 220505102153x Lift and remove steel pipe previously unbolted or torch cut, 18" diameter, includes attached fittings or valves.	73.00	LF	4,483.05	634.84	0.00	0.00	0.00	0.00	5,117.89
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 220505102155x Lift and remove steel pipe previously unbolted or torch cut, 24" thru 26" diameter, includes attached fittings or valves.	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			107.62	*15.24*	*0.00*	*0.00*		*0.00*	*122.86*
USR 220505102156x Lift and remove steel pipe previously unbolted or torch cut, 30" tdiameter, includes attached fittings or valves.	13.00	LF	1,399.03	198.12	0.00	0.00	0.00	0.00	1,597.15
			107.62	*15.24*	*0.00*	*0.00*		*0.00*	*122.86*
USR 220505102156x Lift and remove steel pipe previously unbolted or torch cut, 36" diameter, includes attached fittings or valves.	27.00	LF	2,905.68	411.47	0.00	0.00	0.00	0.00	3,317.15

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 220505102156 Lift and remove steel pipe previously unbolted or torch cut, 42" diameter, includes attached fittings or valves.	52.00	LF	23,279.92	3,296.64	0.00	0.00	0.00	0.00	26,576.55
			13,736.15	*527.30*	*2,252.00*	*0.00*		*0.00*	*16,515.45*
0601441002 Field Fabricate & Install 48" Dia. Bend	**1.00**	**EA**	**13,736.15**	**527.30**	**2,252.00**	**0.00**	**0.00**	**0.00**	**16,515.45**
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	101.00	LF	160.94	4.60	0.00	0.00	0.00	0.00	165.53
			389.30	*55.13*	*254.00*	*0.00*		*0.00*	*698.42*
USR 331113401110x Insert into valve vault & position 48" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	8.00	LF	3,114.37	441.02	2,032.00	0.00	0.00	0.00	5,587.39
			1,917.39	*16.34*	*0.00*	*0.00*		*0.00*	*1,933.73*
USR 221113449650x3 Pipe, steel, Welding labor per joint, 48" pipe size, schedule 80, welding	5.00	EA	9,586.97	81.68	0.00	0.00	0.00	0.00	9,668.65
			174.78	*0.00*	*44.00*	*0.00*		*0.00*	*218.78*
USR 230593502160x3 Pipe testing, nondestructive test, X-ray of welds, 48" diam.	5.00	EA	873.88	0.00	220.00	0.00	0.00	0.00	1,093.88
0601441003 Field Fabricate & Install Valve Vault Piping	**1.00**	**LS**	**107,228.05**	**10,532.32**	**59,055.00**	**0.00**	**0.00**	**0.00**	**176,815.37**
			0.00	*0.00*	*2,386.00*	*0.00*		*0.00*	*2,386.00*
USR 331113401110xx1 Shop fabricate 48" x 42" x 28" long Eccentric Reducer, A-36, 1/2" wall thickness	2.00	EA	0.00	0.00	4,772.00	0.00	0.00	0.00	4,772.00
			0.00	*0.00*	*2,385.00*	*0.00*		*0.00*	*2,385.00*
USR 331113401110xx1 Shop fabricate 48" x 42" x 28" long Concentric Reducer, A-36, 1/2" wall thickness	1.00	EA	0.00	0.00	2,385.00	0.00	0.00	0.00	2,385.00
			0.00	*0.00*	*2,450.00*	*0.00*		*0.00*	*2,450.00*
USR 331113401110xx1 Shop fabricate 48" x 36" x 24" long Eccentric Reducer with 48" dia x 6" extension, A-36, 1/2" wall thickness	1.00	EA	0.00	0.00	2,450.00	0.00	0.00	0.00	2,450.00
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 331113401110xx6 Insert into valve vault & position Shop fabricated 48" x 36" x 24" long Eccentric Reducer with 48" dia x 6" extension, A-36, 1/2" wall thickness	1.00	EA	447.69	63.40	0.00	0.00	0.00	0.00	511.09
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 331113401110xx5 Insert into valve vault & position Shop fabricated 48" x 42" x 28" long Concentric Reducer, A-36, 1/2" wall thickness	1.00	EA	447.69	63.40	0.00	0.00	0.00	0.00	511.09
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
USR 331113401110xx4 Insert into valve vault & position Shop fabricated 48" x 42" x 28" long Eccentric Reducer, A-36, 1/2" wall thickness	2.00	EA	895.38	126.79	0.00	0.00	0.00	0.00	1,022.18
			111.58	*51.92*	*190.00*	*0.00*		*0.00*	*353.50*
USR 331113401100x Pipe, black steel, plain end, welded, A-36, 1/2" wall thickness, 36" diameter, excludes excavation or backfill	12.00	LF	1,338.91	623.05	2,280.00	0.00	0.00	0.00	4,241.96
			330.40	*46.79*	*225.00*	*0.00*		*0.00*	*602.19*
USR 331113401110x Insert into valve vault & position 42" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	8.00	LF	2,643.19	374.30	1,800.00	0.00	0.00	0.00	4,817.49
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	59.00	LF	94.01	2.68	0.00	0.00	0.00	0.00	96.70
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			476.66	*0.00*	*700.00*	*0.00*		*0.00*	*1,176.66*
USR 221113470830x1 Gasket and bolt set, for flanges, 150 lb., 36" pipe size	1.00	EA	476.66	0.00	700.00	0.00	0.00	0.00	1,176.66
			476.66	*0.00*	*817.00*	*0.00*		*0.00*	*1,293.66*
USR 221113470830x2 Gasket and bolt set, for flanges, 150 lb., 42" pipe size	3.00	EA	1,429.98	0.00	2,451.00	0.00	0.00	0.00	3,880.98
			476.66	*0.00*	*934.00*	*0.00*		*0.00*	*1,410.66*
USR 221113470830x3 Gasket and bolt set, for flanges, 150 lb., 48" pipe size	10.00	EA	4,766.59	0.00	9,340.00	0.00	0.00	0.00	14,106.59
			4,772.82	*675.87*	*1,900.00*	*0.00*		*0.00*	*7,348.69*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 36" pipe size, includes 1 weld per joint and weld machine	1.00	EA	4,772.82	675.87	1,900.00	0.00	0.00	0.00	7,348.69
			5,493.14	*777.88*	*2,217.00*	*0.00*		*0.00*	*8,488.01*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 42" pipe size, includes 1 weld per joint and weld machine	3.00	EA	16,479.41	2,333.63	6,651.00	0.00	0.00	0.00	25,464.04
			6,395.58	*905.67*	*2,534.00*	*0.00*		*0.00*	*9,835.25*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 48" pipe size, includes 1 weld per joint and weld machine	6.00	EA	38,373.49	5,434.02	15,204.00	0.00	0.00	0.00	59,011.51
			389.30	*55.13*	*254.00*	*0.00*		*0.00*	*698.42*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
USR 331113401110x Insert into valve vault & position 48" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	11.00	LF	4,282.26	606.41	2,794.00	0.00	0.00	0.00	7,682.66
			194.19	*0.00*	*70.00*	*0.00*		*0.00*	*264.19*
RSM 221113470750 Gasket and bolt set, for flanges, 150 lb., 18" pipe size	3.00	EA	582.58	0.00	210.00	0.00	0.00	0.00	792.58
			299.75	*0.00*	*1,834.00*	*0.00*		*0.00*	*2,133.75*
USR 221113472518x Flange, steel, cast iron, black, blind, 125 lb., 18" pipe size, add 1 gasket and bolt set (material only) for each joint, includes make-up labor, excludes gasket & bolt sets	3.00	EA	899.26	0.00	5,502.00	0.00	0.00	0.00	6,401.26
			1,438.81	*12.26*	*0.00*	*0.00*		*0.00*	*1,451.07*
USR 221113449650x1 Pipe, steel, Welding labor per joint, 36" pipe size, schedule 80, welding	2.00	EA	2,877.63	24.52	0.00	0.00	0.00	0.00	2,902.14
			1,679.29	*14.31*	*0.00*	*0.00*		*0.00*	*1,693.59*
USR 221113449650x2 Pipe, steel, Welding labor per joint, 42" pipe size, schedule 80, welding	4.00	EA	6,717.15	57.23	0.00	0.00	0.00	0.00	6,774.37
			1,917.39	*16.34*	*0.00*	*0.00*		*0.00*	*1,933.73*
USR 221113449650x3 Pipe, steel, Welding labor per joint, 48" pipe size, schedule 80, welding	9.00	EA	17,256.55	147.02	0.00	0.00	0.00	0.00	17,403.57
			131.08	*0.00*	*33.00*	*0.00*		*0.00*	*164.08*
USR 230593502160x1 Pipe testing, nondestructive test, X-ray of welds, 36" diam.	2.00	EA	262.16	0.00	66.00	0.00	0.00	0.00	328.16
			152.92	*0.00*	*38.50*	*0.00*		*0.00*	*191.42*
USR 230593502160x2 Pipe testing, nondestructive test, X-ray of welds, 42" diam.	4.00	EA	611.67	0.00	154.00	0.00	0.00	0.00	765.67
			174.78	*0.00*	*44.00*	*0.00*		*0.00*	*218.78*
USR 230593502160x3 Pipe testing, nondestructive test, X-ray of welds, 48" diam.	9.00	EA	1,572.98	0.00	396.00	0.00	0.00	0.00	1,968.98
0601441004 Install Valve Vault Valves	**1.00**	**LS**	**20,529.25**	**2,647.08**	**983,800.00**	**80,000.00**	**0.00**	**0.00**	**1,086,976.33**
			2,984.60	*441.18*	*65,000.00*	*0.00*		*0.00*	*68,425.78*
USR 352016630160x3 Insert into valve vault, 48" dia Bonneted Knife Valve	4.00	EA	11,938.42	1,764.72	260,000.00	0.00	0.00	0.00	273,703.14
			2,984.60	*441.18*	*425,000.00*	*0.00*		*0.00*	*428,425.78*
USR 352016630160x3 Insert in valve vault, Inline Sleeve Valve, Model B10, 48" x 42"	1.00	EA	2,984.60	441.18	425,000.00	0.00	0.00	0.00	428,425.78
			2,984.60	*441.18*	*292,000.00*	*0.00*		*0.00*	*295,425.78*
USR 352016630160x3 Insert in valve vault, Angled Pattern Sleeve Valve, Model B12, 48" x 36" x 48"	1.00	EA	2,984.60	441.18	292,000.00	0.00	0.00	0.00	295,425.78

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			65.54	*0.00*	*0.00*	*0.00*		*0.00*	*65.54*
MIL B-PLUMBER Allowance for partial dis-assemly & re-assembly of Angled Pattern Sleeve Valve to facilate valve vault access	32.00	HR	2,097.30	0.00	0.00	0.00	0.00	0.00	2,097.30
(Note: Assumed Davis Bacon Plumbers and Pipefitters)									
			262.16	*0.00*	*3,400.00*	*0.00*		*0.00*	*3,662.16*
RSM 230913602200b Ultrasonic Flow Meter - HTD-S3X1A2 Ultrasonic Indicator / Transmitter with 4/20mA output, transducer with 25 ft cable with mtg kit	2.00	EA	524.33	0.00	6,800.00	0.00	0.00	0.00	7,324.33
USR Allowance for Reusing some existing and providing some new pipe Supports	1.00	LS	0.00	0.00	0.00	80,000.00	0.00	0.00	80,000.00
			189,477.26	*36,256.11*	*530,979.45*	*0.00*		*0.00*	*805,000.57*
06014411 Approach Channel & Fish Lock Mod.	**1.00**	**EA**	**189,477.26**	**36,256.11**	**530,979.45**	**0.00**	**48,287.75**	**0.00**	**805,000.57**
			13,978.27	*7,068.55*	*543.39*	*0.00*		*0.00*	*25,469.97*
0601441101 Demolish Control House	**1.00**	**EA**	**13,978.27**	**7,068.55**	**543.39**	**0.00**	**3,879.76**	**0.00**	**25,469.97**
			14.21	*7.91*	*0.59*	*0.00*		*0.00*	*26.80*
HNC 024119252260 Saw cutting, concrete walls, rod reinforcing, per inch of depth	828.00	LF	11,767.49	6,552.38	488.52	0.00	3,379.87	0.00	22,188.26
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100270 Selective concrete demolition, 2 - 5 CF per piece, precast specialty embedded in masonry, excludes shoring, bracing, saw or torch cutting, loading, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038213101700 Concrete core drilling, core, reinforced concrete slab, 18" diameter, up to 6" thick slab, includes bit, layout and set up	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038213101750 Concrete core drilling, core, reinforced concrete slab, 18" diameter, up to 6" thick slab, includes bit, layout and set up, each added inch thick in same hole, add	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038116500820 Concrete sawing, concrete walls, rod reinforcing, per inch of depth	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034123500750 Precast stairs, front entrance, 5 risers, 7' wide, 48" platform	0.00	FLT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.81	*0.49*	*0.50*	*0.00*		*0.00*	*2.13*
RSM 038113500400 Concrete sawing, concrete slabs, mesh reinforcing, up to 3" deep	61.00	LF	49.54	30.03	30.50	0.00	19.78	0.00	129.85

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.50	*0.30*	*0.17*	*0.00*		*0.00*	*1.14*
RSM 038113500420 Concrete sawing, concrete, existing slab, mesh reinforcing, for each additional inch of depth over 3"	61.00	LF	30.34	18.39	10.37	0.00	10.62	0.00	69.73
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034105100250 Precast beam, L shaped, 40' span, 24" x 52", includes material only	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034105102500 Precast beam, tee shaped, 40' span, 12" x 52", includes material only	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119271040 Selective demolition, torch cutting, steel, reinforced concrete walls, 12" to 16" thick, oxygen lance cutting	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119271080 Selective demolition, torch cutting, steel, reinforced concrete walls, 24" thick, oxygen lance cutting	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 220505101200 Fixture, lavatory, wall hung, selective demolition, includes 10' piping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 220505101400 Fixture, water closet, floor mounted, selective demolition, includes 10' piping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 230505102740 Heater, electric, wall, baseboard or quartz, selective demolition	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x1 Remove roof slab panels previously sawcut and load on truck	2.00	EA	465.12	133.64	0.00	0.00	107.60	0.00	706.36
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x2 Remove wall panels previously sawcut and load on truck	5.00	EA	1,162.80	334.10	0.00	0.00	268.99	0.00	1,765.90
			48.06	*0.00*	*0.00*	*0.00*		*0.00*	*56.69*
RSM 024210200100 Deconstruction of building plumbing fixtures, wall hung or countertop lavatory, up to 2 stories, excludes handling, packaging or disposal costs	1.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			48.06	*0.00*	*0.00*	*0.00*		*0.00*	*56.69*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
RSM 024210200140 Deconstruction of building plumbing fixtures, floor mounted water closet, up to 2 stories, excludes handling, packaging or disposal costs	1.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024210200310 Deconstruction of building electrical fixtures, surface mounted incandescent, up to 2 stories, excludes handling, packaging or disposal costs	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			24.03	*0.00*	*0.00*	*0.00*		*0.00*	*28.35*
RSM 024210200320 Deconstruction of building electrical fixtures, surface mounted fluorescent, 2 lamp, up to 2 stories, excludes handling, packaging or disposal costs	2.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			24.23	*0.00*	*0.00*	*0.00*		*0.00*	*28.58*
RSM 024210200610 Deconstruction of millwork and trim, cabinets, wood, up to 2 stories, excludes handling, packaging or disposal costs	3.00	LF	72.69	0.00	0.00	0.00	13.06	0.00	85.75
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024210200710 Deconstruction of building doors and windows, deconstruction of doors & wrap, interior, single, up to 2 stories, excludes handling, packaging or disposal costs, no closers	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			96.91	*0.00*	*3.50*	*0.00*		*0.00*	*118.46*
RSM 024210200730 Deconstruction of building doors and windows, deconstruciton of door & wrap, interior or exterior, single, solid core, up to 2 stories, excludes handling, packaging or disposal costs, no closers	2.00	EA	193.83	0.00	7.00	0.00	36.09	0.00	236.92
			46.15	*0.00*	*3.50*	*0.00*		*0.00*	*58.57*
RSM 024210200810 Deconstruction of building doors and windows, deconstruction of windows & wrap, single, up to 2 stories, excludes casement or cladding, handling, packaging or disposal costs	2.00	EA	92.30	0.00	7.00	0.00	17.84	0.00	117.14
			16,087.60	*2,739.66*	*0.00*	*0.00*		*0.00*	*22,210.52*
0601441102 Demolish Fishlock Equipment	**1.00**	**EA**	**16,087.60**	**2,739.66**	**0.00**	**0.00**	**3,383.26**	**0.00**	**22,210.52**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 050505100260x1 Selective metals demolition, structural framing members, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 110505102858 Hydraulic Gates, canal, flap, knife, slide or sluice, over 60" diameter, selective demolition	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 352016730190 Slide gates, hydraulic structures, steel, self contained, 72" x 72", incl. anchor bolts & grout	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HTW 025210105431 Cut Fishlock Entrance Gate in segments, thermic lance, sheet metal cutting with torch, downsizing, torch < 2" thick, includes changeout time	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 352016260260 Hydraulic sluice gates, hydraulic structures, cast iron, heavy duty, self contained w/crank oper. gate, 132" x 132", AWWA C501	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050505100070 Selective metals demolition, structural bolts/nuts, 7/8" to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			3.44	*0.00*	*0.00*	*0.00*		*0.00*	*4.06*
RSM 050505100070 Remove bolt/nut securing hoisting equipment to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	26.00	EA	89.51	0.00	0.00	0.00	16.09	0.00	105.60
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Hoisting equipment, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	3.00	EA	697.68	200.46	0.00	0.00	161.40	0.00	1,059.54
			28.60	*0.00*	*0.00*	*0.00*		*0.00*	*33.73*
HTW 025210105431 Cut Fishlock Brail in segments, thermic lance, sheet metal cutting with torch, downsizing, torch < 2" thick, includes changeout time	220.00	LF	6,291.00	0.00	0.00	0.00	1,130.49	0.00	7,421.49
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Brail segments, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	32.00	EA	7,441.92	2,138.27	0.00	0.00	1,721.56	0.00	11,301.75
			3.44	*0.00*	*0.00*	*0.00*		*0.00*	*4.06*
RSM 050505100070 Remove bolt/nut securing Fishlock Entrance Gate segments to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	50.00	EA	172.14	0.00	0.00	0.00	30.93	0.00	203.07
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Entrance Gate segments, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	6.00	EA	1,395.36	400.93	0.00	0.00	322.79	0.00	2,119.08

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			23,412.58	*16,819.92*	*2,073.60*	*0.00*		*0.00*	*49,908.51*
0601441103 Demolition at Fishlock Approach Channel	**1.00**	**EA**	**23,412.58**	**16,819.92**	**2,073.60**	**0.00**	**7,602.41**	**0.00**	**49,908.51**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100050 Selective concrete demolition, minimum reinforcing, break up into small pieces, excludes shoring, bracing, saw or torch cutting, loading, hauling, dumping	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100150 Selective concrete demolition, up to 2 tons, remove whole pieces, incl loading, excludes shoring, bracing, saw or torch cutting, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			5.31	*4.67*	*0.64*	*0.00*		*0.00*	*12.52*
RSM 038116500820 Concrete sawing, concrete walls 6 & 15" thick deep, rod reinforcing, per inch of depth	3,240.00	LF	17,190.76	15,127.24	2,073.60	0.00	6,180.18	0.00	40,571.78
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x2 Remove 6" & 15" thick wall panels previously sawcut and load on truck	8.00	EA	1,860.48	534.57	0.00	0.00	430.39	0.00	2,825.44
			1,090.34	*289.53*	*0.00*	*0.00*		*0.00*	*1,627.82*
RSM 110505102854 Remove existing 48" x 48" Hydraulic Gates, canal, flap, knife, slide or sluice, 37" to 48" diameter, selective demolition	4.00	EA	4,361.34	1,158.11	0.00	0.00	991.85	0.00	6,511.30
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119161050 Selective demolition, cutout, concrete, elevated slab, bar reinforced, over 6 C.F., excludes loading and disposal	0.00	CF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024116174200 Bldg. footings and foundations demolition, add for disposal on site, excludes disposal costs and dump fees	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			19,314.82	*1,777.66*	*558.14*	*0.00*		*0.00*	*25,541.25*
0601441104 7' x 7' x 9' deep Cutout to Fishlock Approach Channel base slab	**1.00**	**EA**	**19,314.82**	**1,777.66**	**558.14**	**0.00**	**3,890.62**	**0.00**	**25,541.25**
			0.81	*0.49*	*0.50*	*0.00*		*0.00*	*2.13*
RSM 038113500400 Concrete sawing, concrete slabs, mesh reinforcing, up to 3" deep	28.00	LF	22.74	13.78	14.00	0.00	9.08	0.00	59.60
			0.50	*0.30*	*0.17*	*0.00*		*0.00*	*1.14*
RSM 038113500420 Concrete sawing, concrete, existing slab, mesh reinforcing, for each additional inch of depth over 3"	84.00	LF	41.78	25.33	14.28	0.00	14.63	0.00	96.02
			42.89	*3.80*	*0.00*	*0.00*		*0.00*	*55.08*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
RSM 024119161050 Selective demolition of concrete base slab to expose 36" dia. pipe, bar reinforced, over 6 C.F., excludes loading and disposal	440.00	CF	18,873.39	1,670.03	0.00	0.00	3,691.66	0.00	24,235.08
			1.07	*0.00*	*0.23*	*0.00*		*0.00*	*1.53*
RSM 024119270020 Selective demolition, torch cutting, 36" dia steel pipe, 1/2" thick plate	18.00	LF	19.22	0.00	4.14	0.00	4.20	0.00	27.56
			26.05	*4.06*	*1.66*	*0.00*		*0.00*	*37.48*
RSM 050521902010 Welding 36" dia. steel pipe plug in field, 4 passes, 0.7 Lb/LF, 1/2" thick, continuous fillet, type 6011	9.40	LF	244.89	38.15	15.60	0.00	53.66	0.00	352.30
			3.54	*0.00*	*0.06*	*0.00*		*0.00*	*4.25*
RSM 050110516180 Metal cleaning, steel surface treatment, 500 - 900 SF/Day, wire brush, power tool (SSPC-SP3)	2.00	SF	7.09	0.00	0.12	0.00	1.29	0.00	8.50
			105.71	*30.37*	*510.00*	*0.00*		*0.00*	*762.18*
USR 051223650400x Insert shop fabricated 36" dia. steel pipe plug in existing pipe, 1/2" Thick plate, 10 SF	1.00	EA	105.71	30.37	510.00	0.00	116.10	0.00	762.18
			185.92	*6.38*	*328.05*	*0.00*		*0.00*	*613.86*
0601441105 Concrete Repair to 7' x 7' x 9' deep Cutout	**13.00**	**CY**	**2,416.99**	**82.95**	**4,264.63**	**0.00**	**1,215.59**	**0.00**	**7,980.16**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852400 C.I.P. concrete forms, wall, job built, plywood, over 8' to 16' high, 1 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.06	*0.00*	*2.36*	*0.00*		*0.00*	*13.48*
RSM 031113550020 C.I.P. concrete forms, mat foundation, plywood, 1 use, includes erecting, bracing, stripping and cleaning	126.00	SFC	1,142.07	0.00	297.36	0.00	258.67	0.00	1,698.10
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	1.00	TON	0.00	0.00	380.00	0.00	68.29	0.00	448.29
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110600700 Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	1.00	TON	34.75	4.43	0.00	0.00	7.04	0.00	46.23
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110600600 Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			987.81	*0.00*	*760.00*	*0.00*		*0.00*	*2,061.89*
RSM 032110600500 Reinforcing Steel, in place, footings, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	1.00	TON	987.81	0.00	760.00	0.00	314.08	0.00	2,061.89
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	13.00	CY	0.00	0.00	1,410.50	0.00	253.47	0.00	1,663.97
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350400 Structural concrete, ready mix, normal weight, 5000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350411 Structural concrete, ready mix, normal weight, 6000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			17.69	*6.04*	*0.00*	*0.00*		*0.00*	*27.99*
RSM 033105704650 Structural concrete, placing, slab on grade, pumped, over 6" thick, includes strike off & consolidation, excludes material	13.00	CY	229.91	78.52	0.00	0.00	55.43	0.00	363.86
			11.17	*0.00*	*16.93*	*0.00*		*0.00*	*33.15*
HNC 033923230205 Curing, burlap/poly blanket, 2 ply	0.37	CSF	4.13	0.00	6.27	0.00	1.87	0.00	12.27
			0.49	*0.00*	*0.00*	*0.00*		*0.00*	*0.58*
HNC 033529300010 Concrete finishing, floors, monolithic, screed finish	37.00	SF	18.31	0.00	0.00	0.00	3.29	0.00	21.60
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	13.00	CY	0.00	0.00	1,410.50	0.00	253.47	0.00	1,663.97
			840.93	*27.30*	*408.75*	*0.00*		*0.00*	*1,506.45*
0601441106 15" Thick CIP Wall Height Extension	**25.00**	**CY**	**21,023.31**	**682.38**	**10,218.73**	**0.00**	**5,736.82**	**0.00**	**37,661.24**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	2.20	TON	0.00	0.00	836.00	0.00	150.23	0.00	986.23
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	2.20	TON	76.46	9.75	0.00	0.00	15.49	0.00	101.70

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			691.47	*0.00*	*760.00*	*0.00*		*0.00*	*1,712.29*
RSM 032110600700 Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.50	TON	1,728.66	0.00	1,900.00	0.00	652.07	0.00	4,280.74
			7.10	*0.00*	*2.24*	*0.00*		*0.00*	*11.02*
RSM 031113852000 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 1 use, includes erecting, bracing, stripping and cleaning	1,332.00	SFC	9,462.88	0.00	2,983.68	0.00	2,236.65	0.00	14,683.21
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852050 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852100 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 3 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852150 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 4 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.92	*0.00*	*1.31*	*0.00*		*0.00*	*13.25*
RSM 031113850500 C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning	25.00	LF	247.98	0.00	32.75	0.00	50.45	0.00	331.18
			2.96	*0.00*	*2.05*	*0.00*		*0.00*	*5.91*
HNC 032110602466 Reinforcing steel, in place, dowels, deformed, epoxy coated, 2' long, #6, A775, grade 60	148.00	EA	438.59	0.00	303.40	0.00	133.34	0.00	875.32
			27.26	*9.31*	*0.00*	*0.00*		*0.00*	*43.15*
RSM 033105705350 Structural concrete, placing, walls, pumped, 15" thick, includes strike off & consolidation, excludes material	25.00	CY	681.62	232.80	0.00	0.00	164.32	0.00	1,078.74
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	25.00	CY	0.00	0.00	2,712.50	0.00	487.44	0.00	3,199.94
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 036305101545 Chemical anchoring, for fastener 1-3/4" diam x 12" embedment, incl epoxy cartridge, excl layout, drilling & fastener	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			30.64	*2.97*	*9.45*	*0.00*		*0.00*	*50.80*
RSM 050523151430 Chemical anchor, 3/4" dia x 9-1/2" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	148.00	EA	4,534.12	439.83	1,398.60	0.00	1,145.15	0.00	7,517.69
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 260533950520 Hole drilling, concrete wall, 12" thick, 3/4" pipe size, to 10' high	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.87	*0.00*	*0.11*	*0.00*		*0.00*	*11.78*
RSM 038216100500 Concrete impact drilling, for anchors, up to 4" D, 3/4" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	148.00	EA	1,461.48	0.00	16.28	0.00	265.55	0.00	1,743.32
			2.02	*0.00*	*0.03*	*0.00*		*0.00*	*2.42*
RSM 038216100550 Concrete impact drilling, for anchors, 3/4" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor, for each additional inch of depth, add	1,184.00	EA	2,391.52	0.00	35.52	0.00	436.14	0.00	2,863.18
			93,243.70	*7,084.98*	*25,320.96*	*0.00*		*0.00*	*148,228.91*
0601441107 Seal 8' x 8' Culvert Joints	**1.00**	**EA**	**93,243.70**	**7,084.98**	**25,320.96**	**0.00**	**22,579.27**	**0.00**	**148,228.91**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050523151430 Chemical anchor, 3/4" dia x 9-1/2" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			22.22	*0.00*	*0.26*	*0.00*		*0.00*	*26.52*
USR 038216100300x1 Drill 1/2" Dia x 10" deep grout hole in concrete culvert walls, roof and floor, incl bit & layout	896.00	EA	19,907.78	0.00	232.96	0.00	3,619.30	0.00	23,760.04
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 036423100210 Crack repair, latex injection, 1/4" wide, 12" deep, includes chipping, sand blasting and cleaning	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			81.85	*7.91*	*28.00*	*0.00*		*0.00*	*138.92*
USR 036423100110x1 Joint sealing, epoxy injection, 12" deep, includes chipping, sand blasting and cleaning	896.00	EA	73,335.92	7,084.98	25,088.00	0.00	18,959.97	0.00	124,468.87
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 036423100110x2 Joint sealing, grout injection, 12" deep, includes chipping, sand blasting and cleaning	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*488,000.00*	*0.00*		*0.00*	*488,000.00*
0601441108 Stop Logs	**1.00**	**EA**	**0.00**	**0.00**	**488,000.00**	**0.00**	**0.00**	**0.00**	**488,000.00**
USR Allowance for New Stop Logs	1.00	LS	0.00	0.00	488,000.00	0.00	0.00	0.00	488,000.00
			76,933.62	*7,621.11*	*89,340.40*	*9,000.00*		*0.00*	*215,761.43*
06014413 Electrical	**1.00**	**EA**	**76,933.62**	**7,621.11**	**89,340.40**	**9,000.00**	**32,866.29**	**0.00**	**215,761.43**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			26,103.49	*3,493.04*	*42,509.00*	*0.00*		*0.00*	*85,062.91*
0601441301 Power From Existing Unit Substation	**1.00**	**EA**	**26,103.49**	**3,493.04**	**42,509.00**	**0.00**	**12,957.38**	**0.00**	**85,062.91**
			417.10	*0.00*	*3,525.00*	*0.00*		*0.00*	*4,650.50*
USR 262413401233X Install New CB in (E) USS, hic, 3 pole, to 600 V, 150 amp, for feeder section	1.00	EA	417.10	0.00	3,525.00	0.00	708.40	0.00	4,650.50
			1,961.34	*235.04*	*15,000.00*	*0.00*		*0.00*	*20,286.58*
USR 262419300400X Motor control center, 400A, 480V, 3Ph/3W, incl Cir brkrs & NEMA-3R structures/enclosure	1.00	EA	1,961.34	235.04	15,000.00	0.00	3,090.19	0.00	20,286.58
			910.04	*0.00*	*3,000.00*	*0.00*		*0.00*	*4,612.68*
RSM 262213104900 Transformer, dry-type, 3 phase 480 V primary 120/208 V secondary, 15 kVA, K-13 rated	1.00	EA	910.04	0.00	3,000.00	0.00	702.63	0.00	4,612.68
			1,251.31	*0.00*	*1,200.00*	*0.00*		*0.00*	*2,891.81*
USR 262416302100x Panelboards, 3 phase 4 wire, mcb, 120/208 V, 100 amp, 30 circuits, incl breakers	1.00	EA	1,251.31	0.00	1,200.00	0.00	440.50	0.00	2,891.81
			24.06	*0.00*	*35.20*	*0.00*		*0.00*	*69.91*
USR 260533054150X 150A Feeder/RGS/PVC Coated, 2" C, to 20' high, incl terminations/supports & #1/0 wires	420.00	LF	10,106.69	0.00	14,784.00	0.00	4,472.86	0.00	29,363.56
			23.02	*7.24*	*10.00*	*0.00*		*0.00*	*47.49*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	450.00	LF	10,357.01	3,258.00	4,500.00	0.00	3,255.27	0.00	21,370.28
			1,100.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,887.52*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	1,100.00	0.00	500.00	0.00	287.52	0.00	1,887.52
			8,649.13	*1,436.00*	*7,907.50*	*3,250.00*		*0.00*	*25,059.93*
0601441302 Power for Trash Rake	**1.00**	**EA**	**8,649.13**	**1,436.00**	**7,907.50**	**3,250.00**	**3,817.30**	**0.00**	**25,059.93**
			83.42	*0.00*	*27.50*	*0.00*		*0.00*	*130.85*
RSM 260580102015 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 25 HP motor	1.00	EA	83.42	0.00	27.50	0.00	19.93	0.00	130.85
			589.90	*0.00*	*2,500.00*	*0.00*		*0.00*	*3,645.15*
HNC 262419409480 Combination starter and disconnect switch, non-reversing, size 2, 240 V- 600 V, NEMA 4	1.00	EA	589.90	0.00	2,500.00	0.00	555.26	0.00	3,645.15
			10.43	*0.00*	*10.80*	*0.00*		*0.00*	*25.04*
USR 260533054151x 40A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #8 wires	350.00	LF	3,649.64	0.00	3,780.00	0.00	1,335.11	0.00	8,764.75
			11.51	*7.24*	*3.00*	*5.00*		*0.00*	*31.55*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	150.00	LF	1,726.17	1,086.00	450.00	750.00	720.99	0.00	4,733.16
			1,000.00	*0.00*	*1,000.00*	*0.00*		*0.00*	*2,359.40*
USR Electric connections to control equipment - allow	1.00	EA	1,000.00	0.00	1,000.00	0.00	359.40	0.00	2,359.40

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,000.00	*350.00*	*0.00*	*2,500.00*		*0.00*	*4,541.85*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	0.00	2,500.00	691.85	0.00	4,541.85
			600.00	*0.00*	*150.00*	*0.00*		*0.00*	*884.78*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	600.00	0.00	150.00	0.00	134.78	0.00	884.78
			13,653.19	*350.00*	*14,460.00*	*0.00*		*0.00*	*33,578.04*
0601441303 Power for Valve Operators	**1.00**	**EA**	**13,653.19**	**350.00**	**14,460.00**	**0.00**	**5,114.84**	**0.00**	**33,578.04**
			104.28	*0.00*	*350.00*	*0.00*		*0.00*	*535.91*
USR 260580102077X Valve/ctl connections, flexible conduit/ftgs, 3 phase, sealtite, 460 volt, to 2 HP motor	6.00	EA	625.65	0.00	2,100.00	0.00	489.80	0.00	3,215.45
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054122x 20A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	1,000.00	LF	10,427.54	0.00	10,210.00	0.00	3,708.57	0.00	24,346.11
(Note: 5HP motors & Valves connections)									
			1,000.00	*0.00*	*1,000.00*	*0.00*		*0.00*	*2,359.40*
USR Electric connections to control equipment - allow	1.00	EA	1,000.00	0.00	1,000.00	0.00	359.40	0.00	2,359.40
			1,000.00	*350.00*	*1,000.00*	*0.00*		*0.00*	*2,772.30*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	1,000.00	0.00	422.30	0.00	2,772.30
			600.00	*0.00*	*150.00*	*0.00*		*0.00*	*884.78*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	600.00	0.00	150.00	0.00	134.78	0.00	884.78
			9,497.47	*556.07*	*8,775.10*	*2,500.00*		*0.00*	*25,161.41*
0601441304 Power for Hydraulic Power Units	**1.00**	**EA**	**9,497.47**	**556.07**	**8,775.10**	**2,500.00**	**3,832.76**	**0.00**	**25,161.41**
			62.57	*0.00*	*15.30*	*0.00*		*0.00*	*91.86*
RSM 260580102005 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 5 HP motor	2.00	EA	125.13	0.00	30.60	0.00	27.98	0.00	183.72
			390.27	*0.00*	*1,500.00*	*0.00*		*0.00*	*2,229.95*
HNC 262419409460 Combination starter and disconnect switch, non-reversing, size 0, 240 V- 600 V, NEMA 4	2.00	EA	780.53	0.00	3,000.00	0.00	679.36	0.00	4,459.89
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054122x 20A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	450.00	LF	4,692.39	0.00	4,594.50	0.00	1,668.86	0.00	10,955.75
(Note: 5HP motors & Valves connections)									
			864.00	*0.00*	*1,000.00*	*0.00*		*0.00*	*2,198.96*
USR Electric connections to control equipment - allow	1.00	EA	864.00	0.00	1,000.00	0.00	334.96	0.00	2,198.96
			12.85	*2.06*	*0.00*	*0.00*		*0.00*	*17.60*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	100.00	LF	1,285.42	206.07	0.00	0.00	268.02	0.00	1,759.52

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,000.00	*350.00*	*0.00*	*2,500.00*		*0.00*	*4,541.85*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	0.00	2,500.00	691.85	0.00	4,541.85
			750.00	*0.00*	*150.00*	*0.00*		*0.00*	*1,061.73*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	750.00	0.00	150.00	0.00	161.73	0.00	1,061.73
			8,366.92	*1,436.00*	*7,038.80*	*3,250.00*		*0.00*	*23,702.21*
0601441305 Power for Bulkhead Crane	**1.00**	**EA**	**8,366.92**	**1,436.00**	**7,038.80**	**3,250.00**	**3,610.49**	**0.00**	**23,702.21**
			62.57	*0.00*	*15.30*	*0.00*		*0.00*	*91.86*
RSM 260580102010 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 10 HP motor	1.00	EA	62.57	0.00	15.30	0.00	13.99	0.00	91.86
			528.55	*0.00*	*1,900.00*	*0.00*		*0.00*	*2,864.96*
HNC 262419409470 Combination starter and disconnect switch, non-reversing, size 1, 240 V- 600 V, NEMA 4	1.00	EA	528.55	0.00	1,900.00	0.00	436.41	0.00	2,864.96
			1,000.00	*0.00*	*1,000.00*	*0.00*		*0.00*	*2,359.40*
USR Electric connections to control equipment - allow	1.00	EA	1,000.00	0.00	1,000.00	0.00	359.40	0.00	2,359.40
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054150x 30A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	350.00	LF	3,649.64	0.00	3,573.50	0.00	1,298.00	0.00	8,521.14
			11.51	*7.24*	*3.00*	*5.00*		*0.00*	*31.55*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	150.00	LF	1,726.17	1,086.00	450.00	750.00	720.99	0.00	4,733.16
			1,000.00	*350.00*	*0.00*	*2,500.00*		*0.00*	*4,541.85*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	0.00	2,500.00	691.85	0.00	4,541.85
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85
			3,902.61	*350.00*	*5,050.00*	*0.00*		*0.00*	*10,974.29*
0601441306 Relocate Electrical Panel at Fence	**1.00**	**EA**	**3,902.61**	**350.00**	**5,050.00**	**0.00**	**1,671.68**	**0.00**	**10,974.29**
			2,502.61	*0.00*	*3,950.00*	*0.00*		*0.00*	*7,612.15*
USR 262416302770x Dsconnect/relocate existing electrical pullbox/panel near fence	1.00	EA	2,502.61	0.00	3,950.00	0.00	1,159.54	0.00	7,612.15
			1,000.00	*350.00*	*1,000.00*	*0.00*		*0.00*	*2,772.30*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	1,000.00	0.00	422.30	0.00	2,772.30
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85
			1,964.13	*0.00*	*3,600.00*	*0.00*		*0.00*	*6,564.01*
0601441307 Modify Electrical Security System at Fence	**1.00**	**EA**	**1,964.13**	**0.00**	**3,600.00**	**0.00**	**999.88**	**0.00**	**6,564.01**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,564.13	*0.00*	*3,500.00*	*0.00*		*0.00*	*5,974.16*
USR 262416302798x Modify electrical at Security fence	1.00	EA	1,564.13	0.00	3,500.00	0.00	910.03	0.00	5,974.16
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85
			4,171.02	*0.00*	*0.00*	*0.00*		*0.00*	*4,920.55*
0601441308 Demo Existing Electrical at Existing FCQ7 - MCC	**1.00**	**EA**	**4,171.02**	**0.00**	**0.00**	**0.00**	**749.53**	**0.00**	**4,920.55**
			4.17	*0.00*	*0.00*	*0.00*		*0.00*	*4.92*
USR 260505100101X Disconnect/Remove fdr/circuit, from (E) MCC FCQ7 to 1"C GRS, incl fittings/hangers & conductors	1,000.00	LF	4,171.02	0.00	0.00	0.00	749.53	0.00	4,920.55
(Note: 42 in & 18" fill valves connect to existing FCQ7, Sheet 33)									
			625.65	*0.00*	*0.00*	*0.00*		*0.00*	*738.08*
0601441308 Disconnect/Demo Electrical circuits to Control House	**1.00**	**EA**	**625.65**	**0.00**	**0.00**	**0.00**	**112.43**	**0.00**	**738.08**
			625.65	*0.00*	*0.00*	*0.00*		*0.00*	*738.08*
USR 260505100999X Disconnect/Remove electrical circuits to Control House incl fittings/hangers & conductors	1.00	LF	625.65	0.00	0.00	0.00	112.43	0.00	738.08

Description	UOM	Quantity	LaborCost	EQCost	MatlCost	DirectCost
Itemized Field OH						

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Subcontracted Work					
Prime Contractor	551,503.76	98,603.78	4,017,489.02	80,000.00	4,747,596.56
Prime's Self Perform Over Water Work, Used to apply LS&H	4,478.04	1,302.87	0.00	0.00	5,780.91
Demolition	72,793.27	28,405.79	3,175.13	0.00	104,374.19
Marine Work	22,229.99	9,311.09	0.00	0.00	31,541.08
Diver Crew	152,631.37	0.00	0.00	0.00	152,631.37
Concrete	134,516.69	8,511.92	64,301.40	0.00	207,330.00
Fencing	809.95	63.69	2,920.00	0.00	3,793.64
Electrical	76,933.62	7,621.11	89,340.40	9,000.00	182,895.14
Concrete Mining & Grouting	146,702.09	15,045.13	12,230.00	184,000.00	357,977.22
Shop Fab Contractor	16,503.25	3,846.88	147,557.92	0.00	167,908.05

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
Labor												
				32.7500	*0.0000*		*15.2800*			*0.0000*	*0.0000*	*48.0300*
MIL B-BRKLAYR Bricklayers	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				25.7500	*0.0000*		*11.2500*			*0.0000*	*0.0000*	*37.0000*
MIL B-BRKLAYRH Bricklayers, (Semi-Skilled) (Laborer)	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				32.0400	*0.0000*		*14.1800*			*0.0000*	*0.0000*	*53.4601*
MIL B-CARPNTER Carpenters	LaborCost1	Journeyman	706.1118	22,623.82	0.00	0.00	10,012.67	3,979.69	2,617.66	0.00	0.00	39,233.84
				33.6400	*0.0000*		*14.1800*			*0.0000*	*0.0000*	*57.5257*
MIL B-CARPNTER Carpenters	LaborCost1	Foreman	65.9722	2,219.31	0.00	0.00	935.49	384.70	255.61	0.00	0.00	3,795.10
				29.0500	*0.0000*		*17.5900*			*0.0000*	*0.0000*	*55.6731*
MIL B-CEMTFINR Cement Finishers	LaborCost1	Journeyman	8.1911	237.95	0.00	0.00	144.08	46.58	27.41	0.00	0.00	456.02
				37.0500	*0.0000*		*17.4100*			*0.0000*	*0.0000*	*54.4600*
MIL B-ELECTRN Electricians	LaborCost1	Journeyman	753.5360	27,918.51	0.00	0.00	13,119.06	5,004.12	1,103.48	0.00	0.00	47,145.17
				40.7550	*0.0000*		*17.4100*			*0.0000*	*0.0000*	*66.8685*
MIL B-ELECTRN Electricians	LaborCost1	Foreman	18.4880	753.48	0.00	0.00	321.88	131.13	29.78	0.00	0.00	1,236.27
				35.6400	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*57.6438*
MIL B-EQOPRCRN Equip. Operators, Heavy	LaborCost1	Journeyman	994.7469	35,452.78	0.00	0.00	12,016.54	5,788.41	2,198.68	0.00	0.00	55,456.41
				32.6000	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*51.4168*
MIL B-EQOPRLT Equip. Operators, Light	LaborCost1	Journeyman	1,189.1768	38,767.17	0.00	0.00	14,365.26	6,478.97	3,750.86	0.00	0.00	63,362.25
				36.6500	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*58.8933*
MIL B-EQOPRMED Equip. Operators, Medium	LaborCost1	Journeyman	6.3022	230.97	0.00	0.00	76.13	37.45	26.60	0.00	0.00	371.16
				29.6100	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*50.1840*
MIL B-EQOPROIL Equip. Operators, Oilers / Grade Checker	LaborCost1	Journeyman	487.6229	14,438.51	0.00	0.00	5,890.48	2,478.92	940.97	0.00	0.00	23,748.89
				28.5500	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*48.8614*

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
MIL B-LABORER Laborers, (Semi-Skilled)	LaborCost1	Journeyman	5,698.6640	162,696.86	0.00	0.00	68,782.87	28,226.64	12,533.68	0.00	0.00	272,240.04
				29.5500	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*50.0986*
MIL B-LABORER Laborers, (Semi-Skilled)	LaborCost1	Foreman	1,459.5977	43,131.11	0.00	0.00	17,617.34	7,407.67	3,204.51	0.00	0.00	71,360.63
				24.7600	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*42.2997*
MIL B-LABORERG Laborers, General (Lowest paid)	LaborCost1	Journeyman	62.0667	1,536.77	0.00	0.00	749.14	278.74	80.31	0.00	0.00	2,644.97
				36.3900	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*57.3242*
MIL B-MILLWRT Millwrights	LaborCost1	Journeyman	250.0000	9,097.50	0.00	0.00	3,270.00	1,508.09	455.47	0.00	0.00	14,331.06
				37.9900	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*59.1994*
MIL B-MILLWRT Millwrights	LaborCost1	Foreman	125.0000	4,748.75	0.00	0.00	1,635.00	778.43	237.75	0.00	0.00	7,399.93
				19.5900	*0.0000*		*7.2400*			*0.0000*	*0.0000*	*35.4301*
MIL B-PAINTSS Painters, Structural Steel	LaborCost1	Journeyman	0.2000	3.92	0.00	0.00	1.45	0.65	1.07	0.00	0.00	7.09
				36.6900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*67.9295*
MIL B-PLUMBER Plumbers	LaborCost1	Journeyman	2,588.4083	94,968.70	0.00	0.00	52,001.12	17,921.50	4,793.45	0.00	0.00	169,684.77
				22.3809	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*48.7703*
MIL B-PLUMBER Plumbers	LaborCost1	Apprentice	978.9353	21,909.45	0.00	0.00	19,666.81	5,069.81	1,096.90	0.00	0.00	47,742.97
				39.9900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*69.4083*
MIL B-PLUMBER Plumbers	LaborCost1	Foreman	3.3333	133.30	0.00	0.00	66.97	24.42	6.67	0.00	0.00	231.36
				36.6200	*0.0000*		*17.4000*			*0.0000*	*0.0000*	*64.8249*
MIL B-RODMAN Rodmen, (Reinforcing)	LaborCost1	Journeyman	127.4850	4,668.50	0.00	0.00	2,218.24	839.77	537.69	0.00	0.00	8,264.20
				38.6200	*0.0000*		*17.4000*			*0.0000*	*0.0000*	*67.2991*
MIL B-RODMAN Rodmen, (Reinforcing)	LaborCost1	Foreman	0.6560	25.33	0.00	0.00	11.41	4.48	2.92	0.00	0.00	44.15
				32.2200	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*54.5348*
MIL B-SKILLWKR Skilled Workers	LaborCost1	Journeyman	570.5915	18,384.46	0.00	0.00	7,463.34	3,151.88	1,068.52	0.00	0.00	30,068.19

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
				36.6900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*65.5406*
MIL B-STM/PIPE Steam/Pipefitters	LaborCost1	Journeyman	625.6850	22,956.38	0.00	0.00	12,570.01	4,332.09	1,149.31	0.00	0.00	41,007.80
				39.9900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*69.4083*
MIL B-STM/PIPE Steam/Pipefitters	LaborCost1	Foreman	567.5375	22,695.83	0.00	0.00	11,401.83	4,157.87	1,136.27	0.00	0.00	39,391.79
				33.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*63.5818*
MIL B-STRSTEEL Structural Steel Workers	LaborCost1	Journeyman	306.5552	10,306.39	0.00	0.00	6,008.48	1,989.44	1,707.72	0.00	0.00	20,012.03
				35.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*66.0561*
MIL B-STRSTEEL Structural Steel Workers	LaborCost1	Foreman	121.5093	4,328.16	0.00	0.00	2,381.58	818.19	606.03	0.00	0.00	8,133.96
				23.7900	*0.0000*		*6.5300*			*0.0000*	*0.0000*	*36.8321*
MIL B-TRKDVRLT Truck Drivers, Light	LaborCost1	Journeyman	293.8172	6,989.91	0.00	0.00	1,918.63	1,086.31	1,896.58	0.00	0.00	11,891.42
				33.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*53.2200*
MIL B-WELDERS Welders, Structural Steel	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				35.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*66.0561*
MIL B-WELDERS Welders, Structural Steel	LaborCost1	Foreman	180.4954	6,429.25	0.00	0.00	3,537.71	1,215.37	682.87	0.00	0.00	11,865.20
				200.0000	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*200.0000*
USR 5Diver 5 man Diving Crew - Cost per Manhour	LaborCost1	Journeyman	763.1569	152,631.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	152,631.37
				50.9600	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*69.2332*
USR MD&BL0020 Licensed Boat Captain Class C, Tender Tug	LaborCost1	Journeyman	173.3333	8,833.07	0.00	0.00	0.00	1,077.10	2,090.26	0.00	0.00	12,000.43
				43.4400	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*59.0167*
USR MD&BL0021 Deckhand Tender Tug	LaborCost1	Journeyman	173.3333	7,529.60	0.00	0.00	0.00	918.16	1,781.80	0.00	0.00	10,229.56

Description	EQHours	Total
Equipment		
AIR COMPRESSOR, 100 CFM, 125 PSI (ADD HOSE)	84.5067	739.31
AIR COMPRESSOR, 175 CFM (5 CMM), 100 PSI (689 KPA) (ADD HOSE)	602.4631	8,996.74
AIR COMPRESSOR, 250 CFM (7 CMM), 100 PSI (689 KPA) (ADD HOSE)	369.0667	6,909.30
AIR HOSE, 1.5" (38 MM) DIA x 100' (31 M) LENGTH, HARDROCK (USE AS DRILLING ACCESSORY)	738.1333	1,446.08
AIR HOSE, 1.50", 100', HARDROCK	169.0134	331.11
CHAIN HOIST (MANUAL)	1,135.0751	3,382.52
CHAIN HOIST, MANUAL, 10 TON (9.1 MT)	0.0000	0.00
CONCRETE MIXER, STATIONARY CONCRETE DISPENSER, 15 CY/HR (11.5 M3/HR), 2 CY (1.5 M3) HOPPER	602.4631	6,048.39
CONCRETE PUMP, PUMP & BOOM, 117 CY/HR (89 M3/HR), 75' (23 M) BOOM, TRUCK MOUNTED	5.8622	783.43
CONCRETE SAW, RAIL SAW, 15.5" (394 MM) DEPTH, WALL (ADD 250 CFM (7 CMM) COMPRESSOR & COST FOR SAWBLADE WEAR)	291.0857	3,829.27
CONCRETE SAW, 13" (330 MM) DEPTH, SELF PROPELLED (ADD WATER AND COST FOR SAWBLADE WEAR)	1.4515	26.54
CONCRETE VIBRATOR, 2.5" (63.5 MM) DIA, W/7.5 HP (5.6 KW) GENERATOR	11.7243	35.41
CRANE, HYDRAULIC, SELF-PROPELLED, ROUGH TERRAIN, 30 TON (27 MT), 80' (24.4 M) BOOM, 4X4	90.0000	6,514.36
CRANE, HYDRAULIC, SELF-PROPELLED, YARD, 9 TON (8 MT), 44' (13.4 M) BOOM, 4X4	6.2500	235.04
CRANE, HYDRAULIC, TRUCK MOUNTED, 14 TON (12.7 MT), 80' (24.4 M) BOOM, 6X4	283.7688	14,607.54
CRANE, HYDRAULIC, TRUCK MOUNTED, 25 TON (22.7 MT), 80' (24.4 M) BOOM, 6X4	0.6560	36.34
CRANE, HYDRAULIC, TRUCK MOUNTED, 90 TON (81.6 MT), 114' (34.7 M) BOOM, 8X4	483.2859	64,587.27
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, LIFTING, 25 TON (23 MT), 50' (15.2 M) BOOM	0.0000	0.00
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 2.5 CY (1.9 M3), 60 TON (54 MT), 50' (15.2 M) BOOM (ADD BUCKET)	0.0000	0.00
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 3.0 CY (2.3 M3), 75 TON (68 MT), 100' (30.5 M) BOOM (ADD BUCKET)	3.6810	581.97
CRANE, MECHANICAL, LATTICE BOOM, TRUCK MOUNTED, 125 TON (113 MT), 240' (73.2 M) BOOM	0.0000	0.00
CRANES, HYDRAULIC, TRUCK MTD, 14 TON, 80' BOOM, 6X4	125.0000	9,775.95
DRILL, BREAKER, 12 LB (5 KG), AIR (ADD 100 CFM (2.8 CMM) COMPRESSOR)	84.5067	60.43
DRILL, CORE, 1"-8" DIA (25-203 MM), W/STAND (ADD PUMP)	0.0000	0.00
DRILL, CORE, COLUMN MOUNTED, 9"-36" (229-914 MM) DIA, W/STAND AND HYDRAULIC POWER PACK (ADD COST FOR DRILL STEEL AND BIT WEAR)	61.8519	620.36
GENERATOR SET, SKID MOUNTED, 125 KW, VARIABLE POWER SETTINGS, RECONNECTIBLE	172.8000	5,592.07
HYDRAULIC EXCAVATOR, CRAWLER, 40,000 LB (18,144 KG), 1.00 CY (0.8 M3) BUCKET, 19.6' (5.9 M) MAX DIGGING DEPTH	2.1053	119.87
IMPACT WRENCH (AIR, 300-	80.0000	111.20
LOADER/BACKHOE, WHEEL, 0.80 CY (0.6 M3) FRONT END BUCKET, 9.8' (3.0 M) DEPTH OF HOE, 24" (0.61 M) DIPPER, 4X4	0.6000	13.22

Description	EQHours	Total
LOADER/BACKHOE, WHEEL, 1.25 CY (0.9 M3) FRONT END BUCKET, 12.0' (3.7 M) DEPTH OF HOE, 24" (0.61 M) DIPPER, 7.0 CF (0.2 M3), 4X2	0.4400	12.06
MAN-LIFT, ARTICULATED BOOM, 66' HEIGHT, 500 LBS, 33' REACH, 4X4, SELF PROPELLED, 3' X 6' PLATFROM	48.0000	1,438.93
MARINE EQUIPMENT, BOATS & LAUNCHES, 16', SHALLOW DRAFT, INLAND TUG	173.3333	3,497.82
MARINE EQUIPMENT, BOATS & LAUNCHES, TRUCKABLE WORKBOAT W/PILOT HOUSE & PUSH KNEES, INBOARD, 20.25' X 8' X 3'	173.3333	4,281.22
MARINE EQUIPMENT, WORK BARGE, SECTIONAL, LOADING RAMPS	173.3333	222.81
MARINE EQUIPMENT, WORK BARGE, SECTIONAL, MEDIUM DUTY', W/ONE BUCKHEAD AND SPUDS, 40' X 12' X 4', 36 TON	693.3333	1,309.24
PAVING BREAKER, 66 LB (30 KG) (ADD 100 CFM (2.8 CMM) COMPRESSOR)	738.1333	399.63
POST HOLE DRILL, UP TO 8" DIA, 30" DEEP, ONE MAN OPERATION	1.2800	0.45
TORCH, OXYGEN/ACETYLENE, W/TANKS & HOSES	42.1827	76.77
TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE	0.0000	0.00
TRENCHER, CHAIN TYPE CUTTER, 48" (1.2 M) DEPTH x 16" (406 MM) WIDTH, 2WD, WALK-BEHIND	293.5765	2,419.94
TRUCK OPTION, FLATBED, 8' (2.4 M) x 16' (4.9 M) (ADD 25,000 LB (11,340 KG) GVW TRUCK)	174.2515	185.06
TRUCK OPTION, FLATBED, 8' (2.4 M) x 20' (6.1 M) (ADD 25,000 LB (11,340 KG) GVW TRUCK)	118.2857	150.95
TRUCK OPTION, FLATBED, 8' (2.4M) x 12' (3.7 M) (ADD 25,000 LB (11,340 KG) GVW TRUCK)	1.2800	0.96
TRUCK, HIGHWAY, 25,000 LB (11,340 KG) GVW, 4X2, 2 AXLE (ADD ACCESSORIES)	293.8172	11,262.96
WATER TANK, 500 GAL (1,893 L) PORTABLE	292.5372	769.37
WELDER, ELECTRIC DRIVEN, 300 AMP, SKID MOUNTED	970.6020	1,487.24
WELDER, ENGINE DRIVEN, DIESEL, 300 AMP, TRAILER MOUNTED	145.2758	1,621.23
WELDER, ENGINE DRIVEN, GAS, 200 AMP, TRAILER MOUNTED	455.0586	3,225.76

Description	DirectWork	JOOH	HOOH	Profit	Bond	Allowance	ContractMarkup	ContractorCost
Mark up Report								
	6,081,064.93	*10.00%*	*5.00%*	*8.02%*	*0.84%*	*0.00%*	*25.81*	*7,650,836.23*
Prime Contractor	**6,081,064.93**	**608,106.49**	**334,458.57**	**563,295.13**	**63,911.10**	**0.00**	**1,569,771.29**	**7,650,836.23**
		10.00%	*5.00%*	*8.02%*	*0.84%*	*0.00%*		
Own Work	4,747,596.56	474,759.66	261,117.81	439,774.62	49,896.55	0.00		
		10.00%	*5.00%*	*8.02%*	*0.84%*	*0.00%*		
Subcontracted Work	1,333,468.37	133,346.84	73,340.76	123,520.51	14,014.56	0.00		
	5,780.91	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*5,780.91*
Prime's Self Perform Over Water Work, Used to apply LS&H	**5,780.91**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5,780.91**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	5,780.91	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	104,374.19	*3.00%*	*5.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*123,130.25*
Demolition	**104,374.19**	**3,131.23**	**5,375.27**	**9,030.46**	**1,219.11**	**0.00**	**18,756.06**	**123,130.25**
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	104,374.19	3,131.23	5,375.27	9,030.46	1,219.11	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	31,541.08	*5.00%*	*5.00%*	*10.00%*	*1.00%*	*0.00%*	*22.49*	*38,633.96*
Marine Work	**31,541.08**	**1,577.05**	**1,655.91**	**3,477.40**	**382.51**	**0.00**	**7,092.88**	**38,633.96**
		5.00%	*5.00%*	*10.00%*	*1.00%*	*0.00%*		
Own Work	31,541.08	1,577.05	1,655.91	3,477.40	382.51	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	152,631.37	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*152,631.37*
Diver Crew	**152,631.37**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**152,631.37**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	152,631.37	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	207,330.00	*3.00%*	*5.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*244,587.25*
Concrete	**207,330.00**	**6,219.90**	**10,677.50**	**17,938.19**	**2,421.66**	**0.00**	**37,257.24**	**244,587.25**
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	207,330.00	6,219.90	10,677.50	17,938.19	2,421.66	0.00		

Description	DirectWork	JOOH	HOOH	Profit	Bond	Allowance	ContractMarkup	ContractorCost
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	3,793.64	*3.00%*	*5.00%*	*10.00%*	*1.00%*	*0.00%*	*20.15*	*4,558.24*
Fencing	**3,793.64**	**113.81**	**195.37**	**410.28**	**45.13**	**0.00**	**764.60**	**4,558.24**
		3.00%	*5.00%*	*10.00%*	*1.00%*	*0.00%*		
Own Work	3,793.64	113.81	195.37	410.28	45.13	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	182,895.14	*5.00%*	*3.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*215,761.43*
Electrical	**182,895.14**	**9,144.76**	**5,761.20**	**15,824.09**	**2,136.25**	**0.00**	**32,866.29**	**215,761.43**
		5.00%	*3.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	182,895.14	9,144.76	5,761.20	15,824.09	2,136.25	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	357,977.22	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*357,977.22*
Concrete Mining & Grouting	**357,977.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**357,977.22**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	357,977.22	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	167,908.05	*5.00%*	*0.00%*	*8.00%*	*0.00%*	*0.00%*	*13.40*	*190,407.73*
Shop Fab Contractor	**167,908.05**	**8,395.40**	**0.00**	**14,104.28**	**0.00**	**0.00**	**22,499.68**	**190,407.73**
		5.00%	*0.00%*	*8.00%*	*0.00%*	*0.00%*		
Own Work	167,908.05	8,395.40	0.00	14,104.28	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		

Abbreviated Risk Analysis

The Dalles EFL AWS - Alt 2 low level intake
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	NAME
Cost Engineering:	hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles EFL AWS - Alt 2 low level intake**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = **$ 7,650,836**

	WBS	Potential Risk Areas	Contract Cost	% Contingency	$ Contingency	Total
1	06 01 FISH FACILITIES AT DAMS	Cofferdam	$ 351,839	29.17%	$ 102,620	$ 454,459
2	06 01 FISH FACILITIES AT DAMS	trash rack Alt # 2	$ 1,569,306	29.17%	$ 457,714	$ 2,027,021
3	06 01 FISH FACILITIES AT DAMS	Trash rake Alt # 2	$ 366,079	22.92%	$ 83,893	$ 449,972
4	06 01 FISH FACILITIES AT DAMS	Concrete Mining	$ 234,620	27.08%	$ 63,543	$ 298,163
5	06 01 FISH FACILITIES AT DAMS	72" pipe	$ 342,697	25.00%	$ 85,674	$ 428,372
6	06 01 FISH FACILITIES AT DAMS	Pipe Installation	$ 779,413	27.08%	$ 211,091	$ 990,504
7	06 01 FISH FACILITIES AT DAMS	Valves	$ 1,049,646	31.25%	$ 328,014	$ 1,377,661
8	06 01 FISH FACILITIES AT DAMS	Operations & Maint	$ -	0.00%	$ -	$ -
10	06 01 FISH FACILITIES AT DAMS	Valve Room Modification	$ 1,672,973	56.25%	$ 941,047	$ 2,614,020
11	06 01 FISH FACILITIES AT DAMS	Approach Channel & Fish Lock Mod.	$ 1,012,804	37.50%	$ 379,802	$ 1,392,606
12	06 01 FISH FACILITIES AT DAMS	Electrical	$ 271,458	0.00%	$ -	$ 271,458
13	30 PLANNING, ENGINEERING, AND DESIGN		$ -	0.00%	$ -	$ -
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ -	0.00%	$ -	$ -

Totals	Contract Cost	% Contingency	$ Contingency	Total
Total Construction Estimate	$ 7,650,836	34.68%	$ 2,653,399	$ 10,032,777
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 7,650,836		$ 2,653,399	$ 10,032,777

The Dalles EFL AWS - Alt 2 low level intake

EDR - Pre Feasibility
Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	Cofferdam	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-2	trash rack Alt # 2	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-3	Trash rake Alt # 2	supplier used cost form	Cost not well known	Unlikely	Significant	3
PS-4	Concrete Mining	not well defined yet	support of control building may	LIKELY	Marginal	2
PS-5	72" pipe	can change - availabilit	No contact with suppliers since 2010	LIKELY	Marginal	2
PS-6	Pipe Installation	problems may arrise that	hrs required for in-water installation	Very LIKELY	Marginal	3
PS-7	Valves	y Design - valves still need	not known but probably will not change	Unlikely	Critical	3
PS-8				Very Unlikely	Negligible	0
PS-9	Operations & Maint			Very Unlikely	Marginal	0
PS-10	Valve Room Modification	Confined work area with limited access and complicated pipe layout		Very LIKELY	Significant	4
PS-11	Approach Channel & Fish Lock Mod.	Confined work area with limited access and incomplete design		Very Unlikely	Significant	1
PS-12				Very Unlikely	Negligible	0
PS-13	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy

AS-1	Cofferdam	Design/bid/build		Unlikely	Marginal	1
AS-2	trash rack Alt # 2	Design/bid/build		Unlikely	Marginal	1
AS-3	Trash rake Alt # 2	Design/bid/build		Unlikely	Marginal	1
AS-4	Concrete Mining	Design/bid/build		LIKELY	Marginal	2
AS-5	72" pipe	Design/bid/build		Unlikely	Marginal	1
AS-6	Pipe Installation	Design/bid/build		Unlikely	Marginal	1
AS-7	Valves	Design/bid/build		Unlikely	Marginal	1
AS-8	#REF!			Very Unlikely	Negligible	0
AS-9	Operations & Maint			Very Unlikely	Negligible	0
AS-10	Valve Room Modification	Availability of Valves		Very LIKELY	Critical	5
AS-11	Approach Channel & Fish Lock Mod.	Availability of Gates		Very Unlikely	Critical	2
AS-12				Very Unlikely	Negligible	0
AS-13	Construction Management			Very Unlikely	Negligible	0

Construction Complexity

CC-1	Cofferdam	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-2	trash rack Alt # 2	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-3	Trash rake Alt # 2			LIKELY	Marginal	2
CC-4	Concrete Mining	specialty sub contractor needed		LIKELY	Critical	5
CC-5	72" pipe	In-Water work required and pipe grouting		LIKELY	Marginal	2
CC-6	Pipe Installation			LIKELY	Significant	4
CC-7	Valves			Very Unlikely	Significant	1
CC-8	#REF!			Very Unlikely	Negligible	0
CC-9	Operations & Maint			Unlikely	Negligible	0
CC-10	Valve Room Modification	Limited access		Very LIKELY	Significant	4
CC-11	Approach Channel & Fish Lock Mod.	limited access		Very LIKELY	Significant	4
CC-12				Very Unlikely	Negligible	0
CC-13	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities

VC-1	Cofferdam			Unlikely	Significant	3
VC-2	trash rack Alt # 2			Unlikely	Significant	3
VC-3	Trash rake Alt # 2			Unlikely	Marginal	1
VC-4	Concrete Mining			Unlikely	Marginal	1
VC-5	72" pipe			LIKELY	Marginal	2
VC-6	Pipe Installation			Unlikely	Marginal	1
VC-7	Valves			Unlikely	Critical	3
VC-8	#REF!			Very Unlikely	Negligible	0
VC-9	Operations & Maint			Very Unlikely	Negligible	0
VC-10	Valve Room Modification	Metal Valves		Very LIKELY	Significant	4
VC-11	Approach Channel & Fish Lock Mod.	Metal Gates		Very LIKELY	Significant	4
VC-12				Very Unlikely	Negligible	0
VC-13	Construction Management			Very Unlikely	Negligible	0

Quantities

Q-1	Cofferdam			Unlikely	Marginal	1
Q-2	trash rack Alt # 2			Unlikely	Marginal	1
Q-3	Trash rake Alt # 2			Unlikely	Marginal	1
Q-4	Concrete Mining			Very Unlikely	Marginal	0
Q-5	72" pipe			Very Unlikely	Negligible	0
Q-6	Pipe Installation			Very Unlikely	Marginal	0
Q-7	Valves			Very Unlikely	Critical	2
Q-8	#REF!			Very Unlikely	Negligible	0
Q-9	Operations & Maint			Very Unlikely	Marginal	0
Q-10	Valve Room Modification	Amount of pipe required		Very LIKELY	Marginal	3
Q-11	Approach Channel & Fish Lock Mod.	size of gates		Very Unlikely	Negligible	0
Q-12				Very Unlikely	Negligible	0
Q-13	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment

FI-1	Cofferdam			Unlikely	Marginal	1
FI-2	trash rack Alt # 2			Unlikely	Marginal	1
FI-3	Trash rake Alt # 2			Very LIKELY	Marginal	3
FI-4	Concrete Mining			Very Unlikely	Negligible	0
FI-5	72" pipe			Unlikely	Significant	3
FI-6	Pipe Installation			Very Unlikely	Negligible	0
FI-7	Valves			Unlikely	Significant	3
FI-8	#REF!			Very Unlikely	Negligible	0
FI-9	Operations & Maint			Very Unlikely	Marginal	0
FI-10	Valve Room Modification	Complicated Pipeing		LIKELY	Significant	4
FI-11	Approach Channel & Fish Lock Mod.	Limited access		LIKELY	Significant	4
FI-12				Very Unlikely	Negligible	0
FI-13	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method

CE-1	Cofferdam			Unlikely	Marginal	1
CE-2	trash rack Alt # 2			Unlikely	Marginal	1
CE-3	Trash rake Alt # 2			Unlikely	Negligible	0
CE-4	Concrete Mining			Unlikely	Marginal	1
CE-5	72" pipe			Unlikely	Marginal	1
CE-6	Pipe Installation			Unlikely	Significant	3
CE-7	Valves			Very Unlikely	Significant	1
CE-8	#REF!			Very Unlikely	Negligible	0
CE-9	Operations & Maint			Very Unlikely	Marginal	0
CE-10	Valve Room Modification	supplier quotes available		Unlikely	Marginal	1
CE-11	Approach Channel & Fish Lock Mod.	Based on wt of material		LIKELY	Marginal	2
CE-12				Very Unlikely	Negligible	0
CE-13	Construction Management			Very Unlikely	Negligible	0

External Project Risks

EX-1	Cofferdam			Unlikely	Negligible	0
EX-2	trash rack Alt # 2			Unlikely	Negligible	0
EX-3	Trash rake Alt # 2			Unlikely	Negligible	0
EX-4	Concrete Mining			Unlikely	Marginal	1
EX-5	72" pipe			Unlikely	Marginal	1
EX-6	Pipe Installation			LIKELY	Negligible	1
EX-7	Valves			Very Unlikely	Significant	1
EX-8	#REF!			Very Unlikely	Negligible	0
EX-9	Operations & Maint			Very Unlikely	Marginal	0
EX-10	Valve Room Modification	Fish Concerns		Very Unlikely	Significant	1
EX-11	Approach Channel & Fish Lock Mod.	Fish Concerns		Very Unlikely	Significant	1
EX-12				Very Unlikely	Negligible	0
EX-13	Construction Management			Very Unlikely	Negligible	0

The Dalles EFL AWS - Alt 2 low level intake
EDR - Pre Feasibility
Abbreviated Risk Analysis

Typical Risk Elements	Potential Risk Areas: 0	Cofferdam	trash rack Alt # 2	Trash rake Alt # 2	Concrete Mining	72" pipe	Pipe Installation	Valves	#REF!	Operations & Maint	Valve Room Modification	Approach Channel & Fish Lock Mod		Construction Management
Project Scope	-	3	3	3	2	2	3	3	-	-	4	1	-	-
Acquisition Strategy	-	1	1	1	2	1	1	1	-	-	5	2	-	-
Construction Complexity	-	4	4	2	5	2	4	1	-	-	4	4	-	-
Volatile Commodities	-	3	3	1	1	2	1	3	-	-	4	4	-	-
Quantities	-	1	1	1	-	-	-	2	-	-	3	-	-	-
Fabrication & Project Installed Equipment	-	1	1	3	-	3	-	3	-	-	4	4	-	-
Cost Estimating Method	-	1	1	-	1	1	3	1	-	-	1	2	-	-
External Project Risks	-	-	-	-	1	1	1	1	-	-	1	1	-	-
Weighted Summation	0	14	14	11	13	12	13	15	0	0	27	18	0	0
Weighted %	0.0%	29.2%	29.2%	22.9%	27.1%	25.0%	27.1%	31.3%	0.0%	0.0%	56.3%	37.5%	0.0%	0.0%

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: The Dalles E Fish Ladder AWS - Alt 11
LOCATION: The Dalles, OR.

DISTRICT: NWP Portland PREPARED: 3/29/2012
POC: CHIEF, COST ENGINEERING, Michael R. Moran

This Estimate reflects the scope and schedule in report; The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 11 - 032912

						Program Year (Budget EC): 2014 / Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
		ESTIMATED COST					PROJECT FIRST COST			Spent Thru: 29-Mar-12				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
03	RESERVOIRS			-		-								
04	DAMS			-		-								
05	LOCKS			-		-								
06	FISH & WILDLIFE FACILITIES	$10,084,990	$3,845,407	38.13%	$13,930,397	5.1%	$10,598,297	$4,041,131	**$14,639,428**			$10,598,297	$4,041,131	$14,639,428
07	POWER PLANT			-		-								
	CONSTRUCTION ESTIMATE TOTALS:	$10,084,990	$3,845,407		**$13,930,397**	5.1%	$10,598,297	$4,041,131	**$14,639,428**			$10,598,297	$4,041,131	$14,639,428
01	LANDS AND DAMAGES			-		-								
30	PLANNING, ENGINEERING & DESIGN	$4,033,998	$1,538,163	38.13%	$5,572,161	11.8%	$4,509,742	$1,719,565	**$6,229,307**			$4,509,742	$1,719,565	$6,229,307
31	CONSTRUCTION MANAGEMENT	$1,008,499	$384,541	38.13%	$1,393,040	11.8%	$1,127,435	$429,891	**$1,557,326**			$1,127,435	$429,891	$1,557,326
	PROJECT COST TOTALS:	$15,127,487	$5,768,111	38.13%	**$20,895,598**	7.3%	$16,235,475	$6,190,586	**$22,426,061**			$16,235,475	$6,190,586	$22,426,061

_______________ CHIEF, COST ENGINEERING, Michael R. Moran

_______________ PROJECT MANAGER, George J. Medina

_______________ CHIEF, REAL ESTATE, xxx

_______________ CHIEF, PLANNING,xxx

_______________ CHIEF, ENGINEERING, Lance A. Helwig

_______________ CHIEF, OPERATIONS, xxx

_______________ CHIEF, CONSTRUCTION, Karen L. Garmire

_______________ CHIEF, CONTRACTING, Ralph Banse-Fay

_______________ CHIEF, PM-PB, xxxx

_______________ CHIEF, DPM, xxx

ESTIMATED FEDERAL COST: 100% **$22,426,061**
ESTIMATED NON-FEDERAL COST:

ESTIMATED TOTAL PROJECT COST: **$22,426,061**

O&M OUTSIDE OF TOTAL PROJECT COST: **$2,144,265**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: The Dalles E Fish Ladder AWS - Alt 11
LOCATION: The Dalles, OR.
This Estimate reflects the scope & schedule in report; The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 11 - 032912

DISTRICT: NWP Portland PREPARED: 3/29/2012
POC: CHIEF, COST ENGINEERING, Michael R. Moran

	Estimate Prepared: 29-Mar-12 Effective Price Level: 29-Mar-12			RISK BASED		Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1													
03	RESERVOIRS													
04	DAMS													
05	LOCKS													
06	FISH & WILDLIFE FACILITIES	$10,084,990	$3,845,407	38.13%	$13,930,397	5.1%	$10,598,297	$4,041,131	$14,639,428	2015Q2		$10,598,297	$4,041,131	$14,639,428
07	POWER PLANT													
	CONSTRUCTION ESTIMATE TOTALS:	$10,084,990	$3,845,407	38.13%	**$13,930,397**		$10,598,297	$4,041,131	$14,639,428			$10,598,297	$4,041,131	$14,639,428
01	LANDS AND DAMAGES			38.13%										
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$504,250	$192,271	38.13%	$696,521	11.8%	$563,718	$214,946	$778,664	2015Q2		$563,718	$214,946	$778,664
	Planning & Environmental Compliance			38.13%										
25.0%	Engineering & Design	$2,521,248	$961,352	38.13%	$3,482,600	11.8%	$2,818,588	$1,074,728	$3,893,316	2015Q2		$2,818,588	$1,074,728	$3,893,316
3.0%	Engineering Tech Review ITR & VE	$302,550	$115,362	38.13%	$417,912	11.8%	$338,231	$128,967	$467,198	2015Q2		$338,231	$128,967	$467,198
3.0%	Contracting & Reprographics	$302,550	$115,362	38.13%	$417,912	11.8%	$338,231	$128,967	$467,198	2015Q2		$338,231	$128,967	$467,198
4.0%	Engineering During Construction	$403,400	$153,816	38.13%	$557,216	11.8%	$450,974	$171,957	$622,931	2015Q2		$450,974	$171,957	$622,931
	Planning During Construction			38.13%										
	Project Operations			38.13%										
31	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management	$806,799	$307,632	38.13%	$1,114,431	11.8%	$901,948	$343,913	$1,245,861	2015Q2		$901,948	$343,913	$1,245,861
	Project Operation:			38.13%										
2.0%	Project Management	$201,700	$76,908	38.13%	$278,608	11.8%	$225,487	$85,978	$311,466	2015Q2		$225,487	$85,978	$311,466
	CONTRACT COST TOTALS:	$15,127,487	$5,768,111		**$20,895,598**		$16,235,475	$6,190,586	$22,426,061			$16,235,475	$6,190,586	**$22,426,061**

90% EDR Cost Estimate

US Army Corps of Engineers®
Portland District

The Dalles East Fish Ladder Auxiliary Water Backup System
Alternative No. 11
The Dalles Dam, Oregon

March 29, 2012

HDR

U.S. COST

7800 North Stemmons Freeway, Suite 650
Dallas, Texas 75247
214-630-3994   Fax 214-631-1352

The Dalles E Fish Ladder AWS - 90% EDR Estimate Alt 11 - 032912

Estimated by	U.S.COST Inc.
Designed by	HDR Engineering Inc.
Prepared by	Howard Campbell
Preparation Date	3/29/2012
Effective Date of Pricing	3/29/2012
Estimated Construction Time	365 Days

Table of Contents

Description **Page**

Designed by
HDR Engineering Inc.
Estimated by
U.S.COST Inc.
Prepared by
Howard Campbell

Design Document	90% EDR Drawings
Document Date	3/29/2012
District	Portland
Contact	Howard Campbell
Budget Year	2012
UOM System	Original

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost
PED
CM

Timeline/Currency

Preparation Date	3/29/2012
Escalation Date	3/29/2012
Eff. Pricing Date	3/29/2012
Estimated Duration	365 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB10EB: MII English Cost Book 2010

Labor : Wasco County OR Labor 032012

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP09R08: MII Equipment Region 8 2009

08 NORTHWEST

Sales Tax	6.00
Working Hours per Year	1,540
Labor Adjustment Factor	1.01
Cost of Money	4.88
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.067
Gas	4.231
Diesel Off-Road	3.737
Diesel On-Road	4.440

Shipping Rates

Over 0 CWT	27.78
Over 240 CWT	26.06
Over 300 CWT	23.69
Over 400 CWT	21.52
Over 500 CWT	11.26
Over 700 CWT	9.51
Over 800 CWT	6.48

Date	Author	Note
3/28/2012		Project NoteProject Description: This project requires the construction of a intake tower with screens at the base and trash rake system, an inverted siphon consisting of two 72" diameter pipes with four valves routhed at elevation 161.0 along the face of the dam and through the concrete dam monolith to the existing fishlock, the existing piping and valves within the valve room will be removed and six new valves with associated piping and meters installed in the valve room. The existing fish elevator, equipment, gates and fish lock approach channel shall be removed. Some concrete within the fish lock approach channed shall be demolished and one wall of the fish lock approach channel height will be raised to elevation 111.0. The joints in the existing auxiliary conduit. shall be repaired and one set of new stop logs shall be provided for the fish lock approach channel.Project Location: The Dalles Dam, Oregon.Documents Used as the Basis for this Estimate: 90% EDR documents received March 2012.Volatile Cost Items: Two categories of volatile cost items are fuel (gasoline, on-road diesel and off-road diesel) and materials (e.g., steel pipe, valves).Construction is scheduled to begin July 1, 2014 and end June 2015 lasting 12 months. Mid-point of construction would be at 6 months, or January 2015.Construction Windows: In- water work shall only be allowed in the period starting December 1 and ending January 31.Escalation: 0% - Will be included in the TPCS..1. Taxes: Sales tax is applied at 0.0%.2. FOOH: 10.0% of running costs.3. HOOH: 5.0% of running costs.4. Profit: 7.52% calculated per tables.5. Bond: 0.79% calculated per tables.6. Design/Estimating Contingency: 0.0%7. Price Level: March 20128. Productivity: 100%9. Overtime Usage: N/A.10. Contingency: 0% - Will be included in the TPCS.11. PED costs: 0% - Will be included in the TPCS..12. Owner's Supervision & Inspection costs: 0% - Will be included in the TPCS.Adjustments To Equipment Database:1: Gasoline: 4.2312: Diesel (Off-Road): 3.7373: Diesel (On-Road): 4.440Deployment Site Access: The project construction site is accessible via major highway/local roads/improved roadways.Unusual Conditions (Soil, Water, and Weather): Oregon's season rainy season is October to March. Unique Construction Techniques: It is anticipated that a prudent, well-equipped contractor can perform the construction. Equipment and Labor Availability and Distance Traveled: This estimate assumes equipment and labor availability of a prudent and well-equipped joint venture contractor/fabricator in Eugene, OR., as indicated in Engineer Instructions 01D010, 1 Sep 1997 (Unified Facilities Criteria 3-700-02A, 01 March 2005). This estimate assumes the vessel fabrication and initial assemble will occur at the joint venture contractor's Eugene facility .Environmental Concerns During Construction: Concrete mining, over water work and in- water work shall only be allowed in the period starting December 1 and ending January 31.Acquisition Plan: Competitive Bid. Sub-contracting Plan: The prime contractor will be a heavy mechanical/piping contractor who will selfperform all piping, valve, equipment installation and valve room piping/valve demolition. The concrete demolition, fish elevator & fish elevator equipment, fencing, dam concrete mining, diving and work activites requiring marine equipment will be subcontracted.Databases used: MII English Cost Book 2010, MII Equipment Region 8 2009 & Wasco County OR Labor J032012.Effective Dates for Labor, Equipment and Material Pricing: March 2012

Description	UOM	Quantity	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report A - Summary Bid Items			**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
06 Fish and Wildlife Facilities	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
0601 Fish Facilities at Dams	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
060144 Fishways and Fish Ladders	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**

Description	UOM	Quantity	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report B - Summary System			**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
06 Fish and Wildlife Facilities	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
0601 Fish Facilities at Dams	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
060144 Fishways and Fish Ladders	**EA**	**1.00**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			65,000.00		*81,359.95*				*81,359.95*
06014401 Foundation Preparation	**EA**	**1.00**	**65,000.00**	**16,359.95**	**81,359.95**	**0.00**	**0.00**	**0.00**	**81,359.95**
			1,862,804.08		*2,331,656.24*				*2,331,656.24*
06014402 Intake Tower	**EA**	**1.00**	**1,862,804.08**	**468,852.16**	**2,331,656.24**	**0.00**	**0.00**	**0.00**	**2,331,656.24**
			860,885.84		*1,077,563.59*				*1,077,563.59*
06014403 Trash Rack	**EA**	**1.00**	**860,885.84**	**216,677.75**	**1,077,563.59**	**0.00**	**0.00**	**0.00**	**1,077,563.59**
			290,968.26		*364,202.53*				*364,202.53*
06014404 Trash Rake	**EA**	**1.00**	**290,968.26**	**73,234.27**	**364,202.53**	**0.00**	**0.00**	**0.00**	**364,202.53**
			115,500.00		*144,570.38*				*144,570.38*
06014405 Concrete Mining	**EA**	**1.00**	**115,500.00**	**29,070.38**	**144,570.38**	**0.00**	**0.00**	**0.00**	**144,570.38**
			608.00		*761.03*				*761.03*
06014406 72" Pipe Material	**LF**	**436.00**	**265,088.00**	**66,720.43**	**331,808.43**	**0.00**	**0.00**	**0.00**	**331,808.43**
			746,671.47		*934,602.41*				*934,602.41*
06014407 72" Pipe Installation	**EA**	**1.00**	**746,671.47**	**187,930.95**	**934,602.41**	**0.00**	**0.00**	**0.00**	**934,602.41**
			1,354,359.29		*1,695,240.16*				*1,695,240.16*
06014408 72" Valves	**EA**	**1.00**	**1,354,359.29**	**340,880.87**	**1,695,240.16**	**0.00**	**0.00**	**0.00**	**1,695,240.16**
			141,912.77		*177,631.02*				*177,631.02*
06014409 Pipe Filling System	**EA**	**1.00**	**141,912.77**	**35,718.25**	**177,631.02**	**0.00**	**0.00**	**0.00**	**177,631.02**
			1,329,718.11		*1,664,397.01*				*1,664,397.01*
06014410 Valve Room Modification	**EA**	**1.00**	**1,329,718.11**	**334,678.90**	**1,664,397.01**	**0.00**	**0.00**	**0.00**	**1,664,397.01**
			805,000.57		*1,007,612.46*				*1,007,612.46*
06014411 Approach Channel & Fish Lock Mod.	**EA**	**1.00**	**805,000.57**	**202,611.89**	**1,007,612.46**	**0.00**	**0.00**	**0.00**	**1,007,612.46**
			10,733.53		*13,435.07*				*13,435.07*
06014412 Fish Lock Maintenance Platform	**EA**	**1.00**	**10,733.53**	**2,701.54**	**13,435.07**	**0.00**	**0.00**	**0.00**	**13,435.07**
			208,447.06		*260,911.44*				*260,911.44*
06014414 Electrical	**EA**	**1.00**	**208,447.06**	**52,464.38**	**260,911.44**	**0.00**	**0.00**	**0.00**	**260,911.44**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Report C - Summary All Level			**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
06 Fish and Wildlife Facilities	**1.00**	**EA**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
0601 Fish Facilities at Dams	**1.00**	**EA**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			8,057,088.96		*10,084,990.69*				*10,084,990.69*
060144 Fishways and Fish Ladders	**1.00**	**EA**	**8,057,088.96**	**2,027,901.73**	**10,084,990.69**	**0.00**	**0.00**	**0.00**	**10,084,990.69**
			65,000.00		*81,359.95*				*81,359.95*
06014401 Foundation Preparation	**1.00**	**EA**	**65,000.00**	**16,359.95**	**81,359.95**	**0.00**	**0.00**	**0.00**	**81,359.95**
			250.00		*312.92*				*312.92*
0601440101 Remove Debris/Muck Intake Tower	**260.00**	**CY**	**65,000.00**	**16,359.95**	**81,359.95**	**0.00**	**0.00**	**0.00**	**81,359.95**
			1,862,804.08		*2,331,656.24*				*2,331,656.24*
06014402 Intake Tower	**1.00**	**EA**	**1,862,804.08**	**468,852.16**	**2,331,656.24**	**0.00**	**0.00**	**0.00**	**2,331,656.24**
			221.20		*276.87*				*276.87*
0601440201 Tremie Concrete Intake Tower Base #11	**260.00**	**CY**	**57,511.54**	**14,475.17**	**71,986.71**	**0.00**	**0.00**	**0.00**	**71,986.71**
			1,740,345.93		*2,178,376.41*				*2,178,376.41*
0601440202 Precast Concrete Intake Tower Walls #11	**1.00**	**EA**	**1,740,345.93**	**438,030.48**	**2,178,376.41**	**0.00**	**0.00**	**0.00**	**2,178,376.41**
			64,946.60		*81,293.12*				*81,293.12*
0601440203 CIP Concrete Intake Tower Roof & Work Platform #11	**1.00**	**EA**	**64,946.60**	**16,346.51**	**81,293.12**	**0.00**	**0.00**	**0.00**	**81,293.12**
			860,885.84		*1,077,563.59*				*1,077,563.59*
06014403 Trash Rack	**1.00**	**EA**	**860,885.84**	**216,677.75**	**1,077,563.59**	**0.00**	**0.00**	**0.00**	**1,077,563.59**
			860,885.84		*1,077,563.59*				*1,077,563.59*
0601440301 Intake Screen #11	**1.00**	**EA**	**860,885.84**	**216,677.75**	**1,077,563.59**	**0.00**	**0.00**	**0.00**	**1,077,563.59**
			290,968.26		*364,202.53*				*364,202.53*
06014404 Trash Rake	**1.00**	**EA**	**290,968.26**	**73,234.27**	**364,202.53**	**0.00**	**0.00**	**0.00**	**364,202.53**
			290,968.26		*364,202.53*				*364,202.53*
0601440401 Trash Rake System #11	**1.00**	**EA**	**290,968.26**	**73,234.27**	**364,202.53**	**0.00**	**0.00**	**0.00**	**364,202.53**
			115,500.00		*144,570.38*				*144,570.38*
06014405 Concrete Mining	**1.00**	**EA**	**115,500.00**	**29,070.38**	**144,570.38**	**0.00**	**0.00**	**0.00**	**144,570.38**
			1,500.00		*1,877.54*				*1,877.54*
0601440501 84" Dia Dam Mass Concrete Mining #11	**77.00**	**LF**	**115,500.00**	**29,070.38**	**144,570.38**	**0.00**	**0.00**	**0.00**	**144,570.38**
			608.00		*761.03*				*761.03*
06014406 72" Pipe Material	**436.00**	**LF**	**265,088.00**	**66,720.43**	**331,808.43**	**0.00**	**0.00**	**0.00**	**331,808.43**
			608.00		*761.03*				*761.03*
0601440601 72" Pipe Material #2	**436.00**	**LF**	**265,088.00**	**66,720.43**	**331,808.43**	**0.00**	**0.00**	**0.00**	**331,808.43**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
			746,671.47		*934,602.41*				*934,602.41*
06014407 72" Pipe Installation	**1.00**	**EA**	**746,671.47**	**187,930.95**	**934,602.41**	**0.00**	**0.00**	**0.00**	**934,602.41**
			511.23		*639.91*				*639.91*
0601440701 Install 72" Dia. Intake Piping in Tunnels #11	**85.00**	**LF**	**43,454.91**	**10,937.24**	**54,392.14**	**0.00**	**0.00**	**0.00**	**54,392.14**
			140.23		*175.52*				*175.52*
0601440702 Grout 11" Annular Space #11	**815.00**	**CF**	**114,283.69**	**28,764.25**	**143,047.93**	**0.00**	**0.00**	**0.00**	**143,047.93**
			34,774.97		*43,527.54*				*43,527.54*
0601440703 Field Fabricate & Install 72" Dia x 90 Deg Short R. Bend #11	**4.00**	**EA**	**139,099.90**	**35,010.28**	**174,110.18**	**0.00**	**0.00**	**0.00**	**174,110.18**
			63,997.33		*80,104.92*				*80,104.92*
0601440704 Field Fabricate & Install 72" Dia x 90 Deg Long R. Bend #11	**1.00**	**EA**	**63,997.33**	**16,107.59**	**80,104.92**	**0.00**	**0.00**	**0.00**	**80,104.92**
			34,774.97		*43,527.54*				*43,527.54*
0601440705 Field Fabricate & Install 72" Dia x 45 Deg Bend #11	**2.00**	**EA**	**69,549.95**	**17,505.14**	**87,055.09**	**0.00**	**0.00**	**0.00**	**87,055.09**
			11,271.96		*14,109.02*				*14,109.02*
0601440706 Install Steel Pipe Support #11	**1.00**	**EA**	**11,271.96**	**2,837.06**	**14,109.02**	**0.00**	**0.00**	**0.00**	**14,109.02**
			1,215.19		*1,521.05*				*1,521.05*
0601440707 Install 72" Dia. Intake Piping	**251.00**	**LF**	**305,013.74**	**76,769.40**	**381,783.14**	**0.00**	**0.00**	**0.00**	**381,783.14**
			1,354,359.29		*1,695,240.16*				*1,695,240.16*
06014408 72" Valves	**1.00**	**EA**	**1,354,359.29**	**340,880.87**	**1,695,240.16**	**0.00**	**0.00**	**0.00**	**1,695,240.16**
			1,354,359.29		*1,695,240.16*				*1,695,240.16*
0601440801 Intake Pipe Valves #11	**1.00**	**EA**	**1,354,359.29**	**340,880.87**	**1,695,240.16**	**0.00**	**0.00**	**0.00**	**1,695,240.16**
			141,912.77		*177,631.02*				*177,631.02*
06014409 Pipe Filling System	**1.00**	**EA**	**141,912.77**	**35,718.25**	**177,631.02**	**0.00**	**0.00**	**0.00**	**177,631.02**
			111,755.25		*139,883.11*				*139,883.11*
0601440901 Siphon Fill Pumps	**1.00**	**EA**	**111,755.25**	**28,127.86**	**139,883.11**	**0.00**	**0.00**	**0.00**	**139,883.11**
			30,157.52		*37,747.91*				*37,747.91*
0601440902 Siphon Fill Piping	**1.00**	**EA**	**30,157.52**	**7,590.39**	**37,747.91**	**0.00**	**0.00**	**0.00**	**37,747.91**
			1,329,718.11		*1,664,397.01*				*1,664,397.01*
06014410 Valve Room Modification	**1.00**	**EA**	**1,329,718.11**	**334,678.90**	**1,664,397.01**	**0.00**	**0.00**	**0.00**	**1,664,397.01**
			49,410.97		*61,847.29*				*61,847.29*
0601441001 Demolish Valve Room Piping	**1.00**	**EA**	**49,410.97**	**12,436.33**	**61,847.29**	**0.00**	**0.00**	**0.00**	**61,847.29**
			16,515.45		*20,672.25*				*20,672.25*
0601441002 Field Fabricate & Install 48" Dia. Bend	**1.00**	**EA**	**16,515.45**	**4,156.80**	**20,672.25**	**0.00**	**0.00**	**0.00**	**20,672.25**
0601441003 Field Fabricate & Install Valve Vault Piping	**1.00**	**LS**	**176,815.37**	**44,502.95**	**221,318.31**	**0.00**	**0.00**	**0.00**	**221,318.31**
0601441004 Install Valve Vault Valves	**1.00**	**LS**	**1,086,976.33**	**273,582.83**	**1,360,559.16**	**0.00**	**0.00**	**0.00**	**1,360,559.16**

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
			805,000.57		*1,007,612.46*				*1,007,612.46*
06014411 Approach Channel & Fish Lock Mod.	**1.00**	**EA**	**805,000.57**	**202,611.89**	**1,007,612.46**	**0.00**	**0.00**	**0.00**	**1,007,612.46**
			25,469.97		*31,880.55*				*31,880.55*
0601441101 Demolish Control House	**1.00**	**EA**	**25,469.97**	**6,410.58**	**31,880.55**	**0.00**	**0.00**	**0.00**	**31,880.55**
			22,210.52		*27,800.73*				*27,800.73*
0601441102 Demolish Fishlock Equipment	**1.00**	**EA**	**22,210.52**	**5,590.20**	**27,800.73**	**0.00**	**0.00**	**0.00**	**27,800.73**
			49,908.51		*62,470.07*				*62,470.07*
0601441103 Demolition at Fishlock Approach Channel	**1.00**	**EA**	**49,908.51**	**12,561.55**	**62,470.07**	**0.00**	**0.00**	**0.00**	**62,470.07**
			25,541.25		*31,969.77*				*31,969.77*
0601441104 7' x 7' x 9' deep Cutout to Fishlock Approach Channel base slab	**1.00**	**EA**	**25,541.25**	**6,428.52**	**31,969.77**	**0.00**	**0.00**	**0.00**	**31,969.77**
			613.86		*768.36*				*768.36*
0601441105 Concrete Repair to 7' x 7' x 9' deep Cutout	**13.00**	**CY**	**7,980.16**	**2,008.54**	**9,988.70**	**0.00**	**0.00**	**0.00**	**9,988.70**
			1,506.45		*1,885.61*				*1,885.61*
0601441106 15" Thick CIP Wall Height Extension	**25.00**	**CY**	**37,661.24**	**9,479.02**	**47,140.26**	**0.00**	**0.00**	**0.00**	**47,140.26**
			148,228.91		*185,536.88*				*185,536.88*
0601441107 Seal 8' x 8' Culvert Joints	**1.00**	**EA**	**148,228.91**	**37,307.97**	**185,536.88**	**0.00**	**0.00**	**0.00**	**185,536.88**
			488,000.00		*610,825.51*				*610,825.51*
0601441108 Stop Logs	**1.00**	**EA**	**488,000.00**	**122,825.51**	**610,825.51**	**0.00**	**0.00**	**0.00**	**610,825.51**
			10,733.53		*13,435.07*				*13,435.07*
06014412 Fish Lock Maintenance Platform	**1.00**	**EA**	**10,733.53**	**2,701.54**	**13,435.07**	**0.00**	**0.00**	**0.00**	**13,435.07**
			6,000.00		*7,510.15*				*7,510.15*
0601441201 Concrete Maintenance Platform. #11	**1.00**	**SF**	**6,000.00**	**1,510.15**	**7,510.15**	**0.00**	**0.00**	**0.00**	**7,510.15**
			4,733.53		*5,924.92*				*5,924.92*
0601441202 Ladder #11	**1.00**	**EA**	**4,733.53**	**1,191.39**	**5,924.92**	**0.00**	**0.00**	**0.00**	**5,924.92**
			208,447.06		*260,911.44*				*260,911.44*
06014414 Electrical	**1.00**	**EA**	**208,447.06**	**52,464.38**	**260,911.44**	**0.00**	**0.00**	**0.00**	**260,911.44**
			111,629.94		*139,726.26*				*139,726.26*
0601441301 Power From Existing Unit Substation	**1.00**	**EA**	**111,629.94**	**28,096.32**	**139,726.26**	**0.00**	**0.00**	**0.00**	**139,726.26**
			10,469.22		*13,104.23*				*13,104.23*
0601441302 Power for Trash Rake	**1.00**	**EA**	**10,469.22**	**2,635.01**	**13,104.23**	**0.00**	**0.00**	**0.00**	**13,104.23**
			15,704.31		*19,656.95*				*19,656.95*
0601441303 Power for Valve Operators	**1.00**	**EA**	**15,704.31**	**3,952.64**	**19,656.95**	**0.00**	**0.00**	**0.00**	**19,656.95**
			8,885.37		*11,121.74*				*11,121.74*
0601441304 Power for Hydraulic Power Units	**1.00**	**EA**	**8,885.37**	**2,236.37**	**11,121.74**	**0.00**	**0.00**	**0.00**	**11,121.74**
			14,859.09		*18,598.99*				*18,598.99*

Description	Quantity	UOM	CostToPrime	PrimeCMU	ContractCost	Escalation	Contingency	SIOH	ProjectCost
0601441305 Power for Siphon Priming Pumps	**1.00**	**EA**	**14,859.09**	**3,739.91**	**18,598.99**	**0.00**	**0.00**	**0.00**	**18,598.99**
			23,702.21		*29,667.86*				*29,667.86*
0601441306 Power for Bulkhead Crane	**1.00**	**EA**	**23,702.21**	**5,965.65**	**29,667.86**	**0.00**	**0.00**	**0.00**	**29,667.86**
			10,974.29		*13,736.43*				*13,736.43*
0601441307 Relocate Electrical Panel at Fence	**1.00**	**EA**	**10,974.29**	**2,762.14**	**13,736.43**	**0.00**	**0.00**	**0.00**	**13,736.43**
			6,564.01		*8,216.11*				*8,216.11*
0601441308 Modify Electrical Security System at Fence	**1.00**	**EA**	**6,564.01**	**1,652.11**	**8,216.11**	**0.00**	**0.00**	**0.00**	**8,216.11**
			4,920.55		*6,159.01*				*6,159.01*
0601441309 Demo Existing Electrical at Existing FCQ7 - MCC	**1.00**	**EA**	**4,920.55**	**1,238.46**	**6,159.01**	**0.00**	**0.00**	**0.00**	**6,159.01**
			738.08		*923.85*				*923.85*
0601441310 Disconnect/Demo Electrical circuits to Control House	**1.00**	**EA**	**738.08**	**185.77**	**923.85**	**0.00**	**0.00**	**0.00**	**923.85**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
Detail Report			**1,433,643.45**	**273,719.87**	**6,008,547.99**	**217,250.00**	**123,927.65**	**0.00**	**8,057,088.96**
			1,433,643.45	*273,719.87*	*6,008,547.99*	*217,250.00*		*0.00*	*8,057,088.96*
06 Fish and Wildlife Facilities	**1.00**	**EA**	**1,433,643.45**	**273,719.87**	**6,008,547.99**	**217,250.00**	**123,927.65**	**0.00**	**8,057,088.96**
			1,433,643.45	*273,719.87*	*6,008,547.99*	*217,250.00*		*0.00*	*8,057,088.96*
0601 Fish Facilities at Dams	**1.00**	**EA**	**1,433,643.45**	**273,719.87**	**6,008,547.99**	**217,250.00**	**123,927.65**	**0.00**	**8,057,088.96**
			1,433,643.45	*273,719.87*	*6,008,547.99*	*217,250.00*		*0.00*	*8,057,088.96*
060144 Fishways and Fish Ladders	**1.00**	**EA**	**1,433,643.45**	**273,719.87**	**6,008,547.99**	**217,250.00**	**123,927.65**	**0.00**	**8,057,088.96**
			65,000.00	*0.00*	*0.00*	*0.00*		*0.00*	*65,000.00*
06014401 Foundation Preparation	**1.00**	**EA**	**65,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**65,000.00**
			250.00	*0.00*	*0.00*	*0.00*		*0.00*	*250.00*
0601440101 Remove Debris/Muck Intake Tower	**260.00**	**CY**	**65,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**65,000.00**
			250.00	*0.00*	*0.00*	*0.00*		*0.00*	*250.00*
USR 3500000009 Diver support - Remove Mud to expose bedrock surface	260.00	CY	65,000.00	0.00	0.00	0.00	0.00	0.00	65,000.00
			252,774.24	*97,639.49*	*1,465,270.05*	*9,000.00*		*0.00*	*1,862,804.08*
06014402 Intake Tower	**1.00**	**EA**	**252,774.24**	**97,639.49**	**1,465,270.05**	**9,000.00**	**38,120.31**	**0.00**	**1,862,804.08**
			83.90	*28.80*	*108.50*	*0.00*		*0.00*	*221.20*
0601440201 Tremie Concrete Intake Tower Base #11	**260.00**	**CY**	**21,814.19**	**7,487.35**	**28,210.00**	**0.00**	**0.00**	**0.00**	**57,511.54**
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*108.50*
USR 033105350300x1 Tremie concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	260.00	CY	0.00	0.00	28,210.00	0.00	0.00	0.00	28,210.00
			26.19	*28.80*	*0.00*	*0.00*		*0.00*	*54.99*
USR 033105700400 Place Tremie concrete slab	260.00	CY	6,810.44	7,487.35	0.00	0.00	0.00	0.00	14,297.79
			7,501.88	*0.00*	*0.00*	*0.00*		*0.00*	*7,501.88*
USR 3500000011 Diver support - Place Tremie concrete.	2.00	DAY	15,003.75	0.00	0.00	0.00	0.00	0.00	15,003.75
			223,173.37	*84,605.93*	*1,397,240.00*	*0.00*		*0.00*	*1,740,345.93*
0601440202 Precast Concrete Intake Tower Walls #11	**1.00**	**EA**	**223,173.37**	**84,605.93**	**1,397,240.00**	**0.00**	**35,326.63**	**0.00**	**1,740,345.93**
			0.00	*0.00*	*15,300.00*	*0.00*		*0.00*	*15,300.00*
USR 034105102600x2 Intake Tower Interlocking precast members, 30" x 60" x 30' to 35' long', material only	88.00	EA	0.00	0.00	1,346,400.00	0.00	0.00	0.00	1,346,400.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 034105102600 Intake Tower Interlocking precast members, 36" x 60" x 30' to 35' long', material only	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USR 034 Allowance for Barge Transport of precast concrete	1.00	LS	0.00	0.00	35,000.00	0.00	0.00	0.00	35,000.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			595.38	*958.99*	*0.00*	*0.00*		*0.00*	*1,903.92*
USR 034105102600x2 Lift and place Intake Tower Interlocking precast members, 36" x 60" x 30' to 35' long'	88.00	EA	52,393.66	84,391.30	0.00	0.00	30,759.86	0.00	167,544.82
			0.00	*0.00*	*150.00*	*0.00*		*0.00*	*183.73*
USR 032305501050x2 1 1/4" dia x 6' long 150 ksi threaded bar with coupler. Material cost only. Installed by divers	96.00	EA	0.00	0.00	14,400.00	0.00	3,238.24	0.00	17,638.24
			478.20	*17.89*	*120.00*	*0.00*		*0.00*	*726.80*
USR 032305501050x1 Prestress and grout 150 ksi threaded bar, 88' long, 100 kip, post-tensioned in field	12.00	EA	5,738.46	214.63	1,440.00	0.00	1,328.54	0.00	8,721.62
			7,501.88	*0.00*	*0.00*	*0.00*		*0.00*	*7,501.88*
USR 3500000009 Diver support - Guide interlocking precast concrete member to final position, install restraint , disconnect hoisting hooks and install post-tension rod/coupler.	22.00	DAY	165,041.26	0.00	0.00	0.00	0.00	0.00	165,041.26
			7,786.67	*5,546.21*	*39,820.05*	*9,000.00*		*0.00*	*64,946.60*
0601440203 CIP Concrete Intake Tower Roof & Work Platform #11	**1.00**	**EA**	**7,786.67**	**5,546.21**	**39,820.05**	**9,000.00**	**2,793.67**	**0.00**	**64,946.60**
			0.00	*0.00*	*2,800.00*	*0.00*		*0.00*	*2,800.00*
USR 034105102600x2 Intake Tower precast roof beam, 18" x 24" x 30' long', material only	6.00	EA	0.00	0.00	16,800.00	0.00	0.00	0.00	16,800.00
			148.85	*239.75*	*0.00*	*0.00*		*0.00*	*475.98*
USR 034105102600x2 Lift and place Intake Tower precast roof beam, 18" x 24" x 30' long'	6.00	EA	893.07	1,438.49	0.00	0.00	524.32	0.00	2,855.88
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 034113500100x1 Precast slab, roof/floor members, grouted, hollow, 8" thick, prestressed, MATERIAL COST ONLY	0.00	SF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*7.50*	*0.00*		*0.00*	*7.50*
USR 034113500050x1 Precast slab, roof/floor members, grouted, solid, 6" thick, prestressed, MATERIAL COST ONLY	1,972.00	SF	0.00	0.00	14,790.00	0.00	0.00	0.00	14,790.00
			1.19	*1.92*	*0.00*	*0.00*		*0.00*	*3.81*
USR 034105102600x2 Lift and place Intake Tower Precast roof slab	1,972.00	SF	2,348.19	3,782.26	0.00	0.00	1,378.60	0.00	7,509.05
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113357070 C.I.P. concrete forms, elevated slab, edge forms, 7" to 12" high, 1 use, includes shoring, erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
USR 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105704650 Structural concrete, placing, slab on grade, pumped, over 6" thick, includes strike off & consolidation, excludes material	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110600600 Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			11.17	*0.00*	*16.93*	*0.00*		*0.00*	*33.15*
HNC 033923230205 Curing, burlap/poly blanket, 2 ply	19.72	CSF	220.24	0.00	333.93	0.00	99.58	0.00	653.75
			0.49	*0.00*	*0.00*	*0.00*		*0.00*	*0.58*
HNC 033529300010 Concrete finishing, floors, monolithic, screed finish	1,972.00	SF	975.89	0.00	0.00	0.00	175.37	0.00	1,151.26
			0.00	*0.00*	*2,700.00*	*0.00*		*0.00*	*2,700.00*
USR 034105102600x2 Intake Tower precast Cover Slab, 12' x 8', material only	1.00	EA	0.00	0.00	2,700.00	0.00	0.00	0.00	2,700.00
			148.85	*239.75*	*0.00*	*0.00*		*0.00*	*475.98*
USR 034105102600x3 Lift and place Intake Tower precast Cover Slab, 12' x 8'	1.00	EA	148.85	239.75	0.00	0.00	87.39	0.00	475.98
			0.00	*0.00*	*123.00*	*0.00*		*0.00*	*145.10*
RSM 033105350418 Structural concrete, ready mix, normal weight, 1:2 mix topping, includes sand, Portland cement and water, delivered, excludes all additives and treatments	13.00	CY	0.00	0.00	1,599.00	0.00	287.34	0.00	1,886.34
			3.45	*0.00*	*0.12*	*0.00*		*0.00*	*4.21*
RSM 031113357000 C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning	376.00	LF	1,296.45	0.00	45.12	0.00	241.08	0.00	1,582.65
USR Allowance for 15'-0" x 17'-0" x 29'-0" Precast concrete Work Platform.	1.00	LS	0.00	0.00	0.00	9,000.00	0.00	0.00	9,000.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			39.67	*1.79*	*74.00*	*0.00*		*0.00*	*115.45*
RSM 055133130020 Ladder, shop fabricated, steel, 20" W, bolted to concrete, incl cage	48.00	VLF	1,903.99	85.71	3,552.00	0.00	0.00	0.00	5,541.70
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 055133130020 Ladder, shop fabricated, steel, 20" W, bolted to concrete, incl cage	0.00	VLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			51,934.97	*1,302.87*	*807,648.00*	*0.00*		*0.00*	*860,885.84*
06014403 Trash Rack	**1.00**	**EA**	**51,934.97**	**1,302.87**	**807,648.00**	**0.00**	**0.00**	**0.00**	**860,885.84**
			51,934.97	*1,302.87*	*807,648.00*	*0.00*		*0.00*	*860,885.84*
0601440301 Intake Screen #11	**1.00**	**EA**	**51,934.97**	**1,302.87**	**807,648.00**	**0.00**	**0.00**	**0.00**	**860,885.84**
			0.00	*0.00*	*6,400.00*	*0.00*		*0.00*	*6,400.00*
USR 051223650450x4 Shop fabricated Trashrack Support Framing (11’-7” x 18’-2”) , incl Delivery to site	5.00	EA	0.00	0.00	32,000.00	0.00	0.00	0.00	32,000.00
			0.00	*0.00*	*155,000.00*	*0.00*		*0.00*	*155,000.00*
USR 051223650450x4 Shop fabricated Trashrack Panel, 11'-6" x 18'-0", incl Delivery to site	5.00	EA	0.00	0.00	775,000.00	0.00	0.00	0.00	775,000.00
			35,026.27	*0.00*	*0.00*	*0.00*		*0.00*	*35,026.27*
USR 3500000004 Diver support - Drill 74 ea anchor holes in the concrete Dam face, install anchors and Trash Rack Support Frame, excludes cost of anchors and hoisting cost.	1.00	EA	35,026.27	0.00	0.00	0.00	0.00	0.00	35,026.27
			483.69	*144.76*	*0.00*	*0.00*		*0.00*	*628.46*
USR 034105101700 Install Trash Rack Panel	5.00	EA	2,418.46	723.82	0.00	0.00	0.00	0.00	3,142.28
			2,500.00	*0.00*	*0.00*	*0.00*		*0.00*	*2,500.00*
USR 3500000005 Diver support - Install Trash Rack Screen, excludes hoisting cost.	5.00	EA	12,500.00	0.00	0.00	0.00	0.00	0.00	12,500.00
			0.00	*0.00*	*10.80*	*0.00*		*0.00*	*10.80*
USR 050523208600x2 Williams Stainless Steel Undercut Anchor, 1" dia x 18" long installed below waterline by divers	60.00	EA	0.00	0.00	648.00	0.00	0.00	0.00	648.00
			1,990.24	*579.05*	*0.00*	*0.00*		*0.00*	*2,569.29*
USR 034105101700x1 Install Trashrack Support Frames	1.00	EA	1,990.24	579.05	0.00	0.00	0.00	0.00	2,569.29
			30,237.43	*9,936.42*	*250,794.40*	*0.00*		*0.00*	*290,968.26*
06014404 Trash Rake	**1.00**	**EA**	**30,237.43**	**9,936.42**	**250,794.40**	**0.00**	**0.00**	**0.00**	**290,968.26**
			30,237.43	*9,936.42*	*250,794.40*	*0.00*		*0.00*	*290,968.26*
0601440401 Trash Rake System #11	**1.00**	**EA**	**30,237.43**	**9,936.42**	**250,794.40**	**0.00**	**0.00**	**0.00**	**290,968.26**
			33.15	*3.34*	*16.55*	*0.00*		*0.00*	*53.04*
RSM 050523151435 Chemical anchor, 1" dia x 11-3/4" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	48.00	EA	1,591.03	160.48	794.40	0.00	0.00	0.00	2,545.91

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			28,646.40	*9,775.95*	*250,000.00*	*0.00*		*0.00*	*288,422.35*
USR 412123160450x1 Trashraking System, twinboom DT8300 model, material cost includes PLC auto/manual controls.	1.00	EA	28,646.40	9,775.95	250,000.00	0.00	0.00	0.00	288,422.35
			0.00	*0.00*	*0.00*	*115,500.00*		*0.00*	*115,500.00*
06014405 Concrete Mining	**1.00**	**EA**	**0.00**	**0.00**	**0.00**	**115,500.00**	**0.00**	**0.00**	**115,500.00**
			0.00	*0.00*	*0.00*	*1,500.00*		*0.00*	*1,500.00*
0601440501 84" Dia Dam Mass Concrete Mining #11	**77.00**	**LF**	**0.00**	**0.00**	**0.00**	**115,500.00**	**0.00**	**0.00**	**115,500.00**
			0.00	*0.00*	*0.00*	*1,500.00*		*0.00*	*1,500.00*
USR 317119100120x Dam unreinforced mass concrete mining, 84" Dia diameter bored tunnel, includes mobilization/de-mobilization, 2 setups, mucking	77.00	LF	0.00	0.00	0.00	115,500.00	0.00	0.00	115,500.00
(Note: Two budget price obtained.)									
			0.00	*0.00*	*608.00*	*0.00*		*0.00*	*608.00*
06014406 72" Pipe Material	**436.00**	**LF**	**0.00**	**0.00**	**265,088.00**	**0.00**	**0.00**	**0.00**	**265,088.00**
			0.00	*0.00*	*608.00*	*0.00*		*0.00*	*608.00*
0601440601 72" Pipe Material #2	**436.00**	**LF**	**0.00**	**0.00**	**265,088.00**	**0.00**	**0.00**	**0.00**	**265,088.00**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*380.00*
USR 331113401130x Material Cost ONLY - 72" diameter Pipe, black steel, plain end, welded, A-36, 1/2" wall thickness	436.00	LF	0.00	0.00	165,680.00	0.00	0.00	0.00	165,680.00
			0.00	*0.00*	*228.00*	*0.00*		*0.00*	*228.00*
USR 331113401645 Interior Polyurethane paint & exterior epoxy pipe coating to 72" Dia., material add only	436.00	LF	0.00	0.00	99,408.00	0.00	0.00	0.00	99,408.00
			539,448.09	*96,632.90*	*104,823.00*	*0.00*		*0.00*	*746,671.47*
06014407 72" Pipe Installation	**1.00**	**EA**	**539,448.09**	**96,632.90**	**104,823.00**	**0.00**	**5,767.47**	**0.00**	**746,671.47**
			397.23	*111.68*	*2.33*	*0.00*		*0.00*	*511.23*
0601440701 Install 72" Dia. Intake Piping in Tunnels #11	**85.00**	**LF**	**33,764.26**	**9,492.53**	**198.12**	**0.00**	**0.00**	**0.00**	**43,454.91**
			286.41	*110.81*	*0.00*	*0.00*		*0.00*	*397.22*
HNC 331113401130 Pipe, black steel, plain end, welded, 1/2" wall thickness, 72" diameter, excludes excavation or backfill	85.00	LF	24,344.58	9,418.98	0.00	0.00	0.00	0.00	33,763.56
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 331113401170 Pipe, black steel, plain end, welded, 5/8" wall thickness, 84" diameter, excludes excavation or backfill	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 331113401170x1 Pipe Sleeve, black steel, plain end, welded, 5/8" wall thickness, 84" diameter	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	3.00	EA	8,632.88	73.55	0.00	0.00	0.00	0.00	8,706.43
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	3.00	EA	786.80	0.00	198.12	0.00	0.00	0.00	984.92
			117.92	*12.30*	*10.00*	*0.00*		*0.00*	*140.23*
0601440702 Grout 11" Annular Space #11	**815.00**	**CF**	**96,107.70**	**10,025.99**	**8,150.00**	**0.00**	**0.00**	**0.00**	**114,283.69**
			117.92	*12.30*	*10.00*	*0.00*		*0.00*	*140.23*
USR 314313130100x1 Concrete pressure grouting to annular space, cement and sand, 1:1 mix	815.00	CF	96,107.70	10,025.99	8,150.00	0.00	0.00	0.00	114,283.69
			25,658.18	*3,846.59*	*5,270.20*	*0.00*		*0.00*	*34,774.97*
0601440703 Field Fabricate & Install 72" Dia x 90 Deg Short R. Bend #11	**4.00**	**EA**	**102,632.73**	**15,386.36**	**21,080.80**	**0.00**	**0.00**	**0.00**	**139,099.90**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*380.00*
USR 331113401130x1 72" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness, Material Cost Only	52.00	LF	0.00	0.00	19,760.00	0.00	0.00	0.00	19,760.00
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	904.00	LF	1,440.45	41.13	0.00	0.00	0.00	0.00	1,481.58
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	24.00	EA	32,332.15	12,509.39	0.00	0.00	0.00	0.00	44,841.54
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	4.00	EA	6,062.28	2,345.51	0.00	0.00	0.00	0.00	8,407.79
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 331113401510 Coupling, dresser, pipe, black steel, 72" pipe size, PE style 38	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	20.00	EA	57,552.50	490.33	0.00	0.00	0.00	0.00	58,042.84
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	20.00	EA	5,245.35	0.00	1,320.80	0.00	0.00	0.00	6,566.15

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			48,393.08	*6,583.85*	*9,020.40*	*0.00*		*0.00*	*63,997.33*
0601440704 Field Fabricate & Install 72" Dia x 90 Deg Long R. Bend #11	**1.00**	**EA**	**48,393.08**	**6,583.85**	**9,020.40**	**0.00**	**0.00**	**0.00**	**63,997.33**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*380.00*
USR 331113401130x1 72" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness, Material Cost Only	22.00	LF	0.00	0.00	8,360.00	0.00	0.00	0.00	8,360.00
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	414.00	LF	659.68	18.84	0.00	0.00	0.00	0.00	678.51
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	11.00	EA	14,818.90	5,733.47	0.00	0.00	0.00	0.00	20,552.37
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	1.00	EA	1,515.57	586.38	0.00	0.00	0.00	0.00	2,101.95
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	10.00	EA	28,776.25	245.17	0.00	0.00	0.00	0.00	29,021.42
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	10.00	EA	2,622.67	0.00	660.40	0.00	0.00	0.00	3,283.07
			25,658.18	*3,846.59*	*5,270.20*	*0.00*		*0.00*	*34,774.97*
0601440705 Field Fabricate & Install 72" Dia x 45 Deg Bend #11	**2.00**	**EA**	**51,316.37**	**7,693.18**	**10,540.40**	**0.00**	**0.00**	**0.00**	**69,549.95**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*380.00*
USR 331113401130x1 72" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness, Material Cost Only	26.00	LF	0.00	0.00	9,880.00	0.00	0.00	0.00	9,880.00
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	452.00	LF	720.23	20.57	0.00	0.00	0.00	0.00	740.79
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1,347.17	*521.22*	*0.00*	*0.00*		*0.00*	*1,868.40*
USR 331113401130x Lift & Position cut 72" Dia pipe segments for welding Bend	12.00	EA	16,166.08	6,254.69	0.00	0.00	0.00	0.00	22,420.77

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,515.57	*586.38*	*0.00*	*0.00*		*0.00*	*2,101.95*
USR 331113401130x Lift & place field fabricated 72" Dia Bend for welding to pipe	2.00	EA	3,031.14	1,172.76	0.00	0.00	0.00	0.00	4,203.89
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	10.00	EA	28,776.25	245.17	0.00	0.00	0.00	0.00	29,021.42
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	10.00	EA	2,622.67	0.00	660.40	0.00	0.00	0.00	3,283.07
			5,297.69	*479.50*	*5,320.00*	*0.00*		*0.00*	*11,271.96*
0601440706 Install Steel Pipe Support #11	**1.00**	**EA**	**5,297.69**	**479.50**	**5,320.00**	**0.00**	**174.77**	**0.00**	**11,271.96**
			5,000.00	*0.00*	*0.00*	*0.00*		*0.00*	*5,000.00*
USR 3500000008 Diver support - Drill 8 ea anchor holes in the concrete Dam face, install anchors and steel pipe support, excludes cost of steel pipe support, anchors and hoisting cost.	1.00	EA	5,000.00	0.00	0.00	0.00	0.00	0.00	5,000.00
			0.00	*0.00*	*2,660.00*	*0.00*		*0.00*	*2,660.00*
USR 351900000003 Fabricated Pipe Support (1063 LBS / EA), shop fabricated	2.00	EA	0.00	0.00	5,320.00	0.00	0.00	0.00	5,320.00
			148.85	*239.75*	*0.00*	*0.00*		*0.00*	*475.98*
USR 034105102600z2 Lift and Hold Shop Fabricated Steel Pipe Support	2.00	EA	297.69	479.50	0.00	0.00	174.77	0.00	951.96
			804.53	*187.14*	*201.25*	*0.00*		*0.00*	*1,215.19*
0601440707 Install 72" Dia. Intake Piping	**251.00**	**LF**	**201,936.26**	**46,971.50**	**50,513.28**	**0.00**	**5,592.70**	**0.00**	**305,013.74**
			286.41	*110.81*	*0.00*	*0.00*		*0.00*	*397.22*
HNC 331113401130 Pipe, black steel, plain end, welded, 1/2" wall thickness, 72" diameter, excludes excavation or backfill	251.00	LF	71,888.12	27,813.69	0.00	0.00	0.00	0.00	99,701.81
			2,381.53	*3,835.97*	*0.00*	*0.00*		*0.00*	*7,615.67*
USR 331113401130x9 Lift and place Prefabricated 72" Dia Pipe Segment on steel pipe support approx. 800' to 100' long	2.00	EA	4,763.06	7,671.94	0.00	0.00	2,796.35	0.00	15,231.35
			2,381.53	*3,835.97*	*0.00*	*0.00*		*0.00*	*7,615.67*
USR 331113401130x8 Lift, position and hold Prefabricated 72" Dia x 16' long Pipe Vertical Segment with attached Gate Valve at the Intake Tower until the divers complete boult-up operation	2.00	EA	4,763.06	7,671.94	0.00	0.00	2,796.35	0.00	15,231.35
			1,818.68	*703.65*	*0.00*	*0.00*		*0.00*	*2,522.34*
USR 331113401130x8 Lift, position and hold Prefabricated 72" Dia x 35' long Pipe Vertical Segment with attached 90 Deg Bend at the IFish Ladder	2.00	EA	3,637.37	1,407.31	0.00	0.00	0.00	0.00	5,044.67

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 352016630200x4 Lift and position 72" dia. Gate Valve, includes material cost	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			954.56	*135.17*	*3,800.00*	*0.00*		*0.00*	*4,889.74*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 72" pipe size, includes 1 weld per joint and weld machine	12.00	EA	11,454.77	1,622.10	45,600.00	0.00	0.00	0.00	58,676.87
			476.66	*0.00*	*1,400.00*	*0.00*		*0.00*	*1,876.66*
USR 221113470830x4 Gasket and bolt set, for flanges, 150 lb., 72" pipe size	2.00	EA	953.32	0.00	2,800.00	0.00	0.00	0.00	3,753.32
			2,877.63	*24.52*	*0.00*	*0.00*		*0.00*	*2,902.14*
USR 221113449650x4 Pipe, steel, Welding labor per joint, 72" pipe size, schedule 80, welding	32.00	EA	92,084.01	784.53	0.00	0.00	0.00	0.00	92,868.54
			262.27	*0.00*	*66.04*	*0.00*		*0.00*	*328.31*
USR 230593502160x4 Pipe testing, nondestructive test, X-ray of welds, 72" diam.	32.00	EA	8,392.56	0.00	2,113.28	0.00	0.00	0.00	10,505.84
			4,000.00	*0.00*	*0.00*	*0.00*		*0.00*	*4,000.00*
USR 3500000007 Diver support - Align 72" Dia Valve and install bolt, nut & gasket set, excludes cost of bolt, nut & gasket se and hoisting cost.	1.00	EA	4,000.00	0.00	0.00	0.00	0.00	0.00	4,000.00
			24,428.74	*5,790.54*	*1,324,140.00*	*0.00*		*0.00*	*1,354,359.29*
06014408 72" Valves	**1.00**	**EA**	**24,428.74**	**5,790.54**	**1,324,140.00**	**0.00**	**0.00**	**0.00**	**1,354,359.29**
			24,428.74	*5,790.54*	*1,324,140.00*	*0.00*		*0.00*	*1,354,359.29*
0601440801 Intake Pipe Valves #11	**1.00**	**EA**	**24,428.74**	**5,790.54**	**1,324,140.00**	**0.00**	**0.00**	**0.00**	**1,354,359.29**
			4,836.92	*1,447.64*	*250,000.00*	*0.00*		*0.00*	*256,284.55*
USR 352016630200x4 Lift and position 72" dia. Gate Valve, includes material cost	2.00	EA	9,673.83	2,895.27	500,000.00	0.00	0.00	0.00	512,569.10
			4,836.92	*1,447.64*	*400,000.00*	*0.00*		*0.00*	*406,284.55*
USR 352016630200x4 Lift and position 72" dia. Jet Flow Valve, includes material cost	2.00	EA	9,673.83	2,895.27	800,000.00	0.00	0.00	0.00	812,569.10
			415.43	*0.00*	*3,650.00*	*0.00*		*0.00*	*4,065.43*
USR 110505000001 Hydraulic power unit, 5 H.P.	2.00	EA	830.87	0.00	7,300.00	0.00	0.00	0.00	8,130.87
			218.47	*0.00*	*2,820.00*	*0.00*		*0.00*	*3,038.47*
USR 221119141220h1 Hydraulic hose allowance, carbon steel ends, threaded, 1" diameter	2.00	EA	436.94	0.00	5,640.00	0.00	0.00	0.00	6,076.94
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 72" pipe size, includes 1 weld per joint and weld machine	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			476.66	*0.00*	*1,400.00*	*0.00*		*0.00*	*1,876.66*
USR 221113470830x4 Gasket and bolt set, for flanges, 150 lb., 72" pipe size	8.00	EA	3,813.27	0.00	11,200.00	0.00	0.00	0.00	15,013.27
			21,427.51	*123.86*	*120,361.40*	*0.00*		*0.00*	*141,912.77*
06014409 Pipe Filling System	**1.00**	**EA**	**21,427.51**	**123.86**	**120,361.40**	**0.00**	**0.00**	**0.00**	**141,912.77**
			5,755.25	*0.00*	*106,000.00*	*0.00*		*0.00*	*111,755.25*
0601440901 Siphon Fill Pumps	**1.00**	**EA**	**5,755.25**	**0.00**	**106,000.00**	**0.00**	**0.00**	**0.00**	**111,755.25**
			2,877.63	*0.00*	*53,000.00*	*0.00*		*0.00*	*55,877.63*
RSM 221123112220 Pump, turbine, vertical, stainless steel, 400 GPM, 400' TDH, 7.5 H.P.	2.00	EA	5,755.25	0.00	106,000.00	0.00	0.00	0.00	111,755.25
			15,672.26	*123.86*	*14,361.40*	*0.00*		*0.00*	*30,157.52*
0601440902 Siphon Fill Piping	**1.00**	**EA**	**15,672.26**	**123.86**	**14,361.40**	**0.00**	**0.00**	**0.00**	**30,157.52**
			228.62	*3.06*	*164.00*	*0.00*		*0.00*	*395.69*
RSM 221113475652 Nozzle, steel, W-O-L, weld-on, 6" pipe size, includes 1 weld per joint and weld machine	4.00	EA	914.49	12.26	656.00	0.00	0.00	0.00	1,582.75
			38.89	*0.33*	*62.00*	*0.00*		*0.00*	*101.22*
RSM 221113442350 Pipe, steel, black, welded, 6" diameter, schedule 40, A-53 gr. A/B, includes hanger assemblies	120.00	LF	4,666.42	39.76	7,440.00	0.00	0.00	0.00	12,146.18
			114.31	*1.53*	*0.00*	*0.00*		*0.00*	*115.84*
RSM 221113449330 Pipe, steel, Welding labor per joint, 6" pipe size, schedule 40, welding	22.00	EA	2,514.84	33.71	0.00	0.00	0.00	0.00	2,548.55
			319.74	*2.72*	*206.00*	*0.00*		*0.00*	*528.46*
RSM 221113473610 Elbow, 90 Deg., steel, carbon steel, black, long, butt weld, extra strong, 6" pipe size, includes 1 weld per joint and weld machine	8.00	EA	2,557.89	21.79	1,648.00	0.00	0.00	0.00	4,227.68
			239.80	*2.04*	*54.50*	*0.00*		*0.00*	*296.35*
RSM 221113476160 Flange, steel, forged steel, slip-on, 150 lb., 6" pipe size, welded front and back, includes weld machine	8.00	EA	1,918.42	16.34	436.00	0.00	0.00	0.00	2,370.76
			479.60	*0.00*	*1,850.00*	*0.00*		*0.00*	*2,329.60*
RSM 230523802070 Valves, steel, cast, gate, flanged, 150 lb., 6"	2.00	EA	959.21	0.00	3,700.00	0.00	0.00	0.00	4,659.21
			65.54	*0.00*	*16.50*	*0.00*		*0.00*	*82.04*
RSM 230593502140 Pipe testing, nondestructive test, X-ray of welds, 6" diam.	22.00	EA	1,441.89	0.00	363.00	0.00	0.00	0.00	1,804.89
			87.39	*0.00*	*14.80*	*0.00*		*0.00*	*102.19*
RSM 221113470690 Gasket and bolt set, for flanges, 150 lb., 6" pipe size	8.00	EA	699.10	0.00	118.40	0.00	0.00	0.00	817.50

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			184,975.69	*19,635.42*	*1,045,107.00*	*80,000.00*		*0.00*	*1,329,718.11*
06014410 Valve Room Modification	**1.00**	**EA**	**184,975.69**	**19,635.42**	**1,045,107.00**	**80,000.00**	**0.00**	**0.00**	**1,329,718.11**
			43,482.23	*5,928.73*	*0.00*	*0.00*		*0.00*	*49,410.97*
0601441001 Demolish Valve Room Piping	**1.00**	**EA**	**43,482.23**	**5,928.73**	**0.00**	**0.00**	**0.00**	**0.00**	**49,410.97**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 331216103832 Water Utility distribution Valves, gate valves, cast iron, mechanical joint, with boxes, 250 PSI, 36" diameter, includes valve box and mechanical joint, excludes excavation and backfill	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 221113470730 Gasket and bolt set, for flanges, 150 lb., 14" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 18" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting	29.00	LF	46.21	1.32	0.00	0.00	0.00	0.00	47.53
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 36" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	20.00	LF	31.87	0.91	0.00	0.00	0.00	0.00	32.78
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Torch cut 42" dia. steel pipe, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	22.00	LF	35.06	1.00	0.00	0.00	0.00	0.00	36.06
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113470750x Remove bolt set for flanges & Valves, 18" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			394.89	*46.95*	*0.00*	*0.00*		*0.00*	*441.84*
USR 221113470780x Remove bolt set for flanges & Valves, 24" pipe size	2.00	EA	789.78	93.91	0.00	0.00	0.00	0.00	883.68
			535.92	*63.72*	*0.00*	*0.00*		*0.00*	*599.64*
USR 221113470810x Remove bolt set for flanges & Valves, 30" pipe size	1.00	EA	535.92	63.72	0.00	0.00	0.00	0.00	599.64
			682.08	*81.10*	*0.00*	*0.00*		*0.00*	*763.18*
USR 221113470830x Remove bolt set for flanges & Valves, 36" pipe size	1.00	EA	682.08	81.10	0.00	0.00	0.00	0.00	763.18
			937.86	*111.51*	*0.00*	*0.00*		*0.00*	*1,049.37*
USR 221113470810x Remove bolt set for flanges & Valves, 42" pipe size	8.00	EA	7,502.88	892.12	0.00	0.00	0.00	0.00	8,395.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 221113470810x Remove bolt set for flanges & Valves, 48" pipe size	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			895.38	*126.79*	*0.00*	*0.00*		*0.00*	*1,022.18*
USR 220505109150x Lift and remove valves previously unbolted, 42" diameter, selective demolition	2.00	EA	1,790.76	253.59	0.00	0.00	0.00	0.00	2,044.35
			61.41	*8.70*	*0.00*	*0.00*		*0.00*	*70.11*
USR 220505102153x Lift and remove steel pipe previously unbolted or torch cut, 18" diameter, includes attached fittings or valves.	73.00	LF	4,483.05	634.84	0.00	0.00	0.00	0.00	5,117.89
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 220505102155x Lift and remove steel pipe previously unbolted or torch cut, 24" thru 26" diameter, includes attached fittings or valves.	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			107.62	*15.24*	*0.00*	*0.00*		*0.00*	*122.86*
USR 220505102156x Lift and remove steel pipe previously unbolted or torch cut, 30" tdiameter, includes attached fittings or valves.	13.00	LF	1,399.03	198.12	0.00	0.00	0.00	0.00	1,597.15
			107.62	*15.24*	*0.00*	*0.00*		*0.00*	*122.86*
USR 220505102156x Lift and remove steel pipe previously unbolted or torch cut, 36" diameter, includes attached fittings or valves.	27.00	LF	2,905.68	411.47	0.00	0.00	0.00	0.00	3,317.15
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 220505102156 Lift and remove steel pipe previously unbolted or torch cut, 42" diameter, includes attached fittings or valves.	52.00	LF	23,279.92	3,296.64	0.00	0.00	0.00	0.00	26,576.55
			13,736.15	*527.30*	*2,252.00*	*0.00*		*0.00*	*16,515.45*
0601441002 Field Fabricate & Install 48" Dia. Bend	**1.00**	**EA**	**13,736.15**	**527.30**	**2,252.00**	**0.00**	**0.00**	**0.00**	**16,515.45**
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	101.00	LF	160.94	4.60	0.00	0.00	0.00	0.00	165.53
			389.30	*55.13*	*254.00*	*0.00*		*0.00*	*698.42*
USR 331113401110x Insert into valve vault & position 48" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	8.00	LF	3,114.37	441.02	2,032.00	0.00	0.00	0.00	5,587.39
			1,917.39	*16.34*	*0.00*	*0.00*		*0.00*	*1,933.73*
USR 221113449650x3 Pipe, steel, Welding labor per joint, 48" pipe size, schedule 80, welding	5.00	EA	9,586.97	81.68	0.00	0.00	0.00	0.00	9,668.65
			174.78	*0.00*	*44.00*	*0.00*		*0.00*	*218.78*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
USR 230593502160x3 Pipe testing, nondestructive test, X-ray of welds, 48" diam.	5.00	EA	873.88	0.00	220.00	0.00	0.00	0.00	1,093.88
0601441003 Field Fabricate & Install Valve Vault Piping	**1.00**	**LS**	**107,228.05**	**10,532.32**	**59,055.00**	**0.00**	**0.00**	**0.00**	**176,815.37**
			0.00	*0.00*	*2,386.00*	*0.00*		*0.00*	*2,386.00*
USR 331113401110xx1 Shop fabricate 48" x 42" x 28" long Eccentric Reducer, A-36, 1/2" wall thickness	2.00	EA	0.00	0.00	4,772.00	0.00	0.00	0.00	4,772.00
			0.00	*0.00*	*2,385.00*	*0.00*		*0.00*	*2,385.00*
USR 331113401110xx1 Shop fabricate 48" x 42" x 28" long Concentric Reducer, A-36, 1/2" wall thickness	1.00	EA	0.00	0.00	2,385.00	0.00	0.00	0.00	2,385.00
			0.00	*0.00*	*2,450.00*	*0.00*		*0.00*	*2,450.00*
USR 331113401110xx1 Shop fabricate 48" x 36" x 24" long Eccentric Reducer with 48" dia x 6" extension, A-36, 1/2" wall thickness	1.00	EA	0.00	0.00	2,450.00	0.00	0.00	0.00	2,450.00
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 331113401110xx6 Insert into valve vault & position Shop fabricated 48" x 36" x 24" long Eccentric Reducer with 48" dia x 6" extension, A-36, 1/2" wall thickness	1.00	EA	447.69	63.40	0.00	0.00	0.00	0.00	511.09
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 331113401110xx5 Insert into valve vault & position Shop fabricated 48" x 42" x 28" long Concentric Reducer, A-36, 1/2" wall thickness	1.00	EA	447.69	63.40	0.00	0.00	0.00	0.00	511.09
			447.69	*63.40*	*0.00*	*0.00*		*0.00*	*511.09*
USR 331113401110xx4 Insert into valve vault & position Shop fabricated 48" x 42" x 28" long Eccentric Reducer, A-36, 1/2" wall thickness	2.00	EA	895.38	126.79	0.00	0.00	0.00	0.00	1,022.18
			111.58	*51.92*	*190.00*	*0.00*		*0.00*	*353.50*
USR 331113401100x Pipe, black steel, plain end, welded, A-36, 1/2" wall thickness, 36" diameter, excludes excavation or backfill	12.00	LF	1,338.91	623.05	2,280.00	0.00	0.00	0.00	4,241.96
			330.40	*46.79*	*225.00*	*0.00*		*0.00*	*602.19*
USR 331113401110x Insert into valve vault & position 42" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	8.00	LF	2,643.19	374.30	1,800.00	0.00	0.00	0.00	4,817.49
			1.59	*0.05*	*0.00*	*0.00*		*0.00*	*1.64*
RSM 050521100100 Cutting, steel, to 1/2" thick, by hand, incl prep, torch cutting & grinding, excl staging	59.00	LF	94.01	2.68	0.00	0.00	0.00	0.00	96.70
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HNC 050521905150 Welding, structural steel, 1/2", in field, vertical fillet, welded up, std. oper. factor of 50%	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			476.66	*0.00*	*700.00*	*0.00*		*0.00*	*1,176.66*
USR 221113470830x1 Gasket and bolt set, for flanges, 150 lb., 36" pipe size	1.00	EA	476.66	0.00	700.00	0.00	0.00	0.00	1,176.66
			476.66	*0.00*	*817.00*	*0.00*		*0.00*	*1,293.66*
USR 221113470830x2 Gasket and bolt set, for flanges, 150 lb., 42" pipe size	3.00	EA	1,429.98	0.00	2,451.00	0.00	0.00	0.00	3,880.98
			476.66	*0.00*	*934.00*	*0.00*		*0.00*	*1,410.66*
USR 221113470830x3 Gasket and bolt set, for flanges, 150 lb., 48" pipe size	10.00	EA	4,766.59	0.00	9,340.00	0.00	0.00	0.00	14,106.59
			4,772.82	*675.87*	*1,900.00*	*0.00*		*0.00*	*7,348.69*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 36" pipe size, includes 1 weld per joint and weld machine	1.00	EA	4,772.82	675.87	1,900.00	0.00	0.00	0.00	7,348.69
			5,493.14	*777.88*	*2,217.00*	*0.00*		*0.00*	*8,488.01*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 42" pipe size, includes 1 weld per joint and weld machine	3.00	EA	16,479.41	2,333.63	6,651.00	0.00	0.00	0.00	25,464.04
			6,395.58	*905.67*	*2,534.00*	*0.00*		*0.00*	*9,835.25*
USR 221113476559x Flange, steel, forged steel, weld neck, 150 lb., 48" pipe size, includes 1 weld per joint and weld machine	6.00	EA	38,373.49	5,434.02	15,204.00	0.00	0.00	0.00	59,011.51
			389.30	*55.13*	*254.00*	*0.00*		*0.00*	*698.42*
USR 331113401110x Insert into valve vault & position 48" dia. Black steel pipe, plain end, welded, A-36, 1/2" wall thickness	11.00	LF	4,282.26	606.41	2,794.00	0.00	0.00	0.00	7,682.66
			194.19	*0.00*	*70.00*	*0.00*		*0.00*	*264.19*
RSM 221113470750 Gasket and bolt set, for flanges, 150 lb., 18" pipe size	3.00	EA	582.58	0.00	210.00	0.00	0.00	0.00	792.58
			299.75	*0.00*	*1,834.00*	*0.00*		*0.00*	*2,133.75*
USR 221113472518x Flange, steel, cast iron, black, blind, 125 lb., 18" pipe size, add 1 gasket and bolt set (material only) for each joint, includes make-up labor, excludes gasket & bolt sets	3.00	EA	899.26	0.00	5,502.00	0.00	0.00	0.00	6,401.26
			1,438.81	*12.26*	*0.00*	*0.00*		*0.00*	*1,451.07*
USR 221113449650x1 Pipe, steel, Welding labor per joint, 36" pipe size, schedule 80, welding	2.00	EA	2,877.63	24.52	0.00	0.00	0.00	0.00	2,902.14
			1,679.29	*14.31*	*0.00*	*0.00*		*0.00*	*1,693.59*
USR 221113449650x2 Pipe, steel, Welding labor per joint, 42" pipe size, schedule 80, welding	4.00	EA	6,717.15	57.23	0.00	0.00	0.00	0.00	6,774.37

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,917.39	*16.34*	*0.00*	*0.00*		*0.00*	*1,933.73*
USR 221113449650x3 Pipe, steel, Welding labor per joint, 48" pipe size, schedule 80, welding	9.00	EA	17,256.55	147.02	0.00	0.00	0.00	0.00	17,403.57
			131.08	*0.00*	*33.00*	*0.00*		*0.00*	*164.08*
USR 230593502160x1 Pipe testing, nondestructive test, X-ray of welds, 36" diam.	2.00	EA	262.16	0.00	66.00	0.00	0.00	0.00	328.16
			152.92	*0.00*	*38.50*	*0.00*		*0.00*	*191.42*
USR 230593502160x2 Pipe testing, nondestructive test, X-ray of welds, 42" diam.	4.00	EA	611.67	0.00	154.00	0.00	0.00	0.00	765.67
			174.78	*0.00*	*44.00*	*0.00*		*0.00*	*218.78*
USR 230593502160x3 Pipe testing, nondestructive test, X-ray of welds, 48" diam.	9.00	EA	1,572.98	0.00	396.00	0.00	0.00	0.00	1,968.98
0601441004 Install Valve Vault Valves	**1.00**	**LS**	**20,529.25**	**2,647.08**	**983,800.00**	**80,000.00**	**0.00**	**0.00**	**1,086,976.33**
			2,984.60	*441.18*	*65,000.00*	*0.00*		*0.00*	*68,425.78*
USR 352016630160x3 Insert into valve vault, 48" dia Bonneted Knife Valve	4.00	EA	11,938.42	1,764.72	260,000.00	0.00	0.00	0.00	273,703.14
			2,984.60	*441.18*	*425,000.00*	*0.00*		*0.00*	*428,425.78*
USR 352016630160x3 Insert in valve vault, Inline Sleeve Valve, Model B10, 48" x 42"	1.00	EA	2,984.60	441.18	425,000.00	0.00	0.00	0.00	428,425.78
			2,984.60	*441.18*	*292,000.00*	*0.00*		*0.00*	*295,425.78*
USR 352016630160x3 Insert in valve vault, Angled Pattern Sleeve Valve, Model B12, 48" x 36" x 48"	1.00	EA	2,984.60	441.18	292,000.00	0.00	0.00	0.00	295,425.78
			65.54	*0.00*	*0.00*	*0.00*		*0.00*	*65.54*
MIL B-PLUMBER Allowance for partial dis-assemly & re-assembly of Angled Pattern Sleeve Valve to facilate valve vault access	32.00	HR	2,097.30	0.00	0.00	0.00	0.00	0.00	2,097.30
(Note: Assumed Davis Bacon Plumbers and Pipefitters)									
			262.16	*0.00*	*3,400.00*	*0.00*		*0.00*	*3,662.16*
RSM 230913602200b Ultrasonic Flow Meter - HTD-S3X1A2 Ultrasonic Indicator / Transmitter with 4/20mA output, transducer with 25 ft cable with mtg kit	2.00	EA	524.33	0.00	6,800.00	0.00	0.00	0.00	7,324.33
USR Allowance for Reusing some existing and providing some new pipe Supports	1.00	LS	0.00	0.00	0.00	80,000.00	0.00	0.00	80,000.00
			189,477.26	*36,256.11*	*530,979.45*	*0.00*		*0.00*	*805,000.57*
06014411 Approach Channel & Fish Lock Mod.	**1.00**	**EA**	**189,477.26**	**36,256.11**	**530,979.45**	**0.00**	**48,287.75**	**0.00**	**805,000.57**
			13,978.27	*7,068.55*	*543.39*	*0.00*		*0.00*	*25,469.97*
0601441101 Demolish Control House	**1.00**	**EA**	**13,978.27**	**7,068.55**	**543.39**	**0.00**	**3,879.76**	**0.00**	**25,469.97**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			14.21	*7.91*	*0.59*	*0.00*		*0.00*	*26.80*
HNC 024119252260 Saw cutting, concrete walls, rod reinforcing, per inch of depth	828.00	LF	11,767.49	6,552.38	488.52	0.00	3,379.87	0.00	22,188.26
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100270 Selective concrete demolition, 2 - 5 CF per piece, precast specialty embedded in masonry, excludes shoring, bracing, saw or torch cutting, loading, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038213101700 Concrete core drilling, core, reinforced concrete slab, 18" diameter, up to 6" thick slab, includes bit, layout and set up	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038213101750 Concrete core drilling, core, reinforced concrete slab, 18" diameter, up to 6" thick slab, includes bit, layout and set up, each added inch thick in same hole, add	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 038116500820 Concrete sawing, concrete walls, rod reinforcing, per inch of depth	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034123500750 Precast stairs, front entrance, 5 risers, 7' wide, 48" platform	0.00	FLT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.81	*0.49*	*0.50*	*0.00*		*0.00*	*2.13*
RSM 038113500400 Concrete sawing, concrete slabs, mesh reinforcing, up to 3" deep	61.00	LF	49.54	30.03	30.50	0.00	19.78	0.00	129.85
			0.50	*0.30*	*0.17*	*0.00*		*0.00*	*1.14*
RSM 038113500420 Concrete sawing, concrete, existing slab, mesh reinforcing, for each additional inch of depth over 3"	61.00	LF	30.34	18.39	10.37	0.00	10.62	0.00	69.73
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034105100250 Precast beam, L shaped, 40' span, 24" x 52", includes material only	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 034105102500 Precast beam, tee shaped, 40' span, 12" x 52", includes material only	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119271040 Selective demolition, torch cutting, steel, reinforced concrete walls, 12" to 16" thick, oxygen lance cutting	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119271080 Selective demolition, torch cutting, steel, reinforced concrete walls, 24" thick, oxygen lance cutting	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 220505101200 Fixture, lavatory, wall hung, selective demolition, includes 10' piping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 220505101400 Fixture, water closet, floor mounted, selective demolition, includes 10' piping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 230505102740 Heater, electric, wall, baseboard or quartz, selective demolition	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x1 Remove roof slab panels previously sawcut and load on truck	2.00	EA	465.12	133.64	0.00	0.00	107.60	0.00	706.36
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x2 Remove wall panels previously sawcut and load on truck	5.00	EA	1,162.80	334.10	0.00	0.00	268.99	0.00	1,765.90
			48.06	*0.00*	*0.00*	*0.00*		*0.00*	*56.69*
RSM 024210200100 Deconstruction of building plumbing fixtures, wall hung or countertop lavatory, up to 2 stories, excludes handling, packaging or disposal costs	1.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			48.06	*0.00*	*0.00*	*0.00*		*0.00*	*56.69*
RSM 024210200140 Deconstruction of building plumbing fixtures, floor mounted water closet, up to 2 stories, excludes handling, packaging or disposal costs	1.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024210200310 Deconstruction of building electrical fixtures, surface mounted incandescent, up to 2 stories, excludes handling, packaging or disposal costs	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			24.03	*0.00*	*0.00*	*0.00*		*0.00*	*28.35*
RSM 024210200320 Deconstruction of building electrical fixtures, surface mounted fluorescent, 2 lamp, up to 2 stories, excludes handling, packaging or disposal costs	2.00	EA	48.06	0.00	0.00	0.00	8.64	0.00	56.69
			24.23	*0.00*	*0.00*	*0.00*		*0.00*	*28.58*
RSM 024210200610 Deconstruction of millwork and trim, cabinets, wood, up to 2 stories, excludes handling, packaging or disposal costs	3.00	LF	72.69	0.00	0.00	0.00	13.06	0.00	85.75

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024210200710 Deconstruction of building doors and windows, deconstruction of doors & wrap, interior, single, up to 2 stories, excludes handling, packaging or disposal costs, no closers	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			96.91	*0.00*	*3.50*	*0.00*		*0.00*	*118.46*
RSM 024210200730 Deconstruction of building doors and windows, deconstruciton of door & wrap, interior or exterior, single, solid core, up to 2 stories, excludes handling, packaging or disposal costs, no closers	2.00	EA	193.83	0.00	7.00	0.00	36.09	0.00	236.92
			46.15	*0.00*	*3.50*	*0.00*		*0.00*	*58.57*
RSM 024210200810 Deconstruction of building doors and windows, deconstruction of windows & wrap, single, up to 2 stories, excludes casement or cladding, handling, packaging or disposal costs	2.00	EA	92.30	0.00	7.00	0.00	17.84	0.00	117.14
			16,087.60	*2,739.66*	*0.00*	*0.00*		*0.00*	*22,210.52*
0601441102 Demolish Fishlock Equipment	**1.00**	**EA**	**16,087.60**	**2,739.66**	**0.00**	**0.00**	**3,383.26**	**0.00**	**22,210.52**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 050505100260x1 Selective metals demolition, structural framing members, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 110505102858 Hydraulic Gates, canal, flap, knife, slide or sluice, over 60" diameter, selective demolition	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 352016730190 Slide gates, hydraulic structures, steel, self contained, 72" x 72", incl. anchor bolts & grout	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
HTW 025210105431 Cut Fishlock Entrance Gate in segments, thermic lance, sheet metal cutting with torch, downsizing, torch < 2" thick, includes changeout time	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 352016260260 Hydraulic sluice gates, hydraulic structures, cast iron, heavy duty, self contained w/crank oper. gate, 132" x 132", AWWA C501	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050505100070 Selective metals demolition, structural bolts/nuts, 7/8" to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			3.44	*0.00*	*0.00*	*0.00*		*0.00*	*4.06*
RSM 050505100070 Remove bolt/nut securing hoisting equipment to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	26.00	EA	89.51	0.00	0.00	0.00	16.09	0.00	105.60
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Hoisting equipment, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	3.00	EA	697.68	200.46	0.00	0.00	161.40	0.00	1,059.54
			28.60	*0.00*	*0.00*	*0.00*		*0.00*	*33.73*
HTW 025210105431 Cut Fishlock Brail in segments, thermic lance, sheet metal cutting with torch, downsizing, torch < 2" thick, includes changeout time	220.00	LF	6,291.00	0.00	0.00	0.00	1,130.49	0.00	7,421.49
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Brail segments, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	32.00	EA	7,441.92	2,138.27	0.00	0.00	1,721.56	0.00	11,301.75
			3.44	*0.00*	*0.00*	*0.00*		*0.00*	*4.06*
RSM 050505100070 Remove bolt/nut securing Fishlock Entrance Gate segments to 2" diameter, unbolt & remove, excl shoring, bracing, cutting, loading, hauling, dumping	50.00	EA	172.14	0.00	0.00	0.00	30.93	0.00	203.07
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 050505100260x1 Remove Fishlock Entrance Gate segments, to 10 tons, remove whole or cut up into smaller pieces, incl loading, excl shoring, bracing, cutting, hauling, dumping	6.00	EA	1,395.36	400.93	0.00	0.00	322.79	0.00	2,119.08
			23,412.58	*16,819.92*	*2,073.60*	*0.00*		*0.00*	*49,908.51*
0601441103 Demolition at Fishlock Approach Channel	**1.00**	**EA**	**23,412.58**	**16,819.92**	**2,073.60**	**0.00**	**7,602.41**	**0.00**	**49,908.51**
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100050 Selective concrete demolition, minimum reinforcing, break up into small pieces, excludes shoring, bracing, saw or torch cutting, loading, hauling, dumping	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 030505100150 Selective concrete demolition, up to 2 tons, remove whole pieces, incl loading, excludes shoring, bracing, saw or torch cutting, hauling, dumping	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			5.31	*4.67*	*0.64*	*0.00*		*0.00*	*12.52*
RSM 038116500820 Concrete sawing, concrete walls 6 & 15" thick deep, rod reinforcing, per inch of depth	3,240.00	LF	17,190.76	15,127.24	2,073.60	0.00	6,180.18	0.00	40,571.78
			232.56	*66.82*	*0.00*	*0.00*		*0.00*	*353.18*
USR 030505100270x2 Remove 6" & 15" thick wall panels previously sawcut and load on truck	8.00	EA	1,860.48	534.57	0.00	0.00	430.39	0.00	2,825.44

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,090.34	*289.53*	*0.00*	*0.00*		*0.00*	*1,627.82*
RSM 110505102854 Remove existing 48" x 48" Hydraulic Gates, canal, flap, knife, slide or sluice, 37" to 48" diameter, selective demolition	4.00	EA	4,361.34	1,158.11	0.00	0.00	991.85	0.00	6,511.30
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024119161050 Selective demolition, cutout, concrete, elevated slab, bar reinforced, over 6 C.F., excludes loading and disposal	0.00	CF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 024116174200 Bldg. footings and foundations demolition, add for disposal on site, excludes disposal costs and dump fees	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			19,314.82	*1,777.66*	*558.14*	*0.00*		*0.00*	*25,541.25*
0601441104 7' x 7' x 9' deep Cutout to Fishlock Approach Channel base slab	**1.00**	**EA**	**19,314.82**	**1,777.66**	**558.14**	**0.00**	**3,890.62**	**0.00**	**25,541.25**
			0.81	*0.49*	*0.50*	*0.00*		*0.00*	*2.13*
RSM 038113500400 Concrete sawing, concrete slabs, mesh reinforcing, up to 3" deep	28.00	LF	22.74	13.78	14.00	0.00	9.08	0.00	59.60
			0.50	*0.30*	*0.17*	*0.00*		*0.00*	*1.14*
RSM 038113500420 Concrete sawing, concrete, existing slab, mesh reinforcing, for each additional inch of depth over 3"	84.00	LF	41.78	25.33	14.28	0.00	14.63	0.00	96.02
			42.89	*3.80*	*0.00*	*0.00*		*0.00*	*55.08*
RSM 024119161050 Selective demolition of concrete base slab to expose 36" dia. pipe, bar reinforced, over 6 C.F., excludes loading and disposal	440.00	CF	18,873.39	1,670.03	0.00	0.00	3,691.66	0.00	24,235.08
			1.07	*0.00*	*0.23*	*0.00*		*0.00*	*1.53*
RSM 024119270020 Selective demolition, torch cutting, 36" dia steel pipe, 1/2" thick plate	18.00	LF	19.22	0.00	4.14	0.00	4.20	0.00	27.56
			26.05	*4.06*	*1.66*	*0.00*		*0.00*	*37.48*
RSM 050521902010 Welding 36" dia. steel pipe plug in field, 4 passes, 0.7 Lb/LF, 1/2" thick, continuous fillet, type 6011	9.40	LF	244.89	38.15	15.60	0.00	53.66	0.00	352.30
			3.54	*0.00*	*0.06*	*0.00*		*0.00*	*4.25*
RSM 050110516180 Metal cleaning, steel surface treatment, 500 - 900 SF/Day, wire brush, power tool (SSPC-SP3)	2.00	SF	7.09	0.00	0.12	0.00	1.29	0.00	8.50
			105.71	*30.37*	*510.00*	*0.00*		*0.00*	*762.18*
USR 051223650400x Insert shop fabricated 36" dia. steel pipe plug in existing pipe, 1/2" Thick plate, 10 SF	1.00	EA	105.71	30.37	510.00	0.00	116.10	0.00	762.18
			185.92	*6.38*	*328.05*	*0.00*		*0.00*	*613.86*
0601441105 Concrete Repair to 7' x 7' x 9' deep Cutout	**13.00**	**CY**	**2,416.99**	**82.95**	**4,264.63**	**0.00**	**1,215.59**	**0.00**	**7,980.16**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852400 C.I.P. concrete forms, wall, job built, plywood, over 8' to 16' high, 1 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.06	*0.00*	*2.36*	*0.00*		*0.00*	*13.48*
RSM 031113550020 C.I.P. concrete forms, mat foundation, plywood, 1 use, includes erecting, bracing, stripping and cleaning	126.00	SFC	1,142.07	0.00	297.36	0.00	258.67	0.00	1,698.10
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	1.00	TON	0.00	0.00	380.00	0.00	68.29	0.00	448.29
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110600700 Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	1.00	TON	34.75	4.43	0.00	0.00	7.04	0.00	46.23
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 032110600600 Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	0.00	TON	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			987.81	*0.00*	*760.00*	*0.00*		*0.00*	*2,061.89*
RSM 032110600500 Reinforcing Steel, in place, footings, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	1.00	TON	987.81	0.00	760.00	0.00	314.08	0.00	2,061.89
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	13.00	CY	0.00	0.00	1,410.50	0.00	253.47	0.00	1,663.97
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350400 Structural concrete, ready mix, normal weight, 5000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 033105350411 Structural concrete, ready mix, normal weight, 6000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	0.00	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			17.69	*6.04*	*0.00*	*0.00*		*0.00*	*27.99*
RSM 033105704650 Structural concrete, placing, slab on grade, pumped, over 6" thick, includes strike off & consolidation, excludes material	13.00	CY	229.91	78.52	0.00	0.00	55.43	0.00	363.86
			11.17	*0.00*	*16.93*	*0.00*		*0.00*	*33.15*
HNC 033923230205 Curing, burlap/poly blanket, 2 ply	0.37	CSF	4.13	0.00	6.27	0.00	1.87	0.00	12.27
			0.49	*0.00*	*0.00*	*0.00*		*0.00*	*0.58*
HNC 033529300010 Concrete finishing, floors, monolithic, screed finish	37.00	SF	18.31	0.00	0.00	0.00	3.29	0.00	21.60
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	13.00	CY	0.00	0.00	1,410.50	0.00	253.47	0.00	1,663.97
			840.93	*27.30*	*408.75*	*0.00*		*0.00*	*1,506.45*
0601441106 15" Thick CIP Wall Height Extension	**25.00**	**CY**	**21,023.31**	**682.38**	**10,218.73**	**0.00**	**5,736.82**	**0.00**	**37,661.24**
			0.00	*0.00*	*380.00*	*0.00*		*0.00*	*448.29*
RSM 032116100100 Epoxy coating, for reinforcing steel, add to fabricated & delivered price for coating with epoxy	2.20	TON	0.00	0.00	836.00	0.00	150.23	0.00	986.23
			34.75	*4.43*	*0.00*	*0.00*		*0.00*	*46.23*
RSM 032110602000 Reinforcing steel, unload and sort, add to base	2.20	TON	76.46	9.75	0.00	0.00	15.49	0.00	101.70
			691.47	*0.00*	*760.00*	*0.00*		*0.00*	*1,712.29*
RSM 032110600700 Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	2.50	TON	1,728.66	0.00	1,900.00	0.00	652.07	0.00	4,280.74
			7.10	*0.00*	*2.24*	*0.00*		*0.00*	*11.02*
RSM 031113852000 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 1 use, includes erecting, bracing, stripping and cleaning	1,332.00	SFC	9,462.88	0.00	2,983.68	0.00	2,236.65	0.00	14,683.21
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852050 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 031113852100 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 3 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
RSM 031113852150 C.I.P. concrete forms, wall, job built, plywood, to 8' high, 4 use, includes erecting, bracing, stripping and cleaning	0.00	SFC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.92	*0.00*	*1.31*	*0.00*		*0.00*	*13.25*
RSM 031113850500 C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning	25.00	LF	247.98	0.00	32.75	0.00	50.45	0.00	331.18
			2.96	*0.00*	*2.05*	*0.00*		*0.00*	*5.91*
HNC 032110602466 Reinforcing steel, in place, dowels, deformed, epoxy coated, 2' long, #6, A775, grade 60	148.00	EA	438.59	0.00	303.40	0.00	133.34	0.00	875.32
			27.26	*9.31*	*0.00*	*0.00*		*0.00*	*43.15*
RSM 033105705350 Structural concrete, placing, walls, pumped, 15" thick, includes strike off & consolidation, excludes material	25.00	CY	681.62	232.80	0.00	0.00	164.32	0.00	1,078.74
			0.00	*0.00*	*108.50*	*0.00*		*0.00*	*128.00*
RSM 033105350300 Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	25.00	CY	0.00	0.00	2,712.50	0.00	487.44	0.00	3,199.94
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 036305101545 Chemical anchoring, for fastener 1-3/4" diam x 12" embedment, incl epoxy cartridge, excl layout, drilling & fastener	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			30.64	*2.97*	*9.45*	*0.00*		*0.00*	*50.80*
RSM 050523151430 Chemical anchor, 3/4" dia x 9-1/2" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	148.00	EA	4,534.12	439.83	1,398.60	0.00	1,145.15	0.00	7,517.69
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 260533950520 Hole drilling, concrete wall, 12" thick, 3/4" pipe size, to 10' high	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			9.87	*0.00*	*0.11*	*0.00*		*0.00*	*11.78*
RSM 038216100500 Concrete impact drilling, for anchors, up to 4" D, 3/4" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	148.00	EA	1,461.48	0.00	16.28	0.00	265.55	0.00	1,743.32
			2.02	*0.00*	*0.03*	*0.00*		*0.00*	*2.42*
RSM 038216100550 Concrete impact drilling, for anchors, 3/4" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor, for each additional inch of depth, add	1,184.00	EA	2,391.52	0.00	35.52	0.00	436.14	0.00	2,863.18
			93,243.70	*7,084.98*	*25,320.96*	*0.00*		*0.00*	*148,228.91*
0601441107 Seal 8' x 8' Culvert Joints	**1.00**	**EA**	**93,243.70**	**7,084.98**	**25,320.96**	**0.00**	**22,579.27**	**0.00**	**148,228.91**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 050523151430 Chemical anchor, 3/4" dia x 9-1/2" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			22.22	*0.00*	*0.26*	*0.00*		*0.00*	*26.52*
USR 038216100300x1 Drill 1/2" Dia x 10" deep grout hole in concrete culvert walls, roof and floor, incl bit & layout	896.00	EA	19,907.78	0.00	232.96	0.00	3,619.30	0.00	23,760.04
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
RSM 036423100210 Crack repair, latex injection, 1/4" wide, 12" deep, includes chipping, sand blasting and cleaning	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			81.85	*7.91*	*28.00*	*0.00*		*0.00*	*138.92*
USR 036423100110x1 Joint sealing, epoxy injection, 12" deep, includes chipping, sand blasting and cleaning	896.00	EA	73,335.92	7,084.98	25,088.00	0.00	18,959.97	0.00	124,468.87
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 036423100110x2 Joint sealing, grout injection, 12" deep, includes chipping, sand blasting and cleaning	0.00	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	*0.00*	*488,000.00*	*0.00*		*0.00*	*488,000.00*
0601441108 Stop Logs	**1.00**	**EA**	**0.00**	**0.00**	**488,000.00**	**0.00**	**0.00**	**0.00**	**488,000.00**
USR Allowance for New Stop Logs	1.00	LS	0.00	0.00	488,000.00	0.00	0.00	0.00	488,000.00
			1,626.32	*73.21*	*3,034.00*	*6,000.00*		*0.00*	*10,733.53*
06014412 Fish Lock Maintenance Platform	**1.00**	**EA**	**1,626.32**	**73.21**	**3,034.00**	**6,000.00**	**0.00**	**0.00**	**10,733.53**
			0.00	*0.00*	*0.00*	*6,000.00*		*0.00*	*6,000.00*
0601441201 Concrete Maintenance Platform. #11	**1.00**	**SF**	**0.00**	**0.00**	**0.00**	**6,000.00**	**0.00**	**0.00**	**6,000.00**
			0.00	*0.00*	*0.00*	*15.00*		*0.00*	*15.00*
USR Allowance for concrete Maintenance Platform.	400.00	SF	0.00	0.00	0.00	6,000.00	0.00	0.00	6,000.00
			1,626.32	*73.21*	*3,034.00*	*0.00*		*0.00*	*4,733.53*
0601441202 Ladder #11	**1.00**	**EA**	**1,626.32**	**73.21**	**3,034.00**	**0.00**	**0.00**	**0.00**	**4,733.53**
			39.67	*1.79*	*74.00*	*0.00*		*0.00*	*115.45*
RSM 055133130020 Ladder, shop fabricated, steel, 20" W, bolted to concrete, incl cage	41.00	VLF	1,626.32	73.21	3,034.00	0.00	0.00	0.00	4,733.53
			72,313.20	*6,329.04*	*91,302.70*	*6,750.00*		*0.00*	*208,447.06*
06014414 Electrical	**1.00**	**EA**	**72,313.20**	**6,329.04**	**91,302.70**	**6,750.00**	**31,752.12**	**0.00**	**208,447.06**
			35,247.65	*3,493.04*	*55,885.00*	*0.00*		*0.00*	*111,629.94*
0601441301 Power From Existing Unit Substation	**1.00**	**EA**	**35,247.65**	**3,493.04**	**55,885.00**	**0.00**	**17,004.26**	**0.00**	**111,629.94**
			417.10	*0.00*	*3,525.00*	*0.00*		*0.00*	*4,650.50*
USR 262413401233X Install New CB in (E) USS, hic, 3 pole, to 600 V, 150 amp, for feeder section	1.00	EA	417.10	0.00	3,525.00	0.00	708.40	0.00	4,650.50

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			1,961.34	*235.04*	*15,000.00*	*0.00*		*0.00*	*20,286.58*
USR 262419300400X Motor control center, 400A, 480V, 3Ph/3W, incl Cir brkrs & NEMA-3R structures/enclosure	1.00	EA	1,961.34	235.04	15,000.00	0.00	3,090.19	0.00	20,286.58
			910.04	*0.00*	*3,000.00*	*0.00*		*0.00*	*4,612.68*
RSM 262213104900 Transformer, dry-type, 3 phase 480 V primary 120/208 V secondary, 15 kVA, K-13 rated	1.00	EA	910.04	0.00	3,000.00	0.00	702.63	0.00	4,612.68
			1,251.31	*0.00*	*1,200.00*	*0.00*		*0.00*	*2,891.81*
USR 262416302100x Panelboards, 3 phase 4 wire, mcb, 120/208 V, 100 amp, 30 circuits, incl breakers	1.00	EA	1,251.31	0.00	1,200.00	0.00	440.50	0.00	2,891.81
			24.06	*0.00*	*35.20*	*0.00*		*0.00*	*69.91*
USR 260533054150X 150A Feeder/RGS/PVC Coated, 2" C, to 20' high, incl terminations/supports & #1/0 wires	800.00	LF	19,250.85	0.00	28,160.00	0.00	8,519.74	0.00	55,930.59
			23.02	*7.24*	*10.00*	*0.00*		*0.00*	*47.49*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	450.00	LF	10,357.01	3,258.00	4,500.00	0.00	3,255.27	0.00	21,370.28
			1,100.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,887.52*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	1,100.00	0.00	500.00	0.00	287.52	0.00	1,887.52
			3,398.97	*200.00*	*3,775.50*	*1,500.00*		*0.00*	*10,469.22*
0601441302 Power for Trash Rake	**1.00**	**EA**	**3,398.97**	**200.00**	**3,775.50**	**1,500.00**	**1,594.74**	**0.00**	**10,469.22**
			83.42	*0.00*	*27.50*	*0.00*		*0.00*	*130.85*
RSM 260580102015 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 25 HP motor	1.00	EA	83.42	0.00	27.50	0.00	19.93	0.00	130.85
			589.90	*0.00*	*2,500.00*	*0.00*		*0.00*	*3,645.15*
HNC 262419409480 Combination starter and disconnect switch, non-reversing, size 2, 240 V- 600 V, NEMA 4	1.00	EA	589.90	0.00	2,500.00	0.00	555.26	0.00	3,645.15
			10.43	*0.00*	*10.80*	*0.00*		*0.00*	*25.04*
USR 260533054151x 40A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #8 wires	60.00	LF	625.65	0.00	648.00	0.00	228.88	0.00	1,502.53
			0.00	*0.00*	*0.00*	*0.00*		*0.00*	*0.00*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	0.00	LF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			600.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,297.67*
USR Electric connections to control equipment - allow	1.00	EA	600.00	0.00	500.00	0.00	197.67	0.00	1,297.67
			1,000.00	*200.00*	*0.00*	*1,500.00*		*0.00*	*3,185.19*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	200.00	0.00	1,500.00	485.19	0.00	3,185.19
			500.00	*0.00*	*100.00*	*0.00*		*0.00*	*707.82*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	500.00	0.00	100.00	0.00	107.82	0.00	707.82

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			6,328.12	*350.00*	*6,634.00*	*0.00*		*0.00*	*15,704.31*
0601441303 Power for Valve Operators	**1.00**	**EA**	**6,328.12**	**350.00**	**6,634.00**	**0.00**	**2,392.19**	**0.00**	**15,704.31**
			104.28	*0.00*	*350.00*	*0.00*		*0.00*	*535.91*
USR 260580102077X Valve/ctl connections, flexible conduit/ftgs, 3 phase, sealtite, 460 volt, to 2 HP motor	4.00	EA	417.10	0.00	1,400.00	0.00	326.53	0.00	2,143.64
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054122x 20A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	400.00	LF	4,171.02	0.00	4,084.00	0.00	1,483.43	0.00	9,738.45
(Note: 5HP motors & Valves connections)									
			640.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,344.86*
USR Electric connections to control equipment - allow	1.00	EA	640.00	0.00	500.00	0.00	204.86	0.00	1,344.86
			500.00	*350.00*	*500.00*	*0.00*		*0.00*	*1,592.60*
USR Cutting/Patching & core Drill - Allow	1.00	EA	500.00	350.00	500.00	0.00	242.60	0.00	1,592.60
			600.00	*0.00*	*150.00*	*0.00*		*0.00*	*884.78*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	600.00	0.00	150.00	0.00	134.78	0.00	884.78
			3,145.58	*250.00*	*3,136.30*	*1,000.00*		*0.00*	*8,885.37*
0601441304 Power for Hydraulic Power Units	**1.00**	**EA**	**3,145.58**	**250.00**	**3,136.30**	**1,000.00**	**1,353.48**	**0.00**	**8,885.37**
			62.57	*0.00*	*15.30*	*0.00*		*0.00*	*91.86*
RSM 260580102005 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 5 HP motor	1.00	EA	62.57	0.00	15.30	0.00	13.99	0.00	91.86
			390.27	*0.00*	*1,500.00*	*0.00*		*0.00*	*2,229.95*
HNC 262419409460 Combination starter and disconnect switch, non-reversing, size 0, 240 V- 600 V, NEMA 4	1.00	EA	390.27	0.00	1,500.00	0.00	339.68	0.00	2,229.95
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054122x 20A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	100.00	LF	1,042.75	0.00	1,021.00	0.00	370.86	0.00	2,434.61
(Note: 5HP motors & Valves connections)									
			500.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,179.70*
USR Electric connections to control equipment - allow	1.00	EA	500.00	0.00	500.00	0.00	179.70	0.00	1,179.70
			650.00	*250.00*	*0.00*	*1,000.00*		*0.00*	*2,241.43*
USR Cutting/Patching & core Drill - Allow	1.00	EA	650.00	250.00	0.00	1,000.00	341.43	0.00	2,241.43
			500.00	*0.00*	*100.00*	*0.00*		*0.00*	*707.82*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	500.00	0.00	100.00	0.00	107.82	0.00	707.82
			5,162.55	*250.00*	*6,183.10*	*1,000.00*		*0.00*	*14,859.09*
0601441305 Power for Siphon Priming Pumps	**1.00**	**EA**	**5,162.55**	**250.00**	**6,183.10**	**1,000.00**	**2,263.44**	**0.00**	**14,859.09**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			62.57	*0.00*	*15.30*	*0.00*		*0.00*	*91.86*
RSM 260580102005 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 5 HP motor	2.00	EA	125.13	0.00	30.60	0.00	27.98	0.00	183.72
			390.27	*0.00*	*1,500.00*	*0.00*		*0.00*	*2,229.95*
HNC 262419409460 Combination starter and disconnect switch, non-reversing, size 0, 240 V- 600 V, NEMA 4	2.00	EA	780.53	0.00	3,000.00	0.00	679.36	0.00	4,459.89
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054122x 20A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	250.00	LF	2,606.89	0.00	2,552.50	0.00	927.14	0.00	6,086.53
(Note: 5HP motors & Valves connections)									
			500.00	*0.00*	*500.00*	*0.00*		*0.00*	*1,179.70*
USR Electric connections to control equipment - allow	1.00	EA	500.00	0.00	500.00	0.00	179.70	0.00	1,179.70
			650.00	*250.00*	*0.00*	*1,000.00*		*0.00*	*2,241.43*
USR Cutting/Patching & core Drill - Allow	1.00	EA	650.00	250.00	0.00	1,000.00	341.43	0.00	2,241.43
			500.00	*0.00*	*100.00*	*0.00*		*0.00*	*707.82*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	500.00	0.00	100.00	0.00	107.82	0.00	707.82
			8,366.92	*1,436.00*	*7,038.80*	*3,250.00*		*0.00*	*23,702.21*
0601441306 Power for Bulkhead Crane	**1.00**	**EA**	**8,366.92**	**1,436.00**	**7,038.80**	**3,250.00**	**3,610.49**	**0.00**	**23,702.21**
			62.57	*0.00*	*15.30*	*0.00*		*0.00*	*91.86*
RSM 260580102010 Motor connections, flexible conduit and fittings, 3 phase, sealtite, 460 volt, 10 HP motor	1.00	EA	62.57	0.00	15.30	0.00	13.99	0.00	91.86
			528.55	*0.00*	*1,900.00*	*0.00*		*0.00*	*2,864.96*
HNC 262419409470 Combination starter and disconnect switch, non-reversing, size 1, 240 V- 600 V, NEMA 4	1.00	EA	528.55	0.00	1,900.00	0.00	436.41	0.00	2,864.96
			1,000.00	*0.00*	*1,000.00*	*0.00*		*0.00*	*2,359.40*
USR Electric connections to control equipment - allow	1.00	EA	1,000.00	0.00	1,000.00	0.00	359.40	0.00	2,359.40
			10.43	*0.00*	*10.21*	*0.00*		*0.00*	*24.35*
USR 260533054150x 30A Feeder/RGS/PVC Coated, 3/4" C, to 20' high, incl terminations/supports & #10 wires	350.00	LF	3,649.64	0.00	3,573.50	0.00	1,298.00	0.00	8,521.14
			11.51	*7.24*	*3.00*	*5.00*		*0.00*	*31.55*
USR 31231614075EX Excavating/ utility trench, asphalt/concrete, 36" deep, incl. cutting/backfill	150.00	LF	1,726.17	1,086.00	450.00	750.00	720.99	0.00	4,733.16
			1,000.00	*350.00*	*0.00*	*2,500.00*		*0.00*	*4,541.85*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	0.00	2,500.00	691.85	0.00	4,541.85
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	SubCMU	UserCost	CostToPrime
			3,902.61	*350.00*	*5,050.00*	*0.00*		*0.00*	*10,974.29*
0601441307 Relocate Electrical Panel at Fence	**1.00**	**EA**	**3,902.61**	**350.00**	**5,050.00**	**0.00**	**1,671.68**	**0.00**	**10,974.29**
			2,502.61	*0.00*	*3,950.00*	*0.00*		*0.00*	*7,612.15*
USR 262416302770x Dsconnect/relocate existing electrical pullbox/panel near fence	1.00	EA	2,502.61	0.00	3,950.00	0.00	1,159.54	0.00	7,612.15
			1,000.00	*350.00*	*1,000.00*	*0.00*		*0.00*	*2,772.30*
USR Cutting/Patching & core Drill - Allow	1.00	EA	1,000.00	350.00	1,000.00	0.00	422.30	0.00	2,772.30
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85
			1,964.13	*0.00*	*3,600.00*	*0.00*		*0.00*	*6,564.01*
0601441308 Modify Electrical Security System at Fence	**1.00**	**EA**	**1,964.13**	**0.00**	**3,600.00**	**0.00**	**999.88**	**0.00**	**6,564.01**
			1,564.13	*0.00*	*3,500.00*	*0.00*		*0.00*	*5,974.16*
USR 262416302798x Modify electrical at Security fence	1.00	EA	1,564.13	0.00	3,500.00	0.00	910.03	0.00	5,974.16
			400.00	*0.00*	*100.00*	*0.00*		*0.00*	*589.85*
USR Startup, Testing/Demostration/Lebeling Electrical Systems - Allow	1.00	EA	400.00	0.00	100.00	0.00	89.85	0.00	589.85
			4,171.02	*0.00*	*0.00*	*0.00*		*0.00*	*4,920.55*
0601441309 Demo Existing Electrical at Existing FCQ7 - MCC	**1.00**	**EA**	**4,171.02**	**0.00**	**0.00**	**0.00**	**749.53**	**0.00**	**4,920.55**
			4.17	*0.00*	*0.00*	*0.00*		*0.00*	*4.92*
USR 260505100101X Disconnect/Remove fdr/circuit, from (E) MCC FCQ7 to 1"C GRS, incl fittings/hangers & conductors	1,000.00	LF	4,171.02	0.00	0.00	0.00	749.53	0.00	4,920.55
(Note: 42 in & 18" fill valves connect to existing FCQ7, Sheet 33)									
			625.65	*0.00*	*0.00*	*0.00*		*0.00*	*738.08*
0601441310 Disconnect/Demo Electrical circuits to Control House	**1.00**	**EA**	**625.65**	**0.00**	**0.00**	**0.00**	**112.43**	**0.00**	**738.08**
			625.65	*0.00*	*0.00*	*0.00*		*0.00*	*738.08*
USR 260505100999X Disconnect/Remove electrical circuits to Control House incl fittings/hangers & conductors	1.00	LF	625.65	0.00	0.00	0.00	112.43	0.00	738.08

Description	UOM	Quantity	LaborCost	EQCost	MatlCost	DirectCost
Itemized Field OH						

Description	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Subcontracted Work					
Prime Contractor	691,534.72	107,152.53	4,438,687.80	95,000.00	5,332,375.05
Prime's Self Perform Over Water Work, Used to apply LS&H	1,990.24	579.05	1,381,400.00	0.00	1,383,969.29
Demolition	72,793.27	28,405.79	3,175.13	0.00	104,374.19
Marine Work	65,607.57	105,675.17	14,400.00	0.00	185,682.75
Diver Crew	308,381.72	7,487.35	28,210.00	0.00	344,079.07
Concrete	124,915.03	8,064.94	43,222.36	0.00	176,202.33
Electrical	72,313.20	6,329.04	91,302.70	6,750.00	176,694.94
Concrete Mining & Grouting	96,107.70	10,025.99	8,150.00	115,500.00	229,783.69

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
Labor												
				32.7500	*0.0000*		*15.2800*			*0.0000*	*0.0000*	*48.0300*
MIL B-BRKLAYR Bricklayers	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				25.7500	*0.0000*		*11.2500*			*0.0000*	*0.0000*	*37.0000*
MIL B-BRKLAYRH Bricklayers, (Semi-Skilled) (Laborer)	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				32.0400	*0.0000*		*14.1800*			*0.0000*	*0.0000*	*55.5463*
MIL B-CARPNTER Carpenters	LaborCost1	Journeyman	583.8598	18,706.87	0.00	0.00	8,279.13	3,290.67	2,184.33	0.00	0.00	32,461.00
				33.6400	*0.0000*		*14.1800*			*0.0000*	*0.0000*	*47.8200*
MIL B-CARPNTER Carpenters	LaborCost1	Foreman	33.0306	1,111.15	0.00	0.00	468.37	192.61	127.98	0.00	0.00	1,900.11
				29.0500	*0.0000*		*17.5900*			*0.0000*	*0.0000*	*55.6731*
MIL B-CEMTFINR Cement Finishers	LaborCost1	Journeyman	20.0866	583.52	0.00	0.00	353.32	114.24	67.21	0.00	0.00	1,118.28
				37.0500	*0.0000*		*17.4100*			*0.0000*	*0.0000*	*54.4600*
MIL B-ELECTRN Electricians	LaborCost1	Journeyman	737.2790	27,316.19	0.00	0.00	12,836.03	4,896.16	1,079.67	0.00	0.00	46,128.05
				40.7550	*0.0000*		*17.4100*			*0.0000*	*0.0000*	*66.8685*
MIL B-ELECTRN Electricians	LaborCost1	Foreman	19.7186	803.63	0.00	0.00	343.30	139.86	31.76	0.00	0.00	1,318.56
				35.6400	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*47.7200*
MIL B-EQOPRCRN Equip. Operators, Heavy	LaborCost1	Journeyman	1,056.0483	37,637.56	0.00	0.00	12,757.06	6,145.12	2,246.67	0.00	0.00	58,786.42
				36.6400	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*63.3314*
MIL B-EQOPRCRN Equip. Operators, Heavy	LaborCost1	Foreman	220.3880	8,075.02	0.00	0.00	2,662.29	1,309.31	1,910.87	0.00	0.00	13,957.48
				32.6000	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*53.8830*
MIL B-EQOPRLT Equip. Operators, Light	LaborCost1	Journeyman	941.0196	30,677.24	0.00	0.00	11,367.52	5,126.94	3,459.16	0.00	0.00	50,630.85
				36.6500	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*48.7300*
MIL B-EQOPRMED Equip. Operators, Medium	LaborCost1	Journeyman	54.2288	1,987.49	0.00	0.00	655.08	13.24	9.41	0.00	0.00	2,665.22
				29.6100	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*41.6900*

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
MIL B-EQOPROIL Equip. Operators, Oilers / Grade Checker	LaborCost1	Journeyman	509.9719	15,100.27	0.00	0.00	6,160.46	2,592.53	941.98	0.00	0.00	24,795.25
				28.5500	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*40.6200*
MIL B-LABORER Laborers, (Semi-Skilled)	LaborCost1	Journeyman	5,436.3768	155,208.56	0.00	0.00	65,617.07	26,669.91	13,335.45	0.00	0.00	260,830.99
				29.5500	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*41.6200*
MIL B-LABORER Laborers, (Semi-Skilled)	LaborCost1	Foreman	1,329.7281	39,293.47	0.00	0.00	16,049.82	6,484.65	2,959.77	0.00	0.00	64,787.71
				24.7600	*0.0000*		*12.0700*			*0.0000*	*0.0000*	*48.0558*
MIL B-LABORERG Laborers, General (Lowest paid)	LaborCost1	Journeyman	3.4000	84.18	0.00	0.00	41.04	15.27	22.90	0.00	0.00	163.39
				36.3900	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*57.3242*
MIL B-MILLWRT Millwrights	LaborCost1	Journeyman	250.0000	9,097.50	0.00	0.00	3,270.00	1,508.09	455.47	0.00	0.00	14,331.06
				37.9900	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*59.1994*
MIL B-MILLWRT Millwrights	LaborCost1	Foreman	125.0000	4,748.75	0.00	0.00	1,635.00	778.43	237.75	0.00	0.00	7,399.93
				19.5900	*0.0000*		*7.2400*			*0.0000*	*0.0000*	*35.4301*
MIL B-PAINTSS Painters, Structural Steel	LaborCost1	Journeyman	0.2000	3.92	0.00	0.00	1.45	0.65	1.07	0.00	0.00	7.09
				36.6900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*65.5406*
MIL B-PLUMBER Plumbers	LaborCost1	Journeyman	3,735.7967	137,066.38	0.00	0.00	75,052.16	25,865.73	6,862.23	0.00	0.00	244,846.50
				22.3809	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*48.7703*
MIL B-PLUMBER Plumbers	LaborCost1	Apprentice	1,529.1035	34,222.71	0.00	0.00	30,719.69	7,919.08	1,713.36	0.00	0.00	74,574.84
				39.9900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*69.4083*
MIL B-PLUMBER Plumbers	LaborCost1	Foreman	3.3333	133.30	0.00	0.00	66.97	24.42	6.67	0.00	0.00	231.36
				36.6200	*0.0000*		*17.4000*			*0.0000*	*0.0000*	*64.8249*
MIL B-RODMAN Rodmen, (Reinforcing)	LaborCost1	Journeyman	97.6945	3,577.57	0.00	0.00	1,699.88	643.53	412.05	0.00	0.00	6,333.04
				38.6200	*0.0000*		*17.4000*			*0.0000*	*0.0000*	*67.2991*
MIL B-RODMAN Rodmen, (Reinforcing)	LaborCost1	Foreman	12.2560	473.33	0.00	0.00	213.25	83.72	54.52	0.00	0.00	824.82

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
				32.2200	*0.0000*		*13.0800*			*0.0000*	*0.0000*	*52.4370*
MIL B-SKILLWKR Skilled Workers	LaborCost1	Journeyman	541.3405	17,441.99	0.00	0.00	7,080.73	2,990.30	965.23	0.00	0.00	28,478.25
				36.6900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*65.5406*
MIL B-STM/PIPE Steam/Pipefitters	LaborCost1	Journeyman	772.7858	28,353.51	0.00	0.00	15,525.27	5,350.58	1,419.52	0.00	0.00	50,648.88
				39.9900	*0.0000*		*20.0900*			*0.0000*	*0.0000*	*69.4083*
MIL B-STM/PIPE Steam/Pipefitters	LaborCost1	Foreman	601.6527	24,060.09	0.00	0.00	12,087.20	4,407.80	1,204.57	0.00	0.00	41,759.66
				33.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*53.2200*
MIL B-STRSTEEL Structural Steel Workers	LaborCost1	Journeyman	387.4291	13,025.37	0.00	0.00	7,593.61	2,514.28	1,788.63	0.00	0.00	24,921.89
				35.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*55.2200*
MIL B-STRSTEEL Structural Steel Workers	LaborCost1	Foreman	156.4673	5,573.36	0.00	0.00	3,066.76	1,053.58	642.93	0.00	0.00	10,336.63
				23.7900	*0.0000*		*6.5300*			*0.0000*	*0.0000*	*40.4881*
MIL B-TRKDVRLT Truck Drivers, Light	LaborCost1	Journeyman	292.5372	6,959.46	0.00	0.00	1,910.27	1,081.57	1,892.97	0.00	0.00	11,844.28
				33.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*53.2200*
MIL B-WELDERS Welders, Structural Steel	LaborCost1	Journeyman	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				35.6200	*0.0000*		*19.6000*			*0.0000*	*0.0000*	*63.7368*
MIL B-WELDERS Welders, Structural Steel	LaborCost1	Foreman	53.4432	1,903.65	0.00	0.00	1,047.49	359.86	122.33	0.00	0.00	3,433.32
				29.6100	*0.0000*		*12.0800*			*0.0000*	*0.0000*	*53.7806*
MIL X-EQOPROIL Outside Equip. Oilers / Grade Checker	LaborCost1	Journeyman	220.3880	6,525.69	0.00	0.00	2,662.29	1,120.38	1,544.24	0.00	0.00	11,852.60
				200.0000	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*200.0000*
USR 5Diver 5 man Diving Crew - Cost per Manhour	LaborCost1	Journeyman	1,507.8564	301,571.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	301,571.28
				50.9600	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*69.2332*
USR MD&BL0020 Licensed Boat Captain Class C, Tender Tug	LaborCost1	Journeyman	220.3880	11,230.97	0.00	0.00	0.00	1,369.50	2,657.70	0.00	0.00	15,258.17
				43.4400	*0.0000*		*0.0000*			*0.0000*	*0.0000*	*59.0167*

Description	LaborRate	LaborType	ManHours	BaseWage	Travel	Overtime	TaxableFringe	Payroll	WCI	NonTaxFringe	Subsistence	Total
USR MD&BL0021 Deckhand Tender Tug	LaborCost1	Journeyman	220.3880	9,573.65	0.00	0.00	0.00	1,167.41	2,265.51	0.00	0.00	13,006.58

Description	EQHours	Total
Equipment		
AIR COMPRESSOR, 100 CFM, 125 PSI (ADD HOSE)	84.5067	739.31
AIR COMPRESSOR, 175 CFM (5 CMM), 100 PSI (689 KPA) (ADD HOSE)	401.4778	5,995.38
AIR COMPRESSOR, 250 CFM (7 CMM), 100 PSI (689 KPA) (ADD HOSE)	369.0667	6,909.30
AIR HOSE, 1.5" (38 MM) DIA x 100' (31 M) LENGTH, HARDROCK (USE AS DRILLING ACCESSORY)	738.1333	1,446.08
AIR HOSE, 1.50", 100', HARDROCK	169.0134	331.11
BARGE MOUNTED CRANE, 150 TON, 150' BOOM, FOR LIFTING	220.3880	68,227.72
BUCKET, CONCRETE, GENERAL PURPOSE, 1.0 CY (0.8 M3)	104.0000	96.62
BUCKET, CONCRETE, LOW SLUMP, 6.0 CY, AIR GATE	52.0000	441.37
BUCKET, DRAGLINE, 5.0 CY, MEDIUM WEIGHT	0.0000	0.00
CHAIN HOIST (MANUAL)	1,203.3053	3,585.85
CHAIN HOIST, MANUAL, 10 TON (9.1 MT)	0.0000	0.00
CONCRETE MIXER, STATIONARY CONCRETE DISPENSER, 15 CY/HR (11.5 M3/HR), 2 CY (1.5 M3) HOPPER	401.4778	4,030.61
CONCRETE PUMP, PUMP & BOOM, 117 CY/HR (89 M3/HR), 75' (23 M) BOOM, TRUCK MOUNTED	54.2288	7,247.22
CONCRETE SAW, RAIL SAW, 15.5" (394 MM) DEPTH, WALL (ADD 250 CFM (7 CMM) COMPRESSOR & COST FOR SAWBLADE WEAR)	291.0857	3,829.27
CONCRETE SAW, 13" (330 MM) DEPTH, SELF PROPELLED (ADD WATER AND COST FOR SAWBLADE WEAR)	1.4515	26.54
CONCRETE VIBRATOR, 2.5" (63.5 MM) DIA, W/7.5 HP (5.6 KW) GENERATOR	4.4577	13.46
CRANE, HYDRAULIC, SELF-PROPELLED, ROUGH TERRAIN, 30 TON (27 MT), 80' (24.4 M) BOOM, 4X4	114.0000	8,251.53
CRANE, HYDRAULIC, SELF-PROPELLED, YARD, 9 TON (8 MT), 44' (13.4 M) BOOM, 4X4	6.2500	235.04
CRANE, HYDRAULIC, TRUCK MOUNTED, 14 TON (12.7 MT), 80' (24.4 M) BOOM, 6X4	300.8263	15,485.61
CRANE, HYDRAULIC, TRUCK MOUNTED, 25 TON (22.7 MT), 80' (24.4 M) BOOM, 6X4	0.2560	14.18
CRANE, HYDRAULIC, TRUCK MOUNTED, 90 TON (81.6 MT), 114' (34.7 M) BOOM, 8X4	506.0349	67,627.49
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, LIFTING, 25 TON (23 MT), 50' (15.2 M) BOOM	0.0000	0.00
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 2.5 CY (1.9 M3), 60 TON (54 MT), 50' (15.2 M) BOOM (ADD BUCKET)	0.0000	0.00
CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 3.0 CY (2.3 M3), 75 TON (68 MT), 100' (30.5 M) BOOM (ADD BUCKET)	3.6810	581.97
CRANE, MECHANICAL, LATTICE BOOM, TRUCK MOUNTED, 125 TON (113 MT), 240' (73.2 M) BOOM	0.0000	0.00
CRANES, HYDRAULIC, TRUCK MTD, 14 TON, 80' BOOM, 6X4	125.0000	9,775.95
CRANES, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 5.0 CY, 130' BOOM (ADD BUCKET)	0.0000	0.00
DRILL, BREAKER, 12 LB (5 KG), AIR (ADD 100 CFM (2.8 CMM) COMPRESSOR)	84.5067	60.43
DRILL, CORE, 1"-8" DIA (25-203 MM), W/STAND (ADD PUMP)	0.0000	0.00

Description	EQHours	Total
DRILL, CORE, COLUMN MOUNTED, 9"-36" (229-914 MM) DIA, W/STAND AND HYDRAULIC POWER PACK (ADD COST FOR DRILL STEEL AND BIT WEAR)	59.8519	600.30
GENERATOR SET, SKID MOUNTED, 125 KW, VARIABLE POWER SETTINGS, RECONNECTIBLE	172.8000	5,592.07
IMPACT WRENCH (AIR, 300-	80.0000	111.20
JACKS, HYDRAULIC, 100 TON (90.7 MT)	36.0000	42.48
LOADER/BACKHOE, WHEEL, 0.80 CY (0.6 M3) FRONT END BUCKET, 9.8' (3.0 M) DEPTH OF HOE, 24" (0.61 M) DIPPER, 4X4	0.0000	0.00
PAVING BREAKER, 66 LB (30 KG) (ADD 100 CFM (2.8 CMM) COMPRESSOR)	738.1333	399.63
PUMP, PRESSURE GROUT/MUD JACK, 250 CF/HR (7.1 M3/HR), PUMP, GROUT-MUD JACK-SHOTCRETE, HIGH PRESSURE DUAL CYLINDER GROUT PUMP, 250 CF/HR (7.1 M3/HR), 0-250 PSI (0-1,723 KPA) , TRAILER MTD, W/120 GAL (454 L) HOPPER, 90 GAL (341 L) MIXER & 2" (50.8 MM) HOSE	6.0000	172.15
TORCH, OXYGEN/ACETYLENE, W/TANKS & HOSES	50.0250	91.05
TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE	0.0000	0.00
TRENCHER, CHAIN TYPE CUTTER, 48" (1.2 M) DEPTH x 16" (406 MM) WIDTH, 2WD, WALK-BEHIND	235.0045	1,937.13
TRUCK OPTION, FLATBED, 8' (2.4 M) x 16' (4.9 M) (ADD 25,000 LB (11,340 KG) GVW TRUCK)	174.2515	185.06
TRUCK OPTION, FLATBED, 8' (2.4 M) x 20' (6.1 M) (ADD 25,000 LB (11,340 KG) GVW TRUCK)	118.2857	150.95
TRUCK, HIGHWAY, 25,000 LB (11,340 KG) GVW, 4X2, 2 AXLE (ADD ACCESSORIES)	292.5372	11,213.89
WATER TANK, 500 GAL (1,893 L) PORTABLE	292.5372	769.37
WELDER, ELECTRIC DRIVEN, 300 AMP, SKID MOUNTED	1,483.4368	2,273.06
WELDER, ENGINE DRIVEN, DIESEL, 300 AMP, TRAILER MOUNTED	21.3392	238.14
WELDER, ENGINE DRIVEN, GAS, 200 AMP, TRAILER MOUNTED	477.8077	3,387.02
WORK BARGE, FLAT DECK, 2000 TON WITH RAMP	220.3880	3,873.55
WORK TUG, under 500 HP	220.3880	33,573.91

Description	DirectWork	JOOH	HOOH	Profit	Bond	Allowance	ContractMarkup	ContractorCost
Mark up Report								
	8,057,088.96	*10.00%*	*5.00%*	*7.52%*	*0.79%*	*0.00%*	*25.17*	*10,084,990.69*
Prime Contractor	**8,057,088.96**	**805,708.90**	**443,139.89**	**699,806.52**	**79,246.42**	**0.00**	**2,027,901.73**	**10,084,990.69**
		10.00%	*5.00%*	*7.52%*	*0.79%*	*0.00%*		
Own Work	5,332,375.05	533,237.51	293,280.63	463,148.77	52,447.18	0.00		
		10.00%	*5.00%*	*7.52%*	*0.79%*	*0.00%*		
Subcontracted Work	2,724,713.91	272,471.39	149,859.26	236,657.75	26,799.23	0.00		
	1,383,969.29	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*1,383,969.29*
Prime's Self Perform Over Water Work, Used to apply LS&H	**1,383,969.29**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1,383,969.29**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	1,383,969.29	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	104,374.19	*3.00%*	*5.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*123,130.25*
Demolition	**104,374.19**	**3,131.23**	**5,375.27**	**9,030.46**	**1,219.11**	**0.00**	**18,756.06**	**123,130.25**
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	104,374.19	3,131.23	5,375.27	9,030.46	1,219.11	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	185,682.75	*5.00%*	*5.00%*	*10.00%*	*1.00%*	*0.00%*	*22.49*	*227,438.62*
Marine Work	**185,682.75**	**9,284.14**	**9,748.34**	**20,471.52**	**2,251.87**	**0.00**	**41,755.87**	**227,438.62**
		5.00%	*5.00%*	*10.00%*	*1.00%*	*0.00%*		
Own Work	185,682.75	9,284.14	9,748.34	20,471.52	2,251.87	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	344,079.07	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*344,079.07*
Diver Crew	**344,079.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**344,079.07**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	344,079.07	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	176,202.33	*3.00%*	*5.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*207,865.93*
Concrete	**176,202.33**	**5,286.07**	**9,074.42**	**15,245.03**	**2,058.08**	**0.00**	**31,663.59**	**207,865.93**
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	176,202.33	5,286.07	9,074.42	15,245.03	2,058.08	0.00		

Description	DirectWork	JOOH	HOOH	Profit	Bond	Allowance	ContractMarkup	ContractorCost
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	0.00	*3.00%*	*5.00%*	*10.00%*	*1.00%*	*0.00%*	*0.00*	*0.00*
Fencing	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		3.00%	*5.00%*	*10.00%*	*1.00%*	*0.00%*		
Own Work	0.00	0.00	0.00	0.00	0.00	0.00		
		3.00%	*5.00%*	*8.00%*	*1.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	176,694.94	*5.00%*	*3.00%*	*8.00%*	*1.00%*	*0.00%*	*17.97*	*208,447.06*
Electrical	**176,694.94**	**8,834.75**	**5,565.89**	**15,287.65**	**2,063.83**	**0.00**	**31,752.12**	**208,447.06**
		5.00%	*3.00%*	*8.00%*	*1.00%*	*0.00%*		
Own Work	176,694.94	8,834.75	5,565.89	15,287.65	2,063.83	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	229,783.69	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00*	*229,783.69*
Concrete Mining & Grouting	**229,783.69**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**229,783.69**
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Own Work	229,783.69	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		
	0.00	*5.00%*	*0.00%*	*8.00%*	*0.00%*	*0.00%*	*0.00*	*0.00*
Shop Fab Contractor	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		5.00%	*0.00%*	*8.00%*	*0.00%*	*0.00%*		
Own Work	0.00	0.00	0.00	0.00	0.00	0.00		
		0.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*		
Subcontracted Work	0.00	0.00	0.00	0.00	0.00	0.00		

Abbreviated Risk Analysis

The Dalles EFL AWS Alt. 11 Siphon w intake tower
EDR - Pre Feasibility

Meeting Date: 10-Jan-12

PDT Members (Typical Recommended)

Project Management:	Ron Mason
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
Engineering & Design:	Pete Gaby
Cost Engineering:	R Hannan
Construction:	NAME
Operations:	NAME

Abbreviated Risk Analysis

Project (less than $40M): **The Dalles EFL AWS Alt. 11 Siphon w intake tower**
Project Development Stage: EDR - Pre Feasibility

Total Construction Contract Cost = $ 10,084,991

	WBS	Potential Risk Areas	Contract Cost	% Contingency	$ Contingency	Total
1	06 01 FISH FACILITIES AT DAMS	foundation prep	$ 81,360	31.25%	$ 25,425	$ 106,785
2	06 01 FISH FACILITIES AT DAMS	Intake Tower	$ 2,331,656	50.00%	$ 1,165,828	$ 3,497,484
3	06 01 FISH FACILITIES AT DAMS	Trash rack Alt #11	$ 1,077,564	29.17%	$ 314,289	$ 1,391,853
4	06 01 FISH FACILITIES AT DAMS	Trash removal system Alt #11	$ 364,203	22.92%	$ 83,463	$ 447,666
5	06 01 FISH FACILITIES AT DAMS	Concrete Mining	$ 144,570	31.25%	$ 45,178	$ 189,749
6	06 01 FISH FACILITIES AT DAMS	72" pipe	$ 331,808	25.00%	$ 82,952	$ 414,761
7	06 01 FISH FACILITIES AT DAMS	Pipe Installation	$ 934,602	27.08%	$ 253,121	$ 1,187,724
8	06 01 FISH FACILITIES AT DAMS	Valves	$ 1,695,240	31.25%	$ 529,763	$ 2,225,003
9	06 01 FISH FACILITIES AT DAMS	Pipe filling system	$ 177,631	14.58%	$ 25,905	$ 203,536
10	06 01 FISH FACILITIES AT DAMS	Operations & Maint	$ -	0.00%	$ -	$ -
11	06 01 FISH FACILITIES AT DAMS	Valve Room Modification	$ 1,664,397	56.25%	$ 936,223	$ 2,600,620
12	06 01 FISH FACILITIES AT DAMS	Approach Channel & Fish Lock Mod.	$ 1,021,048	37.50%	$ 382,893	$ 1,403,940
13	06 01 FISH FACILITIES AT DAMS	Electrical	$ 260,911	0.00%	$ -	$ 260,911
14	30 PLANNING, ENGINEERING, AND DESIGN		$ -	0.00%	$ -	$ -
15	31 CONSTRUCTION MANAGEMENT	Construction Management	$ -	0.00%	$ -	$ -

Totals	Contract Cost	% Contingency	$ Contingency	Total
Total Construction Estimate	$ 10,084,991	38.13%	$ 3,845,041	$ 13,669,120
Total Planning, Engineering & Design	$ -	0.00%	$ -	$ -
Total Construction Management	$ -	0.00%	$ -	$ -
Total	$ 10,084,991		$ 3,845,041	$ 13,669,120

The Dalles EFL AWS Alt. 11 Siphon w intake tower

EDR - Pre Feasibility

Abbreviated Risk Analysis

Meeting Date: 10-Jan-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	foundation prep	Foundation condition - equipment costs - weather issues	Properties of embankment unknown - In-water work period during worst part of year.	LIKELY	Marginal	2
PS-2	Intake Tower	Design not completed	Just an initial set of assumptions	Unlikely	Significant	3
PS-3	Trash rack Alt #11	No known supplier used cost form different system	Cost not well known	Unlikely	Significant	3
PS-4	Trash removal system Alt #11	Criterial not well defined yet	demolition or support of control building may be required	Unlikely	Significant	3
PS-5	Concrete Mining	Pipe cost can change - availability unknown	No contact with suppliers since 2010	Very LIKELY	Marginal	3
PS-6	72" pipe	Several problems may arrise that have not been identified	Access - man hrs required for in-water installation	LIKELY	Marginal	2
PS-7	Pipe Installation	Preliminary Design - valves still need design work	Final design not known but probably will not change much	Very LIKELY	Marginal	3
PS-8	Valves	No design - Just a guess	Not sure what this looks like yet	Unlikely	Critical	3
PS-9	Pipe filling system	No information on how this is done	No information	Very LIKELY	Marginal	3
PS-10	Operations & Maint			Very Unlikely	Negligible	0
PS-11	Valve Room Modification	Confined work area with limited access and complicated pipe layout		Very LIKELY	Significant	4
PS-12	Approach Channel & Fish Lock Mod.	Confined work area with limited access and incomplete design		Very Unlikely	Significant	1
PS-13				Very Unlikely	Negligible	0
PS-14	Construction Management			Very Unlikely	Negligible	0

Acquisition Strategy

AS-1	foundation prep	Design/bid/build		Unlikely	Marginal	1
AS-2	Intake Tower	Design/bid/build		Unlikely	Marginal	1
AS-3	Trash rack Alt #11	Design/bid/build		Unlikely	Marginal	1
AS-4	Trash removal system Alt #11	Design/bid/build		Unlikely	Marginal	1
AS-5	Concrete Mining	Design/bid/build		Unlikely	Marginal	1
AS-6	72" pipe	Design/bid/build		Unlikely	Marginal	1
AS-7	Pipe Installation	Design/bid/build		Unlikely	Marginal	1
AS-8	Valves	Design/bid/build		Unlikely	Marginal	1
AS-9	Pipe filling system	Design/bid/build		Unlikely	Marginal	1
AS-10	Operations & Maint			Very Unlikely	Negligible	0
AS-11	Valve Room Modification	Availability of Valves		Very LIKELY	Critical	5
AS-12	Approach Channel & Fish Lock Mod.	Availability of Gates		Very Unlikely	Critical	2
AS-13				Very Unlikely	Negligible	0
AS-14	Construction Management			Very Unlikely	Negligible	0

Construction Complexity						
CC-1	foundation prep	In-Water work	lots of unknowns - weather	LIKELY	Critical	5
CC-2	Intake Tower	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-3	Trash rack Alt #11	In-Water work	lots of unknowns - weather	LIKELY	Significant	4
CC-4	Trash removal system Alt #11	specialty sub contractor needed		LIKELY	Marginal	2
CC-5	Concrete Mining			LIKELY	Critical	5
CC-6	72" pipe	In-Water work required and pipe grouting		LIKELY	Marginal	2
CC-7	Pipe Installation			LIKELY	Significant	4
CC-8	Valves			Very Unlikely	Significant	1
CC-9	Pipe filling system			LIKELY	Marginal	2
CC-10	Operations & Maint			Very Unlikely	Negligible	0
CC-11	Valve Room Modification	Limited access		Very LIKELY	Significant	4
CC-12	Approach Channel & Fish Lock Mod.	limited access		Very LIKELY	Significant	4
CC-13				Very Unlikely	Negligible	0
CC-14	Construction Management			Very Unlikely	Negligible	0

Volatile Commodities						
VC-1	foundation prep			Unlikely	Negligible	0
VC-2	Intake Tower			Unlikely	Significant	3
VC-3	Trash rack Alt #11			Unlikely	Significant	3
VC-4	Trash removal system Alt #11			Unlikely	Marginal	1
VC-5	Concrete Mining			Unlikely	Marginal	1
VC-6	72" pipe			LIKELY	Marginal	2
VC-7	Pipe Installation			Unlikely	Marginal	1
VC-8	Valves			Unlikely	Critical	3
VC-9	Pipe filling system			Unlikely	Negligible	0
VC-10	Operations & Maint			Very Unlikely	Negligible	0
VC-11	Valve Room Modification	Metal Valves		Very LIKELY	Significant	4
VC-12	Approach Channel & Fish Lock Mod.	Metal Gates		Very LIKELY	Significant	4
VC-13				Very Unlikely	Negligible	0
VC-14	Construction Management			Very Unlikely	Negligible	0

Quantities						
Q-1	foundation prep			LIKELY	Marginal	2
Q-2	Intake Tower			Unlikely	Significant	3
Q-3	Trash rack Alt #11			Unlikely	Marginal	1
Q-4	Trash removal system Alt #11			Very Unlikely	Marginal	0
Q-5	Concrete Mining			Very Unlikely	Marginal	0
Q-6	72" pipe			Very Unlikely	Negligible	0
Q-7	Pipe Installation			Very Unlikely	Marginal	0
Q-8	Valves			Very Unlikely	Critical	2
Q-9	Pipe filling system			Unlikely	Negligible	0
Q-10	Operations & Maint			Very Unlikely	Negligible	0
Q-11	Valve Room Modification	Amount of pipe required		Very LIKELY	Marginal	3
Q-12	Approach Channel & Fish Lock Mod.	size of gates		Very Unlikely	Negligible	0
Q-13				Very Unlikely	Negligible	0
Q-14	Construction Management			Very Unlikely	Negligible	0

Fabrication & Project Installed Equipment						
FI-1	foundation prep			Very Unlikely	Negligible	0
FI-2	Intake Tower			Unlikely	Significant	3
FI-3	Trash rack Alt #11			Unlikely	Marginal	1
FI-4	Trash removal system Alt #11			Very LIKELY	Marginal	3
FI-5	Concrete Mining			Very Unlikely	Negligible	0
FI-6	72" pipe			Unlikely	Significant	3
FI-7	Pipe Installation			Very Unlikely	Negligible	0
FI-8	Valves			Unlikely	Significant	3
FI-9	Pipe filling system			LIKELY	Negligible	1
FI-10	Operations & Maint			Very Unlikely	Negligible	0
FI-11	Valve Room Modification	Complicated Pipeing		LIKELY	Significant	4
FI-12	Approach Channel & Fish Lock Mod.	Limited access		LIKELY	Significant	4
FI-13				Very Unlikely	Negligible	0
FI-14	Construction Management			Very Unlikely	Negligible	0

Cost Estimating Method

CE-1	foundation prep			LIKELY	Marginal	2
CE-2	Intake Tower			LIKELY	Significant	4
CE-3	Trash rack Alt #11			Unlikely	Marginal	1
CE-4	Trash removal system Alt #11			LIKELY	Negligible	1
CE-5	Concrete Mining			Unlikely	Marginal	1
CE-6	72" pipe			Unlikely	Marginal	1
CE-7	Pipe Installation			Unlikely	Significant	3
CE-8	Valves			Very Unlikely	Significant	1
CE-9	Pipe filling system			Very Unlikely	Marginal	0
CE-10	Operations & Maint			Very Unlikely	Negligible	0
CE-11	Valve Room Modification	supplier quotes available		Unlikely	Marginal	1
CE-12	Approach Channel & Fish Lock Mod.	Based on wt of material		LIKELY	Marginal	2
CE-13				Very Unlikely	Negligible	0
CE-14	Construction Management			Very Unlikely	Negligible	0

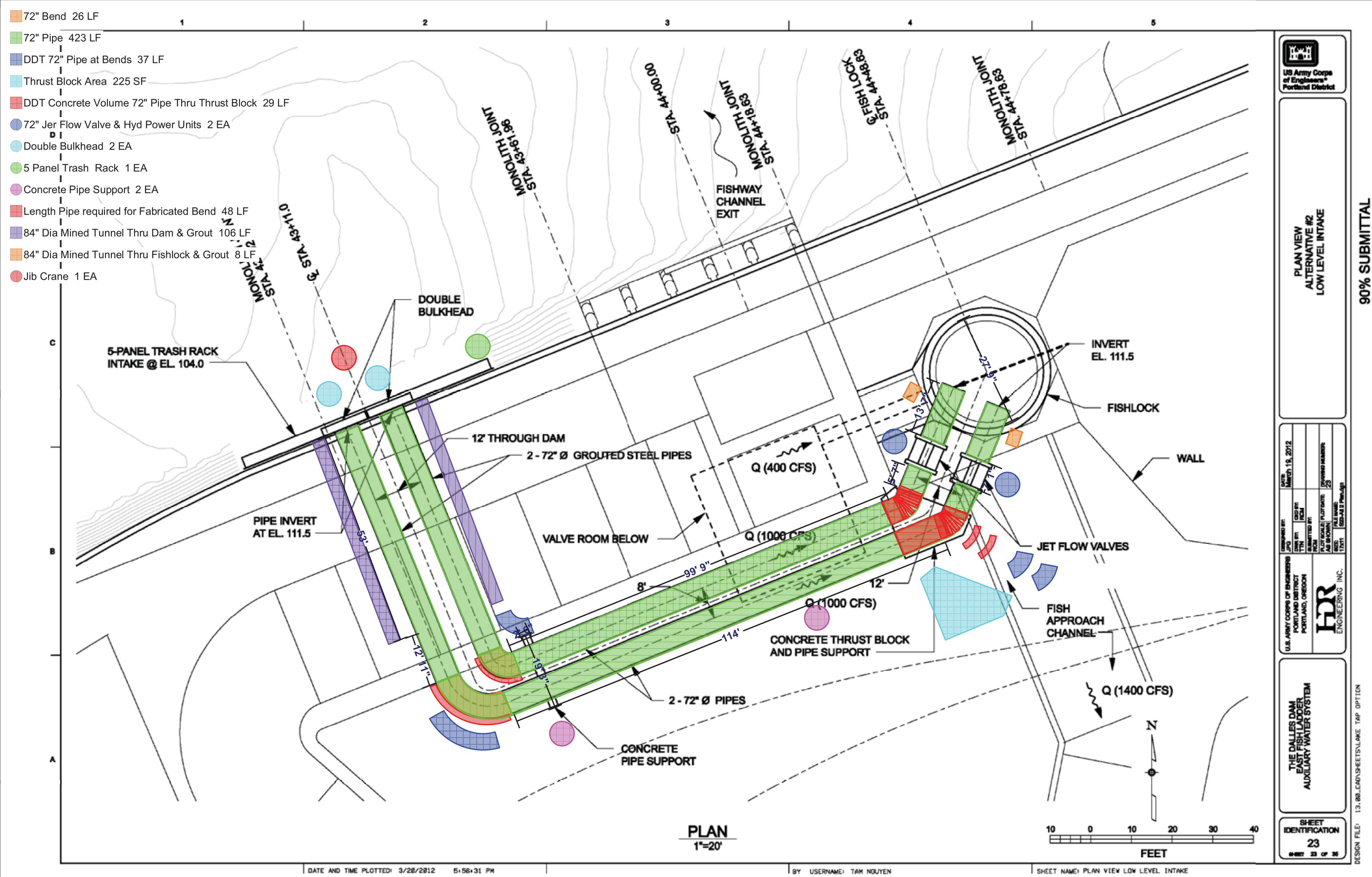
External Project Risks						
EX-1	foundation prep			LIKELY	Marginal	2
EX-2	Intake Tower			Unlikely	Significant	3
EX-3	Trash rack Alt #11			Unlikely	Negligible	0
EX-4	Trash removal system Alt #11			Unlikely	Negligible	0
EX-5	Concrete Mining			Unlikely	Significant	3
EX-6	72" pipe			Unlikely	Marginal	1
EX-7	Pipe Installation			LIKELY	Negligible	1
EX-8	Valves			Very Unlikely	Significant	1
EX-9	Pipe filling system			Unlikely	Negligible	0
EX-10	Operations & Maint			Very Unlikely	Negligible	0
EX-11	Valve Room Modification	Fish Concerns		Very Unlikely	Significant	1
EX-12	Approach Channel & Fish Lock Mod.	Fish Concerns		Very Unlikely	Significant	1
EX-13				Very Unlikely	Negligible	0
EX-14	Construction Management			Very Unlikely	Negligible	0

The Dalles EFL AWS Alt. 11 Siphon w intake tower

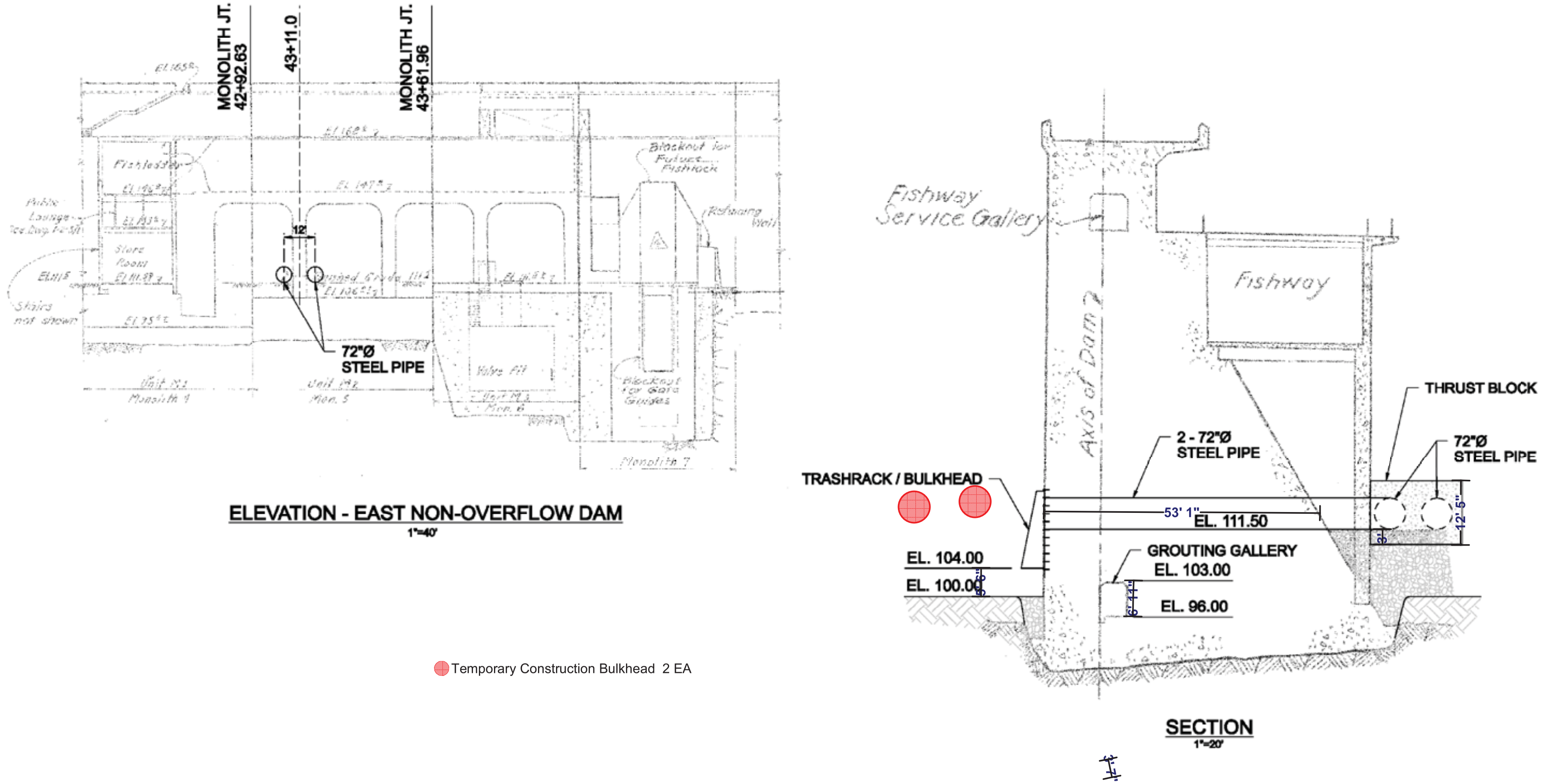
EDR - Pre Feasibility

Abbreviated Risk Analysis

		Potential Risk Areas													
		foundation prep	Intake Tower	Trash rack Alt #11	Trash removal system Alt #11	Concrete Mining	72" pipe	Pipe Installation	Valves	Pipe filling system	Operations & Maint	Valve Room Modification	Approach Channel & Fish Lock Mod		Construction Management
Typical Risk Elements	Project Scope	2	3	3	3	3	2	3	3	3	-	4	1	-	-
	Acquisition Strategy	1	1	1	1	1	1	1	1	1	-	5	2	-	-
	Construction Complexity	5	4	4	2	5	2	4	1	2	-	4	4	-	-
	Volatile Commodities	-	3	3	1	1	2	1	3	-	-	4	4	-	-
	Quantities	2	3	1	-	-	-	-	2	-	-	3	-	-	-
	Fabrication & Project Installed Equipment	-	3	1	3	-	3	-	3	1	-	4	4	-	-
	Cost Estimating Method	2	4	1	1	1	1	3	1	-	-	1	2	-	-
	External Project Risks	2	3	-	-	3	1	1	1	-	-	1	1	-	-



Progress 03-20-12 3.pdf (64% of Scale); Dalles E Fish Ladder 90% Progress Dwg - 032212; HC-2012_1; 3/30/2012 09:53 AM



ELEVATION - EAST NON-OVERFLOW DAM
1"=40'

Temporary Construction Bulkhead 2 EA

SECTION
1"=20'

90% SUBMITTAL

SECTION VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING, INC.

DATE: March, 2012

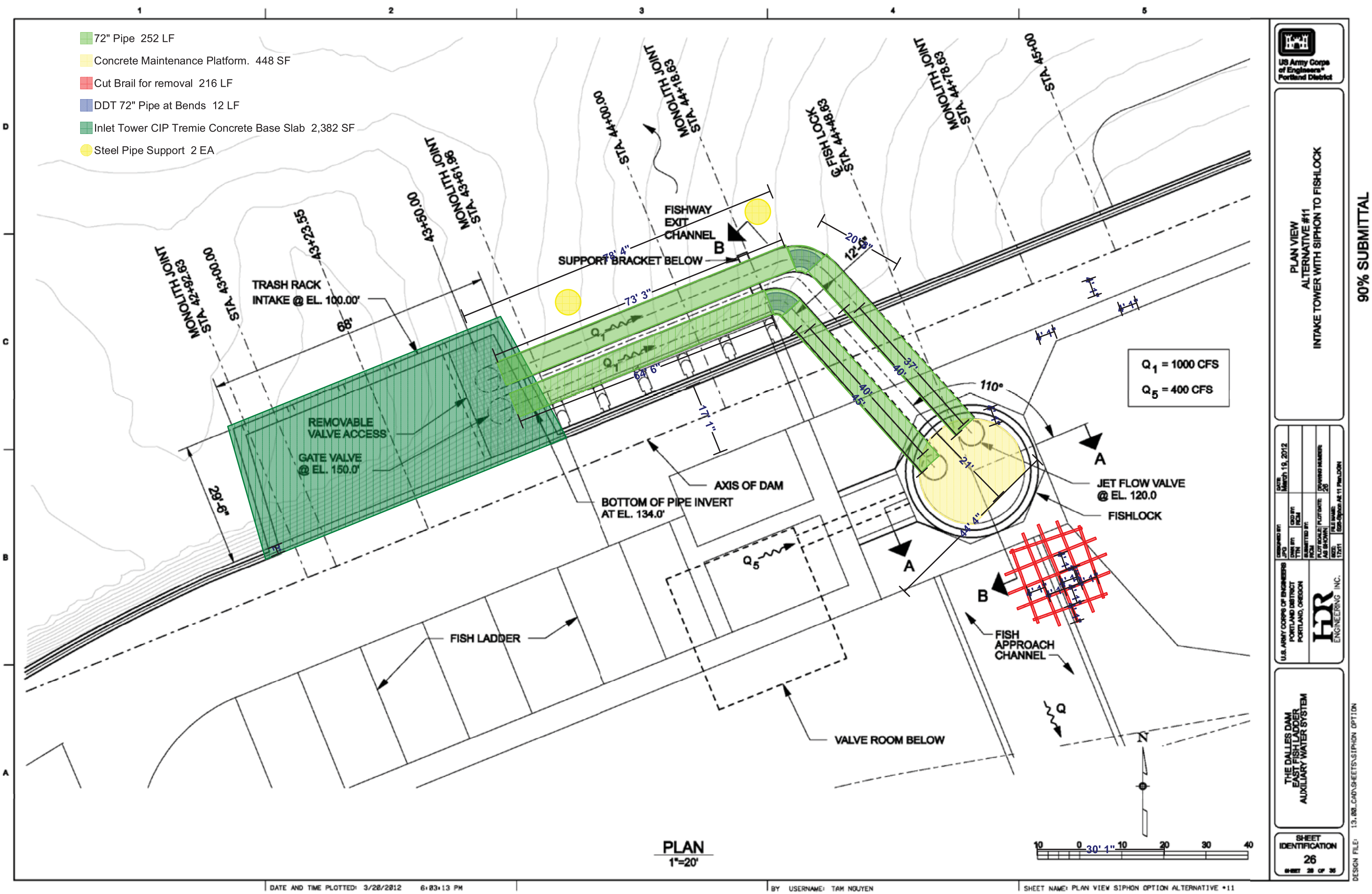
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
24
SHEET 24 OF 35

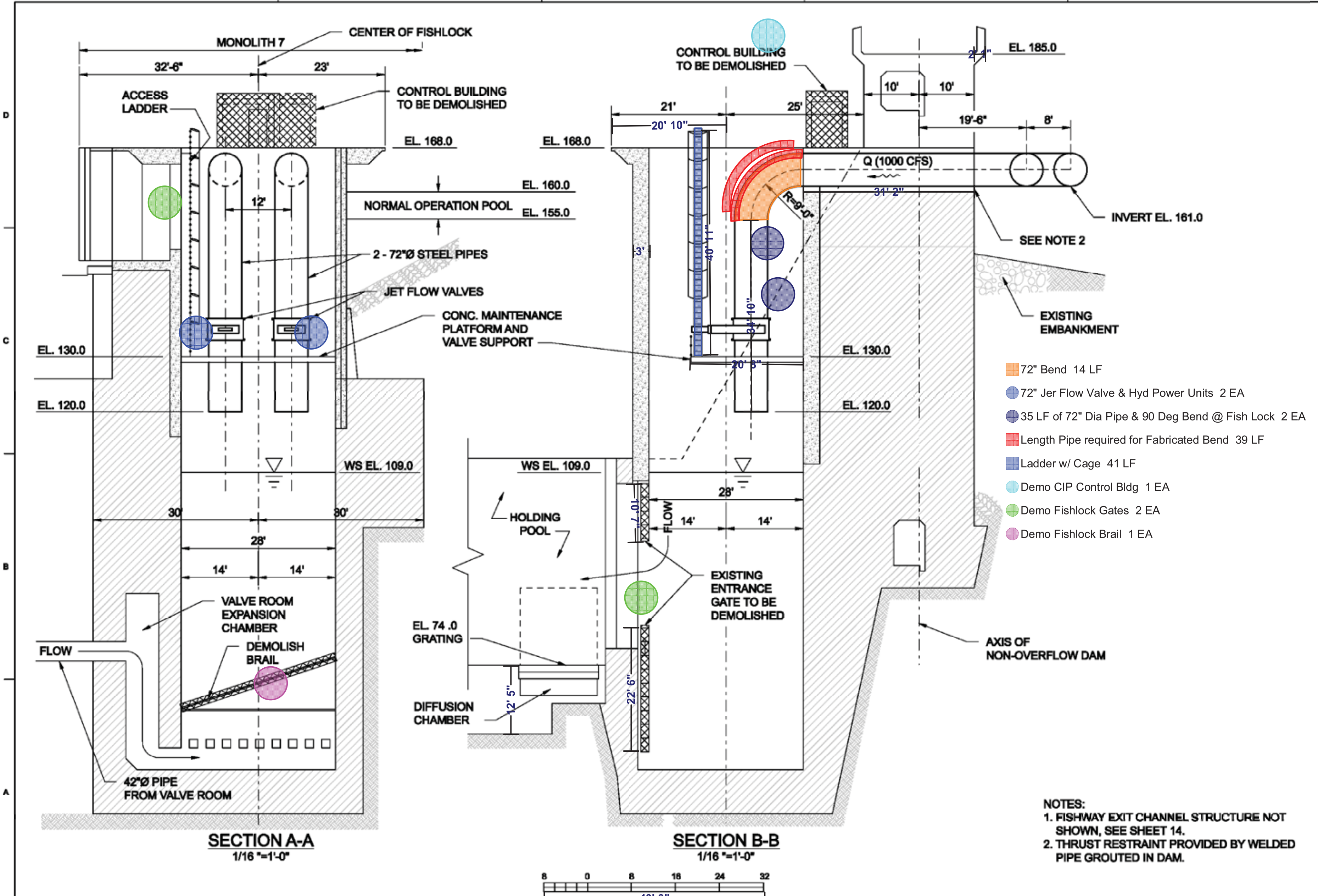
US Army Corps of Engineers Portland District

DATE AND TIME PLOTTED: 3/20/2012 6:01:03 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: SECTION VIEW LOW LEVEL OPTION

DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



Progress 03-20-12 5.pdf (64% of Scale); Dalles E Fish Ladder 90% Progress Dwg - 032212; HC-2012_1; 3/30/2012 09:53 AM



US Army Corps of Engineers® Portland District

SECTIONS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

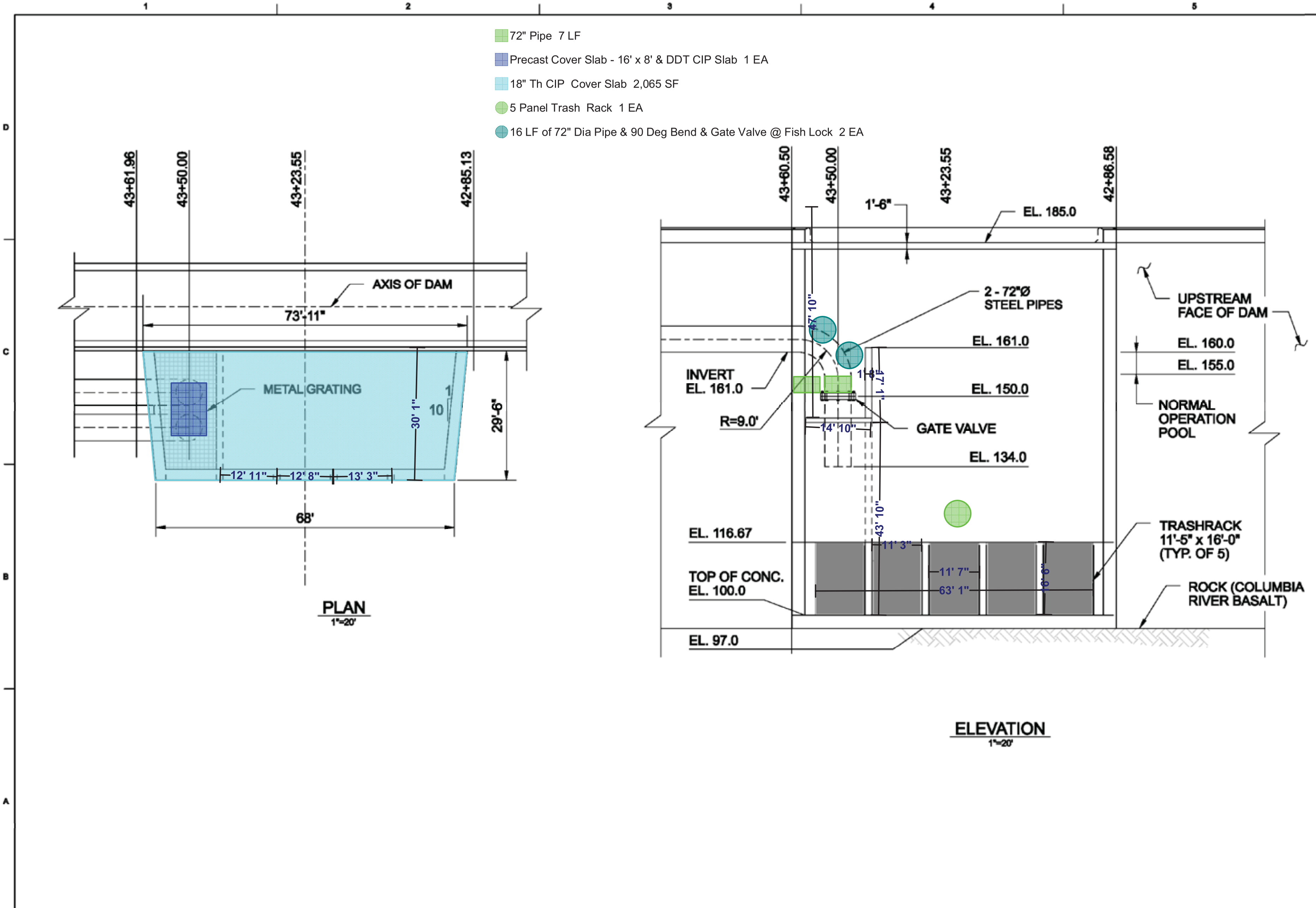
DATE: March 19, 2012

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
27
SHEET 27 OF 36

DATE AND TIME PLOTTED: 3/20/2012 4:35:04 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #11

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



US Army Corps of Engineers® Portland District

INTAKE TOWER
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

HDR ENGINEERING, INC.

DESIGNED BY: JPO | DATE: March 19, 2012
DWN BY: TTN | CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 29
SIZE: 17X11 | FILE NAME: 029-Siphon Alt 11 Intake.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
29
SHEET 29 OF 35

90% SUBMITTAL

DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION

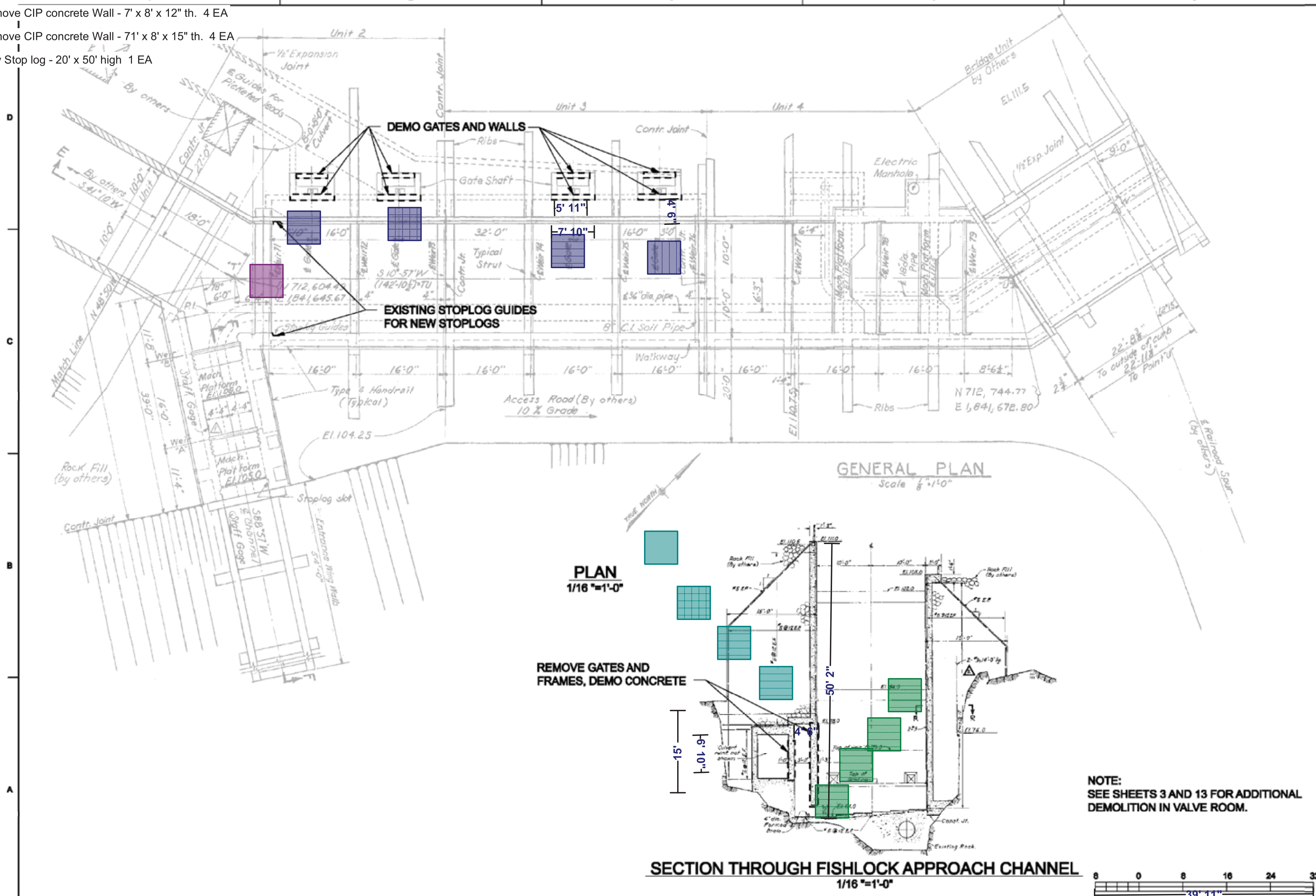
DATE AND TIME PLOTTED: 3/20/2012 6:00:10 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #11

Remove 48" x 48" Gates 4 EA

Remove CIP concrete Wall - 7' x 8' x 12" th. 4 EA

Remove CIP concrete Wall - 71' x 8' x 15" th. 4 EA

New Stop log - 20' x 50' high 1 EA



NOTE:
SEE SHEETS 3 AND 13 FOR ADDITIONAL DEMOLITION IN VALVE ROOM.

US Army Corps of Engineers® Portland District

FISHLOCK APPROACH CHANNEL MODIFICATIONS PLAN AND SECTION

90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

HDR ENGINEERING, INC.

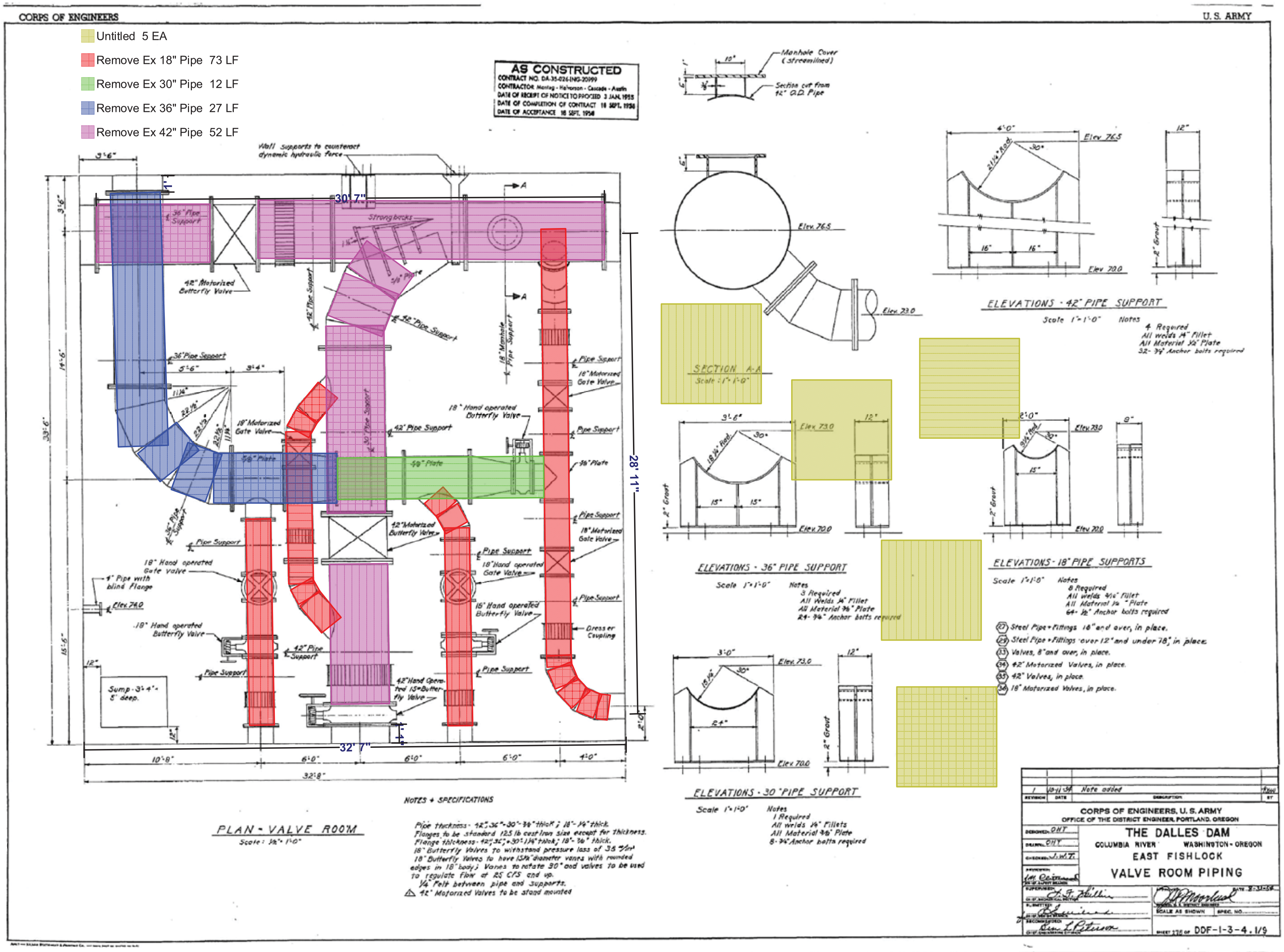
DATE: March 19, 2012

THE DALLES DAM EAST FISH LADDER AUXILIARY WATER SYSTEM

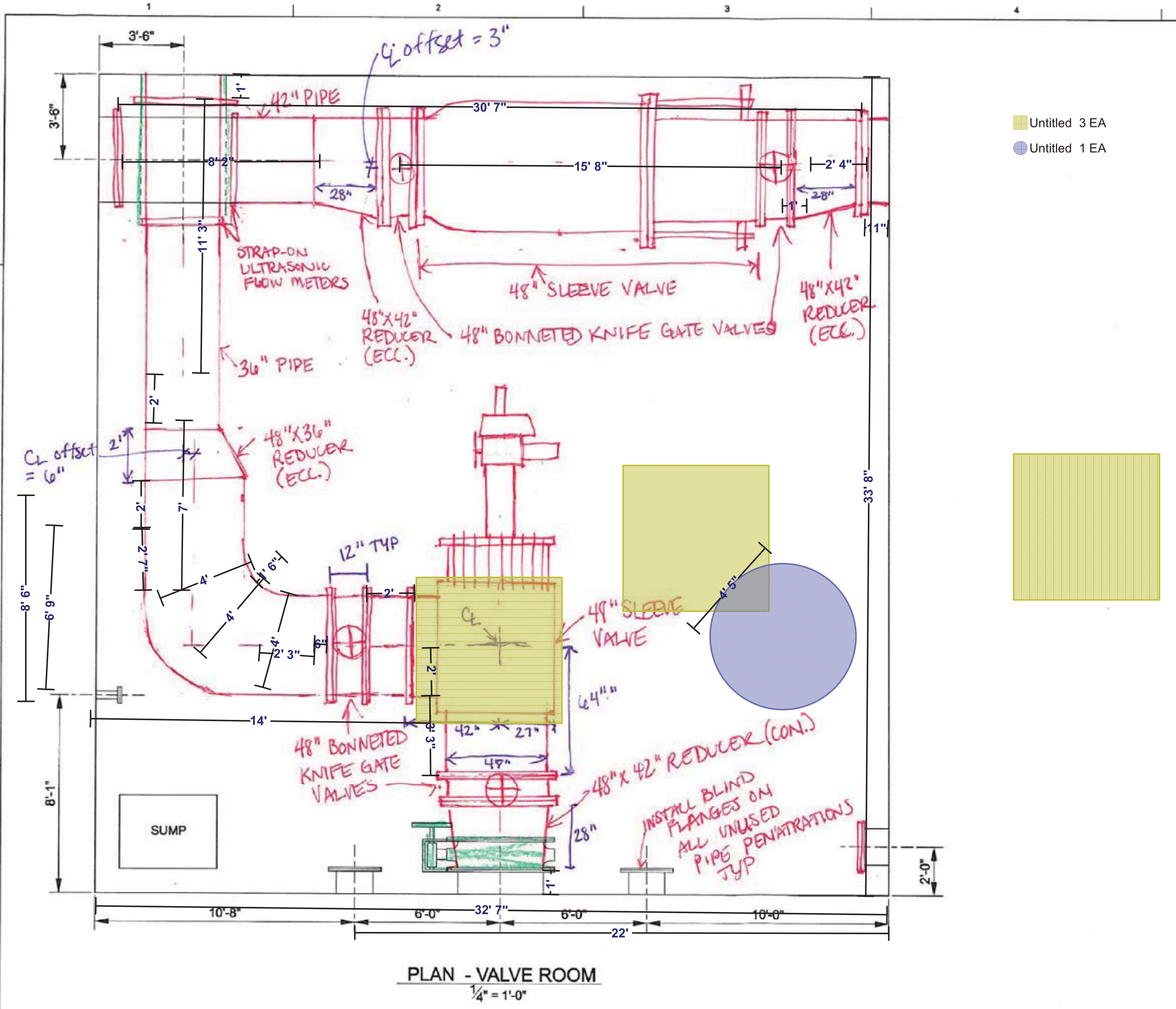
SHEET IDENTIFICATION 30 SHEET 30 OF 36

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

DATE AND TIME PLOTTED: 3/20/2012 6:10:55 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: FISHLOCK CHANNEL MODIFICATIONS PLAN AND SECTION



ddf_1-3-4.19_ddf_1-0-52_ddf_1-0-58 1.pdf (64% of Scale); Dalles E Fish Ladder 90% Progress Dwg - 032212; HC-2012_1; 3/30/2012 09:53 AM



PLAN - VALVE ROOM

¼" = 1'-0"

US Army Corps of Engineers® Portland District

VALVE ROOM MECHANICAL PLAN

KN 3/21/12

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: JPG | DATE: January 25, 2012

DWN BY: HG | CKD BY: RCM

SUBMITTED BY: RCM

PLOT SCALE: NTS | PLOT DATE: | DRAWING NUMBER: 2

SIZE: 17x11 | FILE NAME: BXX-Valve Room Mech Plan.dgn

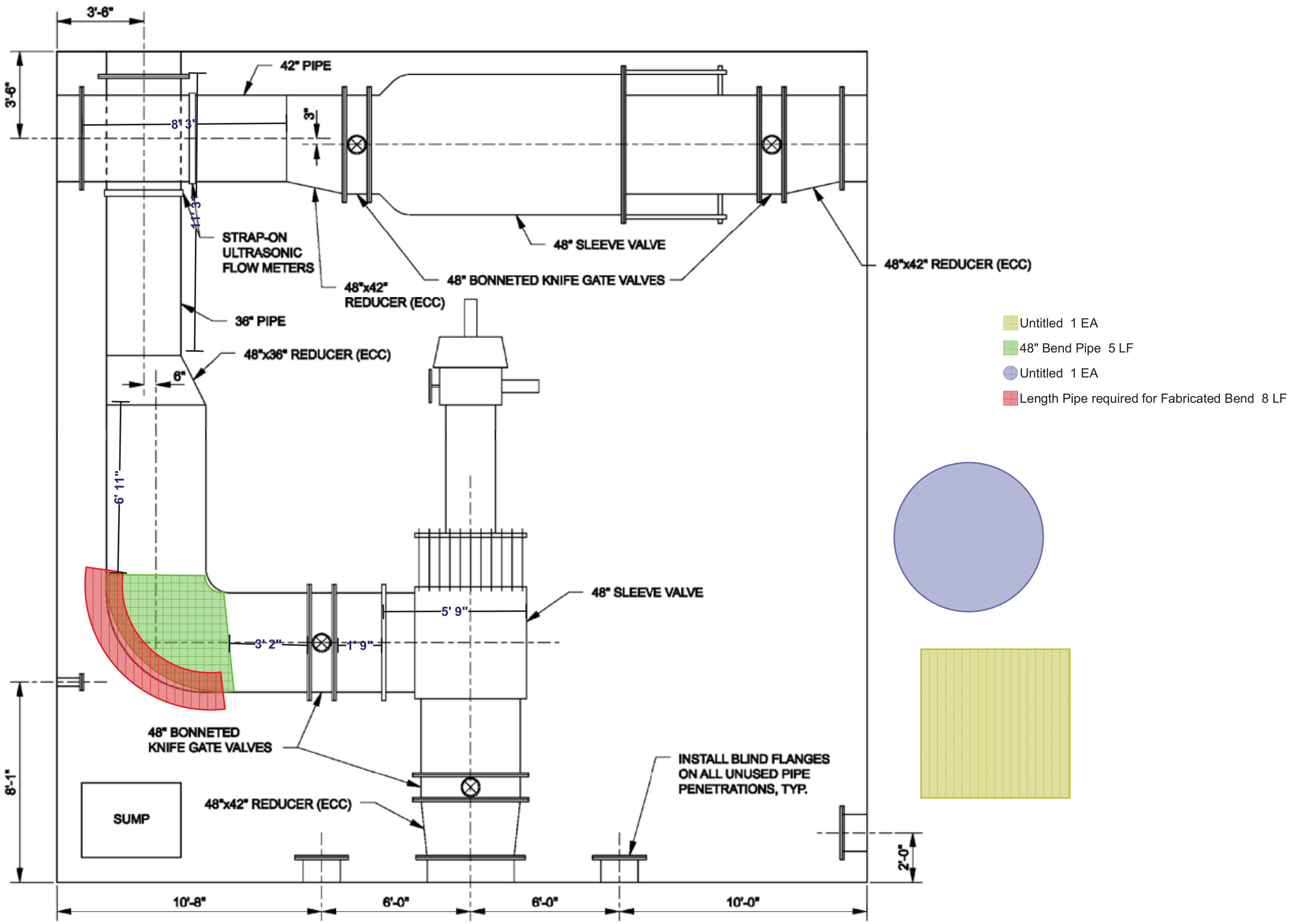
THE DALLES DAM EAST FISH LADDER AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION X

SHEET X OF XX

DATE AND TIME PLOTTED: 3/15/2012 5:09:11 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN - VALVE ROOM

¼" = 1'-0"

US Army Corps of Engineers® Portland District

VALVE ROOM MECHANICAL PLAN

90% SUBMITTAL

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: JPG | DWN BY: HG | CKD BY: RCM | SUBMITTED BY: RCM | DATE: March 19, 2012 | PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 32 | SIZE: 17X11 | FILE NAME: 032-Valve Room Mech Plan.dgn

THE DALLES DAM EAST FISH LADDER AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION 32

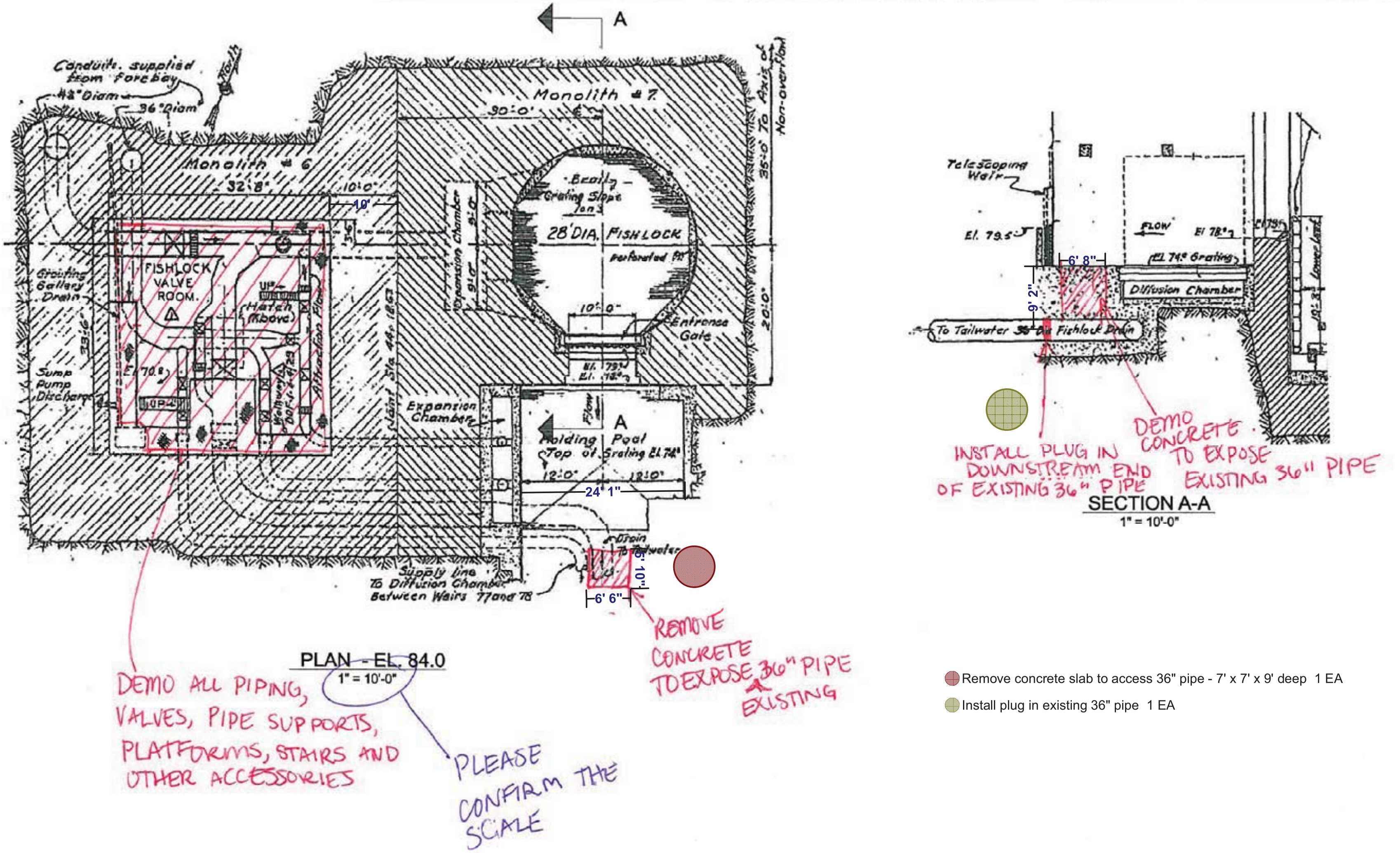
SHEET 32 OF 36

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

DATE AND TIME PLOTTED: 3/22/2012 12:22:32 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1



Remove concrete slab to access 36" pipe - 7' x 7' x 9' deep 1 EA

Install plug in existing 36" pipe 1 EA

US Army Corps of Engineers Portland District

VALVE ROOM DEMOLITION PLAN

KN 3/21/12

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

HDR ENGINEERING INC.

DATE: January 25, 2012

THE DALLES DAM EAST FISH LADDER AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION X SHEET X OF XX

DATE AND TIME PLOTTED: 3/16/2012 10:04:26 AM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

Takeoff Tab

Dalles E Fish Ladder 90% Progress Dwg - 032212

Bid No. 17

No.	Name	Height	Area	Quantity1	UOM1	Quantity2	UOM2	Quantity3	UOM3
000 The Dalles EFL AWS									
24	16 LF of 72" Dia Pipe & 90 Deg Bend & Gate Valve @ Fish Lock	6' 0"	Alternate #11	2.00	EA	0		0	
25	18" Th CIP Cover Slab	0"	Alternate #11	2,064.54	SF	200.20	LF	0	
26	35 LF of 72" Dia Pipe & 90 Deg Bend @ Fish Lock	6' 0"	Alternate #11	2.00	EA	0		0	
27	48" Bend Pipe	4' 0"	Valve Room - Common to Alt 2 & Alt	4.51	LF	0		0	
28	5 Panel Trash Rack	6' 0"	Multi-Area Total	2.00	EA	0		0	
			Alternate #2	1.00	EA	0		0	
			Alternate #11	1.00	EA	0		0	
29	72" Bend	6' 0"	Multi-Area Total	39.77	LF	0		0	
			Alternate #2	25.57	LF	0		0	
			Alternate #11	14.20	LF	0		0	
30	72" Jer Flow Valve & Hyd Power Units	6' 0"	Multi-Area Total	4.00	EA	0		0	
			Alternate #2	2.00	EA	0		0	
			Alternate #11	2.00	EA	0		0	
31	72" Pipe	6' 0"	Multi-Area Total	682.72	LF	0		0	
			Alternate #2	423.42	LF	0		0	
			Alternate #11	259.30	LF	0		0	
32	84" Dia Mined Tunnel Thru Dam & Grout	3' 0"	Alternate #2	106.00	LF	0		0	
33	84" Dia Mined Tunnel Thru Fishlock & Grout	3' 0"	Alternate #2	8.07	LF	0		0	
34	Concrete Maintenance Platform.	0"	Alternate #11 @ Fishlock	447.61	SF	76.87	LF	0	
35	Concrete Pipe Support	6' 0"	Alternate #2	2.00	EA	0		0	
36	Cut Brail for removal	0"	Alternate #11 @ Fishlock	216.17	LF	0		0	
37	DDT 72" Pipe at Bends	4' 0"	Multi-Area Total	48.85	LF	0		0	
			Alternate #2	37.20	LF	0		0	
			Alternate #11	11.65	LF	0		0	
38	DDT Concrete Volume 72" Pipe Thru Thrust Block	6' 0"	Alternate #2	29.18	LF	0		0	
39	Demo CIP Control Bldg	6' 0"	Fishlock - Common to Alt 2 & Alt 11	1.00	EA	0		0	
40	Demo Fishlock Brail	6' 0"	Fishlock - Common to Alt 2 & Alt 11	1.00	EA	0		0	
41	Demo Fishlock Gates	6' 0"	Fishlock - Common to Alt 2 & Alt 11	2.00	EA	0		0	
42	Double Bulkhead	6' 0"	Alternate #2	2.00	EA	0		0	
45	Inlet Tower CIP Tremie Concrete Base Slab	0"	Alternate #11	2,382.33	SF	0		0	

Takeoff Tab

Dalles E Fish Ladder 90% Progress Dwg - 032212

Bid No. 17

No.	Name	Height	Area	Quantity1	UOM1	Quantity2	UOM2	Quantity3	UOM3
46	Install plug in existing 36" pipe	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	1.00	EA	0		0	
47	Jib Crane	6' 0"	Alternate #2	1.00	EA	0		0	
48	Ladder w/ Cage	1' 3"	Alternate #11	41.42	LF	0		0	
49	Length Pipe required for Fabricated Bend	1' 6"	Multi-Area Total	95.13	LF	0		0	
			Alternate #2	48.13	LF	0		0	
			Valve Room - Common to Alt 2 & Alt	7.86	LF	0		0	
			Alternate #11	39.14	LF	0		0	
50	New Stop log - 20' x 50' high	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	1.00	EA	0		0	
51	Precast Cover Slab - 16' x 8' & DDT CIP Slab	1' 0"	Alternate #11	1.00	EA	0		0	
52	Remove 48" x 48" Gates	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	4.00	EA	0		0	
53	Remove CIP concrete Wall - 7' x 8' x 12" th.	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	4.00	EA	0		0	
54	Remove CIP concrete Wall - 71' x 8' x 15" th.	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	4.00	EA	0		0	
55	Remove concrete slab to access 36" pipe - 7' x 7' x 9' deep	6' 0"	F'lock Approach Channel - Common to Alt 2 & Alt 1	1.00	EA	0		0	
56	Remove Ex 18" Pipe	1' 6"	Valve Room - Common to Alt 2 & Alt	72.58	LF	0		0	
58	Remove Ex 30" Pipe	2' 6"	Valve Room - Common to Alt 2 & Alt	12.42	LF	0		0	
59	Remove Ex 36" Pipe	3' 0"	Valve Room - Common to Alt 2 & Alt	27.00	LF	0		0	
60	Remove Ex 42" Pipe	3' 6"	Valve Room - Common to Alt 2 & Alt	52.00	LF	0		0	
61	Steel Pipe Support	6' 0"	Alternate #11	2.00	EA	0		0	
62	Temporary Construction Bulkhead	6' 0"	Alternate #2	2.00	EA	0		0	
63	Thrust Block Area	0"	Alternate #2	225.05	SF	61.80	LF	0	
(unassigned)									
1	Untitled	6' 0"	Multi-Area Total	9.00	EA	0		0	
			(unassigned)	4.00	EA	0		0	
			Valve Room - Common to Alt 2 & Alt	5.00	EA	0		0	
2	Untitled	6' 0"	(unassigned)	2.00	EA	0		0	

Alternative #2 - Low Level Intake: Concrete Quantities for Intake Structure

Concrete pipe supports (2)	192.10	sf
	7.11	cy
Concrete at pipe exit at base of dam	598	sf
	22.15	cy
Concrete thrust block at Jet Flow Valves	922	sf
Note: #7 @12 for all concrete	34.15	cy
Total Concrete =	63.41	lbs

Alternative #2 - Low Level Intake:Trash Rack Enclosures, Trashrack Panels, and Bulkheads

(1)

Trashrack Enclosure				
HSS 14x4x1/2 vertical members			71.59	lf
	55.53	plf	3,975	lbs
HSS 7x4x1/2 vertical members (corners)			28.64	lf
	31.71	plf	908	lbs
HSS 8x4x1/2 horizontal frame members			59.14	lf
	35.11	plf	2,076	lbs
L 6x6x 1 Inside horizontal			50	lf
	37.40	plf	1,870	lbs
0.75 Plate				
Top	174.00	sf		
Bottom	174.00	sf		
Mounting Flange	74.50	sf		
Sides	94.30	sf	516.8	sf
			15,827	lbs
Trashrack Panels (5)	5			
	43,789	lbs each	218,945	lbs
Bulkheads (2)				
MC 9x25.4			41.4	lf
	248.00	plf	10,267	lbs
0.75 " Plate (front and back, top and bottom)				
	357	sf	10,933	lbs
1.0 " Plate (rails)				
	302	lf		
	0.33	sf	49,070	lbs
Total Steel Weight =			302,939	lbs

(1) 24656 lbs — 1EA

(2) * (2) 43787 lbs/EA x 5 EA

(3) (3) 35135 lbs/EA x 2.

Undercut Anchors

1" Diameter x 1'-6" - Williams Stainless Steel S-9 Undercut Anchor - ASTM A193 316 B8M Class II

Bulkhead Rails =	162.00	pcs
Trashrack Enclosure =	84.00	pcs
Total Quantity of Anchors =	246	pcs

Alternative #11 - Siphon; Concrete Quantities for Intake Structure

Precast Concrete Section - Postentioned

Front face width:	68.00 ft	
back face width:	73.92 ft	
out-to-out depth (face of dam to front):	29.50 ft	
Height of trapezoidal enclosure:	85.00 ft	
Area of one trash rack (11'-6" x 16'-0"):	184.00 ft^2	
Number of trash racks:	5.00	
Thickness of walls:	2.50 ft	
XS Area of 'wall' around top slab:	4.22 ft^2 (measured in CAD)	
Volume of concrete-ext walls:	24254 ft^3 =	898 yd^3
Volume of top and bottom slab:	9420 ft^3 =	349 yd^3
Volume of interior wall:	1823 ft^3 =	68 yd^3
Volume of 'wall' around top slab:	536 ft^3 =	20 yd^3
	Total Concrete Weight =	1334.5 yd^3

Alternative #11 - Siphon: Trash Rack Panels and Pipe Brackets

Trash Racks and Panels

HSS 14x4x1/2 vertical members		71.59 lf
	55.53 plf	3,975 lbs
HSS 7x4x1/2 vertical members (corners)		28.64 lf
	31.71 plf	908 lbs
L 6x6x 1 Inside horizontal		41.4 lf
	37.40 plf	1,548 lbs

Pipe Support Brackets (2)

HSS 8x6x5/8		42 lf
	50.60 plf	2,125 lbs
Trashrack Panels Weight	43789.00 lbs each	
	5	218,945 lbs
	Total Steel Weight =	227,502 lbs

Trash Rack Support Panel.
8556 lbs ÷ 5 = 1712 lbs/EA
+ 5 EA

(4)

(5)

Temporary Coffer Dam 9000 lbs EA X 2

Appendix H

Meeting Minutes

Subject: Minutes for the 20 % Review Meeting	
Client: U.S. Army Corps of Engineers	
Project: The Dalles East Fish Ladder Auxiliary Water System Backup, 20% Review Meeting	Project No: 000000000171578
Meeting Date: November 17, 2011	Meeting Location: HDR, Mountain Rooms
Notes by: Jennifer Switzer/Ron Mason	

ttendees

Ron Mason, HDR	Nina Sass, HDR	Karen Kuhn, USACE
Jennifer Switzer, HDR	David Ward, HDR	Sean Tackley, USACE
Rich Hannan, HDR	Al Petrasek, HDR (via phone)	Bob Cordie, USACE
Kristi Nelson, HDR	Lisa Larson, NHC	Rick Reiner, USACE
Pete Gaby, HDR	Randy Lee, USACE	

opics Discussed

✓ Opening Statement/Introductions by USACE/ HDR team Members	Randy Lee/Ron Mason/All
✓ Purpose of the Meeting/Overall Objectives	Randy/Ron
✓ Discussion of Review Comments (ITR/DrChecks)	Ron
✓ Technical Discussions of Project Alternatives	HDR
✓ Hydraulic Improvements Analysis by NHC	Lisa Larson, NHC
✓ Next Phase of the Project/Further Actions	Ron Mason
✓ Action Items from Meeting	All

ction otes

OPENING STATEMENT/INTRODUCTIONS

Randy Lee began the meeting with its purpose as a 20% review meeting. He confirmed the flow requirement of 1,400 cfs for the east fish ladder (EFL) auxiliary water supply (AWS) backup system. HDR has submitted a draft design criteria memorandum, 20% engineering design report (EDR) outline, and a technical memorandum, hydraulic analysis of the header pipe system. All documents are available for review in DrChecks and comments would be appreciated in the next 1-2 days. If unable to access DrChecks, please contact Randy Lee or Karen Kuhn. If unable to submit comments in DrChecks, please email Randy Lee and Karen Kuhn with comments for uploading to DrChecks.

Ron Mason shared that Don Best (electrical engineer) and Pete Gaby (Structural Engineer) were unavailable to attend the meeting, but could be reached by phone if any questions came up during the meeting. He then asked all meeting attendees to introduce themselves and their employer.

PURPOSE OF THE MEETING/OVERALL OBJECTIVES

Ron Mason provided a review of the agenda (see attached) explaining the goal of the meeting is to review the three submitted documents and review the four alternatives being evaluated.

For the 20% report outline, input is being requested. HDR has prepared this as a guide to the end. It can be changed, but hopefully not much. Comments are needed now before HDR proceeds significantly down the path of report preparation.

Ron displayed the 20% outline and went through each section. Sections 1 and 2 will be complete at the 60% report submittal. Section 3 provides discussion of the four alternatives being taken to the 60% report. Each alternative will have the same sub categorical discussions including: hydraulic, biological, cost, electrical, structural, etc., where appropriate.

Randy Lee questioned the use of the word “Evaluation” in the sub headings. Ron Mason clarified the use as meaning impacts/benefits due to new feature being proposed. He stated the word can be changed if the U.S. Army Corps of Engineers (USACE) makes the request (“Evaluation” to “Design”), but should do so in DrChecks.

Sean Tackley asked Rob Reiner and Bob Cordie if they would like an explicit discussion on operations and maintenance (O&M). Ron Mason stated asset management is included as part of the project and captured in the cost. He also reiterated including this request formally in DrChecks.

Bob Cordie asked if a cost cap was ever established that would enable alternatives to be cut before they are fully developed. Due to funding being known annually with fiscal budgets being developed, that this was frustrating, but not possible. Bob said so many studies have been done, alternative chosen, then get to the end and oops too expensive.

Ron said the alternatives developed to 60% are evaluated including a cost component and all are relative. The cost component evaluation factor discussed during the brainstorming meeting held in December 2010 was on a high, medium, and low with different factors being weighted differently.

Two alternatives will be taken to the 90% report.

Randy questioned the name “River Wet Tap” and wanted to know if changing the name would be possible. Ron said this is definitely possible, and asked the USACE to make the recommended name change (DrChecks).

If there are certain items the USACE does not want included in the report, Ron Mason requested a letter to document removal of any items (i.e., equalizing headers). He also said that for 60% report submittal, the , sections 1-4, will be 95% complete. The schedule is tight and since the bulk of the work will be completed for the 60% submittal, one-half to two-thirds of the budget will be expended during development of the 60% report submittal.

Since all alternatives will be taken to the 60%, HDR/USACE will be able to do an equal comparison of the alternatives.

Lastly, appendices will be provided with technical computations.

Ron and Randy agreed that after the 60% report submittal, choosing the two selected alternatives that will move on to the 90% report will come from evaluation. It was recommended that a project development team (PDT, HDR/USACE) meeting be held to prepare a matrix for evaluation and scoring of the alternatives. Ron reiterated that HDR has no plans to independently select the two final alternatives without the USACE’s involvement.

TECHNICAL DISCUSSIONS OF PROJECT ALTERNATIVES

Ron showed the plan view of the project including fish lock, ladders, junction pool etc. (see simple sketches attached to this memo)

The four alternatives selected by the USACE through its own internal process include: a siphon directly into the fishlock (Alt #1), a river wet tap tunnel bored through the rock (Alt. #2), a single pump/pumphouse on east side of cul-de-sac (Alt. #10), and an upstream intake tower with siphon (Alt. #11).

Discussion of alternative #10. Single pump/pumphouse on east side of cul-de-sac.

Kristi Nelson gave an overview of the pump station locations. Two proposed pump station location options discussed:

- Site A, further north in the cul-de-sac - with discharge pipe(s) through or over the fish ladder to the AWS Culvert.
- Site B located further south toward end of fish ladder – with discharge pipes around the end of the fish ladder to the AWS Culvert.
- Both sites are workable based on the preliminary elevation determined for the pump suction.

Kristi asked for clarification on the conduit versus culvert. Reiner explained the open stretch of channel is the "culvert."

Rick Reiner asked if it's cheaper to use pipe above ground, can you have above ground for both? Most likely the pipe would be installed above ground.

Location and the issue of maintenance access to pump station (200 tons of equipment assuming full 1,400 cfs) was discussed. The existing access road goes 2/3 out towards the end of the fish ladder, but can likely be improved to provide access to the end of the ladder.

Biology perspective – site A preferred – farther away from any kind of attraction flows.

Cordie mentioned John Day pump intake was located a couple feet from fish access. Tackley mentioned possible sturgeon impacts may determine best site location. David Ward mentioned boat access was tricky for ODFW in the cul-de-sac. Kristi Nelson said both sites will be pursued until it the best alternative can be figure out.

An isometric 3-dimensional view of the fishlock was shown to provide an overview of the project.

Understanding of operating water surface levels in the AWS system is important for pump design. The following is required:

- Min and Max. tailwater elevations; and design WSE elevations in the AWS system at the location of the discharge pipe from the pump station where it connects to the AWS system
- Motor & electrical installation elevations to avoid damage during flooding

Full operating range of tailwater conditions (min & max) and AWS culvert WSE need to be finalized. This information is needed to allow for proper pump operations.

Design Life of chosen alternative = 50 years

Randy Lee mentioned the USACE is not doing any hydraulic modeling of the AWS (culvert) as it was removed from the scope. Lisa Larson could use rough estimate of WSE from existing operations since this is conceptual design. An estimated AWS pressure grade line of 5 feet above the tailwater elevation was considered to be adequate for this level of design.

Electrical components: PMF flood tailwater condition of 133 feet seems excessively conservatively high? What is the 500–year level? USACE has data and will provide guidance at to the design elevation that USACE wants electrical equipment place.

Kristi Nelson mentioned concern with flow conditions in the AWS culvert at the location of the pumping plant discharge pipe. Randy Lee/Ron Mason concurred, this is preliminary design, more detailed hydraulic evaluation would be needed if this alternative is selected. A DDR in future (not under current task order) will be required for the selected alternative.

Lastly, discussion regarding discharge pipes coming in to the side of the AWS Culvert to reduce turbulent flow conditions. The next phase of the study will need to address turbulent conditions in the AWS culvert.

Alternative #1. Siphon Pipe to supply water in to fishlock.

The siphon will be angled down or at an angle with supports. How much water? Negative pressure issues?

Alternative #2. River Wet Tap Tunnel Bored through the Rock

Need bathymetry. Intake (100's of feet out from dam)

Alternative #11. Upstream Intake Tower with Siphon to Fishlock

Intake tower with siphon pipe to fishlock, the alternative will have a base footing or slab to support an intake tower with opening(s) at base of tower that would draw water from a deep location in the reservoir. This would help to eliminate fish entrainment (lower than Alt #1). The intake tower could not be dewatered.

Hydraulic

Lisa Larson provided a discussion covering header pipe hydraulic memorandum submittal. Key points were as follows:

- Constriction down to 6-inch AWS drain
- Constriction down to 4-inch diffuser drain
- Equalizer header pipe system designed to fill AWS channel
- Utilize all pipes (1-14); estimated total flow would be about 65 cfs, primary limiting factor is the 6-inch pipe constriction
- A network model was not developed (beyond scope of effort). Would see more losses with network model which would result in a smaller discharge.
- High velocities to consider – 20 fps – may be too high for long-term operation; may cause damage to valve seats
- AWWA guidelines recommend maximum velocity of 16 fps
- If these improvements are selected, energy dissipation to reduce high velocities needs to be considered
- 7 conduit drains in AWS channel
- 15 diffuser pipes in the AWS system
- Total number of pipes = 22, (12-inch pipes)
- A go/no go decision on the header pipe system improvements needs to be made by USACE as soon as possible
- NHC conducted a limited hydraulic analysis. This level of detail was appropriate for the USACE – just for use as a barometer.

Valve room Hydraulic Analysis: 42-inch pipe – looks promising (approx. 400 cfs). USACE did some estimates recently and got several hundred cfs. Verifies this as a wise investment on the part of the government.

Reiner mentioned there is a planned winter outage Dec 1/Jan/Feb.
16 fps – applies on this pipe. 16 fps – 42-inch pipe = 154 cfs. Jan/Feb the access plate will be removed on the 42-inch pipe to inspect the valve and clean out any debris. Additionally, the three, 18-inch pipes that connect to the 36-inch pipe will also be cleaned and inspected.

Randy Lee confirmed 42-inch Weldolette pressure tap gage gave a reading of 40 psi.

Randy Lee will send Ron Mason a memorandum with field testing results and pressure gage measurements.

Siphon Discussion – one issue – negative pressures. Need input on limit negative pressures in the design (-5 to -10 feet of head) > negative head. Possible solutions: incorporate a d/s control valve, increase pipe diameter size, increase number of pipes, trial and error process.

Intake/inlet of the siphon will be submerged. Currently, submergence is one pipe diameter. Siphon could produce 800+ cfs using two, 6-foot pipes. Then how to distribute flows back into system. Diameter of fishlock is roughly 28 feet. Siphon will have two valves to open and fill.

Lacking in design criteria for siphon design.

The amount of time to fill siphon pipes will need to be determined; – how long is acceptable?; this will set the requirements for the filling pumps.

It was mentioned that previously NOAA Fisheries assumes start-up time of days to less than a week is acceptable.

Ron Mason asked the USACE representatives to review the design criteria memorandum and provide comments regarding any glaring issues, fish screen criteria is important.

Tackley will ask NOAA Fisheries to draft a memo stating no fish screens are required. He also recommended changing 1-inch to ¾-inch turbine grate spacing to exclude lamprey from getting into system.

Two existing fish turbine trashracks have 1-inch spacing. Preference for the pump station intake = ¾-inch.

Discussion of the Intake tower with deep inlets. - issues with inlet openings (location and size), trashrack requirements, potential for debris issues. Discussed possibility of raising the openings.

Gravity means – reliable versus mechanical means (pumps can break).

Discussion regarding considering 2 pumps instead of 1 pump. Pumps will require monthly maintenance. For pumps, Hydraulic Institute standards exist, but may still need to be modeled.

USACE needs to decide as soon as possible whether it wants multiple pumps or one pump. Cordie/Reiner mentioned two examples of pump failures (at Foster Dam, 4 pumps are failing after 8,000 hours and at John Day they are constantly struggling to keep the pumps operational).

Reiner asked if he could introduce another possible alternative idea someone gave him. Take one of the fish turbines (each 15 MW) and remove the turbine. Use the wicket gates to control flow. Randy Lee to check with USACE's HDC regarding this as a possibility.

USACE Action Items:

Action Item	Responsible Person
Provide any comments in DrChecks for the design criteria memorandum, 20% report outline, and hydraulic memorandum submittals	USACE
Tailwater elevation and elevation of where we're pumping to	Bob Cordie
Motor mount and electrical elevations	Bob Cordie
Operation range for pumps (min 72.5 max 86?)	USACE
Elevation by which mechanical equipment is placed	USACE
Tailwater duration curves?	USACE
Design to regulated condition – does the USACE want to use as design criteria?	USACE

Action Item	Responsible Person
Bathymetry	USACE
Memorandum with field testing results and pressure gage measurements	Randy Lee
Check with HDC regarding new alternative – removing one fish turbine.	Randy Lee
Field measurements for fishlock	Randy Lee
New name for River Wet Tap alternative	Randy Lee
Decision regarding one versus multiple pump	USACE
Go/no go decision on the header pipe system improvements	USACE
USACE/HDR 60% Meeting	USACE
Alternative #10 - Site A/Site B requirements/limitations	USACE
Request NOAA Fisheries to draft a memo stating no fish screens required	Sean Tackley
Request notes from USFWS	Sean Tackley

HDR Action Items:

Action Item	Responsible Person
Email scanned 1953 The Dalles EFL Hydraulic report to Randy Lee, Karen Kuhn, Lisa Larson	Done, 11/28/2011
Email conceptual drawing to Sean Tackley so he and Dave Ward can research	Done, 12/5/2011

Attachments

20% Review Meeting Sign-In

Plan View and Alternative Sketches

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The Dalles East Fish Ladder Auxiliary Water System (AWS) Engineering Design Report
20% Design Review Meeting Sign-In

Please print clearly

Name	Agency/Firm	Email	Phone
Karen Kuhn	USACE-NWP	Karen.A.Kuhn@usace.army.mil	503-808-4897
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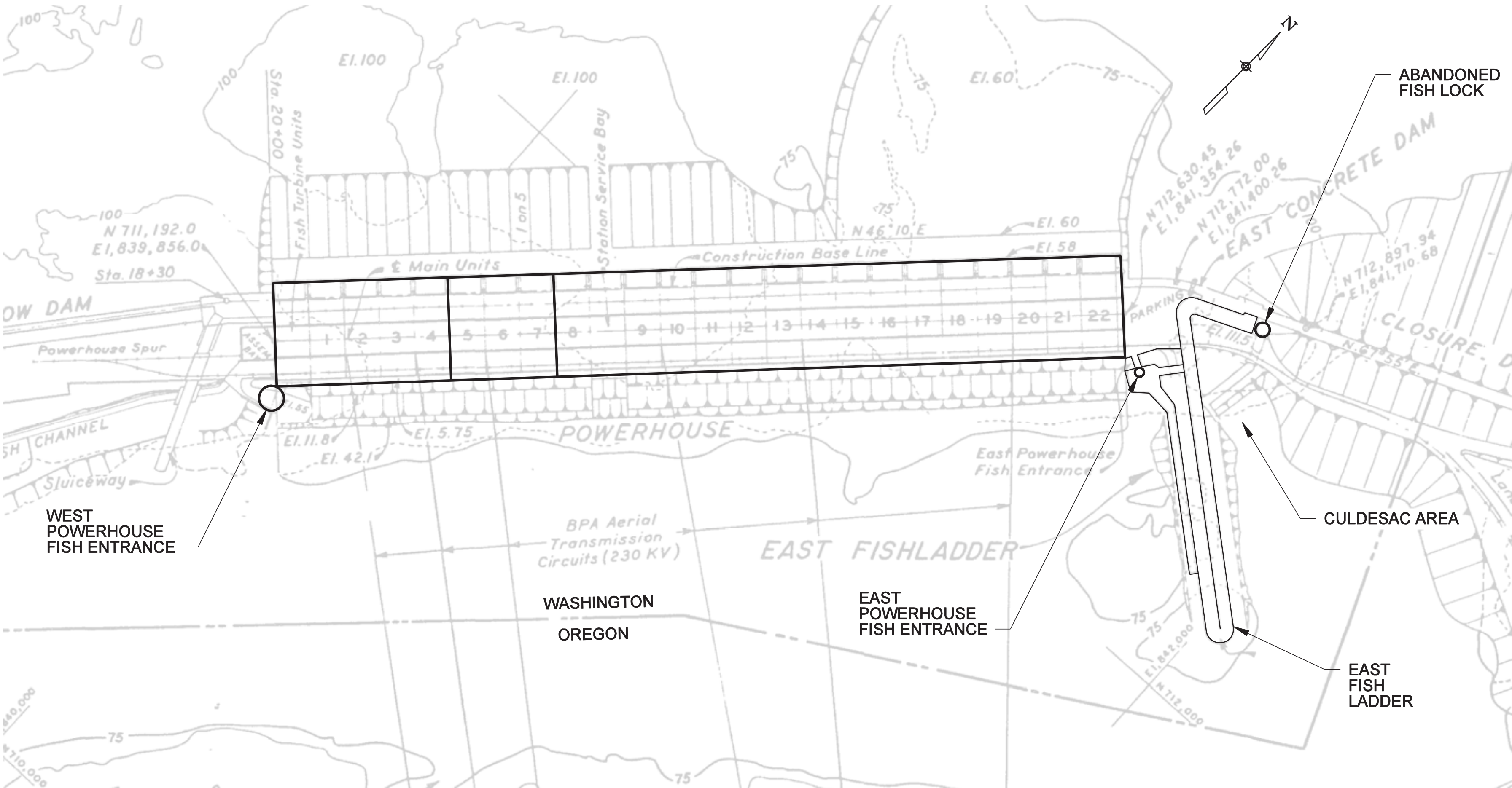
USACE TO #26 - Brainstorming Meeting - December 8, 2010

Criteria for Ranking:

[1]General Scoring:	[2]Est. Construction Time:	[3]Implement/ Switchback Time:	[4] Cost:	[5]Total Scores:
N/A = 0	< 6 months = 4	hours = 4	high = 0	Poor = 8
Poor = 1	6-12 months = 3	days = 3	medium-high = 1	Fair = 16
Fair = 2	12-18 months = 2	weeks = 2	medium = 2	Good = 24
Good = 3	18-24 months = 1	months = 1	low-medium = 3	Excellent = 32
Excellent = 4	24+ months = 0		low = 4	

Alternatives			Rated Item	Rated Item	Rated Item	Rated Item	Rated Item	Rated Item	Rated Item	Rated Item			
								Post Construction					
o.	Description	is Passage e uire ents	is genc iological Concerns[1]	Esti ated Construction i e[2]	I ple ent Switc ac i e	Cost[4]	Constructa ilit [1]	Disruption to Pro ect Operations[1]	elia ilit [1]	Maintenance spects[1]	Miscellaneous Concerns	otal Score	an ing
1	**Siphon for Additional Water to the Fish Lock** (pipe or use existing adit)	Fish screens need to be considered for siphon intakes	3	2	4	4	3	4	3	3	- Rehab fish lock - Priming pump - Exercise valves	26	3
2	**River Wet Tap** (boring tunnels under dam to increase water to Fish Lock)	Fish screens need to be considered for siphon intakes	3	1	4	0	2	4	4	4	- Deep water intake (lamprey) - Construction - mining under dam into water, dam safety	22	8
3	**Ice Trash Sluice Water Tap** (either below or along side)										- Not rated due to biological and physical constraints		
4	**Fish Lock Direct Tap to Reservoir Forebay**	Fish screens required	3	2	4	2	3	4	4	4	- Dam safety - mining through dam - Underwater construction	26	5
5	**Install Concrete Lid on Open Channel Fishway**										- Not rated - use as a potential component with Alternatives 1, 2, and 4.		
6	**Tainter Gate # 23** (modify stoplogs with a pipe to AWS culvert)	Fish screens required	3	2	2	2	3	2	3	3	- Assumes screen is part of fabricated unit.	20	9
7	**New Third Fish Turbine** (with maximum flow of 5,000 cfs ; federally owned and operated)	Fish screens or mitigation may be required depending on depth of intake	3	0	4	0	0	4	3	1	- Time to construct - Major disruption to overall operations during construction - Buy in from NW Power Council	15	11
8	**Pipe(s) to AWS Culvert** (using existing 8' x 8' opening; full length pipe)	Fish screens	3	1	4	3	3	4	4	4	- Energy dissipation - Isolate east entrance - Exercise valves	26	4
9	**Remove Flow Restrictions on Current System** (at fish lock and downstream)										- Not rated - use as a potential component for Alternatives 1, 2, 4, and 5.		
10	**Single Pump/Pumphouse on East Side** (cul de sac area)	Fish screens will be required based on depth variables	2	0	4	0	3	4	1	0	- Sturgeon in cul de sac (spawning or congregation area?) predator issues - Constructed in the wet -Some minimal power use - High maintenance	14	12
11	**Upstream Intake Tower with Siphon**	Assumes no screens needed	2	1	4	2	3	4	3	3	- 'Predator habitat	22	7



PLAN VIEW
NOT TO SCALE

US Army Corps of Engineers® Portland District

PLAN VIEW
POWER HOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

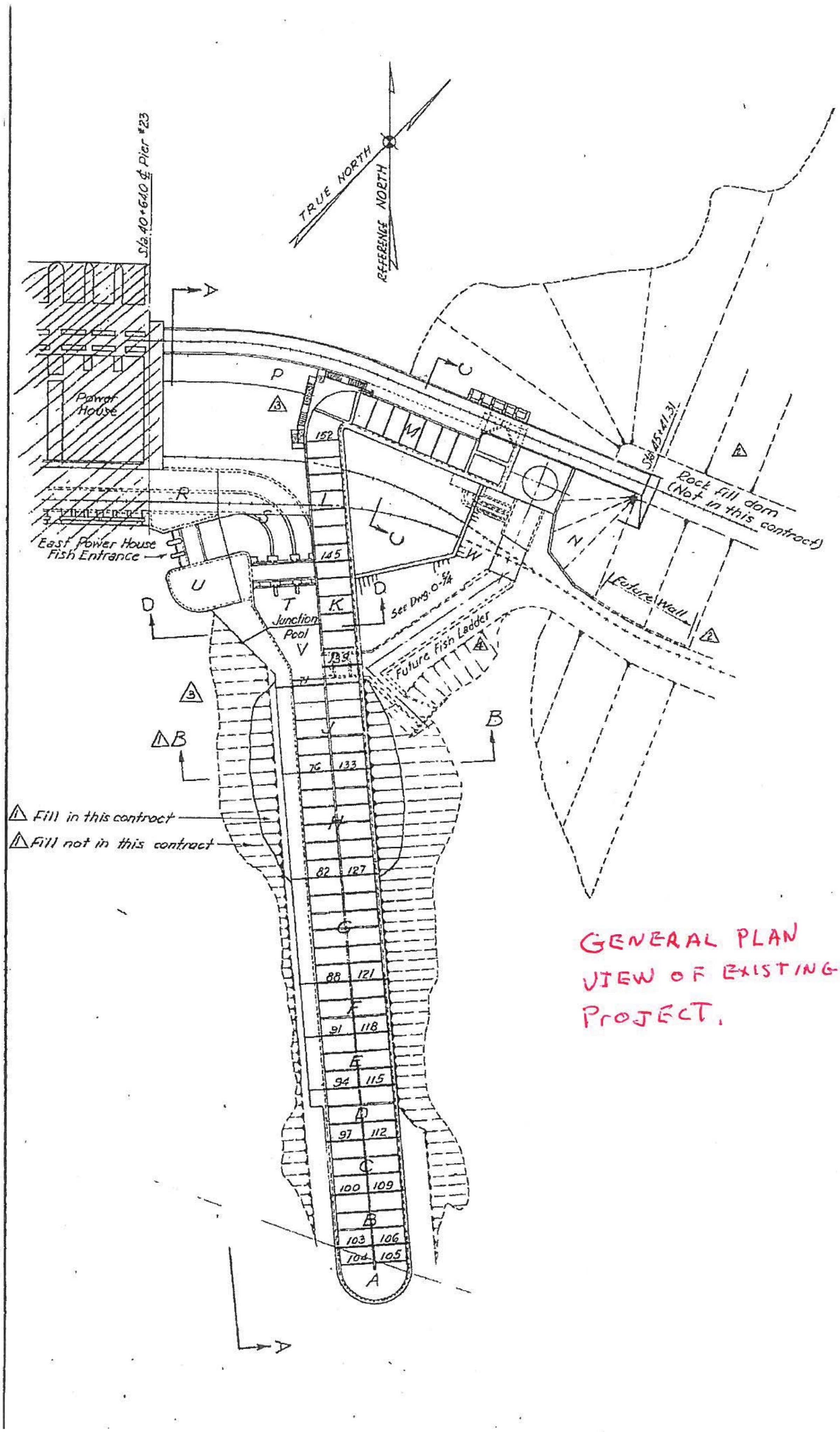
HDR ENGINEERING INC.

DESIGNED BY: RCM		DATE: December 15th, 2010
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 02
SIZE: 17X11	FILE NAME: 147341-S02.DGN	

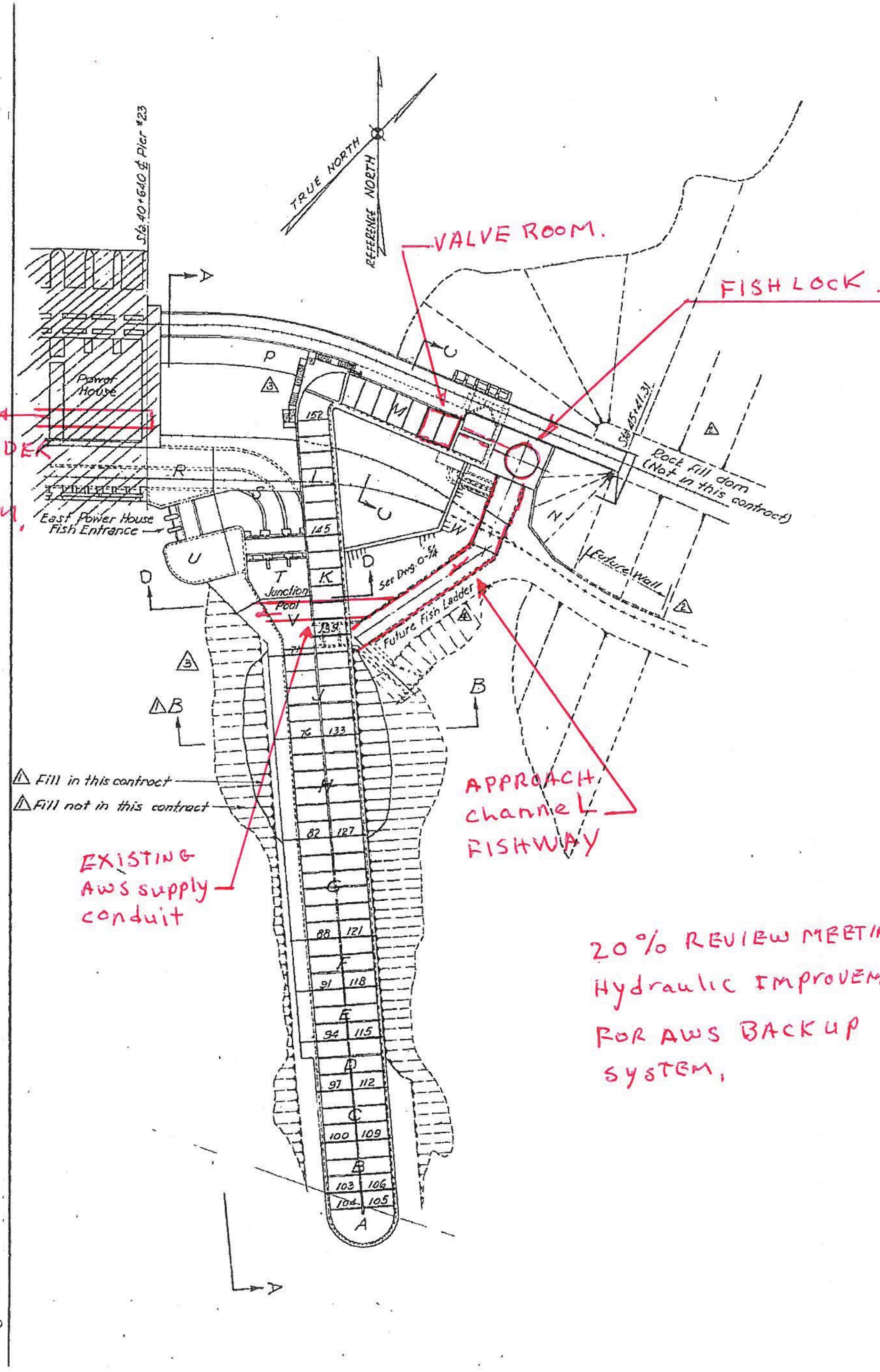
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM
BACKUP LETTER REPORT

SHEET IDENTIFICATION
02
SHEET 2 OF 2

DATE AND TIME PLOTTED: $$$DATE$$$$ $TIME
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW POWER HOUSE
DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\

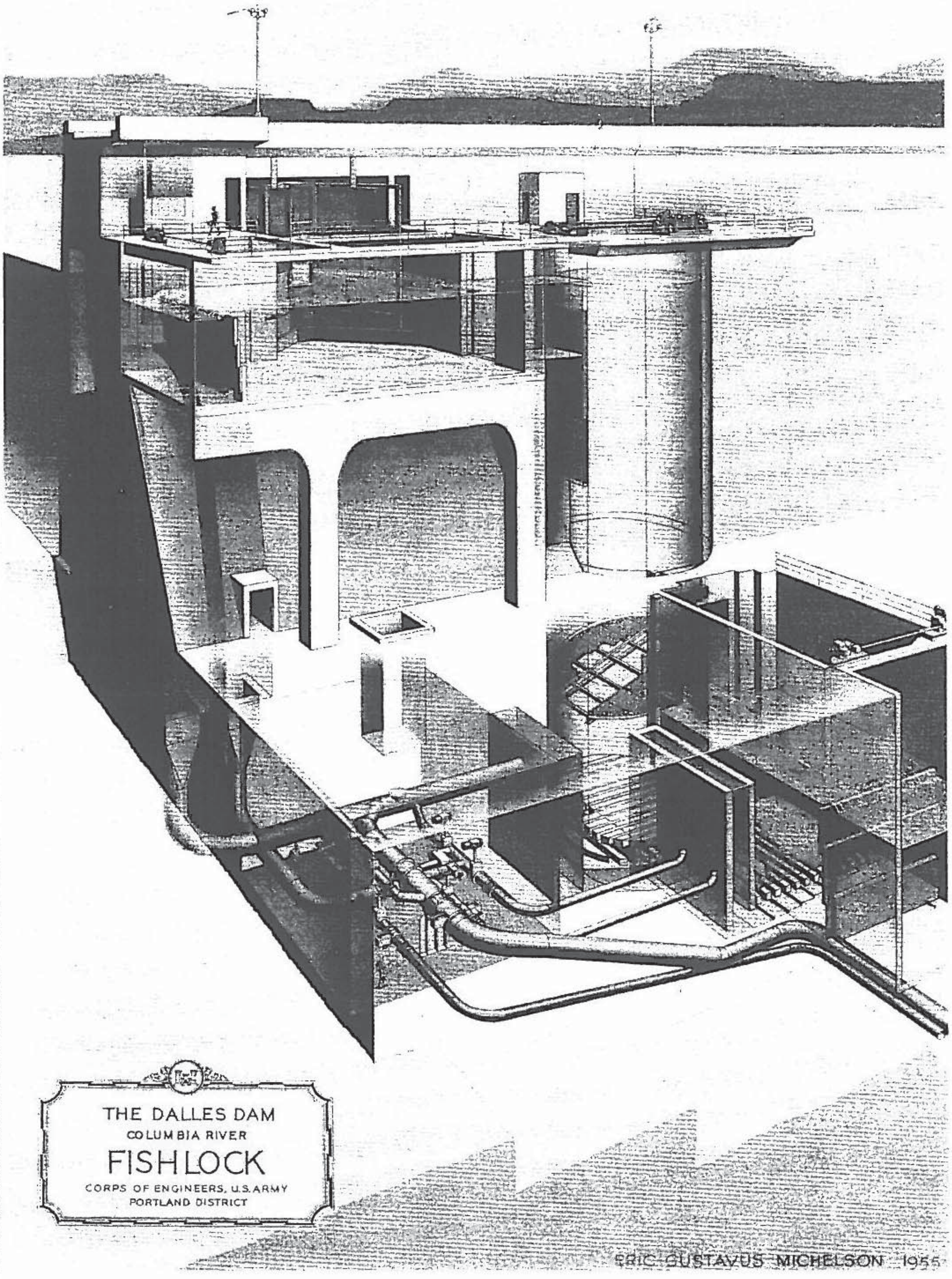


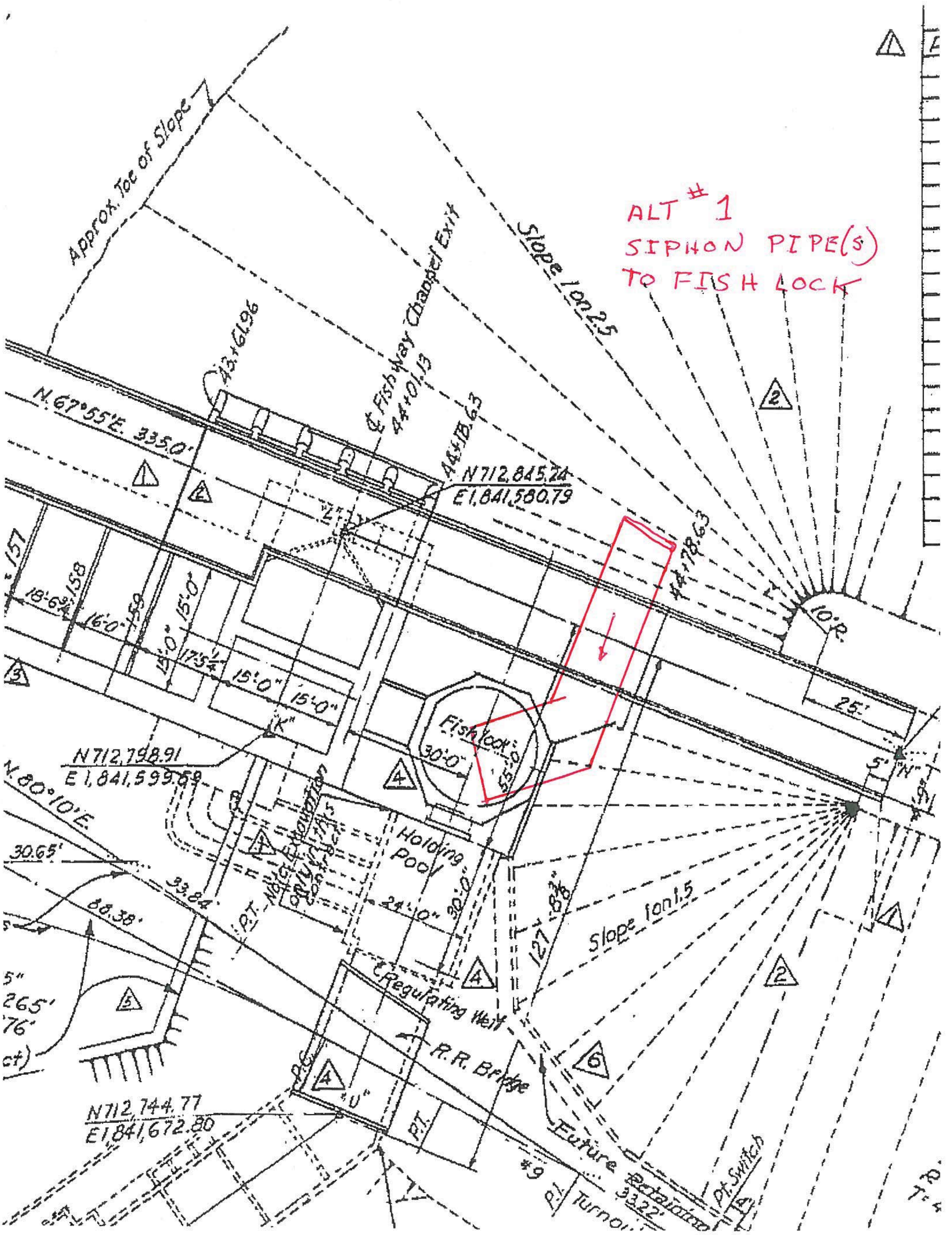
GENERAL PLAN VIEW OF EXISTING PROJECT.

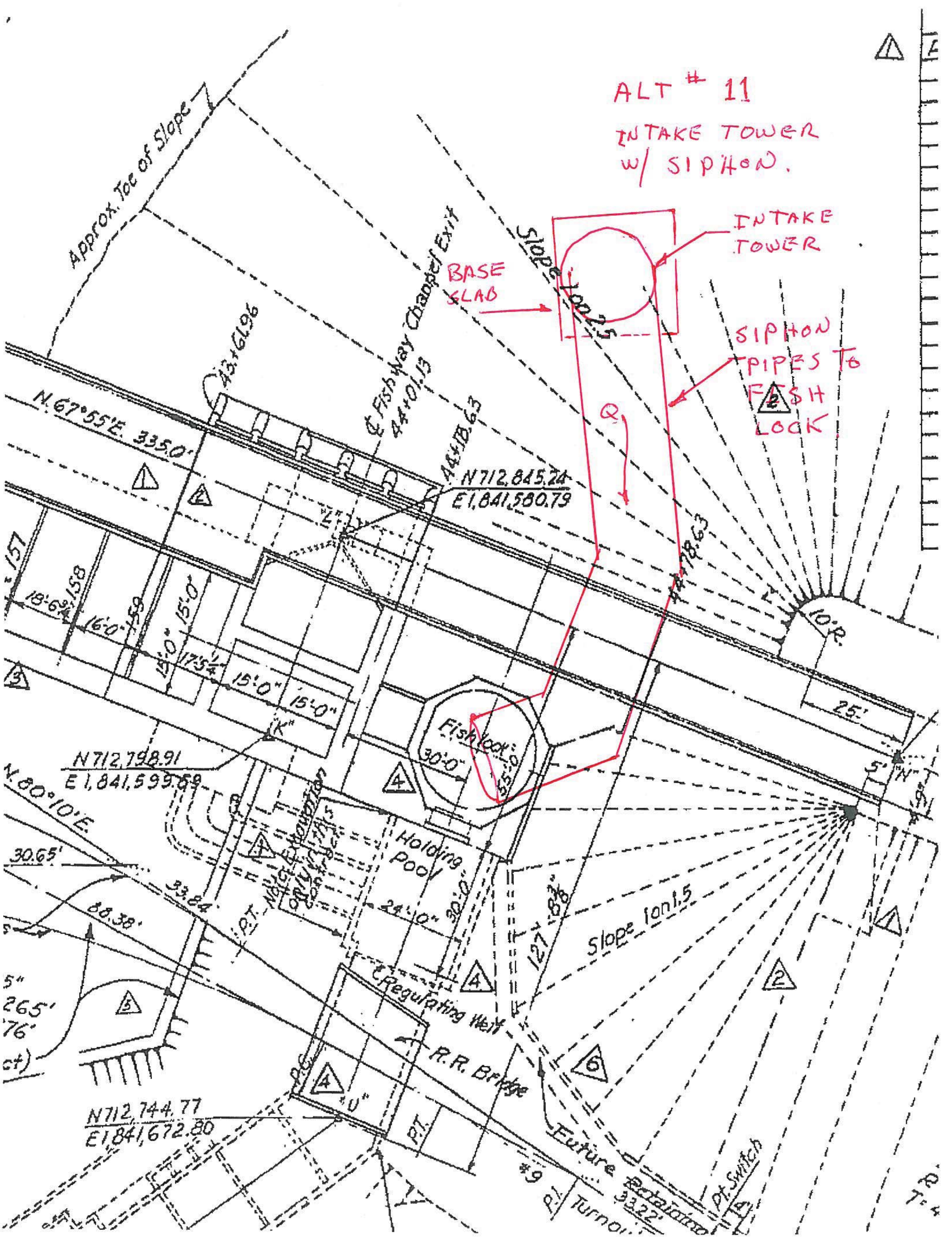


20% REVIEW MEETING.
Hydraulic Improvements
FOR AWS BACKUP
SYSTEM.

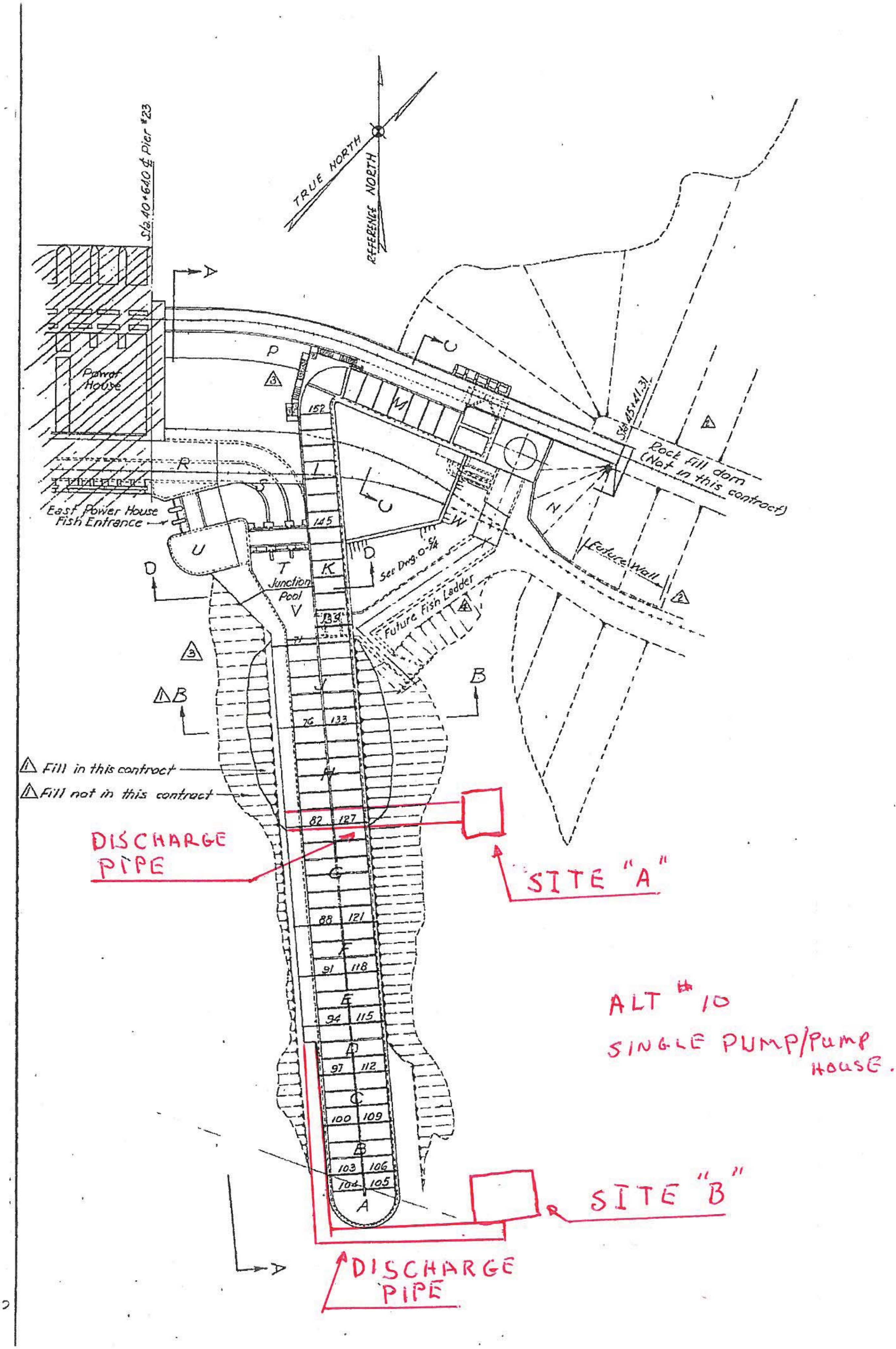
THE DALLES DAM - FISH LOCK
Corps of Engineers, Portland District



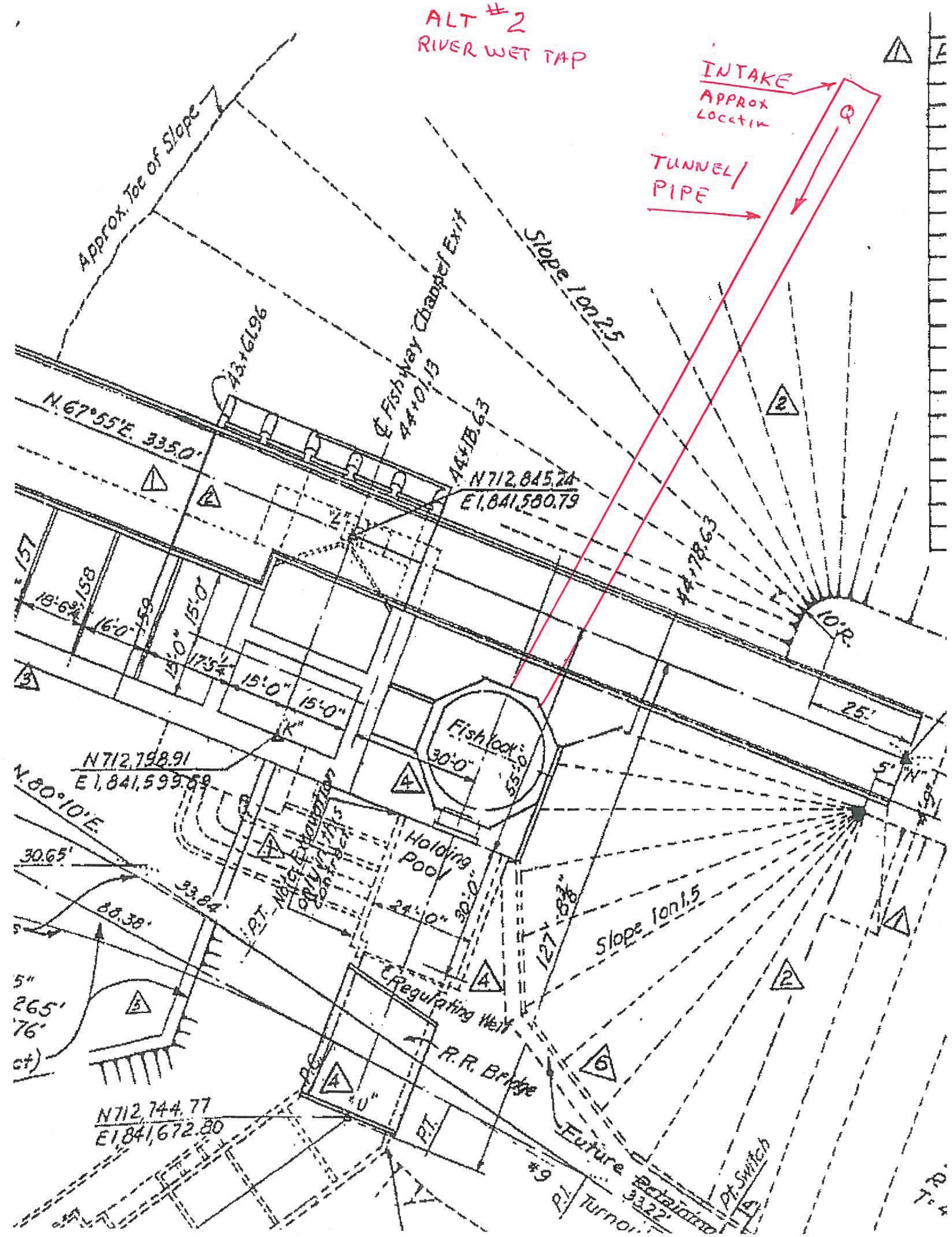

ALT # 1
SIPHON PIPE(S)
TO FISH LOCK
Approx. Toe of Slope
Slope 1 on 2.5
℄ Fishway Channel Exit
44+01.13
43+61.96
44+78.63
N 67°55'E. 335.0'
N 712,845.24
E 1,841,580.79
N 712,798.91
E 1,841,599.59
N 80°10'E.
Fish lock
30'-0"
55'-0
10'R.
25'
Holding Pool
24'-0"
30'-0"
15'-0"
17'-5 1/4"
16'-0"
18'-6 3/4"
30.65'
33.84'
88.38'
127'-8 3/8"
Slope 1 on 1.5
℄ Regulating Weir
R.R. Bridge
Future Retaining
N 712,744.77
E 1,841,672.80
P.C.
P.T.
P.I.
Turnout
33.22'
Pt. Switch
#9



ALT # 11
INTAKE TOWER w/ SIPHON.
INTAKE TOWER
BASE SLAB
SIPHON PIPES TO FISH LOCK
Q
Approx. Toe of Slope
Slope 1 on 2.5
¢ Fishway Channel Exit 44+01.13
43+61.96
44+18.63
N.67°55'E. 335.0'
N712,845.24
E1,841,580.79
N712,798.91
E1,841,599.69
N712,744.77
E1,841,672.80
N.80°10'E.
30.65'
33.84
88.38'
Fish lock
30'-0"
35'-0"
Holding Pool
24'-0"
30'-0"
15'-0"
17'-5 1/4"
16'-0"
18'-6 3/4"
¢ Regulating Weir
R.R. Bridge
Future Retaining
Slope 1 on 1.5
127+83
10'R.
25'
44+18.63
P.I.
Turnout
33.22'
Pt. Switch
#9
P.C.
P.T.



Sta. 40+64.0 ℄ Pier #23
TRUE NORTH
REFERENCE NORTH
Power House
East Power House Fish Entrance
Junction Pool
Future Fish Ladder
Future Wall
Rock fill dam (Not in this contract)
Sta. 45+41.31
See Dwg. O-74
Fill in this contract
Fill not in this contract
DISCHARGE PIPE
SITE "A"
SITE "B"
DISCHARGE PIPE
ALT # 10
SINGLE PUMP/PUMP HOUSE.



ALT #2
RIVER WET TAP
INTAKE
APPROX LOCATION
TUNNEL/PIPE
Q
Approx. Toe of Slope
Slope 1 on 2.5
¢ Fishway Channel Exit
44+01.13
43+61.96
44+18.63
44+78.63
N.67°55'E. 335.0'
N712,845.24
E1,841,580.79
N712,798.91
E1,841,599.69
N712,744.77
E1,841,672.80
N.80°10'E.
30.65'
33.84
88.38'
18'-6¾"
16'-0"
15'-0"
17'-5¼"
15'-0"
15'-0"
Fishlock
30'-0"
55'-0"
Holding Pool
24'-0"
30'-0"
127'-8¾"
Slope 1 on 1.5
10'R.
25'
5'
"N"
"K"
"L"
"U"
¢ Regulating Weir
R.R. Bridge
Future Petaluma
P.T.
P.C.
Pt. Switch
P.I.
#9 Turnout
33.22'

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60 ED eview and Iternatives an ing Matri Meeting Minutes

Subject:	Minutes for the 60% EDR Review and Alternatives Ranking Matrix Meeting
Client:	U.S. Army Corps of Engineers
Project:	The Dalles East Fish Ladder Auxiliary Water System Backup, 60% Review Meeting — Project No: 000000000171578
Meeting Date:	February 7, 2012 — Meeting Location: HDR, Mountain Rooms
Notes by:	Jennifer Switzer/Ron Mason

ttendees

Ron Mason, HDR	Nina Sass, HDR	Karen Kuhn, USACE
Jennifer Switzer, HDR	David Ward, HDR	Sean Tackley, USACE
Rich Hannan, HDR	Lisa Larson, NHC (via phone)	Bob Cordie, USACE
Kristi Nelson, HDR	Randy Lee, USACE	Rick Reiner, USACE
Pete Gaby, HDR	Jeff Ament, USACE	Rick Russell, USACE

opics Discussed

✓ Introductions by Team Members and sign-in	Randy Lee/Ron Mason/All
✓ Purpose of the Meeting and Overall Objectives	Randy Lee / Ron Mason
✓ Review of the Alternatives	HDR Technical Team Members / R. Lee/R. Mason
✓ Discussion and completion of matrix	Ron Mason
✓ Review Comments on 60% EDR	Ron Mason / Randy Lee
✓ Project Schedule	Ron Mason / Randy Lee
✓ Action Items from Meeting	All

OPENING STATEMENT/INTRODUCTIONS

Ron Mason welcomed everyone to the 60% Report Review and Alternative Ranking Matrix Meeting. He began by going over the meeting's agenda which includes:

- Goal of meeting to finalize alternative ranking matrix (USACE not yet met to discuss and rank alternatives)

Randy Lee said he thought the project was on track to get report done on-time.

Introductions around the table were done next.

Overview of today's meeting:

- HDR ranked the alternatives and included its alternatives ranking matrix in the 60% review report. Want joint team process to share ideas and come up with a collaborative alternatives ranking matrix.
- Expected Reliability was added to alternatives ranking matrix in final moments of 60% report preparation, but each alternative was given a ranking of "1" as a placeholder only. Not a true ranking completed for Expected Reliability.
- Review alternatives. Everyone should have access to the 60% Design report in DrChecks (report submitted 25 January 2012)
- All comments need to be put into DrChecks. R. Lee said this was an easy task for USACE reviewers, but S. Tackley said he would take other agency comments and upload them to DrChecks. R. Lee stated 15 February 2012 is the deadline for review comments (perhaps a day or two after that, but no later than the 17th). He said if anyone does not have access to DrChecks to let him know and he will request access. J. Switzer, HDR, will download DrChecks comments.

R. Mason: The onus will fall on the USACE to determine which two alternatives to take to the 90%design level; however, he expects the group to reconvene at the 90% level to discuss selection of the final proposed alternative.

Question: What agency comments have been solicited? S. Tackley – report has been sent out to other agencies. R. Lee stated this is a USACE project and although the USACE does not want to work in a vacuum, ultimately, the recommendation for a solution is a USACE decision. S. Tackley stated he is communicating with other agencies and comments he's received as of Friday seem to be going in the same direction as the USACE.

R. Mason projected an alternatives overview map and gave a review of each alternative stating that the valve room improvements are expected to provide 400 cfs while the four alternatives have been designed to meet 1,000 cfs for a total of 1,400 cfs (design discharge). Without the valve room improvements, every alternative would need to be upsized to meet the design discharge of 1,400 cfs.

USACE Fishlock Flow Test

R. Reiner/B. Cordie shared a test they recently ran at The Dalles Dam which could provide additional flow for minimal cost:

- Attempted to open the two pipes (42-inch and 36-inch) in the valve room.
- 36-inch pipe clogged
- Able to open 42-inch pipe
- Test sent water through the fishlock, approach channel and two open gates into the conduit between the fishlock approach channel and the AWS where it would flow through diffusers into the junction pool, the entrance and ladder pools
- Straight through valve room, some obstructions up to the fish cassion (fishlock), the two existing gates serve as large flow obstruction. Took readings and determined 8-foot head loss from fishlock to head at fish entrance
- Gate at downstream side of fishlock – unusual (bulky, difficult to access). Water flow comes up in front of and over gate. Gates rise up to seal
- Butterfly valve (not complete seal – old and rubber seal gone).
- Fishlock or Caisson = water holding mechanism
- Original operation - Silo flooded with water, brail transports fish up to higher elevation where they can exit to the forebay

- Some equipment needs to be removed (wire rope, gear boxes, etc.) to work as emergency water
- Previous run, the water came out into the cul-de-sac. 42-inch valve test showed about 200 cfs @ 85.5 elevation (91.5 – stop log elevation)
- #2 and #4 gates in fishlock approach channel were open for test
- Cassion, approach channel, #2 and #4 diffuser valves – water was screaming by, through water conduit through opening of culvert, filled culvert area (junction pool)
- Experienced 6-8" of silt in the water conduit at upper end and 2" diameter rock sediment at far end of water conduit when gates and conduit were being inspected prior to test
- 1st test, butterfly valve closed (w/leakage) then ran a test flow for one day ~ 300 cfs
- Only opened 2 diffuser gates, #2 and #4 (the rest of the diffusers were unable to get open).
- Adjusted entrance weir to get a biologically acceptable differential and reasonable entrance depth (Elevation tailwater-Elevation entrance weir).
- Operated E3 – no calculated flow just head and depth
- West and South entrance closed, but diffusers to these not closed, and some water movement observed flowing towards East entrance through Transportation and Collection channel
- Turbidity which came from the 8' x 8' culvert was gone after testing had run awhile

Question: Were you able to open/close the south and west fish entrances?

B. Cordie: Yes. Unable to close 5 of the 8 diffuser valves. Probably just a maintenance issue which should be able to be fixed and not too costly.

- Flow test readings (stage) taken at the following:
    1. E3 weir
    2. 20 feet upstream of E3 weir
    3. Tailrace elevation 30 ft. south of east entrance
    4. Next to cul-de-sac channel (near staff gage)
    5. At fishlock cassion (read water column height)
    6. Outflow of water conduit
    7. South entrance
    8. West entrance
    9. Weir (dial gage) J6
- Visual appearance – very tame, hear little gurgling and see some wire movement

Question: How much flow can you put through water conduits?

L. Larson: Information provided in a table in the 60% report, but it is above 1,400 cfs with diffuser grating leading to the 8' x8' culvert removed

Need to upsize valves in the valve room or will be violating 16 fps maximum velocity.

1,400 cfs will pass through the approach channel will it go through approach channel culvert? Yes, but recommend structural modifications to different gates (4 gates and removal of concrete).

Everything R. Reiner presented has been documented in a report which was emailed to Ron Mason February 6. Mason will disseminate to HDR project team.

Question: In the 60% report, the 400 cfs (valve room improvements) – most effective and most cost effective methods of increasing flow to supplement other alternatives. Were new valves included in cost estimate? R. Hannan asked if the valves would need upsizing. Answer was yes. May need to revisit cost estimate to include valve replacement in valve room. (Note: Cost estimate included upsizing of valves)

- The existing 36-inch pipe is manifold to three 18-inch pipes; the 36 inch pipe does not have a valve.
- The 36-inch pipe was not used during flow test due to blockage.
- L. Larson: confirmed would increase flow by 30%, but start to get high velocities (upward of 40 fps)
- R. Lee/L. Larson 400 cfs – limiting velocities to 25 fps (RL stated this is high)
- K. Nelson: 400 cfs and 16 fps limits would need two, 48-inch valves – which could fit into the valve room.

REVIEW OF THE ALTERNATIVES

Alternative #1 – Siphon for Additional Water to the Fishlock

This alternative proposes the use of two 72-inch steel siphon pipes that will convey water from the forebay (~EL 134 ft.) to the existing fishlock. The fishlock will then discharge into the fishway approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the AWS and through diffusers to the junction pool, entrance and ladder pools.

- No tower – instead run along embankment face through two, 72-inch pipes from EL 134 ft. at entrance to EL 161 ft. as it runs through dam
- Potentially better for lamprey
- Two, 72-inch pipes discharge into fishlock, through approach channel, into culvert, and eventually bubbling up into junction pool, entrance and ladder pools.

Alternative #11 – Intake Tower with Siphon to Fishlock

This alternative requires two, 72-inch siphon pipes that will convey water from an upstream intake tower with low level inlet openings (~EL 100 ft.) to the existing fishlock. The fishlock will then discharge into the fishway approach channel (no longer in use) which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool, entrance and ladder pools.

- Intake tower allows you to draw water from deeper elevation ~ EL100 ft.
- Two, 72-inch pipes – follow exact alignment along the upstream face of dam with pipes at an invert elevation of 161 ft. just above normal forebay elevation of 160.0 ft.
- Deeper intake – minimizing impacts to juvenile salmonid species, but concern for shadow or noise and/or vibration from pipes affecting adult exit as they pass under pipes. There is not a lot of information regarding location or path adults take after exiting fish ladder but is assumed to exit and turn right heading upstream.
-

Alternative #10 – Single Pump/Pump house on East Side of Cul-de-sac Area

This alternative proposes the use of a single pump and pump house. The pump house will be located in the east side of the “Cul-de-sac” with access to the pump house from the north. A vertical axial flow pump was assumed.

- Pumphouse along bankline and hooks up to approach channel

Alternative #2 – Low Level Intake

This alternative proposes the use of two, 72-inch pipes that will convey water from the forebay to the existing fishlock. The fishlock will then discharge into the approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool entrance and ladder pools.

- Pipes through monolith ~ EL 111.5 ft. through gate into fishlock.
- No long pipes in water to vibrate or provide predator habitat like Alt. #1 or #11
- Not pressurized with bulkheads in place
- Elevation 109 ft gave us 1 foot of freeboard at end of approach channel
- Normal pool elevation of The Dalles forebay is between 155 and 160 ft
- Potential dam safety concern as pipes require more coring through monolith needed at EL 111.5 ft

Review of Drawings from 60% EDR:

- Alternative #2 – the pipe intake invert is elevation 111.5 ft
- Alt #10 –The pump outlet discharge pipe (11 ft dia) will discharge into the side of the approach channel. This is a change from the original concept design. Check valves for the 11-foot pipe are commercially available, but will require a special design. 7,000-hp pump is the current design. Junction tower provides constant head during startup and operation. Current design calls for one pump, with a design head of 52-foot. Butterfly valve and sluice gate provided for safety during maintenance. Assumes mechanical trash rake. Run time to keep it exercised includes maintenance weekly to exercise the pump to keep bearings lubed. Also need to operate pump once a month for 30-45 minutes. Heat exchanger and other ancillary units may need some O&M.

  R. Lee – Due to reductions in money and manpower, the USACE, more and more, looks at design, structure, and O&M requirements when making decisions about the direction of a project.

  R. Hannan – Pat Hunter at John Day, said he loves his pumps, but they are turbine pumps and not the same as pump proposed at The Dalles Dam. Bob Cordie said John Day has both turbine (south) and electric (north) pumps, but the electric pumps are being replaced.

  Disadvantages to Pump (Alternative #10) – more costly, more O&M requirements, etc.

  R. Mason stated this is not HDR's preferred alternative, but that it was part of the USACE's scope of work for HDR to evaluate this alternative. Relative to fisheries, the pumphouse is better for juvenile salmonids.

- Alt #11. Intake tower, two, 72-inch siphon pipes, to fishlock.
  - P Gaby said a mechanical trashrake could be used on this alternative

ALTERNATIVES RANKING MATRIX

Once all the alternatives were reviewed, the Alternative Ranking Matrix from the 60% report was discussed and updated with USACE and HDR input. R. Mason explained the 60% report has a draft version of the alternatives ranking matrix as populated by HDR, but was intending to review at today's meeting and update with input from the USACE.

Expected Reliability

Expected Reliability was requested by USACE as an evaluation criterion near the 60% submittal date and as such, a column was added, but only a placeholder of "1" was included across all alternatives. This will be discussed and true values input into the matrix.

HDR alternatives matrix was based on each alternative evaluated on own merit as a stand alone, not evaluated against each other.

During initial review of the alternatives matrix, it was noted that alternative #10 is by far the most expensive alternative at roughly $22 million. The remaining three alternatives are in the $4 to $5 million cost range.

Question: Why are #1 and #11 so close in cost (only $300,000 more for #11) since #11 has an intake tower?

R. Hannan: The intake tower (Alt #11) does not have a coffer dam, it requires foundation work (tremie concrete), and estimated to use prefabricated units for the intake tower. The construction for Alt #1 is more costly to build. Alt #12 requires more in-water work (divers), fabricated pipe along embankment with 1V:2H rock slope.

Electrical availability for alternatives was discussed. Alternatives #1, #11, and #2 would not require high voltage. Alternative #10 would require high voltage.

J. Ament asked if the siphon valves would need to open at the same time (simultaneously)? L. Larson/R. Mason replied yes, will need to be digitally in sync. R. Reiner stated he has real experience with siphons and R. Mason stated the Bureau of Reclamation use siphons a lot for canals (different design parameters), but once turned on, they should work, if not, need to prime again and restart.

Biological Impacts

DW explained why the alternatives received the initial scoring for Biological Impacts. He said since all alternatives draw water from the Columbia River, he was unable to give any alternative a score of 3 or 4. The other following were part of the decision:

- 80-85% of juvenile fish passage is at the spillway
- 15-20% of juvenile fish passage is at the powerhouse either through the ice and trash sluiceway or the turbines (J. Ament said an attraction study showed fish went along the powerhouse to the spillway)
- Alternative #1 may entrain juvenile salmonids and Alternative #2 may impact sturgeon and lamprey.
- B. Cordie stated that the upper level of the water column would be more impactive for fish species.
- S. Tackley agreed with DW – There is a certainty for where salmon will be located, but an uncertainty for where lamprey would be located
- Shallower intakes = noise concern for adult fish exiting fishway.
- Alt #2 and #11 – intakes at same locations (downstream of EFL exist) preferable for adult passage.
- Alt #11 Lower biological impact? ST questioned the foundation size and potential eddy issues?
- Foundation size is approximately 45 feet by 34 feet. Not big, and B. Cordie explained that there is riprap further down which should keep the flow out away from the face of the dam which may help. No flow along powerhouse.
- Pikeminnow will sit in eddy out of high flows and pick off other fish, thus a potential biological impact for Alt. #11. Alternative #1 may entrain juvenile salmonids; whereas Alternative #11 may attract predators. Nature of the potential impact differs, but the scores should be the same for Alternative #1 and Alternative #11.
- R. Lee explained for Alternative #10 there would be no fish screening, just trash rack with ¾-inch spacing.

Impact to Existing Facility

Provided definitions from 60% EDR. Ranking scores were based on the following:

- Alt #1 - Low electrical demands, separate systems that do not affect existing facility

- Alt #2 – drilling through monolith. Pipes on ground may be an impediment to existing parking. R. Reiner: The dam already has little storage and parking space and would hate to see any lost. Discussion regarding raising or lowering (underground) the pipes. Potential impacts to intake level. May require jet flow valve to provide energy dissipation-no wide open flow (glorified gate valve). Assumes free discharge into the atmosphere. For submerged discharge, an evaluation of the jet flow valve will be needed. R. Lee stated B. Cordie and R. Reiner need to confer at the Dam, but HDR needs to proceed as proposed. L. Larson added that anywhere we use energy dissipation valves will need to be looked at and evaluated. R. Lee asked if there would be any impact of water jet against wall or does the water fall to the bottom of the fishlock? B. Cordie asked if the approach channel would be capped. R. Mason stated no.

  Alt #2 (jet flow valves pressurized system, siphons not pressurized) Jet flow valves not used at extreme amount head (designed for 200', the present design uses approximately 40' of head). Did look at other types of valves, but found none.

  R Russell - valves instead of roller gates (bulk head, stop logs, etc.)? L. Larson – intake has a bulkhead.

  R. Hannan/P. Gaby – lower bulkhead (roller gate) to dewater and open valves for inspection.

- Alt #10 – largest amount of O & M requirements. (OPM at The Dalles Dam does not want Alt #10)

Expected Reliability

- Alt #10 - Pump and ancillary components reliability will be reduced if maintenance is not performed
- Alt #11 same as Alt #1

Constructability, Ease of Operations, and Maintenance

Alternative #2

- Constructability - Small coffer dam boring in one in-water season? R. Hannan – yes.
- May be able to use pipes smaller than 72 inches.
- Maintenance – Valves and operating of valves.

Alternative #10

- Constructability – harder to construct due to in-water work.
- Ease of Operations – trash rake, one person to open valve and push a button. Electricity – tapping off main units. Close to bankline and add new substation in cul-de-sac area.

Alternative #11

- Constructability – Alt #1 is harder than #11 even though #11 is deeper due to the use of barges
- Discussed the possibility of stacking the two, 72-inch pipes. May be possible, but would have an increased construction cost and possible shadowing impact for fish movement.

The ranking scores for Biological Impacts for Alternatives #1 and #11 were deemed the same but for different issues:

- Alt #1 – direct entrainment issues

- Alt #11 – predation

Fishlock improvements, valve room – not included in matrix same fee for each alternative (approx. $1+ million). It was requested to have the fishlock/valve room costs added to the alternatives ranking matrix.

USACE Action Items:

USACE Action Items	Responsible Person	Date
USACE comments due on the 60% EDR (in DrChecks)	R. Lee (USACE reviewers)	15 Feb 2012
Selection of two alternatives to take to 90% level	R. Lee	21 Feb 2012

HDR Action Items:

HDR Action Items	Responsible Person	Date
90% EDR submittal	HDR Project Team	04 April 2012
Provide access to The Dalles Fishlock Flow Test – January 2012	R. Mason	Done
Send updated Alternatives Ranking Matrix to Randy Lee/Sean Tackley	J. Switzer	Done
90% EDR review meeting	R. Mason	TBD

Attachments

60% Review Meeting Sign-In

Alternatives Ranking Matrix

60% EDR Sheets

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USACE TO3 The Dalles EFL AWS Alternatives Ranking and 60% EDR Review Meeting - Sign-In

Please print clearly

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USACE TO #3 The Dalles EFL AWS Backup

Alternatives Ranking Matrix, Updated

7-Feb-2012

Alternatives		Ranked Items						Total Score	Ranking
o.	Description	Constructa ilit	Ease o Operations	Maintenance e uire ents	iological I pacts	I pact to E isting acilit	E pected elia ilit		
1	**Siphon for Additional Water to the Fishlock**	2.5	3	2.5	2	4	.	**17.5**	**2**
2	**Low Level Intake**	3	4	**3.5**	2.5	2.5	4	**19.5**	**1**
10	**Single Pump/Pump House on East Side of Cul-de-sac Area**	**2**	**3**	**0.5**	1	2	1.	**10**	**4**
11	**Intake Tower with Siphon to Fishlock**	2.5	3	2.5	2	.	.	**17**	**3**

Cost(s)				Total Costs
Construction	Operational	Maintenance	Valve oo I prove ents	
$4,554,601	$48,195	$238,000	$1,078,305	**$5,919,101**
$3,907,953	$48,195	$238,000	$1,078,305	**$5,272,453**
$19,811,100	$207,803	$1,958,400	$1,078,305	**$23,055,608**
$4,892,200	$48,195	$238,000	$1,078,305	**$6,256,700**

Matrix Assumptions:
1. Score: Poor = 1; Fair = 2; Good = 3; Excellent =4
2. Title for alternative numbers taken from Brainstorming Session
3. Operational Costs assume 1 year for operation
4. Maintenance Costs for 50 years.
5. Start up time for all alternatives is less than 24 hours, therefore this item was not included in the ranking system.
6. If more than one alternative has the same Ranking Score, higher ranking given to alternative with lowest Cost.

Note(s):
* Operational costs for Alternative 10 do not include electrical costs for operating the pump.
** Valve Room Improvements are the same for all alternatives

8.0 S EE S

S eet 1. eneral La out o ll lternatives S ow low

S eet 2. Plan View, lternative 1 Sip on or dditional ater to is loc

S eet . Section View, lternative 1 Sip on or dditional ater to is loc

S eet 4. Detail, lternative 1 Sip on or dditional ater to is loc

S eet . Plan View, Low Level Inta e

S eet 6. Section View, Low Level Inta e

S eet 7. Detailed View, Low Level Inta e ras rac and Co erda

S eet 8. Plan View, lternative 10 Single Pu p Pu p ouse

S eet . Section Views, lternative 10 Single Pu p Pu p ouse

S eet 10. Section Views and Details, lternative 10 Single Pu p Pu p ouse

S eet 11. ridge Details, lternative 10 Single Pu p Pu p ouse

S eet 12. Plan View, lternative 11 Inta e ower wit Sip on to is loc

S eet 1 . Section Views, lternative 11 Inta e ower wit Sip on to is loc

S eet 14. Detailed Views, lternative 11 Inta e ower wit Sip on to is loc

S eet 1 . Inta e ower, lternative 11 Inta e ower wit Sip on to is loc

S eet 16. eneral Plan and Pro ile

S eet 17. is loc pproac C annel Modi ications Plan and Section

S eet 18. lternatives 1 and 11 Electrical One Line Diagra s

S eet 1 . lternative 2 Electrical One Line Diagra s

S eet 20. lternative 10 Electrical One Line Diagra

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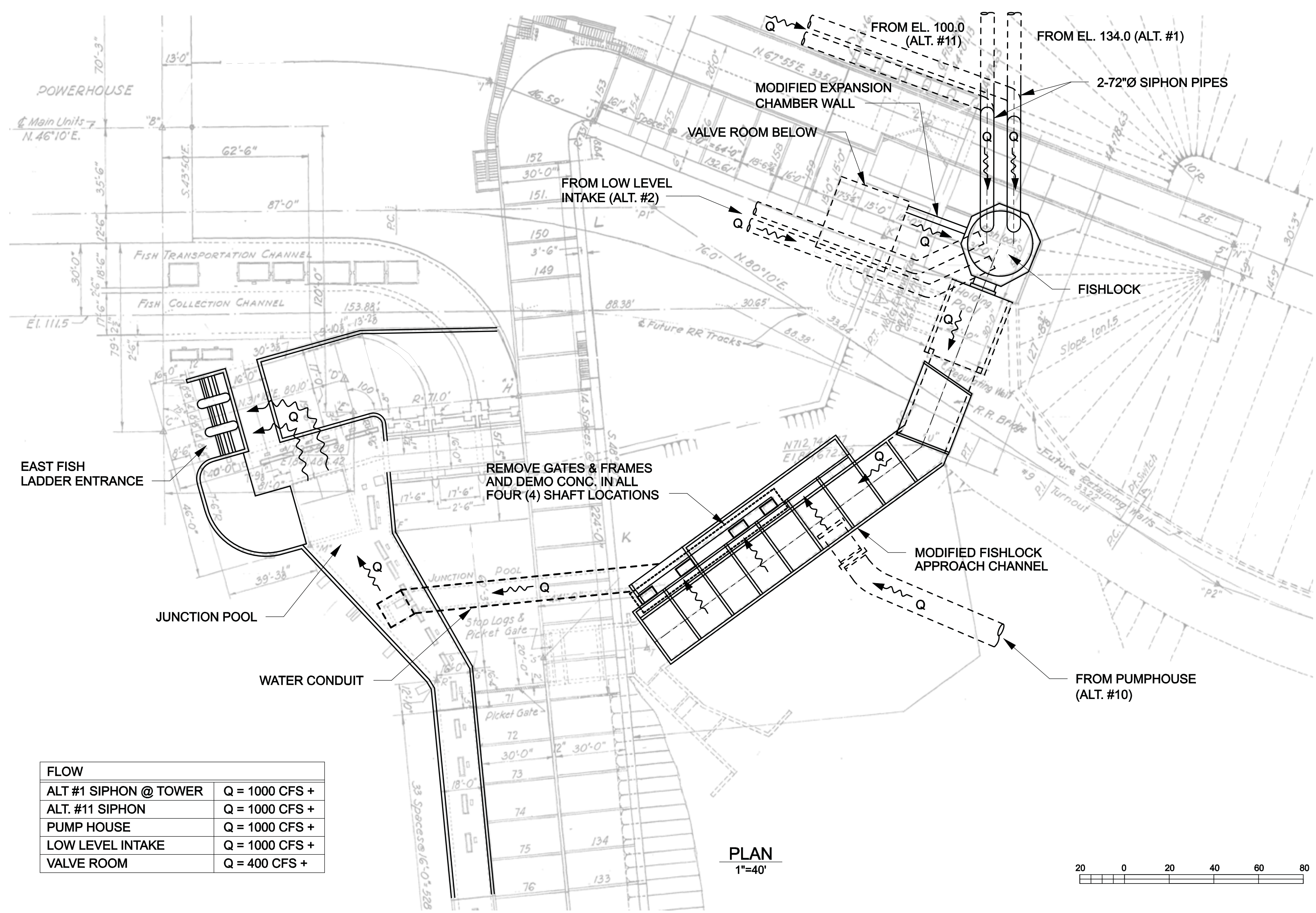


FLOW	
ALT #1 SIPHON @ TOWER	Q = 1000 CFS +
ALT. #11 SIPHON	Q = 1000 CFS +
PUMP HOUSE	Q = 1000 CFS +
LOW LEVEL INTAKE	Q = 1000 CFS +
VALVE ROOM	Q = 400 CFS +

US Army Corps of Engineers®
Portland District

GENERAL LAYOUT OF ALL ALTERNATIVES
SHOW FLOW

DESIGNED BY: RCM | DATE: January 25, 2012
DWN BY: TTN | CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: NTS | PLOT DATE: | DRAWING NUMBER: 1
SIZE: 17X11 | FILE NAME: S01-Typical Flow Path Plan View.DGN

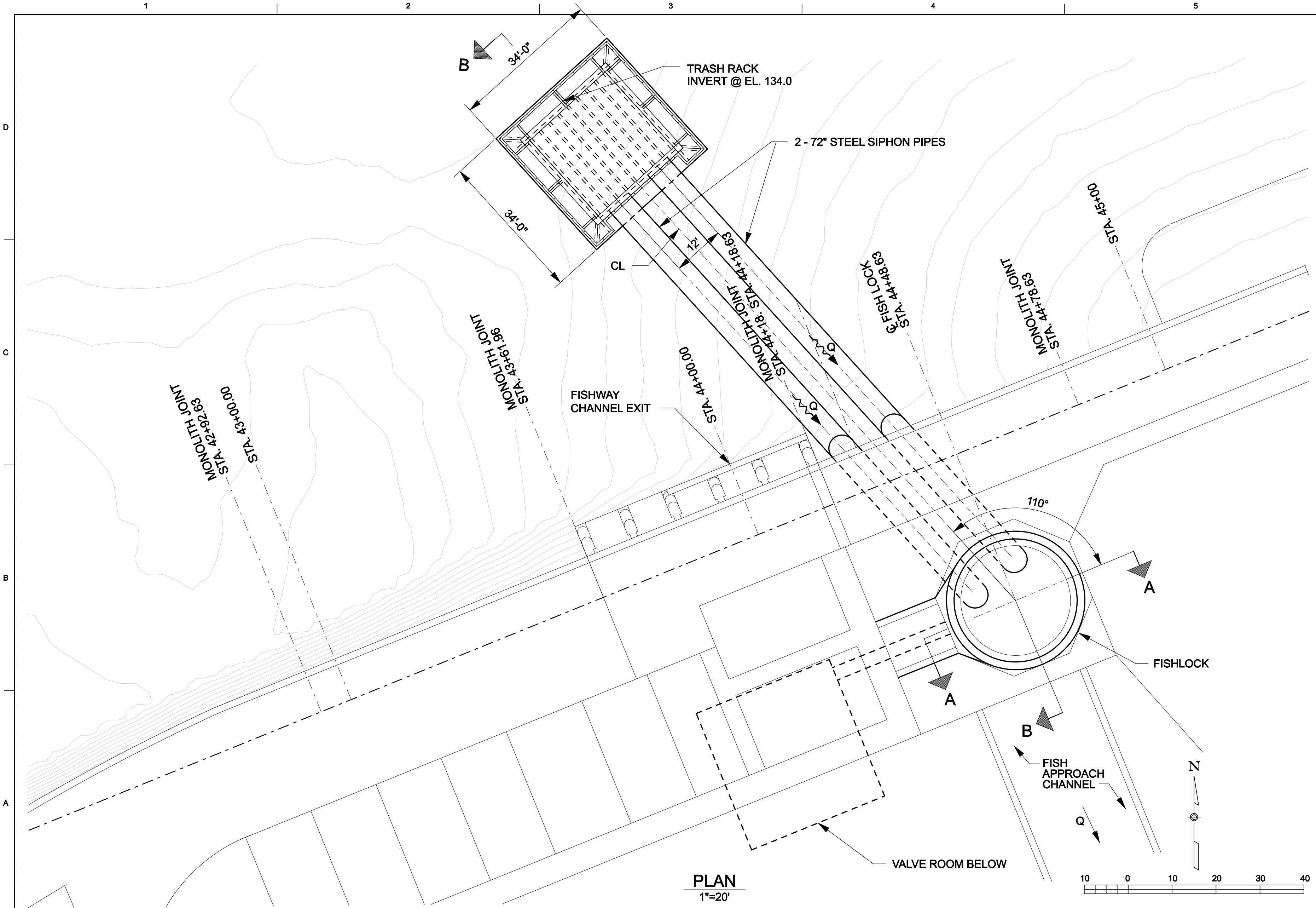
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
1
SHEET 1 OF 20

DATE AND TIME PLOTTED: 1/24/2012 3:55:17 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: TYPICAL FLOW PATH - GENERAL PLAN VIEW
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1"=20'

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #1
SIPHON FOR ADDITIONAL WATER TO FISH LOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

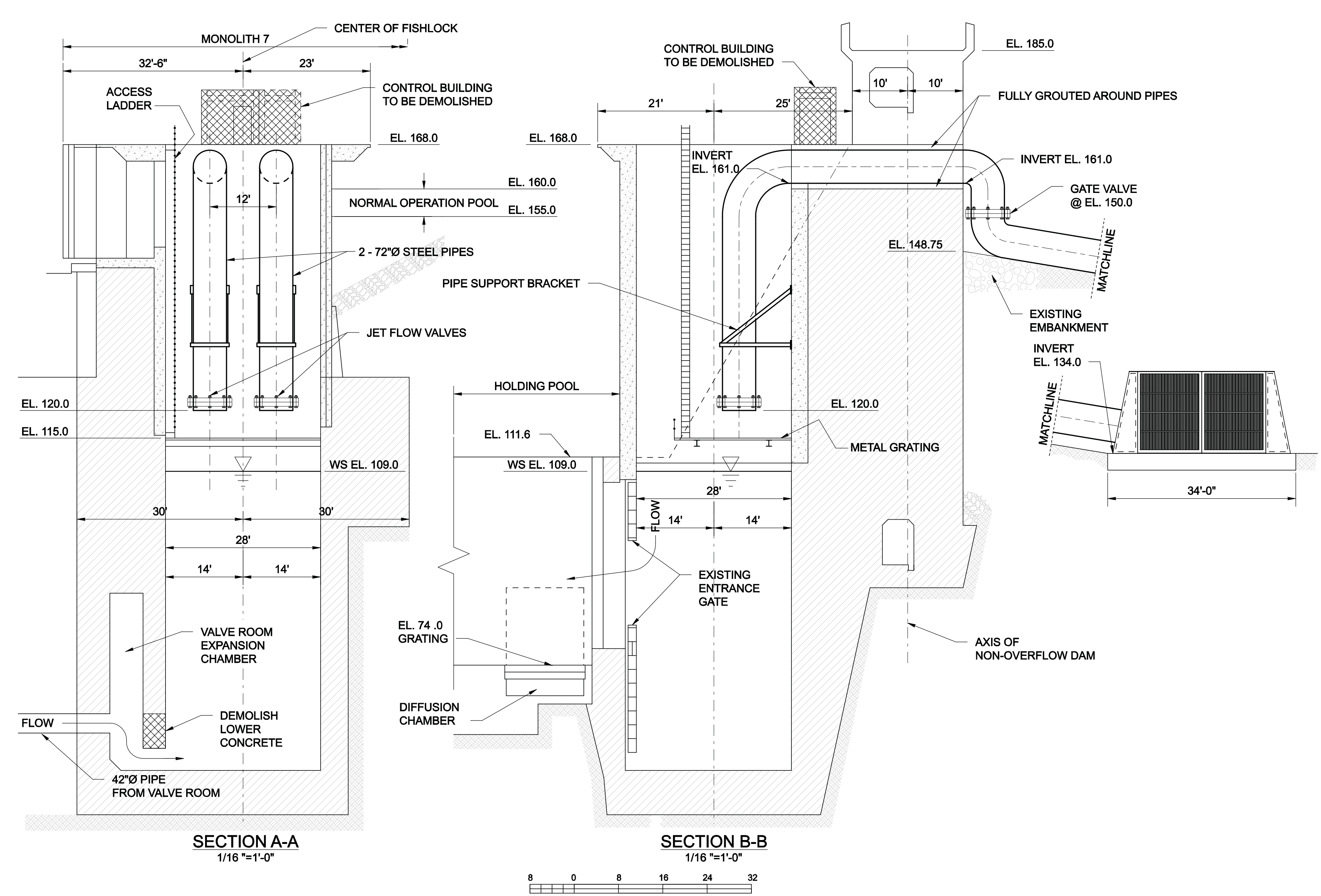
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 2
SIZE: 17X11	FILE NAME: S02-Siphon Alt 1 Plan.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
2
SHEET 2 OF 20

DATE AND TIME PLOTTED: 1/24/2012 4:01:44 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #1
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



US Army Corps of Engineers® Portland District

SECTIONS
ALTERNATIVE #1
SIPHON FOR ADDITIONAL WATER TO FISHLOCK

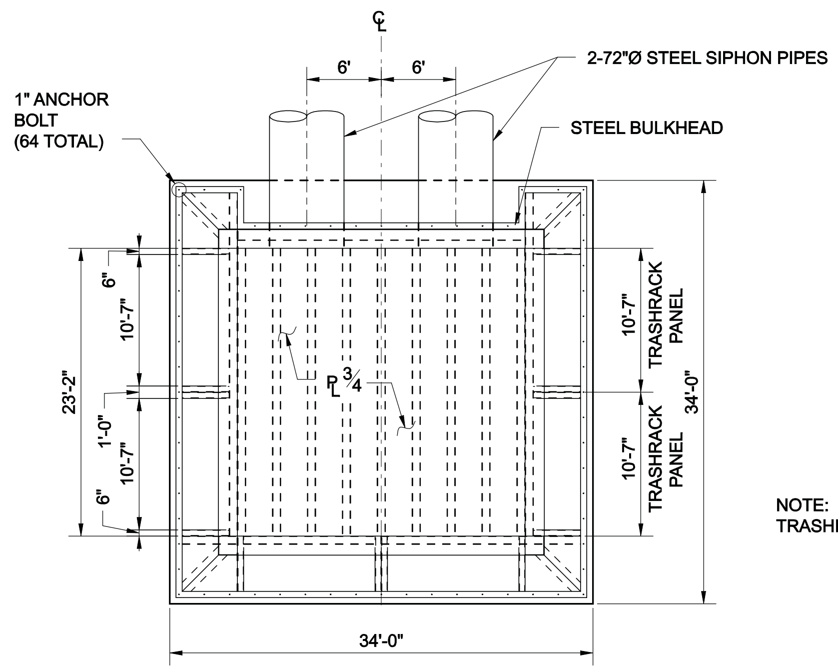
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING, INC.

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 3	
SIZE: 17X11	FILE NAME: S02-Siphon Alt 1 Section.dgn

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

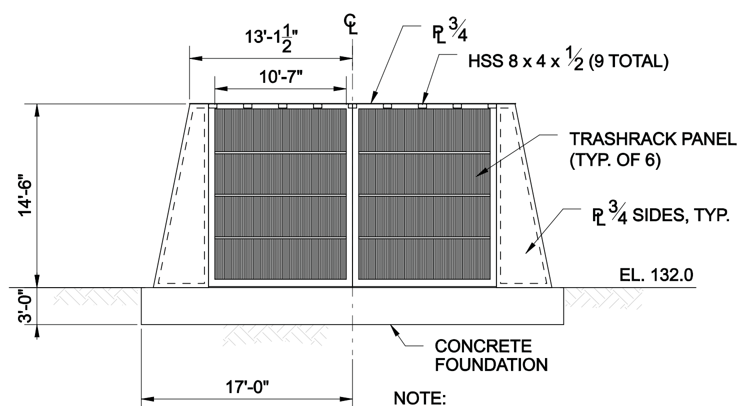
SHEET IDENTIFICATION
3
SHEET 3 OF 20



PLAN

1"=10'

NOTE:
TRASHRACK BARS NOT SHOWN FOR CLARITY.



NOTE:
TRASHRACK IS SYMM. ABOUT CL

ELEVATION

1"=10'

NOTE:
TRASHRACK PANELS ARE ALL ONE SIZE,
SAME AS LOW LEVEL INLET.

5 0 5 10 20 30

US Army Corps of Engineers® Portland District

ALTERNATIVE #1
SIPHONS FOR ADDITIONAL WATER TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

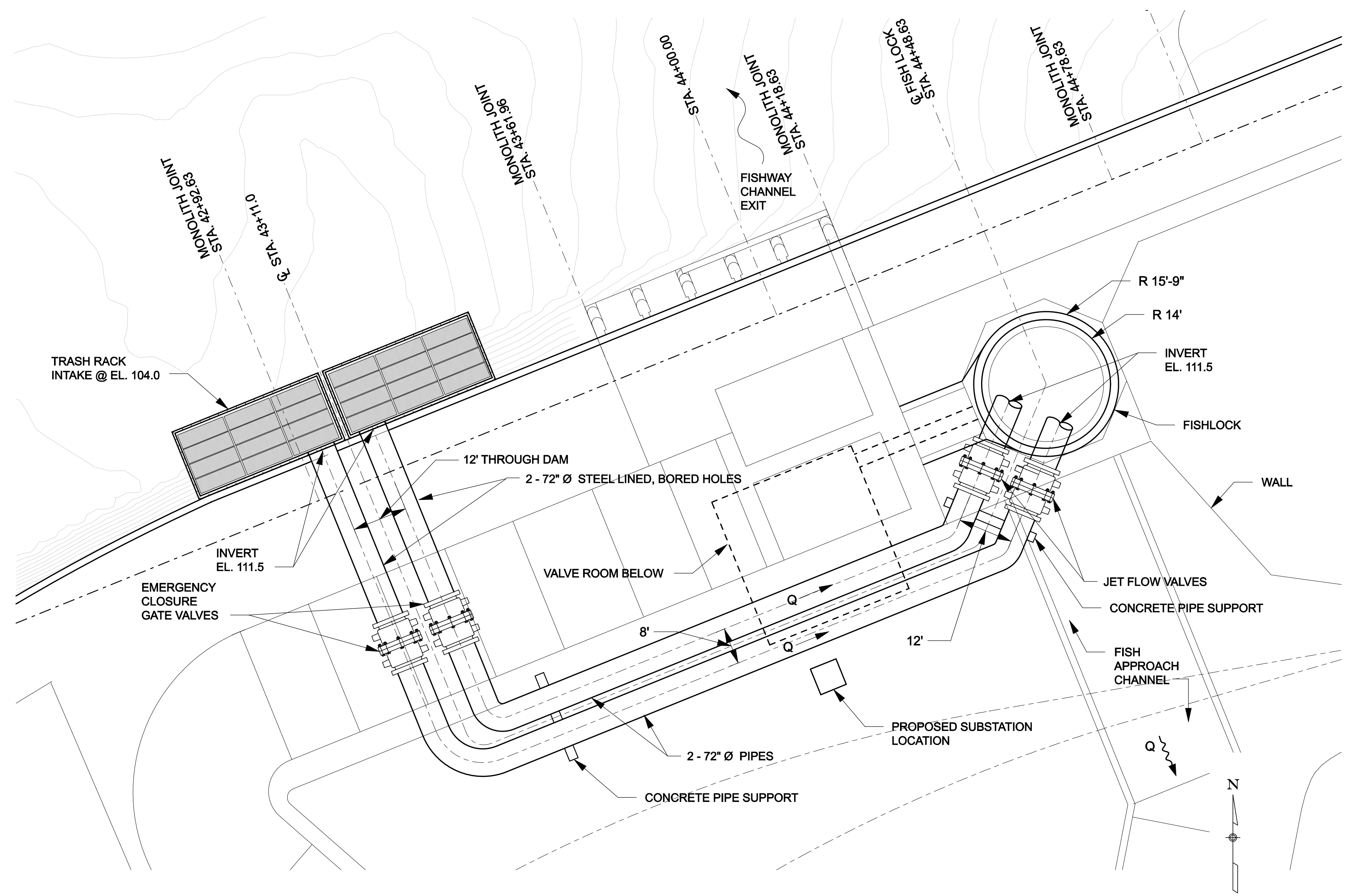
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 4
SIZE: 17X11	FILE NAME: S04-Siphon Alt 1 Detail.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
4
SHEET 4 OF 20

DATE AND TIME PLOTTED: 1/24/2012 4:34:47 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #1
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



PLAN
1"=20'

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 5	
SIZE: 17X11	FILE NAME: S05-Lower Level Intake Plan.dgn

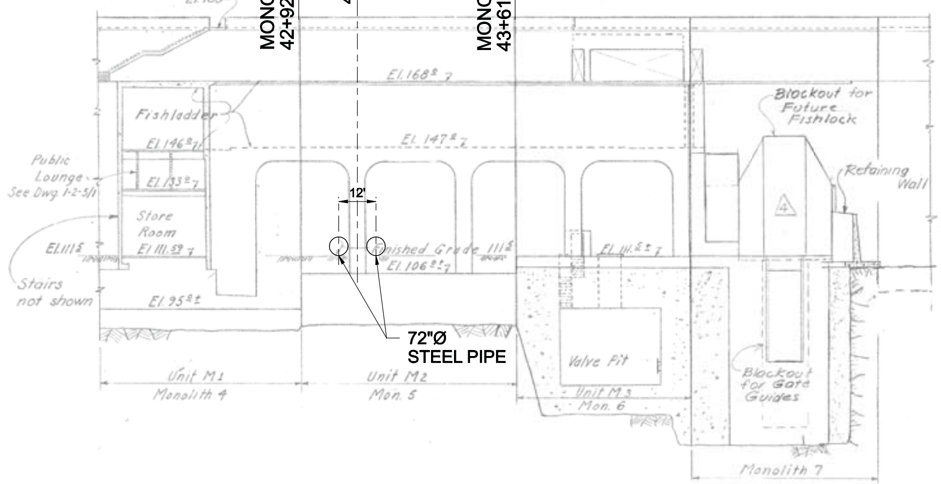
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

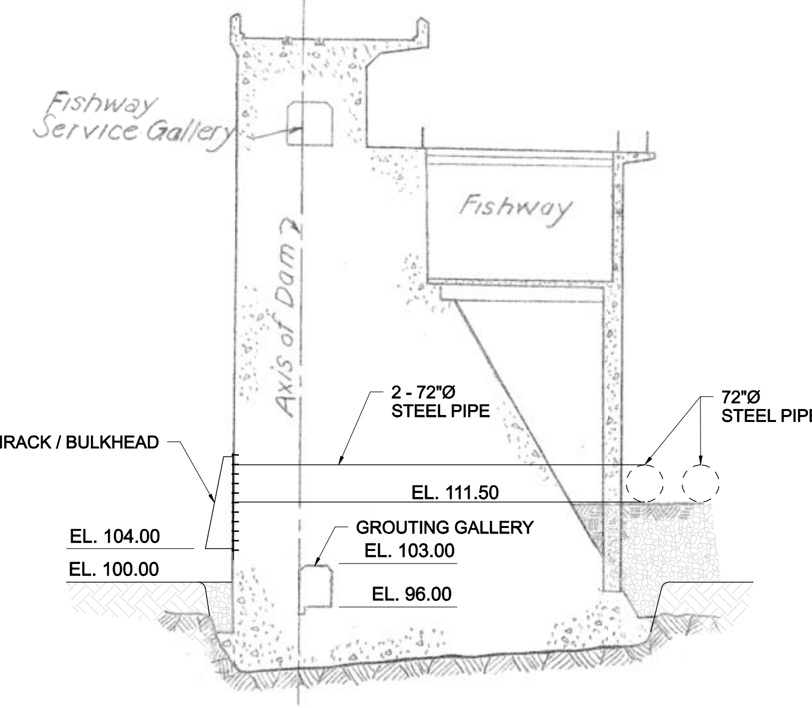
SHEET IDENTIFICATION
5
SHEET 5 OF 20

DATE AND TIME PLOTTED: 1/24/2012 5:01:41 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW LOW LEVEL INTAKE
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



ELEVATION - EAST NON-OVERFLOW DAM

1"=40'



SECTION

1"=20'

US Army Corps of Engineers® Portland District

SECTION VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 6	
SIZE: 17X11	FILE NAME: S06-Low Level Intake Section.dgn

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

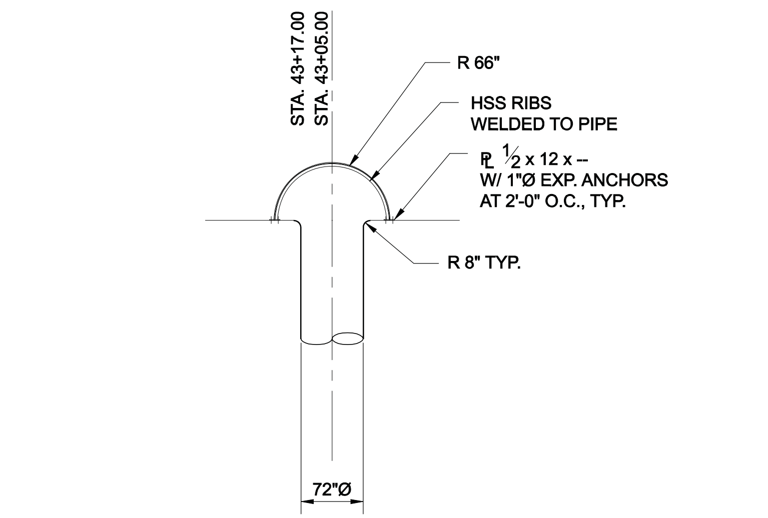
HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

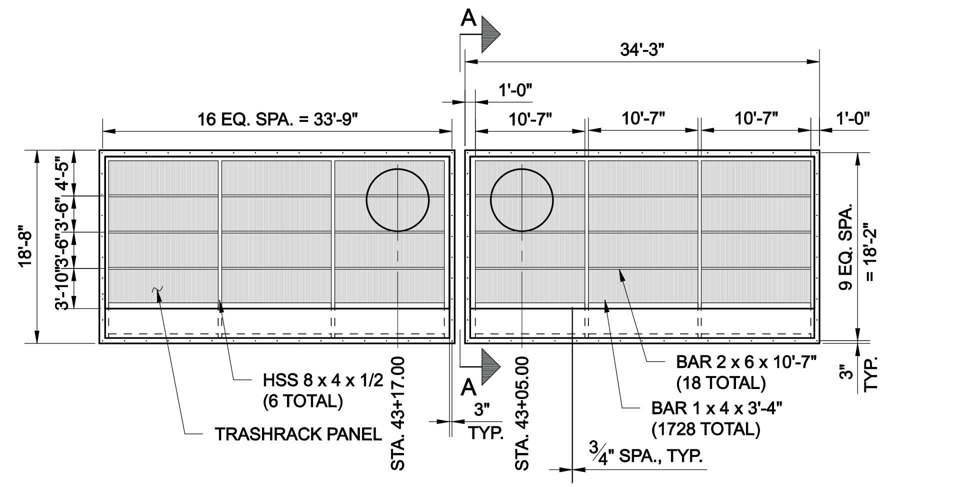
SHEET IDENTIFICATION
6
SHEET 6 OF 20

DATE AND TIME PLOTTED: 1/24/2012 5:09:21 PM | BY USERNAME: TAM NGUYEN | SHEET NAME: SECTION VIEW LOW LEVEL OPTION

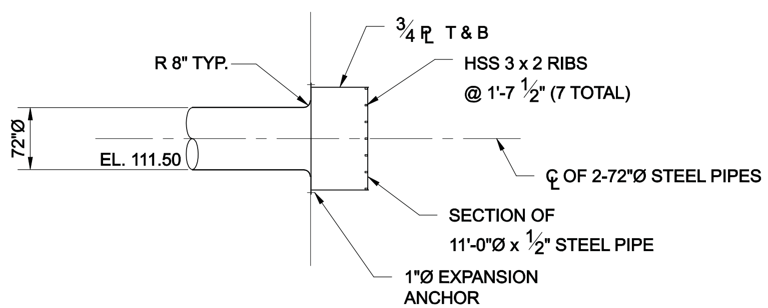
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



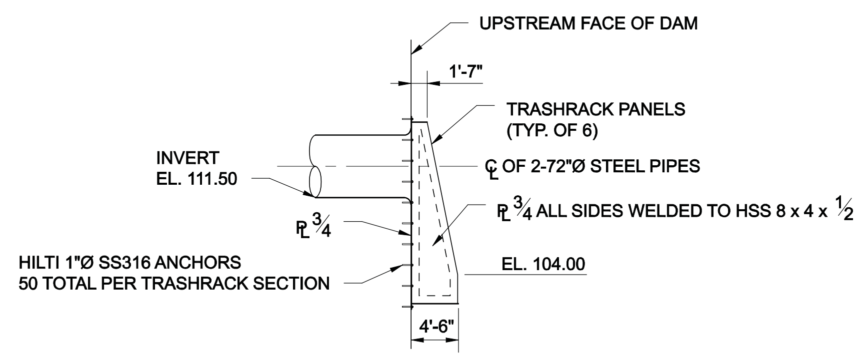
PLAN
1"=1'-0"



ELEVATION
1"=1'-0"



ELEVATION
1"=1'-0"



SECTION A-A
1"=1'-0"

1 0 1 2 3 4

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PLAN, ELEVATIONS, AND SECTION
ALTERNATIVE #2
LOW LEVEL INTAKE
TRASHRACK AND COFFERDAM

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 7
SIZE: 17X11	FILE NAME: S07-Low Level Intake Detail.dgn	

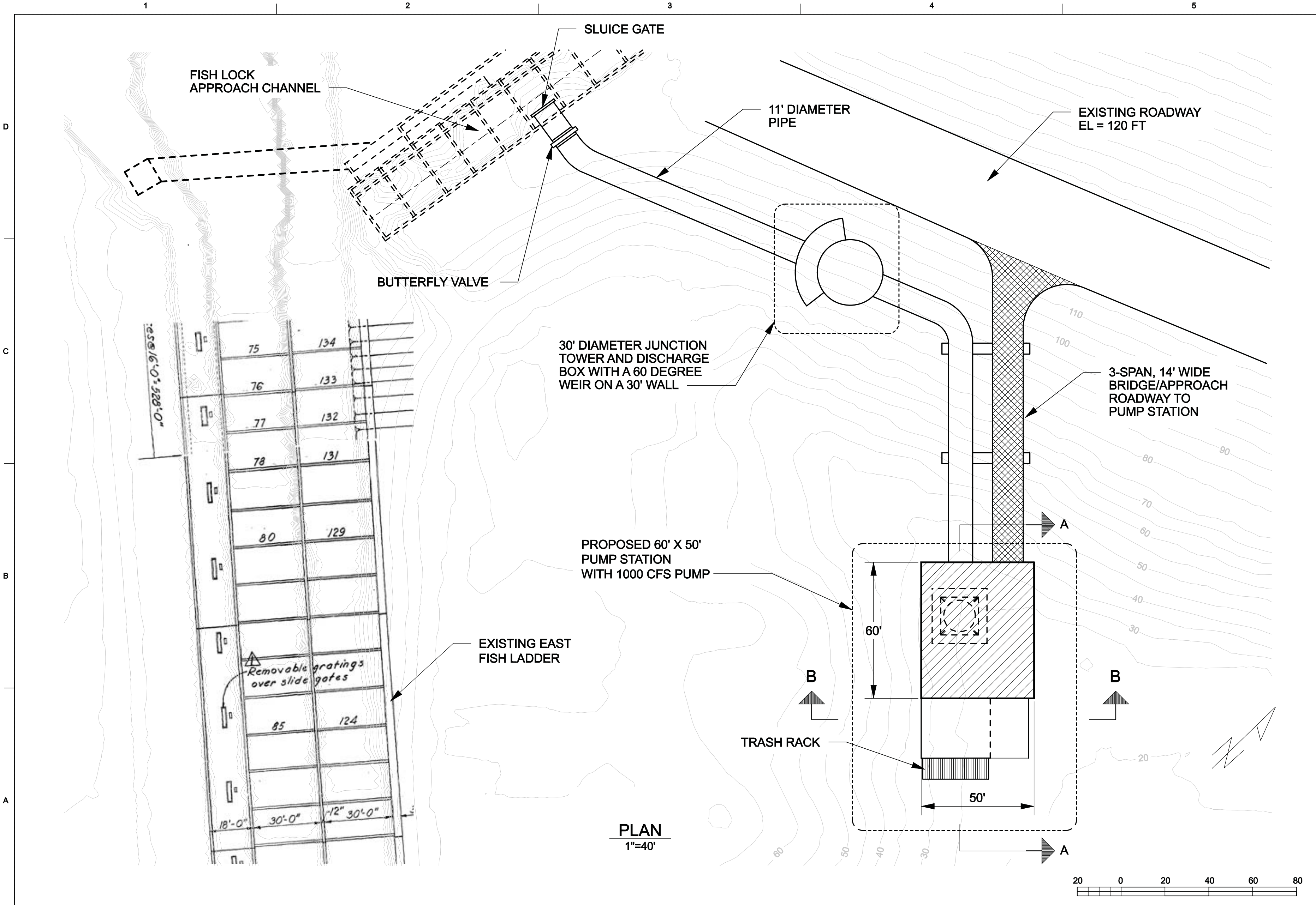
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
7
SHEET 7 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:28:04 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAIL LOW LEVEL OPTION CONSTRUCTION COFFERDAM
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



US Army Corps of Engineers® Portland District

PLAN VIEWS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

DESIGNED BY: RCM		DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 8
SIZE: 17X11	FILE NAME: S08-Pump Station.dgn	

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

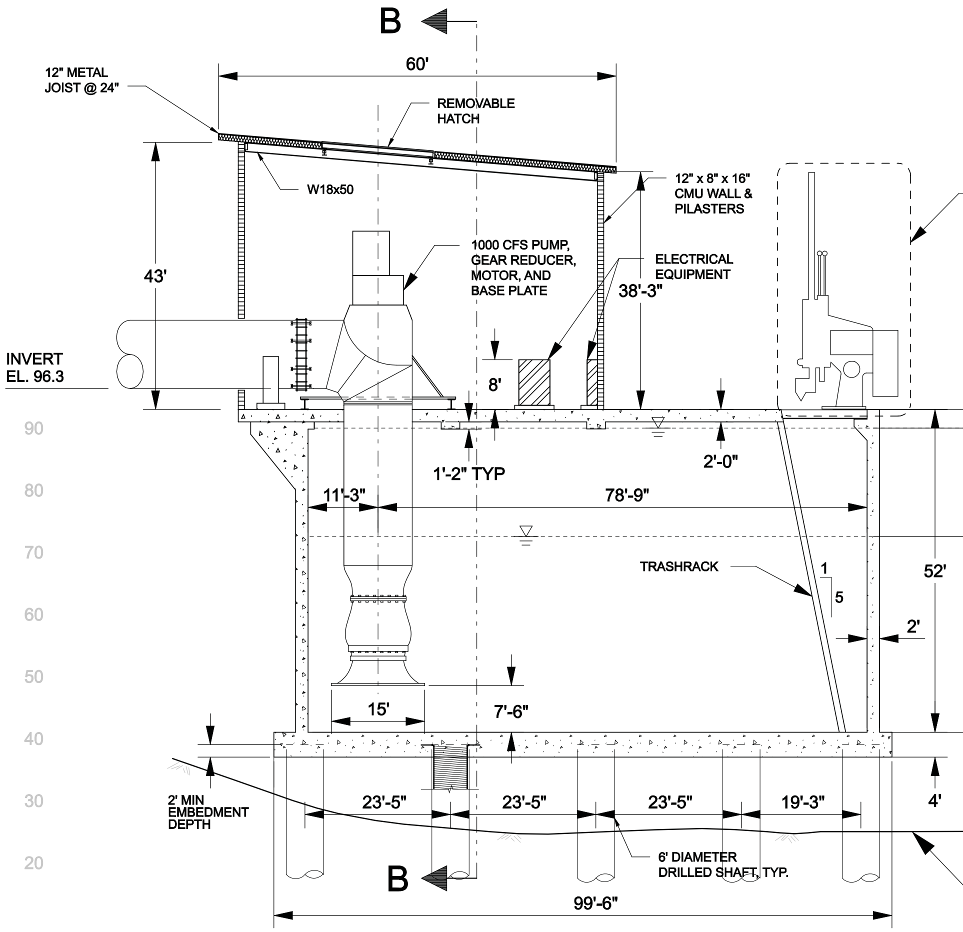
SHEET IDENTIFICATION
8
SHEET 8 OF 20

DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION

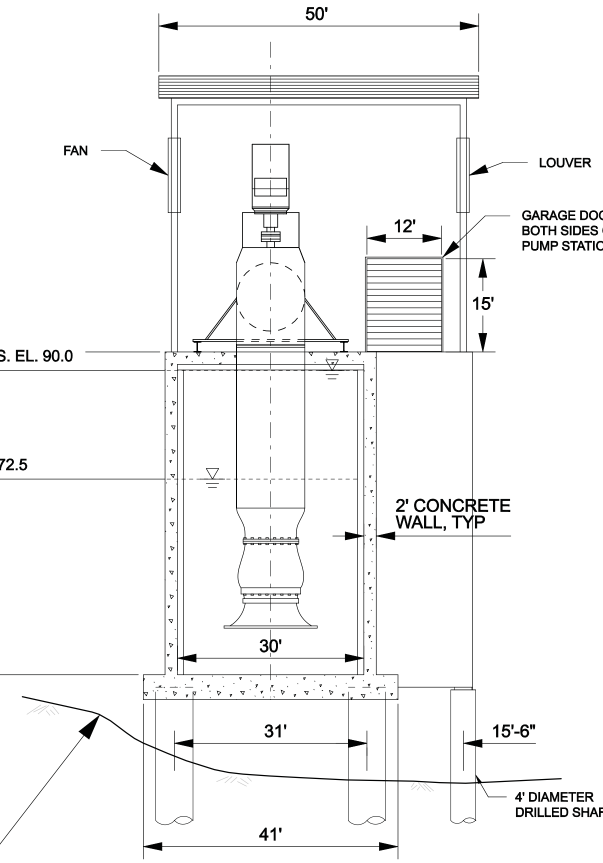
DATE AND TIME PLOTTED: 1/25/2012 11:07:34 AM

BY USERNAME: NINA SASS

SHEET NAME: SECTION VIEWS SINGLE PUMP PUMP HOUSE ALTERNATIVE #10



SECTION A-A
1"=20'



SECTION B-B
1"=20'

US Army Corps of Engineers®
Portland District

SECTION VIEWS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

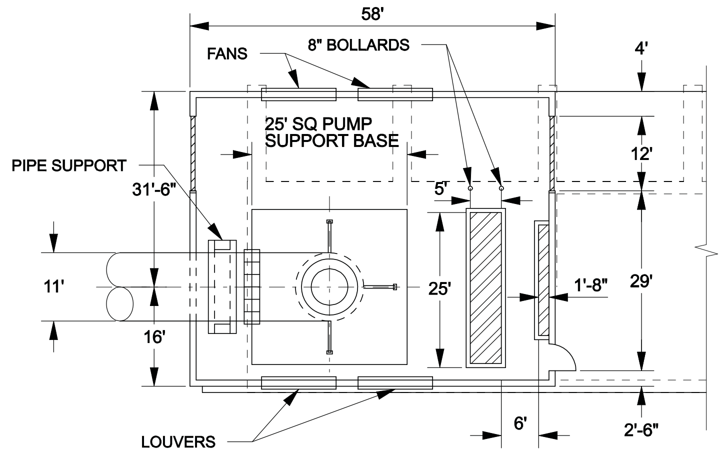
HDR ENGINEERING INC.

DESIGNED BY: PJG		DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 9
SIZE: 17X11	FILE NAME: S09-Pump Station.dgn	

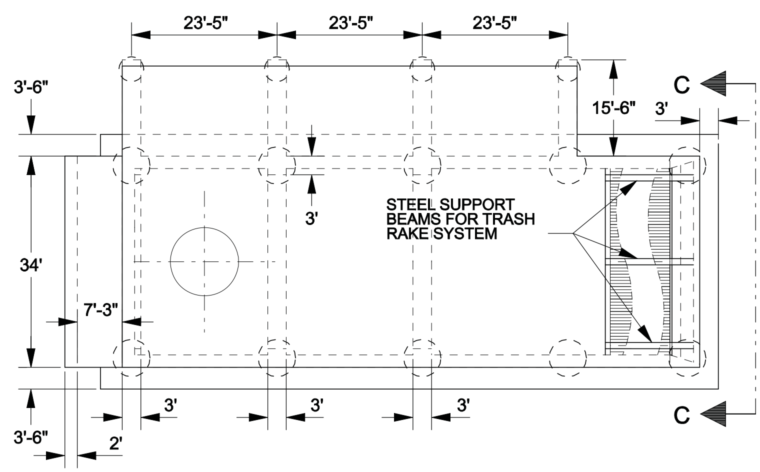
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
9
SHEET 9 OF 20

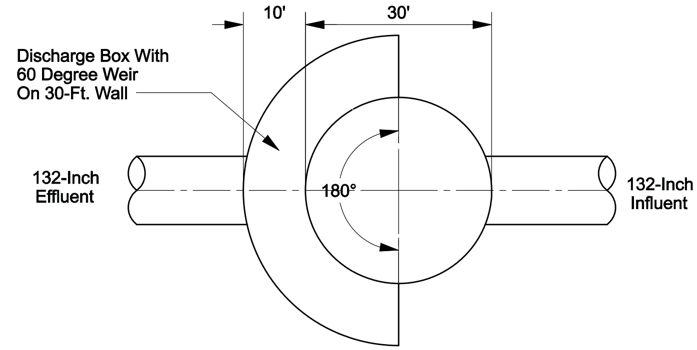
DATE AND TIME PLOTTED: 1/25/2012 11:27:38 AM
BY USERNAME: NINA SASS
SHEET NAME: SECTION VIEWS SINGLE PUMP PUMP HOUSE ALTERNATIVE #10
DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION



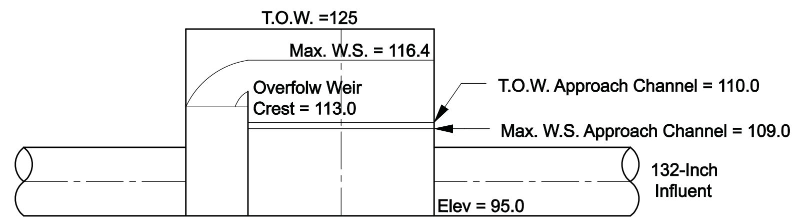
PLAN @ EL. 123.0
1"=20'



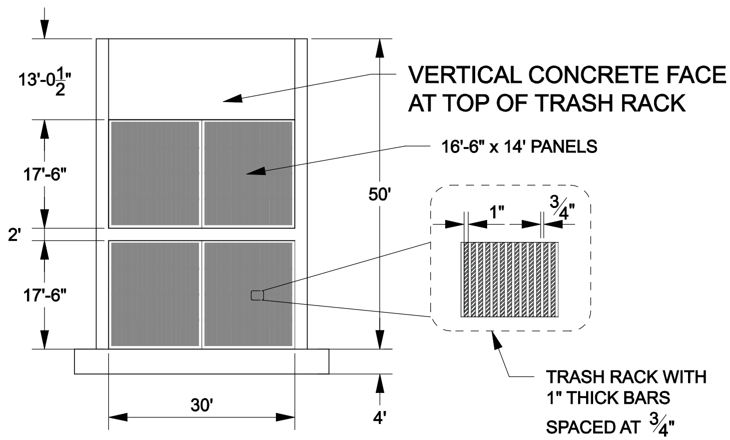
PLAN @ EL. 93.0
1"=20'



JUNCTION TOWER STRUCTURE
1"=20'



JUNCTION TOWER PROFILE ALONG PIPE CENTERLINE
1"=20'



SECTION C-C
1"=20'

US Army Corps of Engineers® Portland District

SECTION VIEWS AND DETAILS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

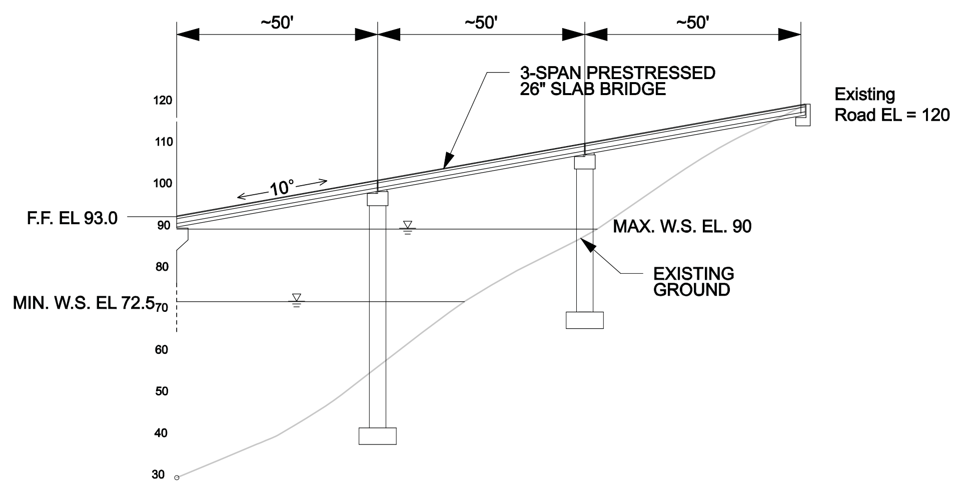
HDR ENGINEERING INC.

DESIGNED BY: PJG		DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 10
SIZE: 17X11	FILE NAME: S10-Pump Station.dgn	

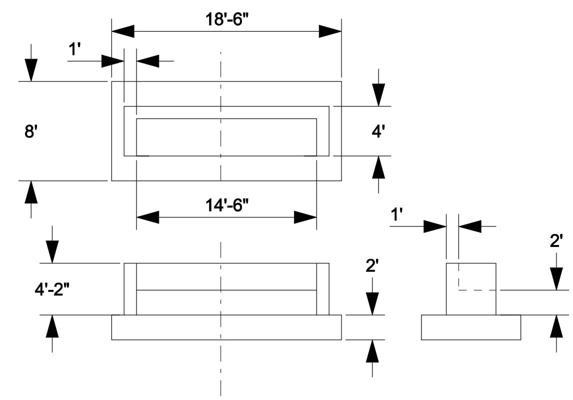
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
10
SHEET 10 OF 20

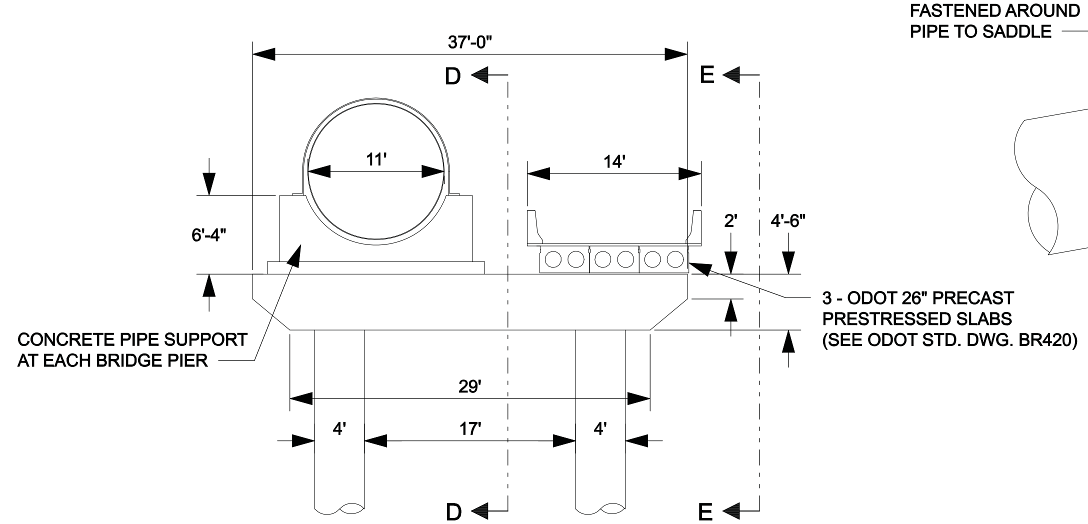
DATE AND TIME PLOTTED: 1/25/2012 12:18:33 PM
BY USERNAME: NINA SASS
SHEET NAME: SECTION VIEWS AND DETAILS ALTERNATIVE #10 SINGLE PUMP PUMP HOUSE
DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION



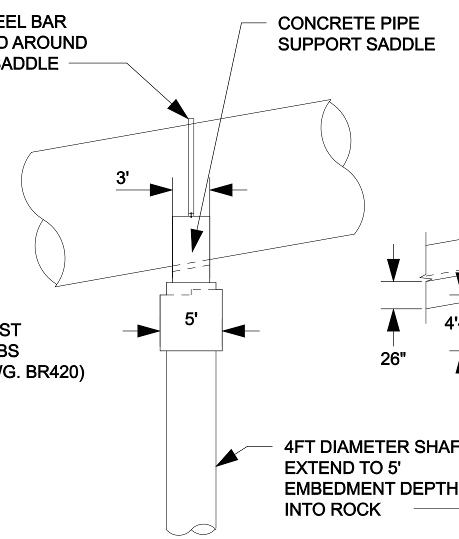
BRIDGE PROFILE
SCALE 1" = 30'



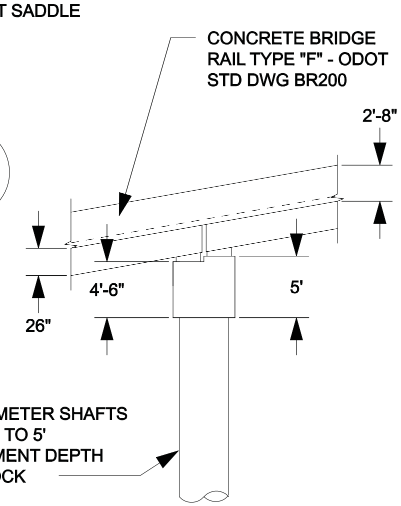
BRIDGE ABUTMENT LAYOUT
SCALE 1" = 10'



BRIDGE PIER CROSS SECTION
SCALE 1" = 10'



SECTION D-D
SCALE 1" = 10'



SECTION E-E
SCALE 1" = 10'

US Army Corps of Engineers® Portland District

BRIDGE DETAILS
ALTERNATIVE #10
SINGLE PUMP PUMPHOUSE

DESIGNED BY: PJG		DATE: January 25, 2012
DWN BY: NLS	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 11
SIZE: 17X11	FILE NAME: S11-Pump Station.dgn	

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

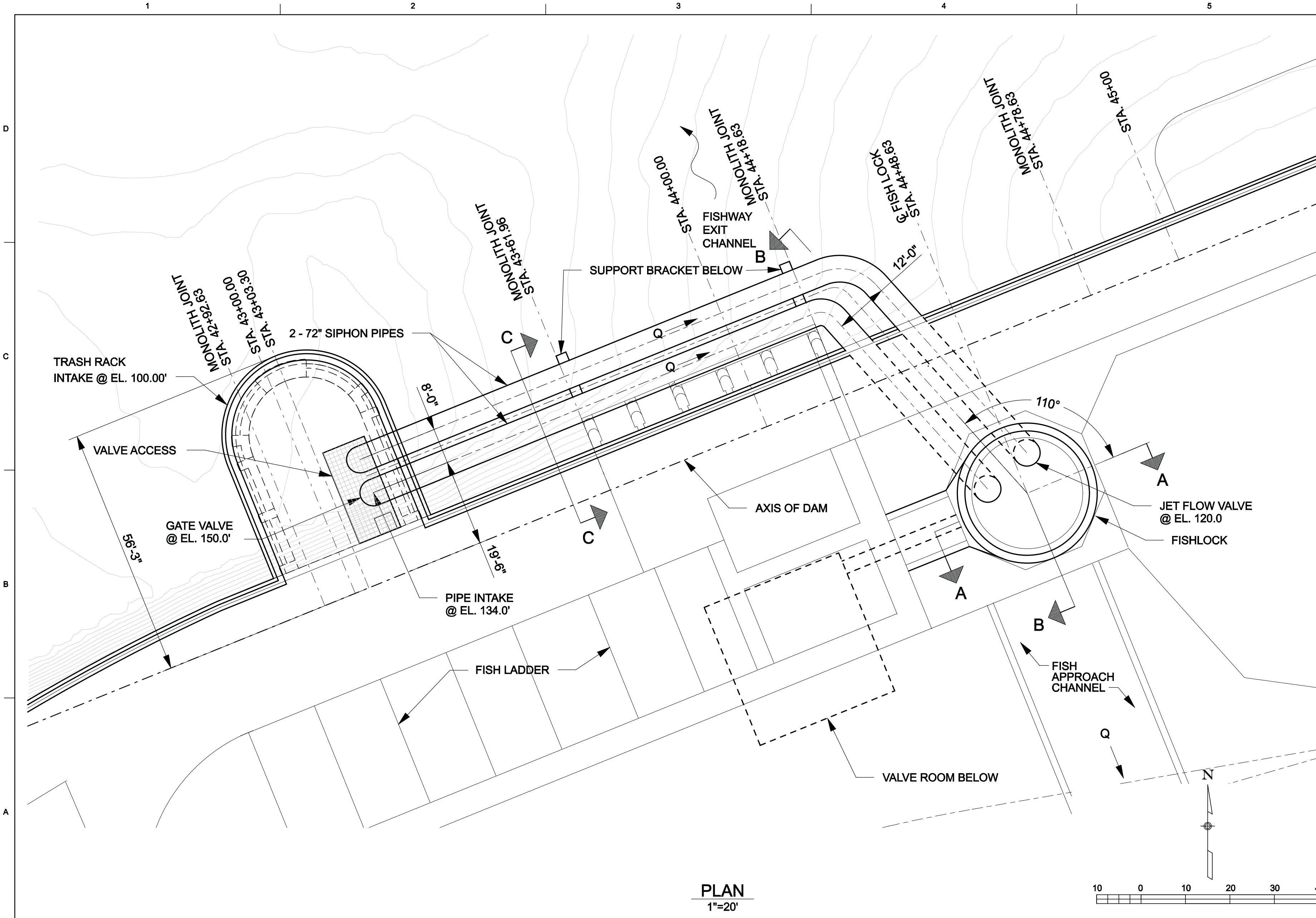
HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
11
SHEET 11 OF 20

DESIGN FILE: 13.00_CAD\SHEETS\PUMP STATION OPTION

DATE AND TIME PLOTTED: 1/25/2012 12:22:25 PM
BY USERNAME: NINA SASS
SHEET NAME: BRIDGE SECTIONS PUMP STATION OPTION ALTERNATIVE #10



PLAN
1"=20'

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

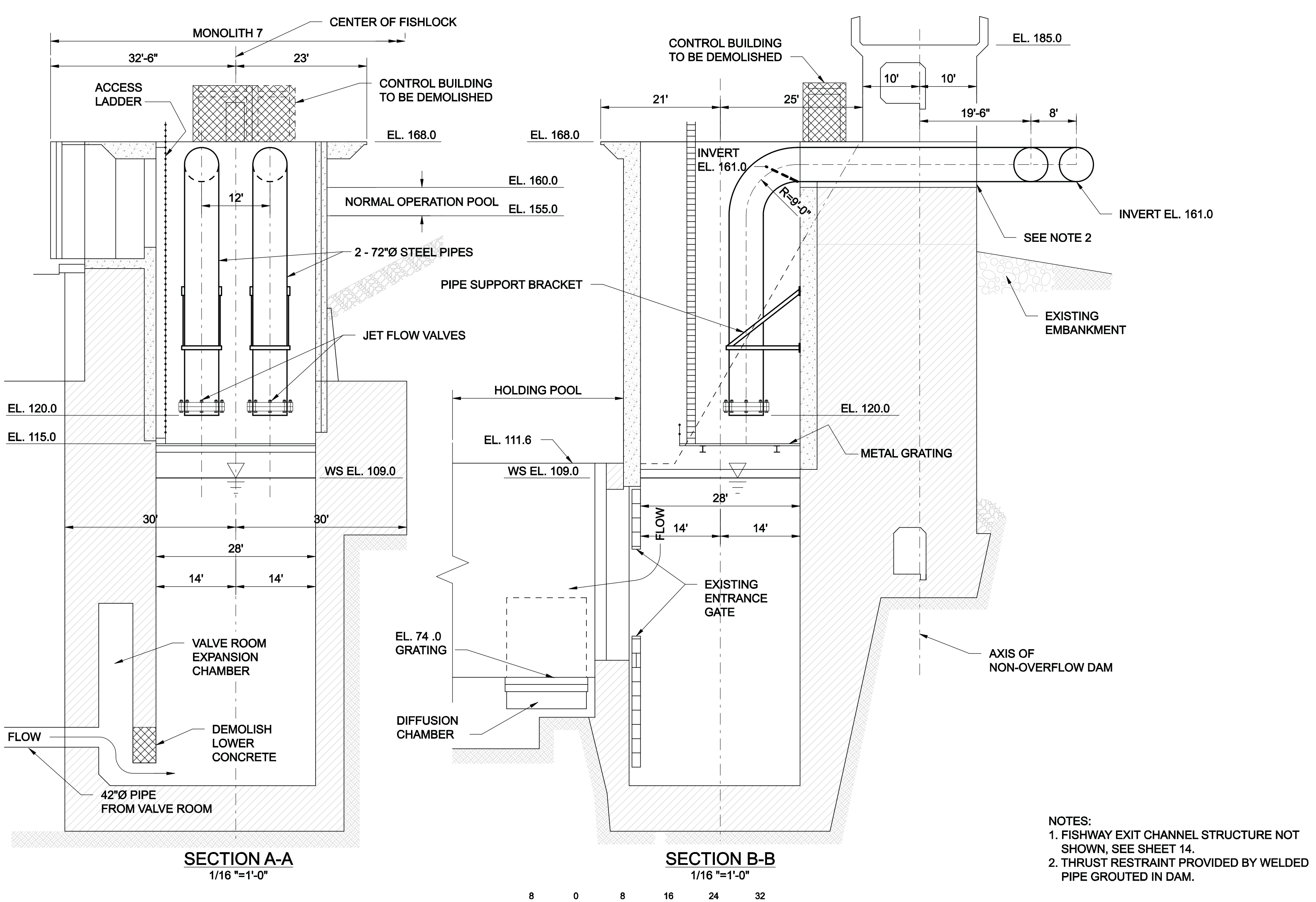
HDR ENGINEERING INC.

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:
DRAWING NUMBER: 12	
SIZE: 17X11	FILE NAME: S12-Siphon Alt 11 Plan.DGN

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
12
SHEET 12 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:35:21 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



NOTES:
1. FISHWAY EXIT CHANNEL STRUCTURE NOT SHOWN, SEE SHEET 14.
2. THRUST RESTRAINT PROVIDED BY WELDED PIPE GROUTED IN DAM.

US Army Corps of Engineers® Portland District

SECTIONS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

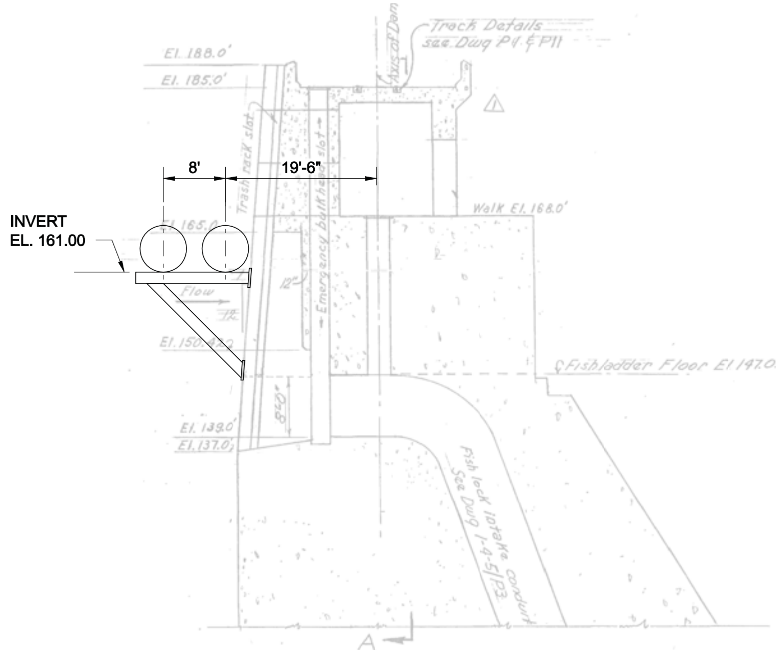
DATE: January 25, 2012
DESIGNED BY: JPG | DWN BY: TTN | CKD BY: RCM | SUBMITTED BY: RCM | PLOT SCALE: AS SHOWN | PLOT DATE: | DRAWING NUMBER: 13 | SIZE: 17X11 | FILE NAME: S13-Siphon Alt 11 Section.dgn

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON
HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
13
SHEET 13 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:51:38 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



SECTION C-C
1/16 "=1'-0"

8 0 8 16 24 32

US Army Corps of Engineers® Portland District

DETAILS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S03-Siphon-Alternative 11.DGN	

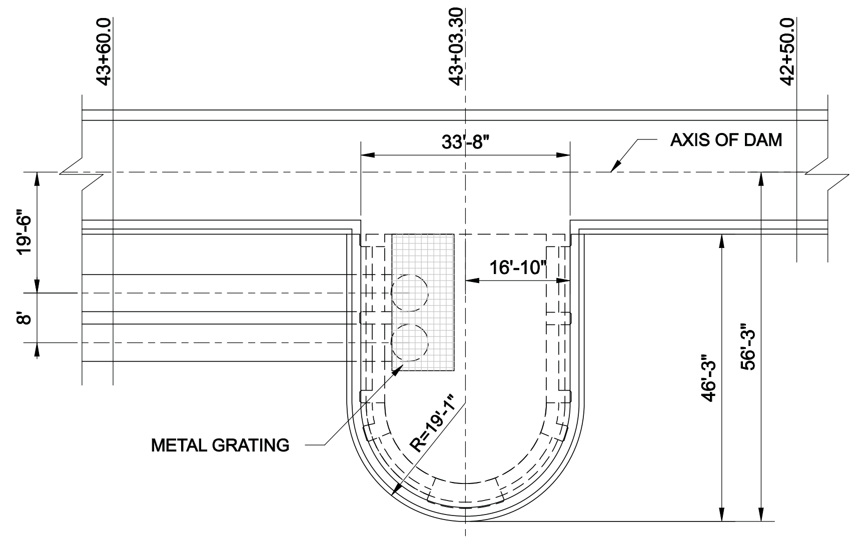
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

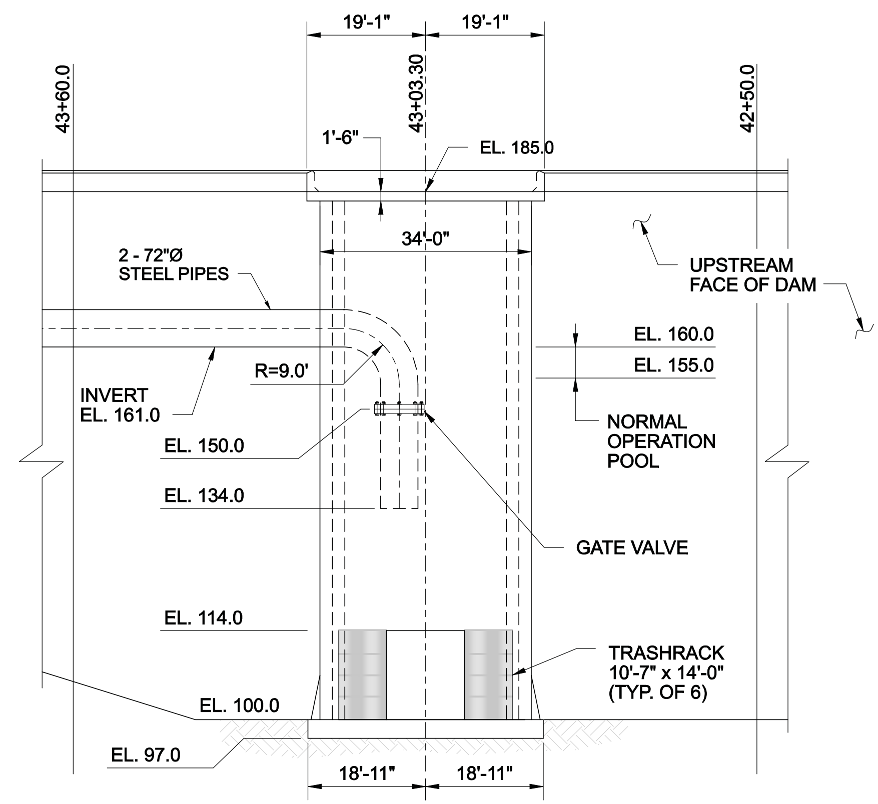
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
14
SHEET 14 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:53:49 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAILS SIPHON OPTION ALTERNATIVE 11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1"=20'



ELEVATION
1"=20'

US Army Corps of Engineers® Portland District

INTAKE TOWER
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

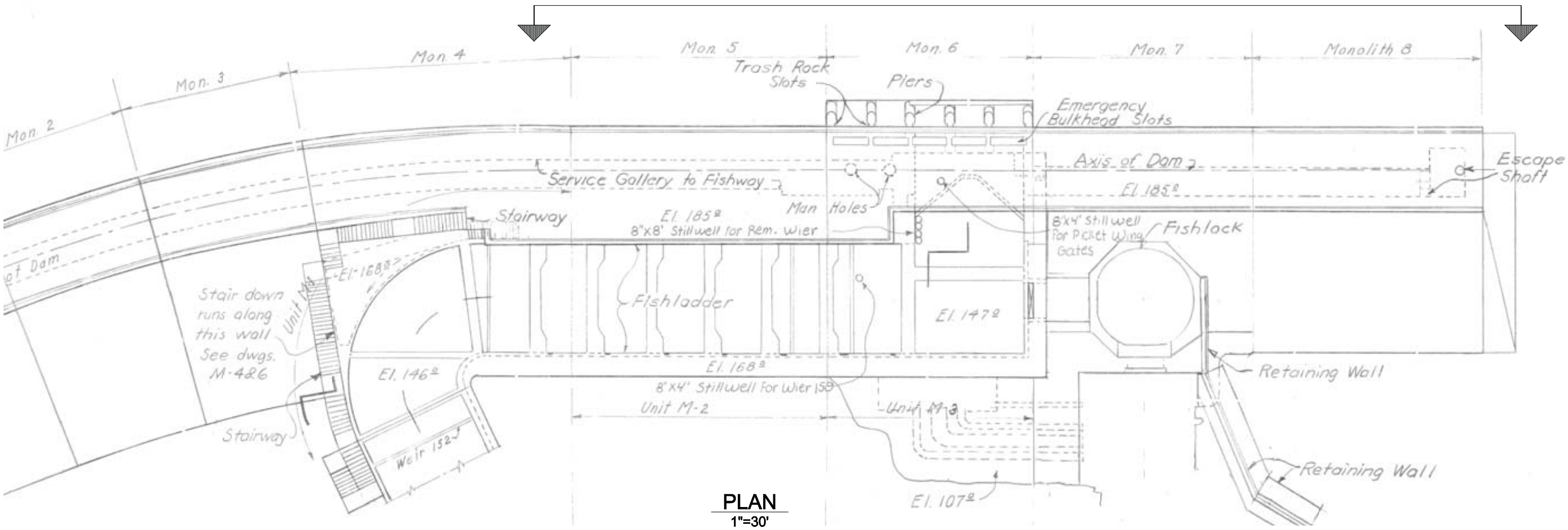
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S15-Siphon Alt 11 Intake.dgn	

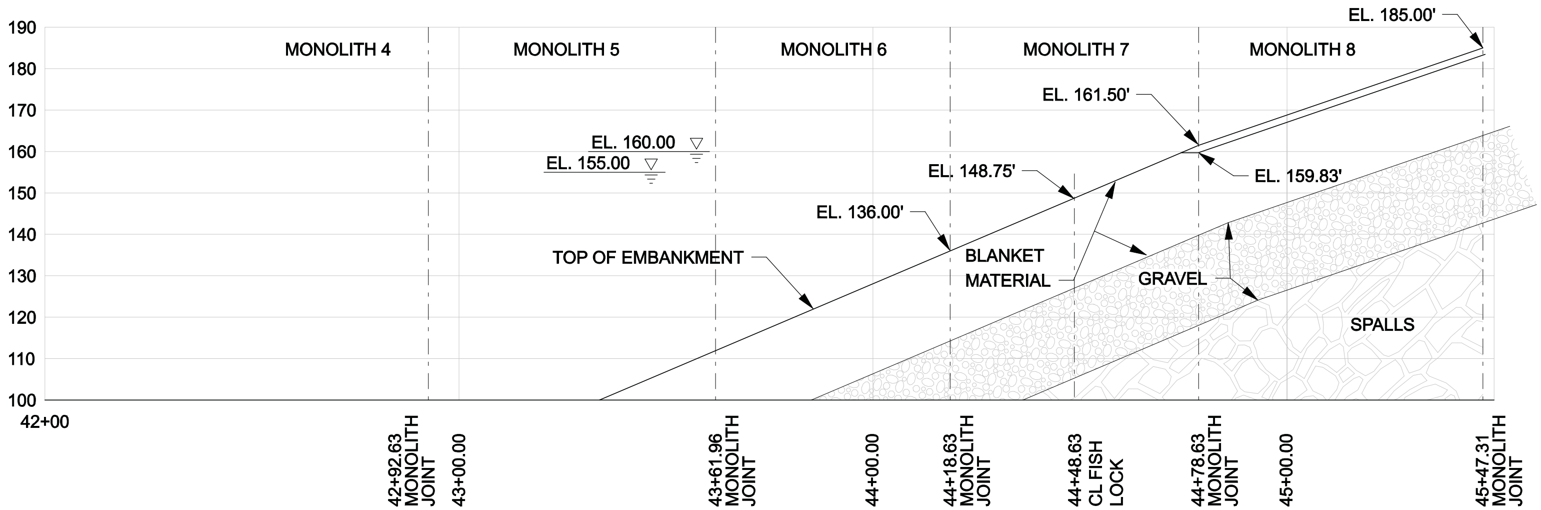
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
15
SHEET 15 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:55:59 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



PLAN
1"=30'



UPSTREAM PROFILE
1"=30'

US Army Corps of Engineers® Portland District

GENERAL PLAN AND PROFILE

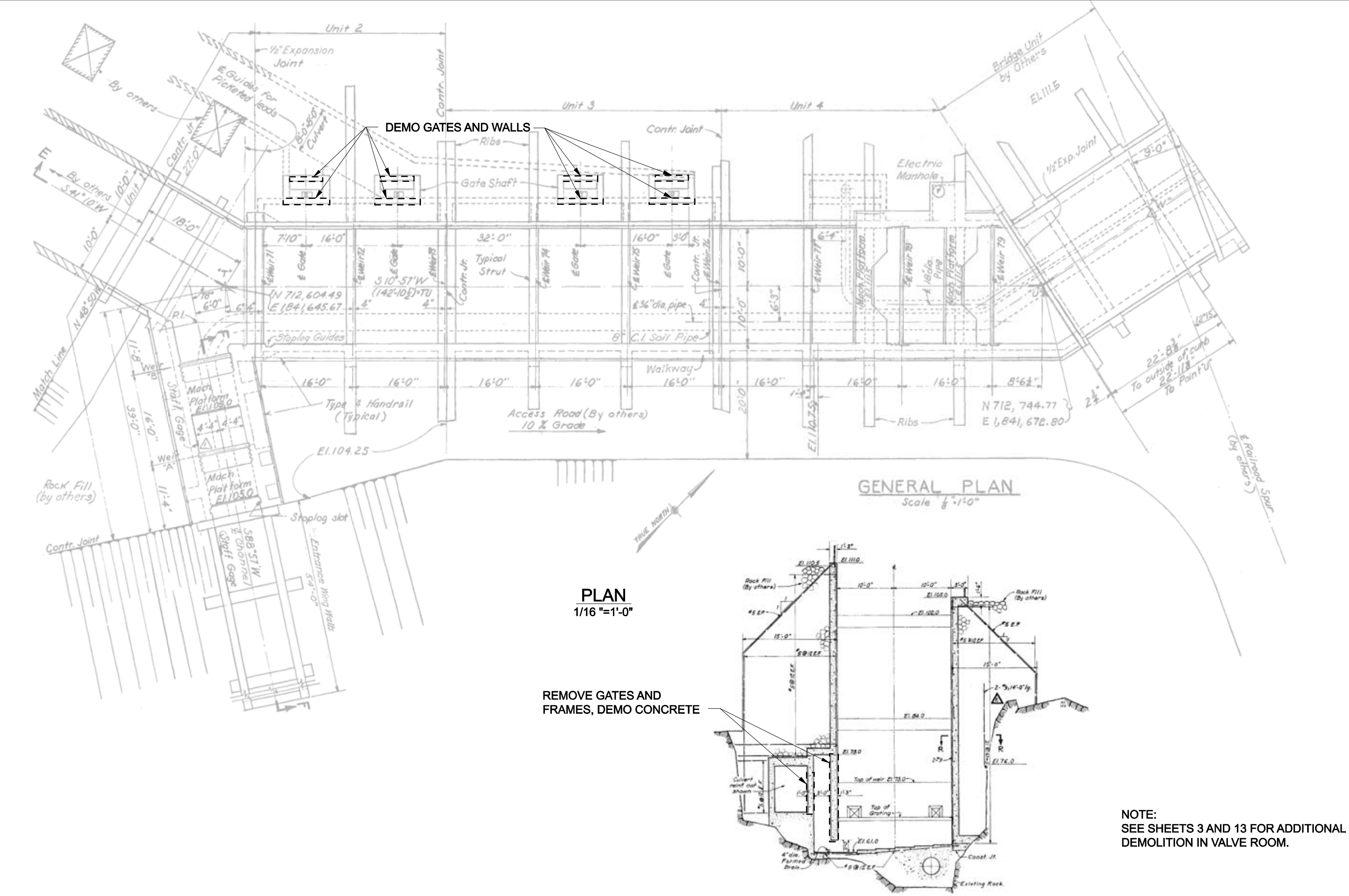
U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON	DESIGNED BY: JPG		DATE: January 25, 2012
HDR ENGINEERING INC.	DWN BY: TTN	CKD BY: RCM	
	SUBMITTED BY: RCM		
	PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 16
	SIZE: 17X11	FILE NAME: S16-Siphon Plan Profile.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
16
SHEET 16 OF 20

DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION

DATE AND TIME PLOTTED: 1/25/2012 10:57:49 AM | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN AND PROFILE EMBANKMENT ALTERNATIVE #1



PLAN
1/16 "=1'-0"

SECTION THROUGH FISHLOCK APPROACH CHANNEL
1/16 "=1'-0"

NOTE:
SEE SHEETS 3 AND 13 FOR ADDITIONAL DEMOLITION IN VALVE ROOM.

8 0 8 16 24 32

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FISHLOCK APPROACH CHANNEL MODIFICATIONS PLAN AND SECTION

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 17
SIZE: 17X11	FILE NAME: S17-Fishlock Approach Channel Mods.dgn	

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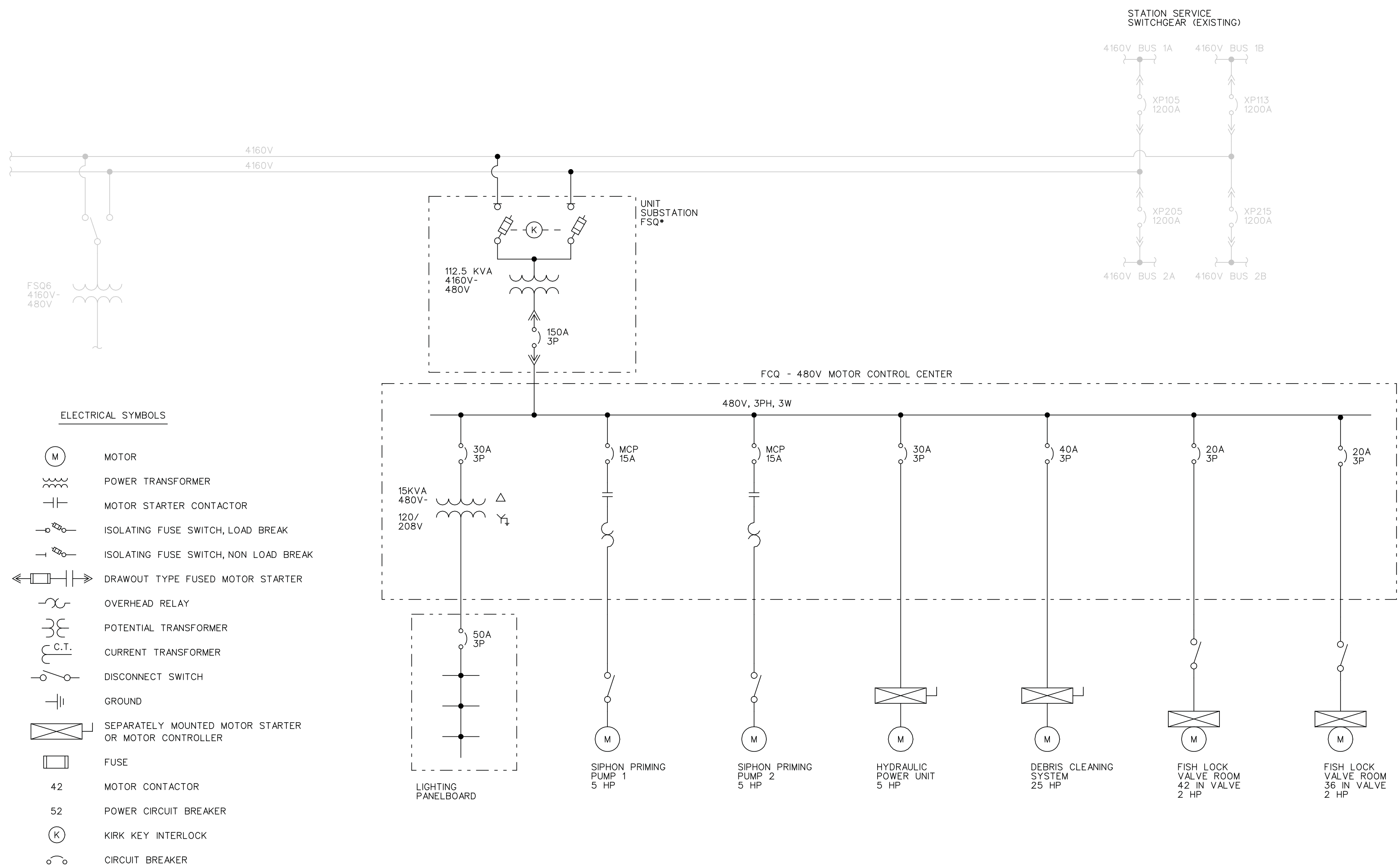
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
17
SHEET 17 OF 20

DATE AND TIME PLOTTED: 1/25/2012 11:00:50 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: FISHLOCK CHANNEL MODIFICATIONS PLAN AND SECTION
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



ALTERNATIVE •1 - SIPHON FOR ADDITIONAL WATER TO THE FISH LOCK

ALTERNATIVE •11 - UPSTREAM INTAKE TOWER WITH SIPHON

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ALTERNATIVES #1 AND #11 ELECTRICAL ONE-LINE DIAGRAMS

U.S. ARMY CORPS OF ENGINEERS PORTLAND DISTRICT PORTLAND, OREGON

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DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 18
SIZE: 17X11	FILE NAME: S18-Alternative 1 & 11.DGN	

THE DALLES DAM EAST FISH LADDER AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION 18

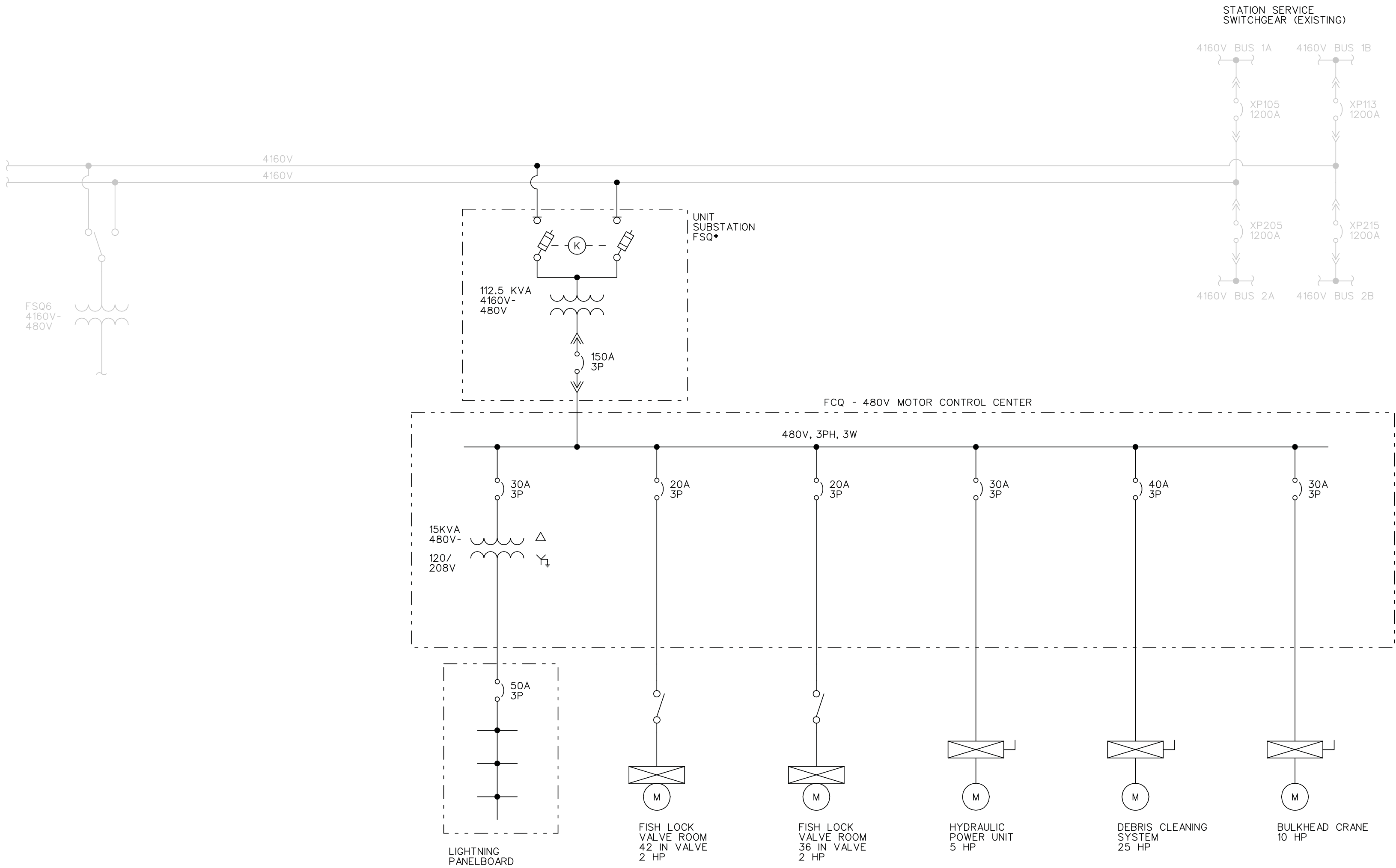
SHEET 18 OF 20

DATE AND TIME PLOTTED: 1/25/2012 2:08:11 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVES •1 AND •11 - ELECTRICAL ONE-LINE DIAGRAMS

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\



ALTERNATIVE *2 - LOW LEVEL INTAKE

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Portland District

ALTERNATIVE #2
ELECTRICAL ONE-LINE DIAGRAMS

DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 19
SIZE: 17X11	FILE NAME: S19-Alternative 2.DGN	

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THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

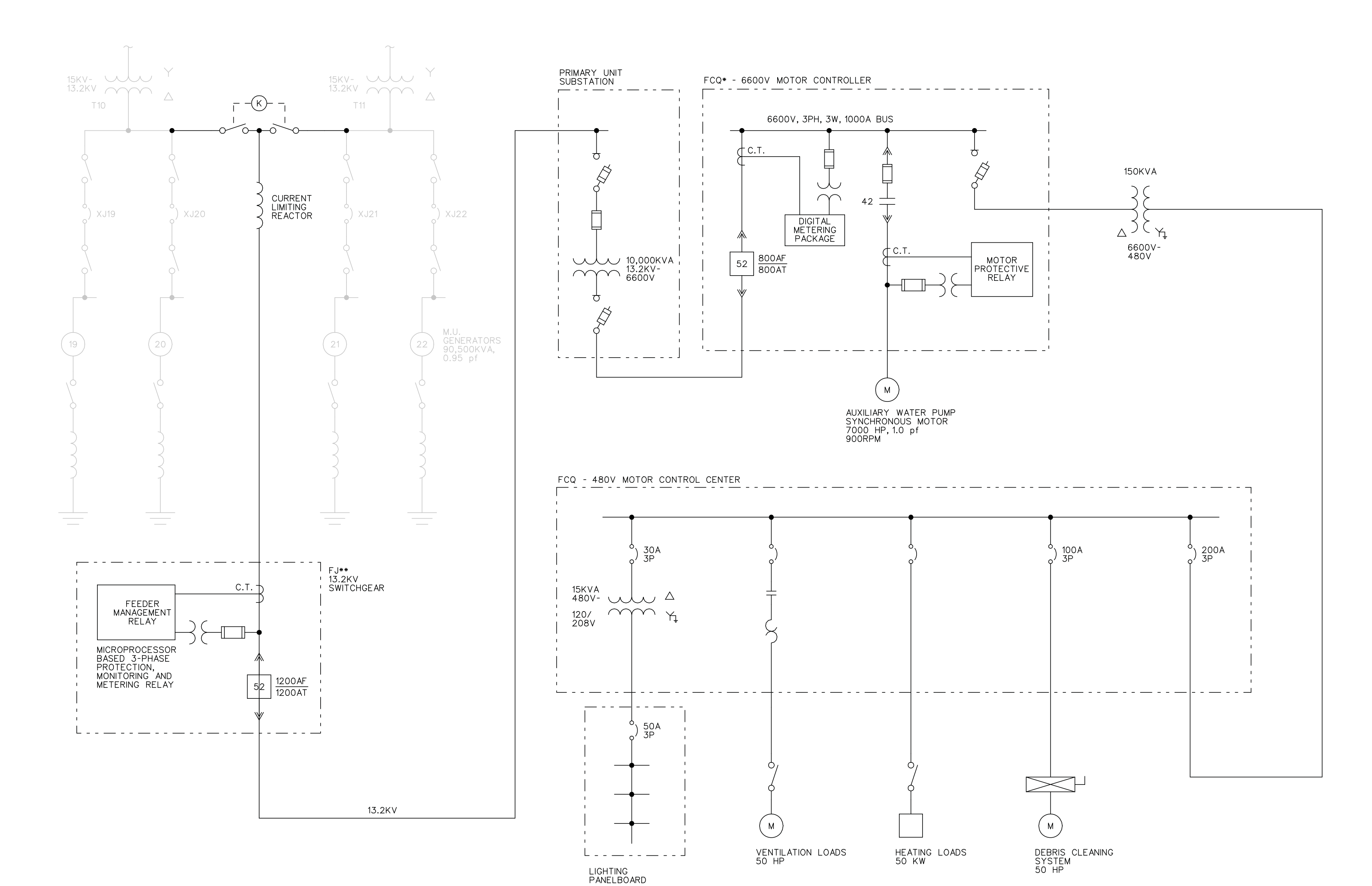
SHEET
IDENTIFICATION
19
SHEET 19 OF 20

DATE AND TIME PLOTTED: 1/25/2012 2:17:22 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVES *1 AND *11 - ELECTRICAL ONE-LINE DIAGRAMS

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\



ALTERNATIVE *10 - SINGLE PUMP/PUMP HOUSE ON EAST SIDE OF CUL-DE-SAC

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ALTERNATIVE #10
ELECTRICAL ONE-LINE DIAGRAM

DESIGNED BY: DB	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: NTS	PLOT DATE:
DRAWING NUMBER: 20	
SIZE: 17X11	FILE NAME: S20-Alternative 10.DGN

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THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

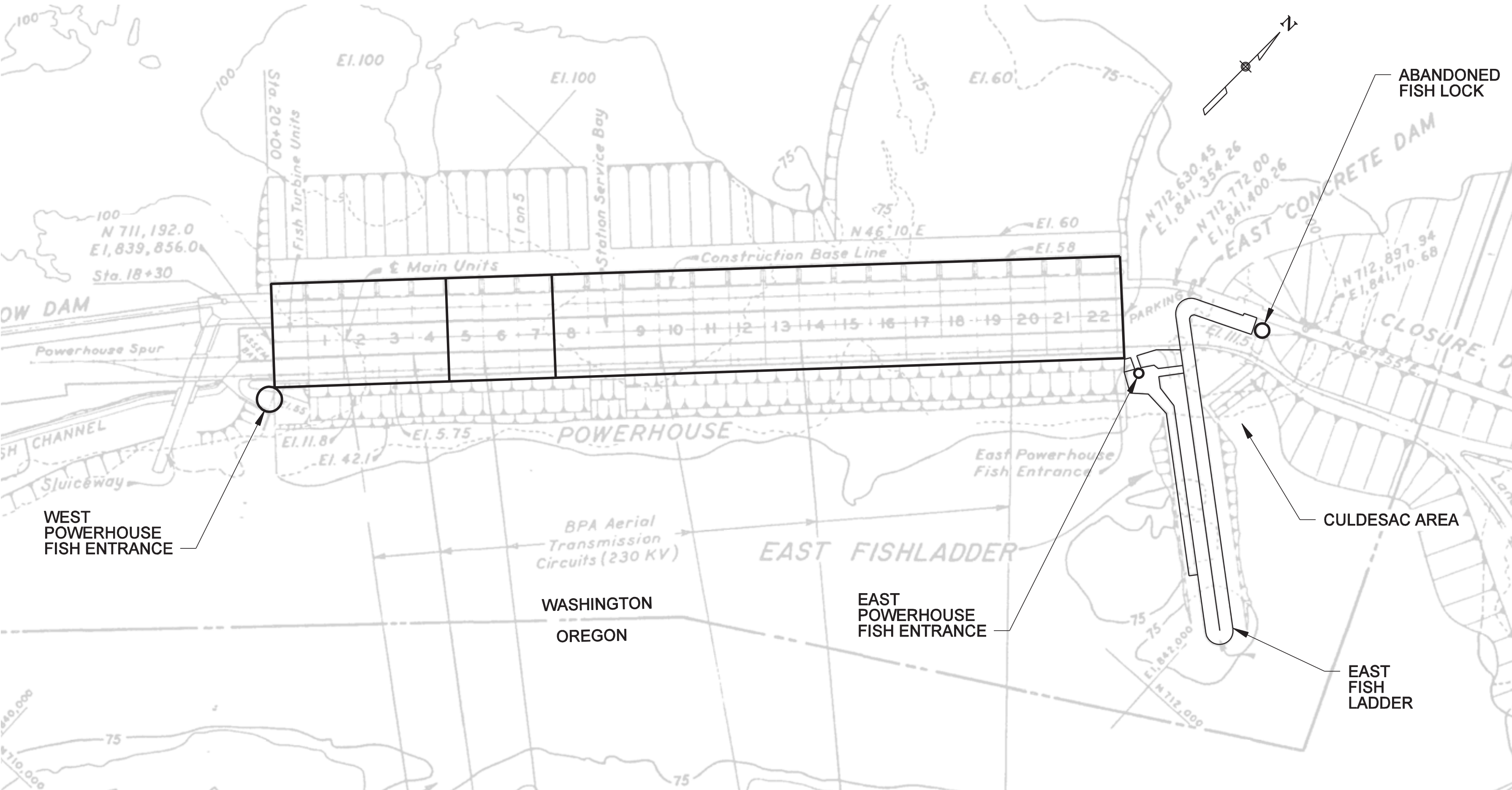
SHEET IDENTIFICATION
20
SHEET 20 OF 20

DATE AND TIME PLOTTED: 1/25/2012 2:46:27 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVE *10 - ELECTRICAL ONE-LINE DIAGRAM

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\



PLAN VIEW
NOT TO SCALE

US Army Corps of Engineers® Portland District

PLAN VIEW
POWER HOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: RCM		DATE: December 15th, 2010
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 02
SIZE: 17X11	FILE NAME: 147341-S02.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM
BACKUP LETTER REPORT

SHEET IDENTIFICATION
02
SHEET 2 OF 2

ONE COMPANY
Many Solutions℠

Meeting Minutes

Subject: Minutes for the Detailed Discussion of Alternatives #2 and #11 Meeting	
Client: U.S. Army Corps of Engineers	
Project: The Dalles East Fish Ladder Auxiliary Water System Backup, 60% Review Meeting	Project No: 000000000171578
Meeting Date: March 12, 2012	Meeting Location: HDR, Mountain Rooms
Notes by: Jennifer Switzer/Ron Mason	

ttendees

Ron Mason, HDR	Kristi Nelson, HDR	Lisa Larson, NHC
Jennifer Switzer, HDR	Pete Gaby, HDR	Karen Kuhn, USACE
Rich Hannan, HDR	David Ward, HDR	Rick Reiner, USACE
Don Best, HDR		

opics Discussed

✓ Introductions by Team Members and sign-in	Ron Mason/All
✓ Meeting Objectives and Purpose	Ron Mason
✓ Alternative #2; Alternative #11; and Fishlock, Valve Room, and Approach Channel Discussion	HDR Technical Team Members / Ron Mason
✓ Action Items from Meeting	Ron Mason

OPENING STATEMENT/INTRODUCTIONS

Ron Mason welcomed everyone to the meeting and started with the purpose of the meeting which is to have the U.S. Army Corps of Engineers (USACE) bring in any specialized concerns before HDR's final push on the 90% submittal. Mr. Mason also noted that he had received last minute cancellations from Randy Lee due to illness and Sean Tackley due to scheduling conflict.

Mr. Mason also mentioned a meeting held last week to discuss cost engineering and Rick Russell's needs and to broach items still needed from the USACE (to be discussed later in the meeting).

This Wednesday (March 14, 2012), Howard Campbell (US Cost MCASES II cost estimator) will be in town to conduct a site visit and meet with USACE staff (specifically Rick Russell, the USACE cost estimator); however, HDR has been informed Mr. Russell will not be at this site visit. Mr. Mason is hoping the USACE can find someone in the USACE's cost estimating department who can attend this site visit to make the most out of Mr. Campbell's visit.

Next, Mr. Mason provided the anticipated approach for the project once the work under the current task order is completed:

- First phase will include Design Document Report (DDR) including final design of chosen alternative.

- The DDR will lead into the plans and specifications phase.
- USACE/HDR anticipate two task orders for the above work. May/June timeframe for scope of next phase. Schedule may be too quick/short, if detailed hydraulic engineering and physical model are necessary.

Upcoming project schedule dates:

14 March 2012: US Cost Site Visit

16 March 2012: All of drawings for 90% EDR complete. Mr. Mason sent an email on 2/19/2012 to request all 90% drawing changes.

19 March 2012: US Cost (Howard Campbell) needs all quantities and cost information

27 March 2012: Final 90% EDR write-ups due

28 March 2012: QC Review

9 April 2012: Six hard copies of 90% EDR delivered to USACE

Mr. Mason reminded the group that Pete Gaby is continuing to coordinate all drawing changes. He also recommended the project team continue to talk with their USACE counterparts as the project develops.

For the next phase of the project, a DDR will be prepared and will include final detailed design. All configurations will be done for the chosen alternative and fishlock, valve room, and approach channel modifications. The current EDR does not include the detailed design that will be included in the new DDR.

Karen Kuhn thinks instead of an alternatives ranking matrix (as prepared for the current alternatives) some kind of comparison table would need to be developed to help determine which alternative will be taken to the design phase.

It was agreed that both alternatives (#2 and #11) are relatively risk free, but that the Low Level Intake (LLI, Alt #2) is probably a more flexible and comfortable option for the USACE. Dave Ward stated the LLI potentially would affect less juvenile salmon and with more bedrock it could mean less lamprey in this area. Both alternatives have intakes at relatively the same elevation (100 ft and 104 ft)

ALTERNATIVE #2 and #11 DETAILED DISCUSSION (including fishlock, valve room, and approach channel modifications)

Alternative #2 – Low Level Intake

This alternative proposes the use of two, 72-inch pipes that will convey water from the forebay to the existing fishlock. The fishlock will then discharge into the approach channel which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool entrance and ladder pools.

One major change for this alternative is two emergency closure gate valves to be removed. There will be a new drawing showing two bulkheads (2 slots); one for emergency and one for normal use. This will result in a substantial cost savings for the project. The two bulkhead gates will be located at the intake. Envision one bulkhead for each pipe. Bulkheads will be located below the invert of the pipe and brought up to close and stop flow.

For dam safety inspections, Rick Reiner asked if the bulkheads would be removable (i.e., pull out bulkheads). It was confirmed they would be removable.

R. Reiner discussed the possibility of stacking the pipes to save parking space as it is very limited at the dam.

- L. Larson – Exit of the pipe can be higher, but does not want the inlets any higher.
- P. Gaby – Second pipe starting at el. 134 ft could go to el. 168 ft.
- P. Gaby – a positive factor to stacking pipes is that the support tower would not have to be as far out from the face of the dam.
- L. Larson – not worried about bends with stacking, just pressure. Design Criteria is fairly lenient, but pressure criteria has a limit of 20 and it's already close with the current configuration. Probably not going to be able to stack the pipes for the siphon alternative.
- R. Mason asked R. Reiner if his preference would be to have the pipes travel up over the door or dig a trench under the door.
- K. Nelson said a trench will not work due to sediment issues and valve requirements.
- R. Reiner – no choice for where pipes go given existing stairs going up and over rather than under.

The logistics of pipe raising/lowering and computations due to bends.

R. Mason proposed keeping exact alignment of pipes unless R. Lee gives change instructions by March 14, 2012 (prior to site visit). Proposed up and over the valve room entrance door. Can make a change in DDR phase, but need to keep this task order moving along.

R. Reiner also mentioned Bob Cordie is concerned about vibrations from the pipes and the possibility of adding some sort of rubber gasket between the supports and pipes.

- K. Nelson to investigate saddle area separation (not along dam).
- ~ 17 feet per second = velocity at this location (saddle)
- Valve room, when valves are opening will experience the most vibration
- This will be considered during the DDR phase of the project.
- Heavy duty isolation at saddle can be added. Rigid at two ends. Will need expansion coupling joint.

<u>Bulkheads</u>

- Three bulkheads:
    - One (1) - construction (temporary
    - One (1) – normal operations
    - One (1) – positive closure (emergency bulkhead)
- Drawings need to be redone to show double.
- Roller gate and inline valve
- As close to exist of dam – to keep pressure down
- Jet flow valve to dissipate energy

Alternative #11 – Intake Tower with Siphon to Fishlock

This alternative requires two, 72-inch siphon pipes that will convey water from an upstream intake tower with low level inlet openings (~EL 100 ft.) to the existing fishlock. The fishlock will then discharge into the fishway approach channel (no longer in use) which in turn will flow through an 8-foot by 8-foot culvert and finally discharge into the junction pool, entrance and ladder pools.

Intake Tower Access

Intake tower not designed to be dewatered. According to Mr. Reiner, access for gate valve maintenance (cleaning of rust/silt and possible greasing valve components) is required. K. Nelson to work with P. Gaby and L. Larson to determine elevation of valve to allow maintenance. Proposed options:

- K. Nelson proposed revised design for dewatering the tower to a level to accommodate maintenance.
- Fishlock access options for steps and platforms are uncertain due to limited space, but discussed ship ladders and landings for USACE staff to keep clean ladders.
- At a minimum, ladders with landings are required (Reiner)
- K.Nelson to research options to provide access to downstream and upstream valves in the intake tower.
- Gate valve at elevation 150 ft, normal min. pool = el. 155 ft. Can we move the gate valve up to elevation 155 or a bit higher for maintenance? L. Larson said this was an options, but needed to avoid the area of the bend
- What about past the 90 degree bend? Is moving the gate valve into the horizontal stretch of pipe an option? R. Mason stated the horizontal stretch of the 72-inch pipes was not an option.
- Another option for maintenance is man baskets, but also uncertain due to space limitations.
- R. Mason: Diffuser valves maintenance requirements = grease shaft, couplings. Similar to tainter gates.
- R. Reiner: Spillway gates/navlock gates switched to pucks (composite). Trying to get away from grease. May be an issue here too.
- R. Mason: Greasing of bearing surfaces. Options for Greaseless bearing or an automatic grease system.
- R. Mason: Major maintenance/rehab will require a diver to disconnect valve.
- K. Nelson: Accuate valve on regular basis is recommended
- R. Mason: At Lost Creek Dam, they had to replace seat in the valve one time in 20 years.
- P Gaby: Could put flanges at top of curve for full rehabilitation (if necessary)
- K. Nelson: Still need dry access for maintenance
- R. Reiner: Divers are costly, penstock for station service. Dewater with bulkhead to gain access.
- P. Gaby: Propose building inside (like a small coffer dam)
- R. Reiner: Could work. Ideally, landing right above normal pool (el. 165 ft). Turn on pump to dewater and use a clean ladder to go down.
- P. Gaby: Could pour floor and walls (cast in place) to make room around gate valves. Entrance from top via ladder. Dewater with sump pump (if necessary). A lot cheaper. Proposed options:
    - El. 161 ft landing with metal railing. Ladder to el. 145 ft
    - ~ 185 ft ship ladder to el. ~ 161 ft landing and straight extension ladder (clean)
    - ~ 161 ft – 145 ft design so minimal leakage
    - ~ 145 ft concrete floor
    - ~ 162 ft wall height
    - Keep area in the dry
    - Valve mounted to concrete floor
- Mechanical rake system
    - Current size = 14 ft x 10 ft 6 in.
    - Propose minimize length and raise trash rack height

R. Mason asked USACE if the top can be the same shape as below the water. R. Reiner said it could.

Proposed change: man basket for access to valve instead of ladder.

Downstream siphon valve – can it be raised? Yes, but the higher the more head loss.

Ultrasonic flow meters will be installed to allow educated setting of valves to maintain 109 ft WSE. End of pipe = 120 ft (works for hydraulics). Pipe drop to 117 ft, valve could move up.

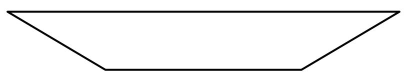
No solid concrete floor, grating with beams

Final determination: Valve at elevation130 ft, with ships ladder and platforms

<u>Mechanical Trash Rake/Airburst Cleaning System Discussion</u>

K. Nelson discussed proposed mechanical trash rake system on curved tower structure and stated the one vendor she contacted does not make a trash rake that can move on a curved surface. As currently designed, a trash rake is not feasible. The trash rake would need to be lined up in one plane. Proposed solutions:

- Reconfigure shape of Intake Tower and put mechanical trash rake system along front of a more rectangular-shaped tower structure with angled ends



- Rectangular-shaped Intake Tower assumes sufficient sweeping velocities.
- K. Kuhn asked what the necessary velocity is. CFD drawings will need to be reviewed.
- Angled ends with rounded corners would be better for sweeping velocities and hydrodynamic forces.
- R. Mason mentioned other vendors may have proposed solution to the problem.
- R. Mason stated the discussion around trying to solve the debris problem is changing the entire design. Until we know an airburst system would not work, why change the design?
- K. Nelson – reiterated the debris options are all dependent on sweeping velocities.
- P. Gaby – on possible tower reconfiguration would be to have most (5) trash rakes located on front and one on the downstream side.
- R. Hannan proposed one pipe instead of two? Configuration of pipes stays the same, curved nose stays the same, extend front with trash racks in front.
- R. Mason asked R. Reiner which direction he is leaning (Mechanical trash rake or air burst)?
- R. Reiner stated he is leaning toward the mechanical trash rake option.
- Airburst system requirements: 2 hp, 2,600 gal air receiver.
- R. Mason noted changes from the 60% EDR:
    - Mechanical trash rake
    - Intake tower design

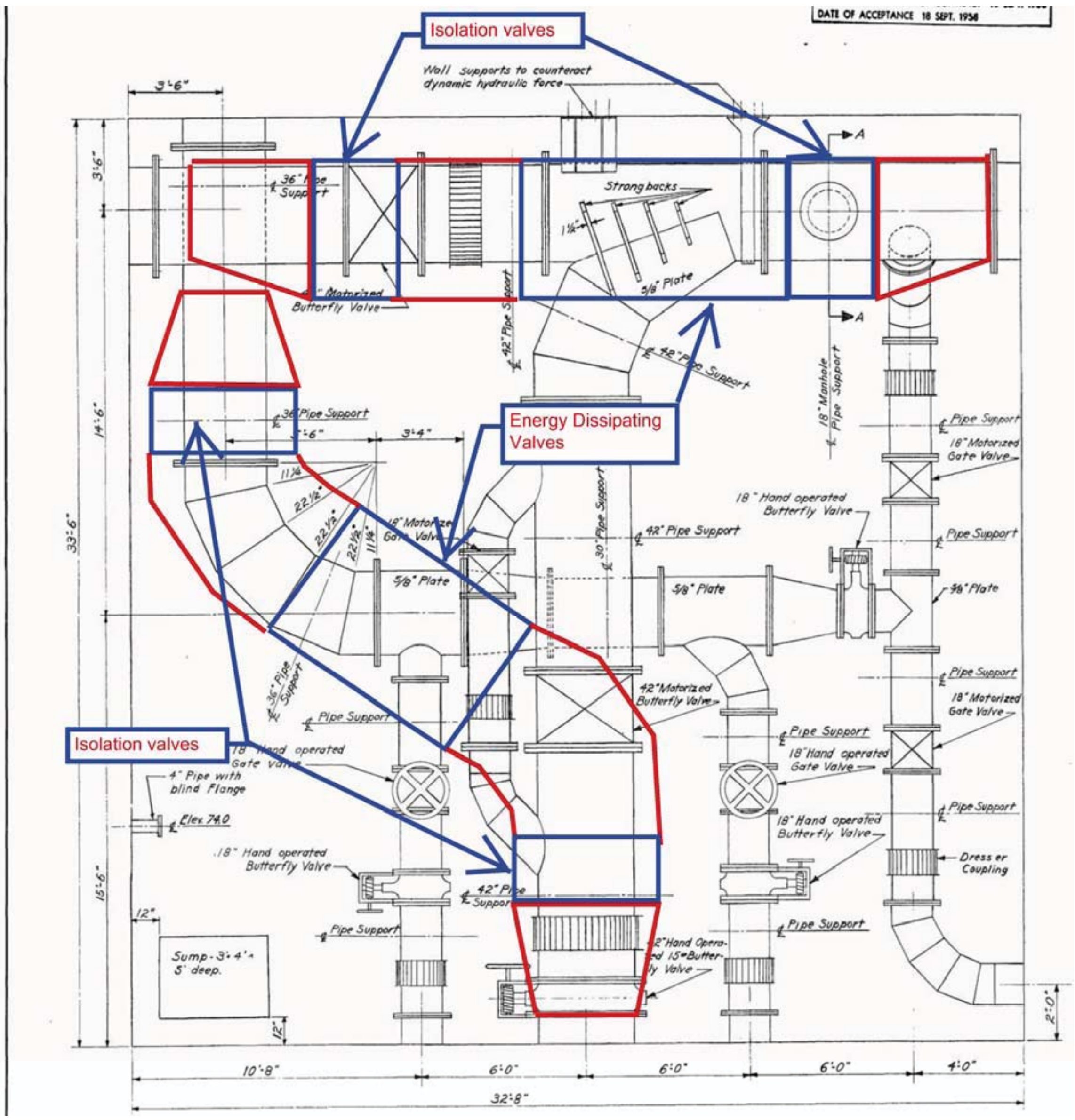
<u>Fishlock and Approach Channel</u>

- Existing entrance gate by the fishlock will need to be moved/removed.
- WSE in fishlock and fishlock approach channel is all at el. 109 ft.
- Control is going to be downstream at area where we have four diffuser valve gates to control WSE.
- Looking at putting gate in 8 x 8 channel “water conduit”
- Maximize opening to minimize headloss in the existing fishlock outlet.
- Discussed removal techniques for concrete in the fishlock.

Valve Room Changes

- Valve room changes – refine improvements, so that if valve room modifications become stand alone option without Alternatives #2 or #11, they would be implemented.
- R. Mason stated we are not to do detailed design in this phase. Detail engineering is to be done in DDR phase of the project.
- Per R. Reiner, USACE may use valve room, fishlock, approach channel changes as stand alone option.
- L. Larson discussed hydraulic calcs and how they developed. El. 109 ft to get 1,400 cfs. Discussed isolation in conduit. Install sill in bottom of conduit so you can install gate.
- No isolation between junction pool and water backing up into fishlock. Need to figure out a slide gate somewhere.
- At downstream end of fishlock approach channel, add a small sluice gate to block it off or open to flush out.
- Possibility of using stoplogs – existing stop logs (newer as of 2002) – move to end of approach channel
- Need to use crane, boom over to pick up stoplogs (cannot drive over approach channel)
- Keep existing stoplogs and either add new stoplogs or a wall with sluice gate.
- Fishlock approach channel wall on the south side of the channel will be raised to 110 ft el.
- Isolation gate (temporary bulkhead) – can be used to isolate the channel
- R. Reiner: Annual dewater of fishway is roughly 2-month period from December 1 to end of January. Most current dewater occurred Dec 1, 2011 through January 2012. Lifted stoplogs to provide access.
- K. Kuhn: How will the diffuser gates change? Will this change impact the downstream flow conditions? Suggested mentioning in the EDR that these topics will be reviewed further.

K. Nelson provided a drawing showing the proposed Valve Room pipe configurations.



Demolish everything in the valve room, 42-inch pipe connect to 42-inch pipe. 36-inch pipe rerouted to 42-inch drain. Upsize to 48 inches with bonneted knife 48-inch valves (2 x isolation valves). Upstream and downstream energy dissipating valves (flow control valves). Without energy dissipating valves, flows could potentially be too high. The energy dissipating valves increase head loss and reduce/control flow to prevent excessive velocities.

Valve options – jet flow valve (won't work) and sleeve valves are being proposed.

36-inch pipe to 48 inches to 42 inches. Isolation valves at upstream and downstream ends to open/close…not much energy loss with these types of valves. Energy dissipation valve to dissipate head. High velocities will tear up seats in valves. For pipes there is no maximum velocities limits in USACE design engineering manuals. The team-developed design criteria states max 16 fps. Propose sleeve energy dissipating valves.

R. Reiner stated a concern regarding rocks entering the pipe system possibly causing damage and how that could affect the proposed valve room alterations.

Lastly, regarding the valve room changes, Mr. Reiner wanted to know the possibility of achieving discharges greater than the 400 cfs. Mr. Mason said the design criteria is 400 cfs (for the valve room) and suggested Reiner speak with USACE officials if he would like this velocity criteria to be increased which would increase the discharge. Ms. Nelson will keep this in mind as the project progresses to see about increasing pipe size. The difficulty is when you increase the pipe size, the 16 fps increases to 25 fps or 40 fps.

USACE Action Items:

USACE Action Items	Responsible Person	Date
Engineering and Design Cost	Rick Russell	ASAP
Supervision and administrative costs during construction	Rick Russell	ASAP
Spreadsheet for total project costs	Rick Russell	ASAP
Need to schedule a date for meeting with David Ward, Sean Tackley, Ron Mason, and Randy Lee to decide how to address NOAA comments	Rick Russell	ASAP
Operation and maintenance costs	Rick Reiner	ASAP
Comments finalized and up to date – most of comments are in realm of USACE responsibilities	USACE (Lee/Kuhn)	3/16/2012
Decision to not remove or bore through expansion chamber wall in bottom of fishlock	R. Lee/K. Kuhn	

HDR Action Items:

HDR Action Items	Responsible Person	Date
90% EDR submittal (six copies)	HDR Project Team	09 April 2012

Attachments

Alt #2 and #11 Review Meeting Sign-In

Sheets and Drawings

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USACE TO3 The Dalles EFL AWS
Detailed Discussion of Alternatives #2 and #11 Meeting - Sign-In
8:30 – Noon March 12, 2012

Please print clearly

Name	Agency/Firm	Email	Phone
Rick Reiner	COE TD	richard.l.reiner@usace.army.mil	541-506-7805
Karen Kuhn	USACE	Karen.A.Kuhn@usace.army.mil	503-808-4897
Lisa Larson	NHC	llarson@nhc-sea.com	206 241 6000
Kristi Nelson	HDR	Kristi.Nelson@hdrinc.com	503-423-3732
Jennifer Switzer	HDR	Jennifer.switzer@hdrinc.com	503-727-3923
RON MASON	HDR	RONALD.MASON@hdrinc.com	503-423-3802
Rich Hannan	HDR	Richard.HANNAN@hdrinc.com	503-423-3751
DON BEST	HDR	don.best@hdrinc.com	503-423-3735
DAVE WARD	HDR	DAVID.WARD@HDRINC.COM	503-423-3824
PETE GABY	HDR	peter.gaby@hdrinc.com	503-724-6602

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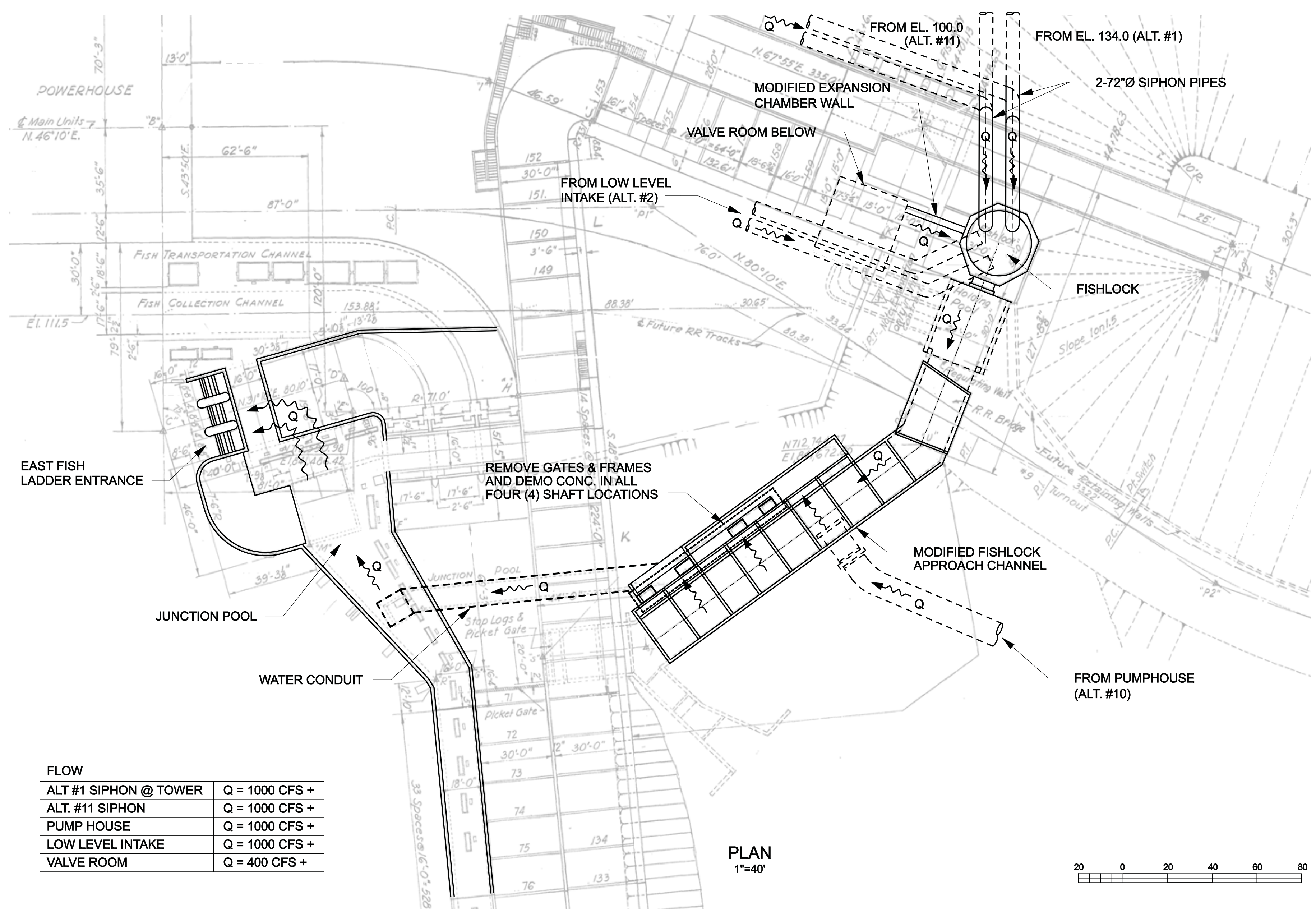

FLOW	
ALT #1 SIPHON @ TOWER	Q = 1000 CFS +
ALT. #11 SIPHON	Q = 1000 CFS +
PUMP HOUSE	Q = 1000 CFS +
LOW LEVEL INTAKE	Q = 1000 CFS +
VALVE ROOM	Q = 400 CFS +

PLAN
1"=40'

20 0 20 40 60 80

US Army Corps of Engineers® Portland District

GENERAL LAYOUT OF ALL ALTERNATIVES
SHOW FLOW

DATE: January 25, 2012
DESIGNED BY: RCM
DWN BY: TTN
CKD BY: RCM
SUBMITTED BY: RCM
PLOT SCALE: NTS
PLOT DATE:
DRAWING NUMBER: 1
SIZE: 17X11
FILE NAME: S01-Typical Flow Path Plan View.DGN

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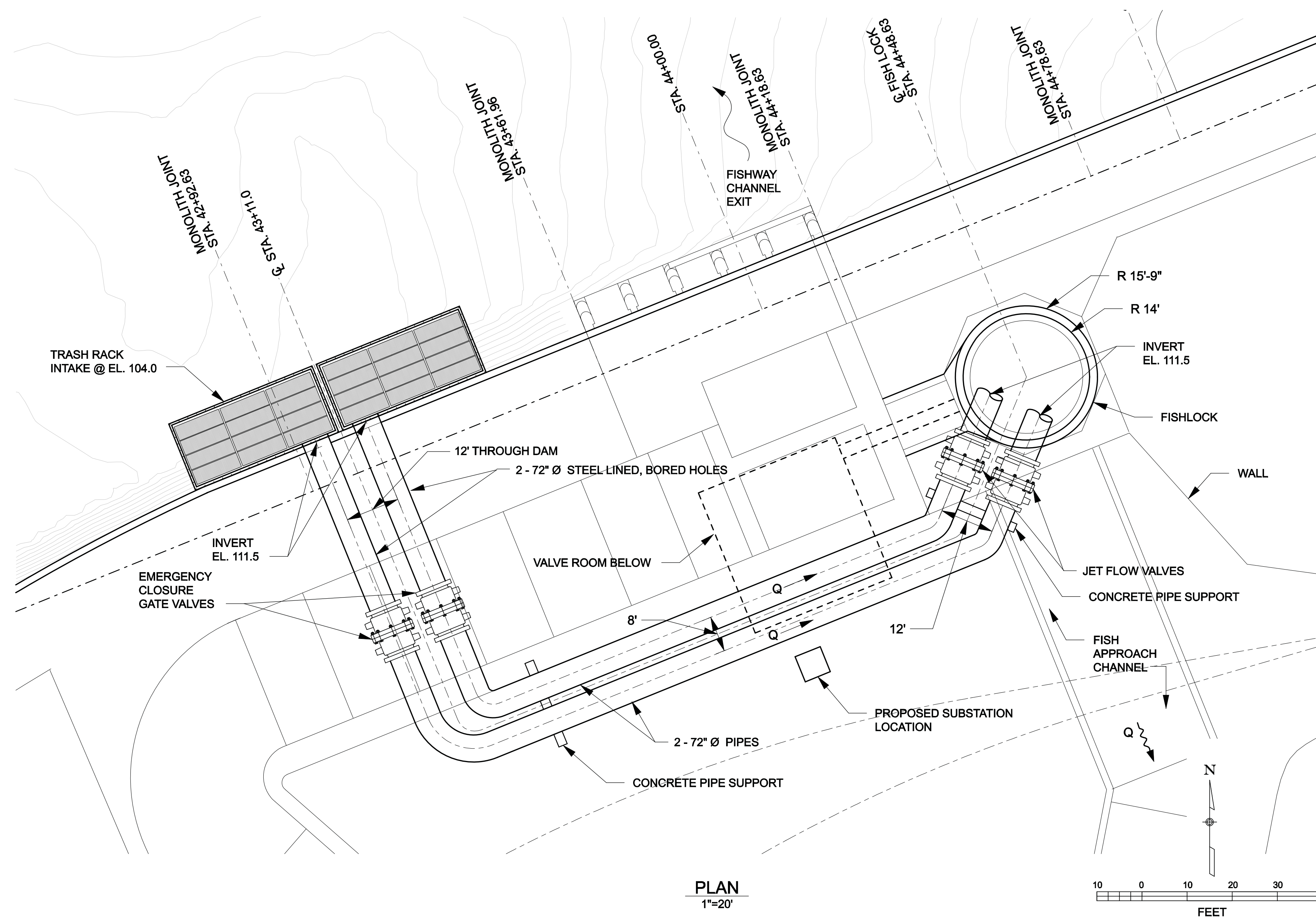
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
1
SHEET 1 OF 20

DATE AND TIME PLOTTED: 1/24/2012 3:55:17 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: TYPICAL FLOW PATH - GENERAL PLAN VIEW
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1"=20'

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

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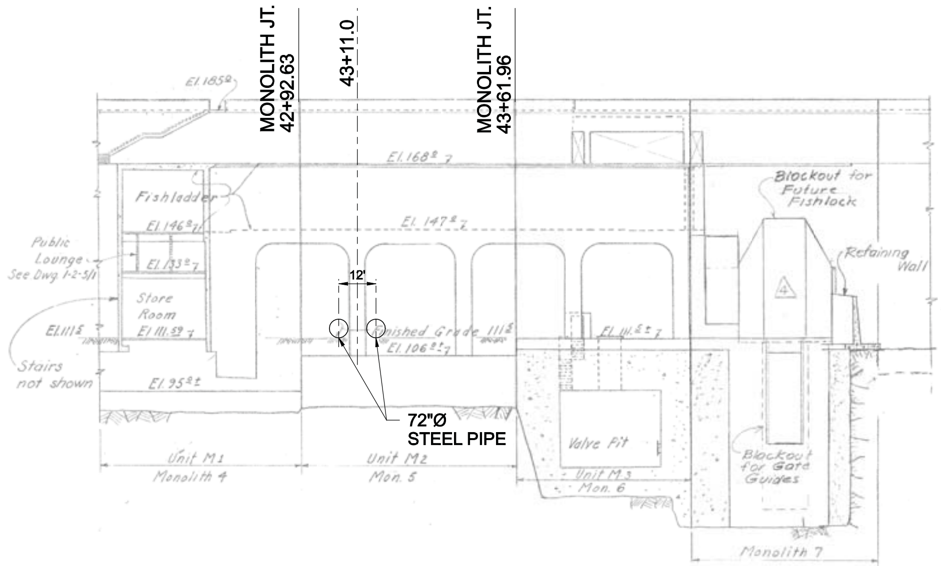
DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 5
SIZE: 17X11	FILE NAME: S05-Lower Level Intake Plan.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

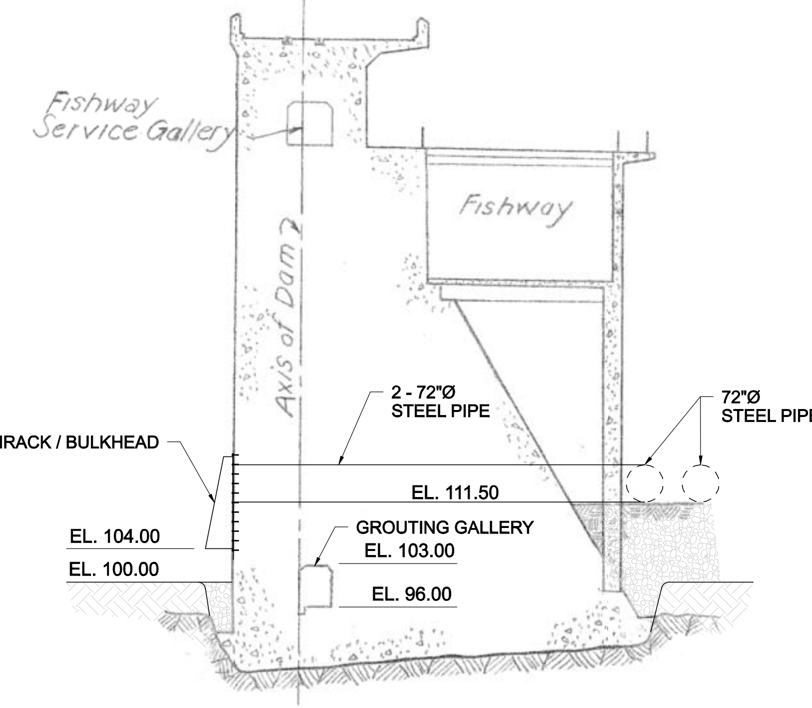
SHEET IDENTIFICATION
5
SHEET 5 OF 20

DATE AND TIME PLOTTED: 1/24/2012 5:01:41 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW LOW LEVEL INTAKE
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



ELEVATION - EAST NON-OVERFLOW DAM

1"=40'



SECTION

1"=20'

US Army Corps of Engineers® Portland District

SECTION VIEW
ALTERNATIVE #2
LOW LEVEL INTAKE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

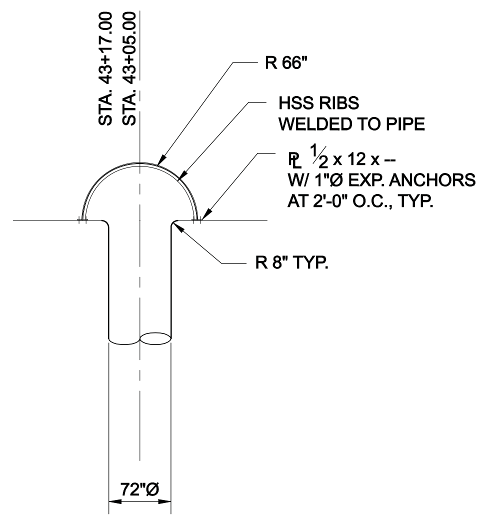
HDR ENGINEERING INC.

DESIGNED BY: JPG	DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM
SUBMITTED BY: RCM	
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 6
SIZE: 17X11	FILE NAME: S06-Low Level Intake Section.dgn

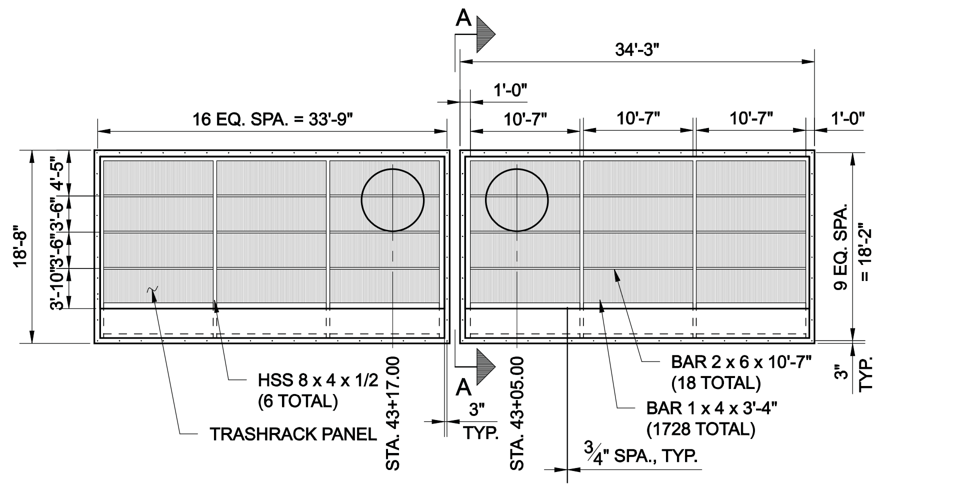
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
6
SHEET 6 OF 20

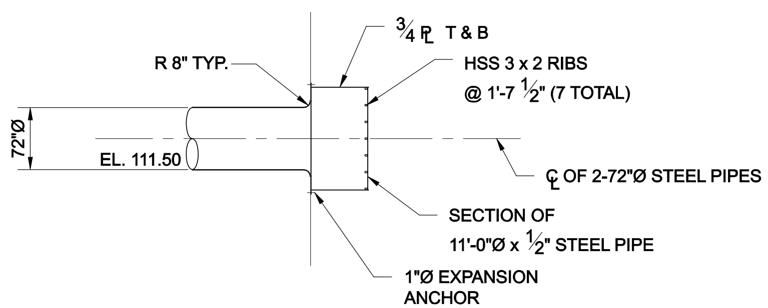
DATE AND TIME PLOTTED: 1/24/2012 5:09:21 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW LOW LEVEL OPTION
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



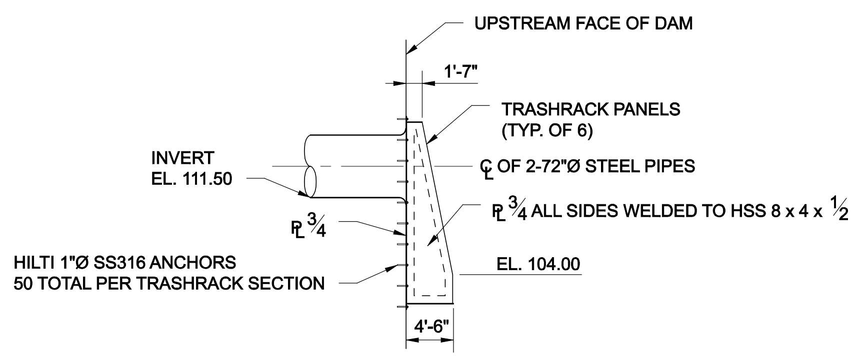
PLAN
1"=1'-0"



ELEVATION
1"=1'-0"



ELEVATION
1"=1'-0"



SECTION A-A
1"=1'-0"

US Army Corps of Engineers®
Portland District

PLAN, ELEVATIONS, AND SECTION
ALTERNATIVE #2
LOW LEVEL INTAKE
TRASHRACK AND COFFERDAM

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 7
SIZE: 17X11	FILE NAME: S07-Low Level Intake Detail.dgn	

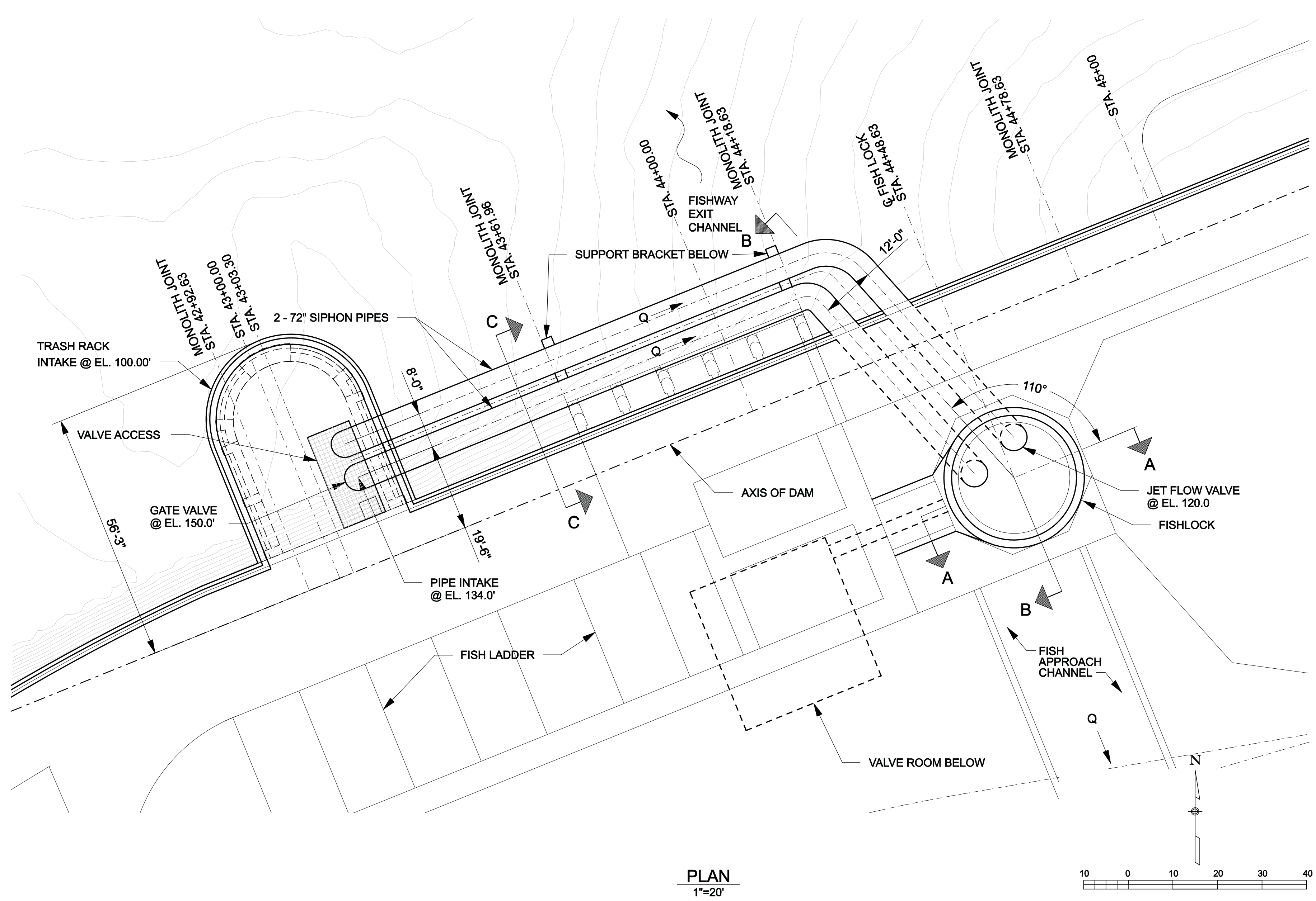
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
7
SHEET 7 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:28:04 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAIL LOW LEVEL OPTION CONSTRUCTION COFFERDAM
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



PLAN
1"=20'

US Army Corps of Engineers® Portland District

PLAN VIEW
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

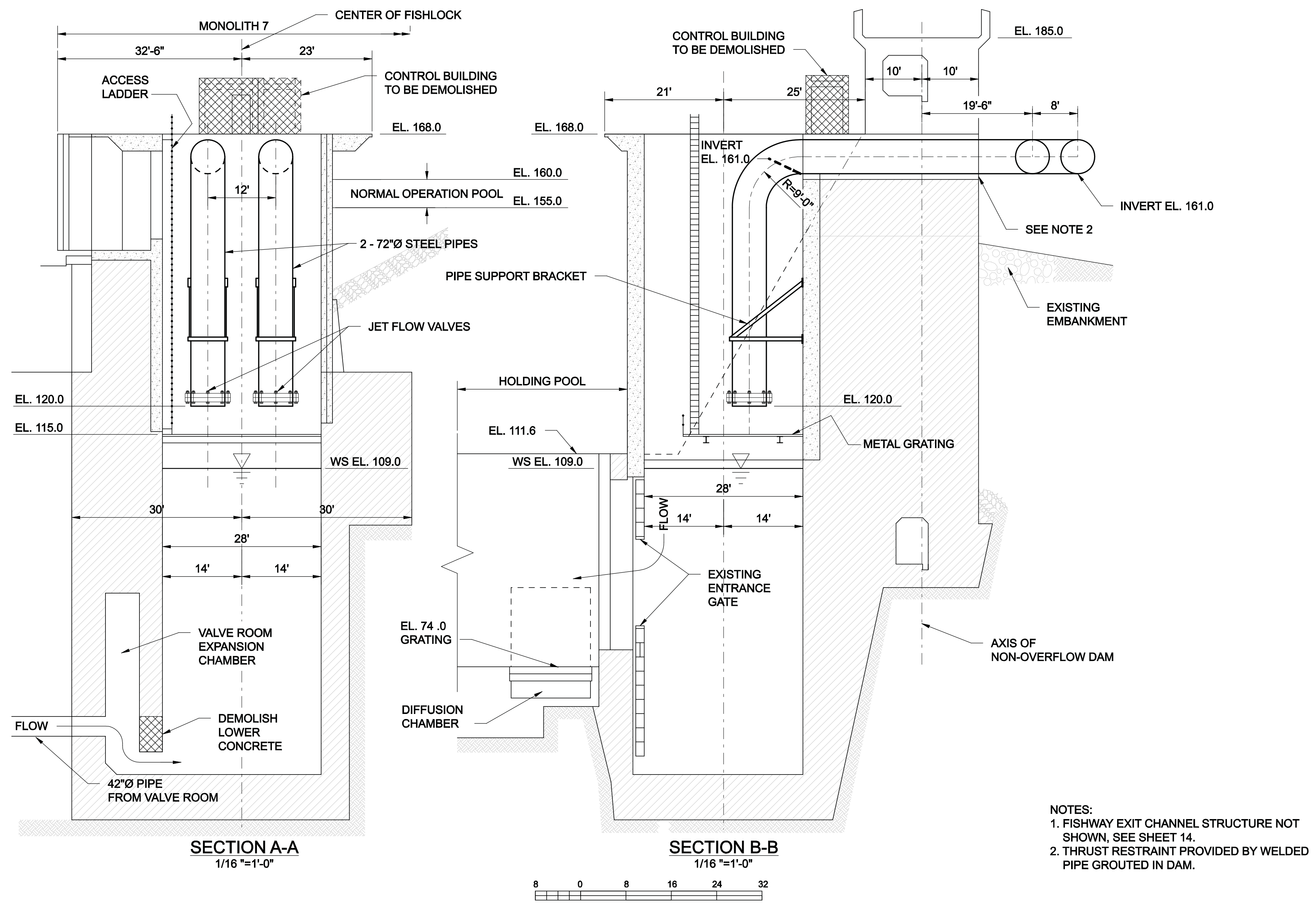
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 12
SIZE: 17X11	FILE NAME: S12-Siphon Alt 11 Plan.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
12
SHEET 12 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:35:21 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



NOTES:
1. FISHWAY EXIT CHANNEL STRUCTURE NOT SHOWN, SEE SHEET 14.
2. THRUST RESTRAINT PROVIDED BY WELDED PIPE GROUTED IN DAM.

US Army Corps of Engineers® Portland District

SECTIONS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

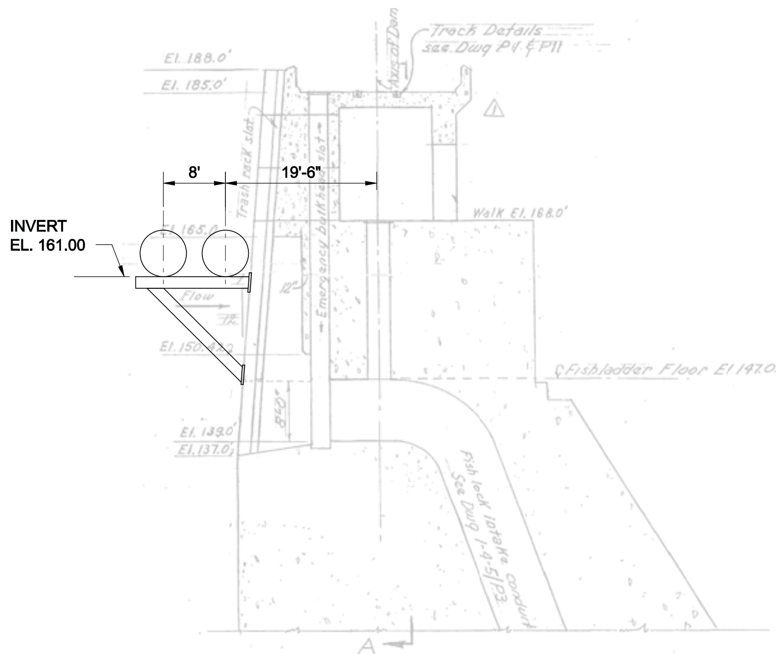
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 13
SIZE: 17X11	FILE NAME: S13-Siphon Alt 11 Section.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
13
SHEET 13 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:51:38 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: SECTION VIEW SIPHON OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



SECTION C-C
1/16 "=1'-0"

8 0 8 16 24 32

US Army Corps
of Engineers®
Portland District

DETAILS
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S03-Siphon-Alternative 11.DGN	

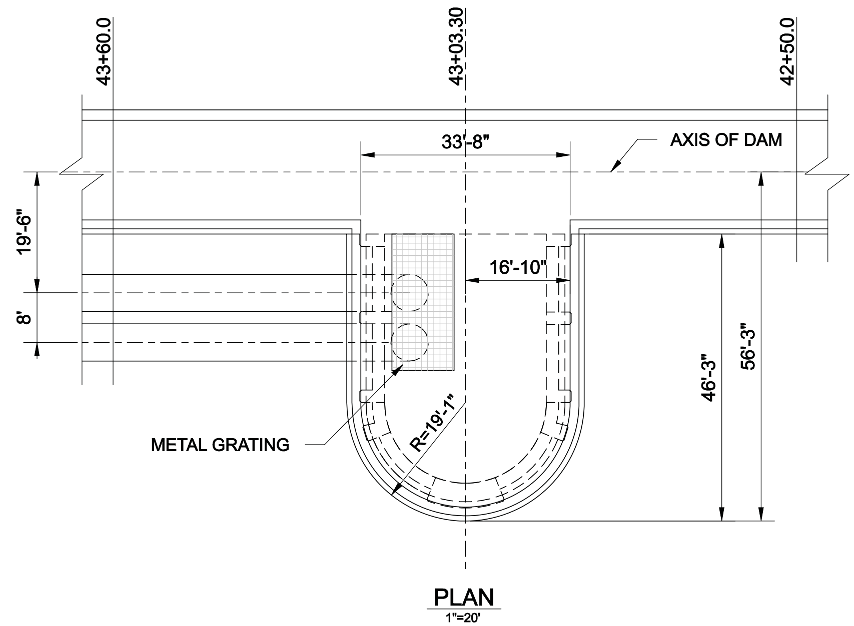
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

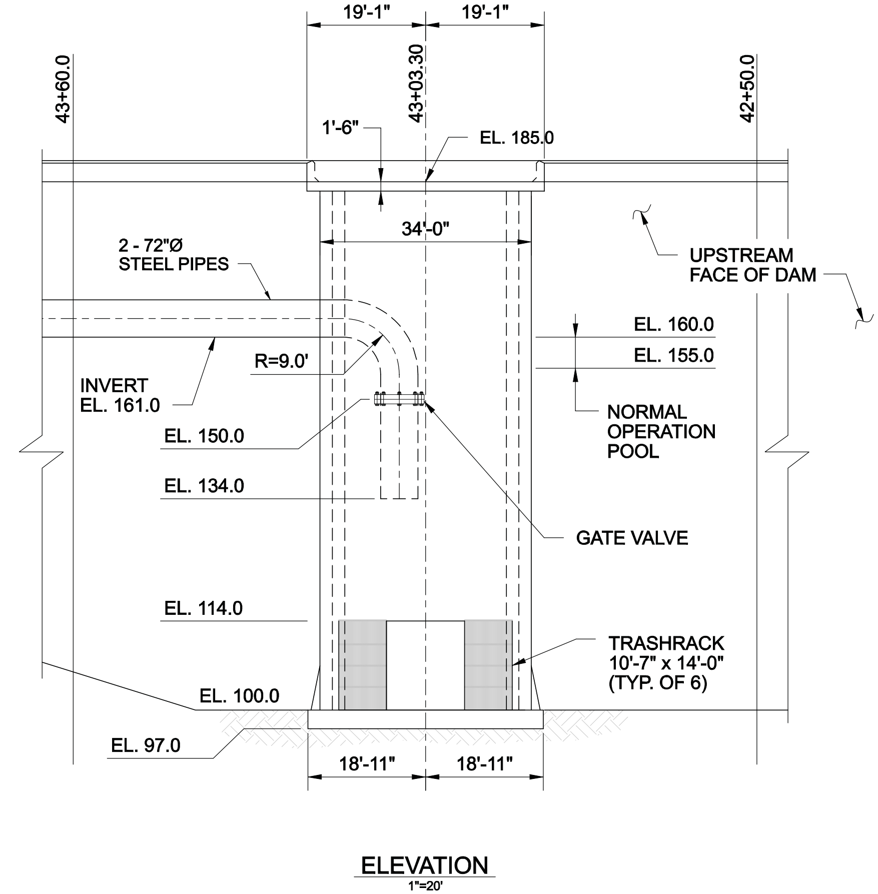
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
14
SHEET 14 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:53:49 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: DETAILS SIPHON OPTION ALTERNATIVE 11
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1"=20'



ELEVATION
1"=20'

US Army Corps of Engineers®
Portland District

INTAKE TOWER
ALTERNATIVE #11
INTAKE TOWER WITH SIPHON TO FISHLOCK

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

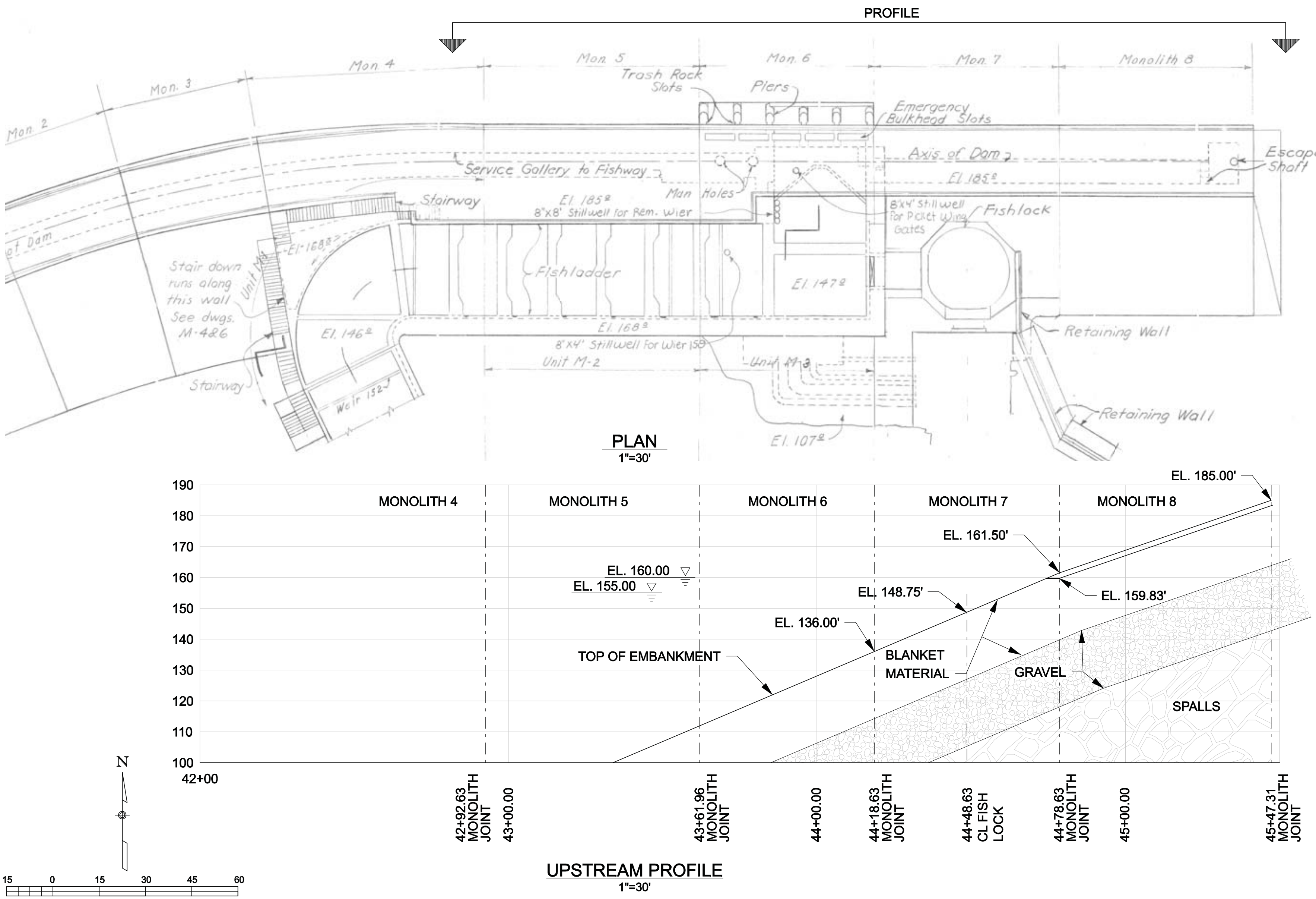
HDR ENGINEERING INC.

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 14
SIZE: 17X11	FILE NAME: S15-Siphon Alt 11 Intake.dgn	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
15
SHEET 15 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:55:59 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN AND ELEVATION TOWER OPTION ALTERNATIVE #11
DESIGN FILE: 13.00_CAD\SHEETS\LAKE TAP OPTION



US Army Corps of Engineers®
Portland District

GENERAL PLAN AND PROFILE

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 16
SIZE: 17X11	FILE NAME: S16-Siphon Plan Profile.dgn	

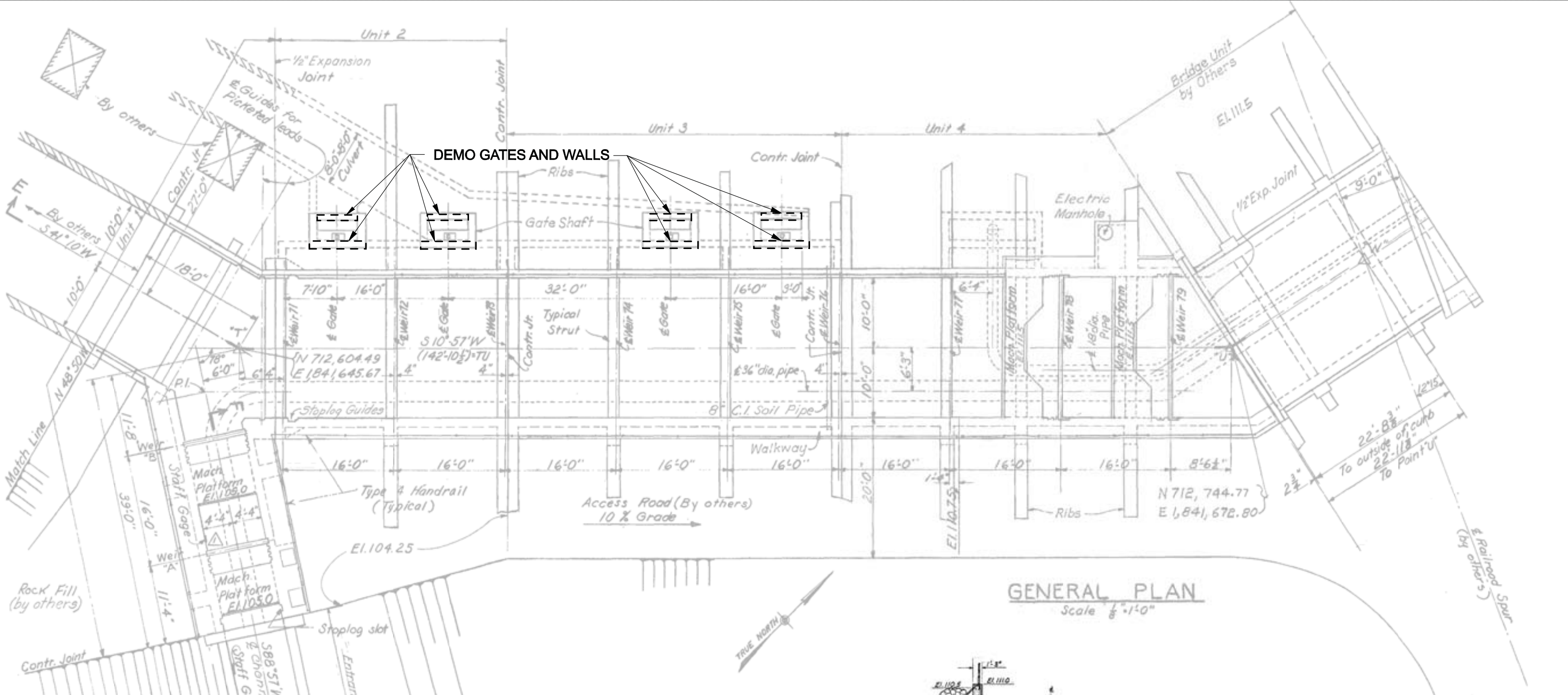
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

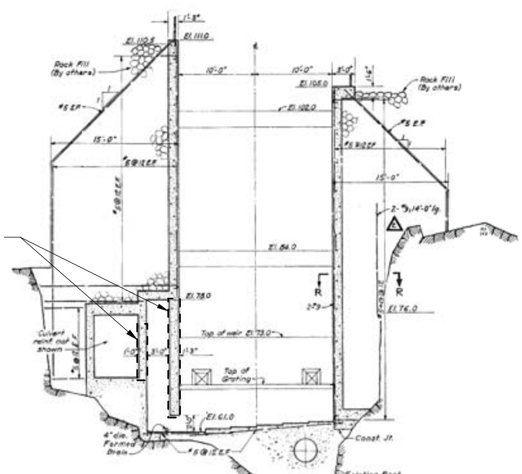
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
16
SHEET 16 OF 20

DATE AND TIME PLOTTED: 1/25/2012 10:57:49 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: PLAN AND PROFILE EMBANKMENT ALTERNATIVE #1
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



PLAN
1/16 "=1'-0"



SECTION THROUGH FISHLOCK APPROACH CHANNEL
1/16 "=1'-0"

NOTE:
SEE SHEETS 3 AND 13 FOR ADDITIONAL DEMOLITION IN VALVE ROOM.

8 0 8 16 24 32

US Army Corps of Engineers®
Portland District

FISHLOCK APPROACH
CHANNEL MODIFICATIONS
PLAN AND SECTION

DESIGNED BY: JPG		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: AS SHOWN	PLOT DATE:	DRAWING NUMBER: 17
SIZE: 17X11	FILE NAME: S17-Fishlock Approach Channel Mods.dgn	

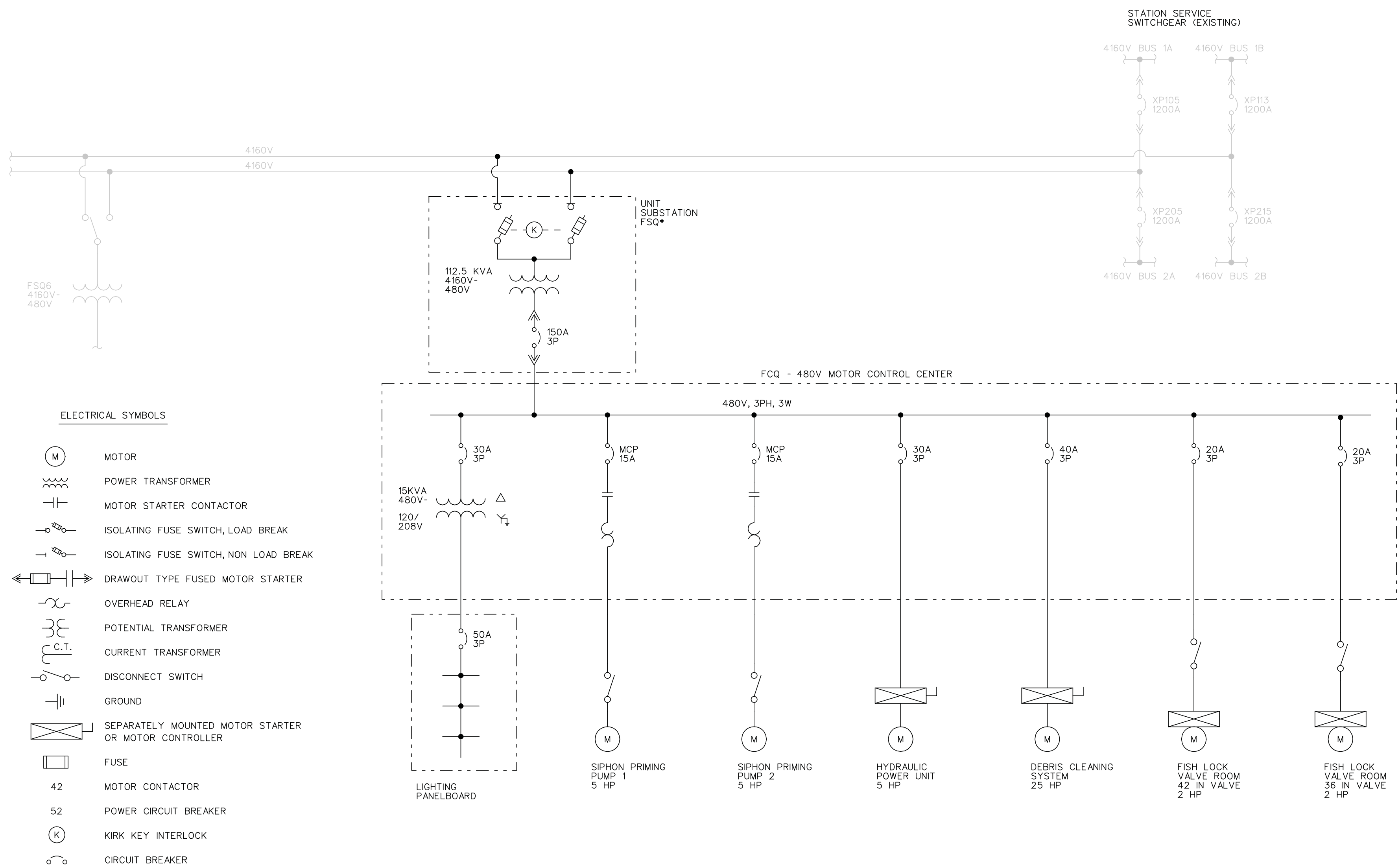
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
17
SHEET 17 OF 20

DATE AND TIME PLOTTED: 1/25/2012 11:00:50 AM
BY USERNAME: TAM NGUYEN
SHEET NAME: FISHLOCK CHANNEL MODIFICATIONS PLAN AND SECTION
DESIGN FILE: 13.00_CAD\SHEETS\SIPHON OPTION



ALTERNATIVE #1 - SIPHON FOR ADDITIONAL WATER TO THE FISH LOCK

ALTERNATIVE #11 - UPSTREAM INTAKE TOWER WITH SIPHON

US Army Corps of Engineers® Portland District

ALTERNATIVES #1 AND #11
ELECTRICAL ONE-LINE DIAGRAMS

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

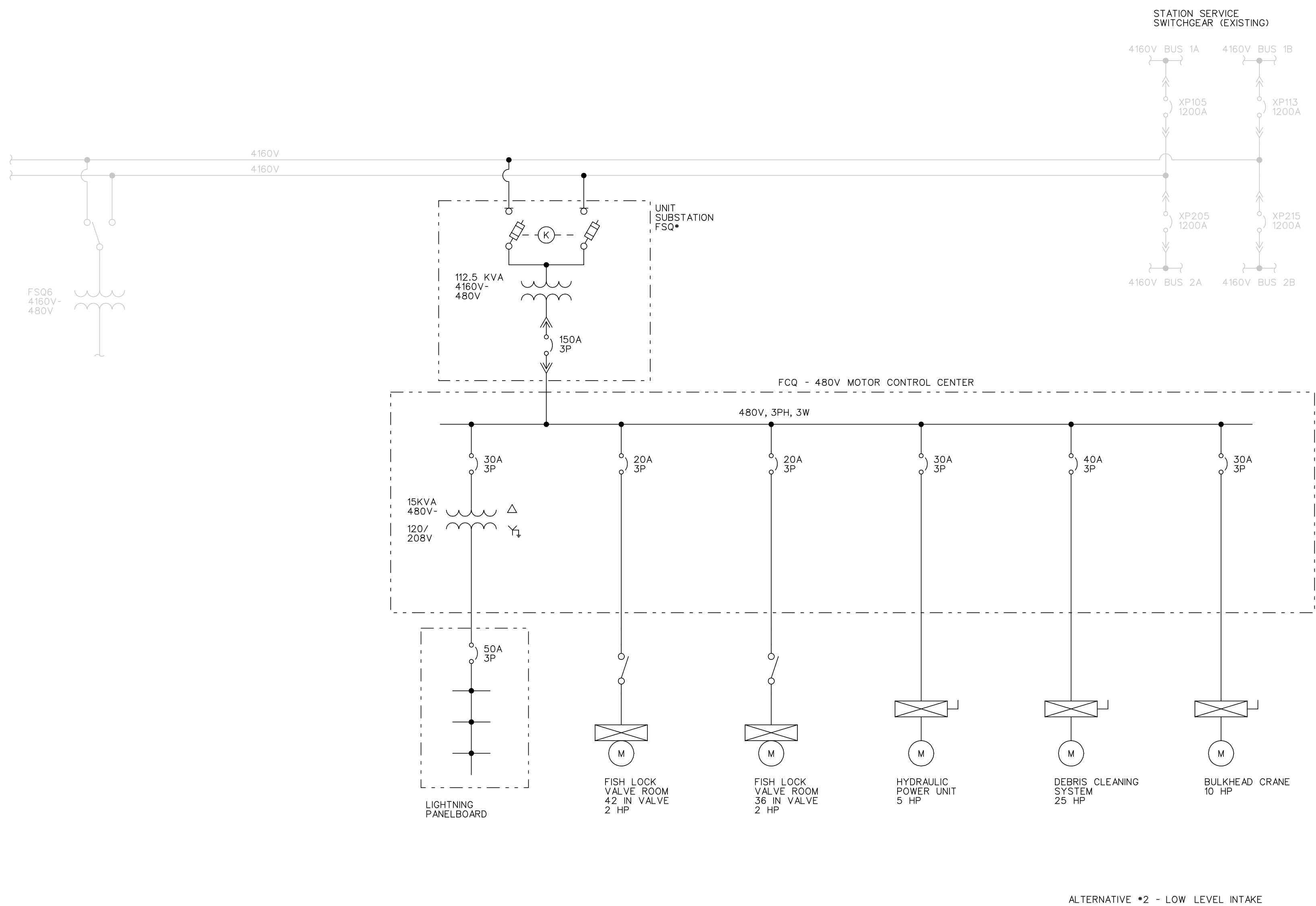
HDR ENGINEERING INC.

DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 18
SIZE: 17X11	FILE NAME: S18-Alternative 1 & 11.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

SHEET IDENTIFICATION
18
SHEET 18 OF 20

DATE AND TIME PLOTTED: 1/25/2012 2:08:11 PM
BY USERNAME: TAM NGUYEN
SHEET NAME: ALTERNATIVES #1 AND #11 - ELECTRICAL ONE-LINE DIAGRAMS
DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\



US Army Corps of Engineers® Portland District

ALTERNATIVE #2
ELECTRICAL ONE-LINE DIAGRAMS

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

DESIGNED BY: DB		DATE: January 25, 2012
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 19
SIZE: 17X11	FILE NAME: S19-Alternative 2.DGN	

THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM

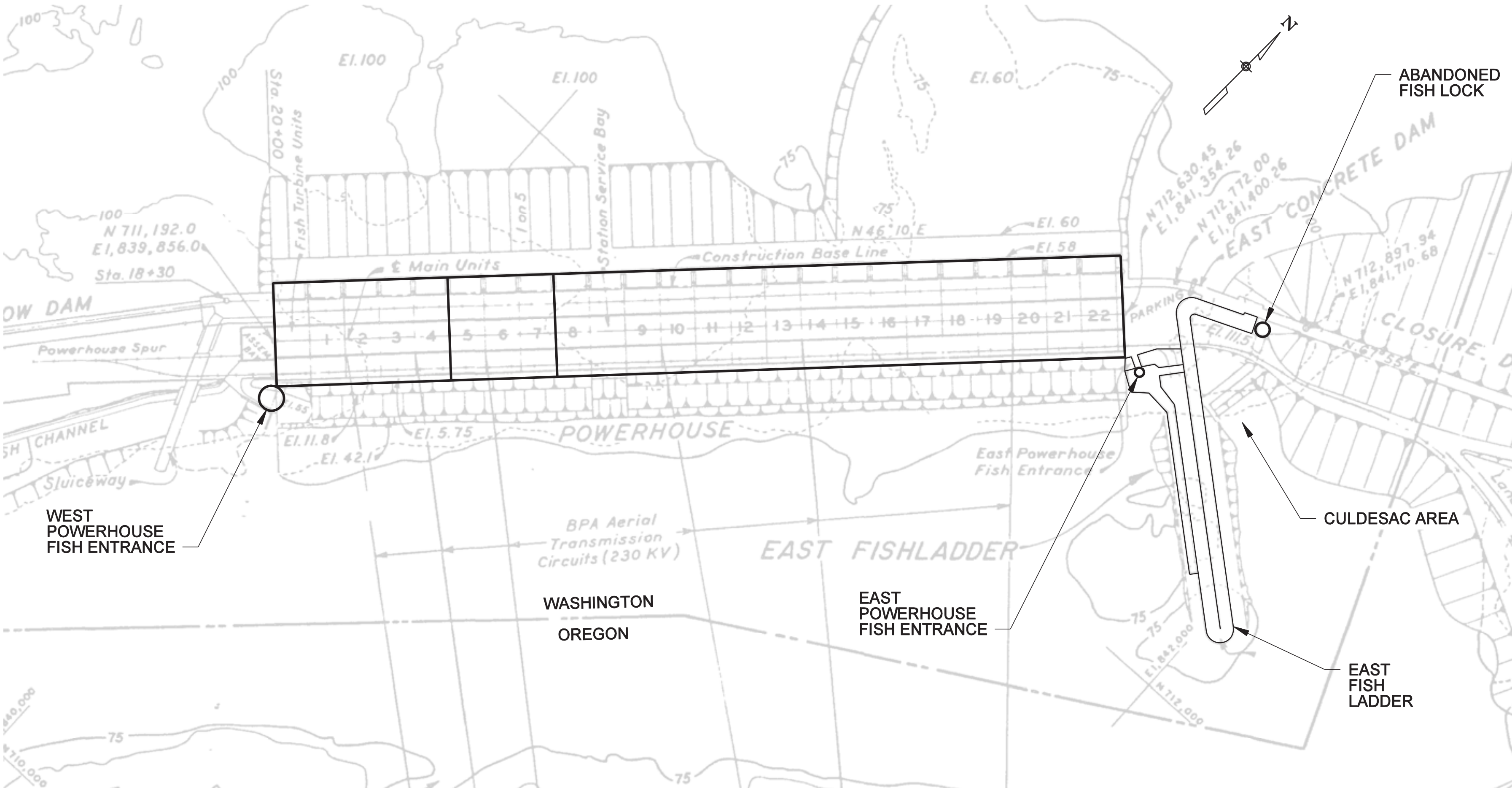
SHEET IDENTIFICATION
19
SHEET 19 OF 20

DATE AND TIME PLOTTED: 1/25/2012 2:17:22 PM

BY USERNAME: TAM NGUYEN

SHEET NAME: ALTERNATIVES *1 AND *11 - ELECTRICAL ONE-LINE DIAGRAMS

DESIGN FILE: I_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\



PLAN VIEW
NOT TO SCALE

US Army Corps of Engineers® Portland District

PLAN VIEW
POWER HOUSE

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

HDR ENGINEERING INC.

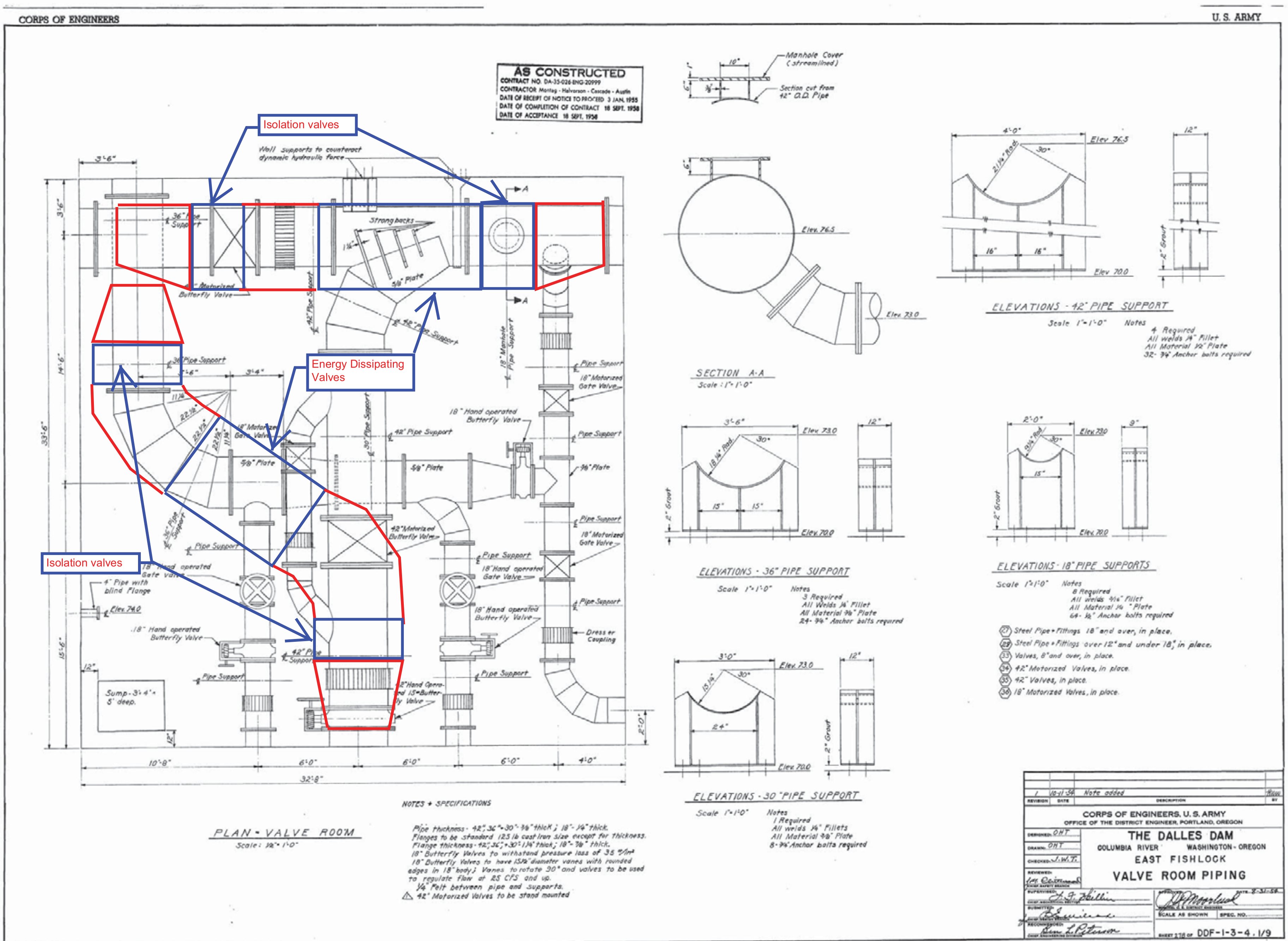
DESIGNED BY: RCM		DATE: December 15th, 2010
DWN BY: TTN	CKD BY: RCM	
SUBMITTED BY: RCM		
PLOT SCALE: NTS	PLOT DATE:	DRAWING NUMBER: 02
SIZE: 17X11	FILE NAME: 147341-S02.DGN	

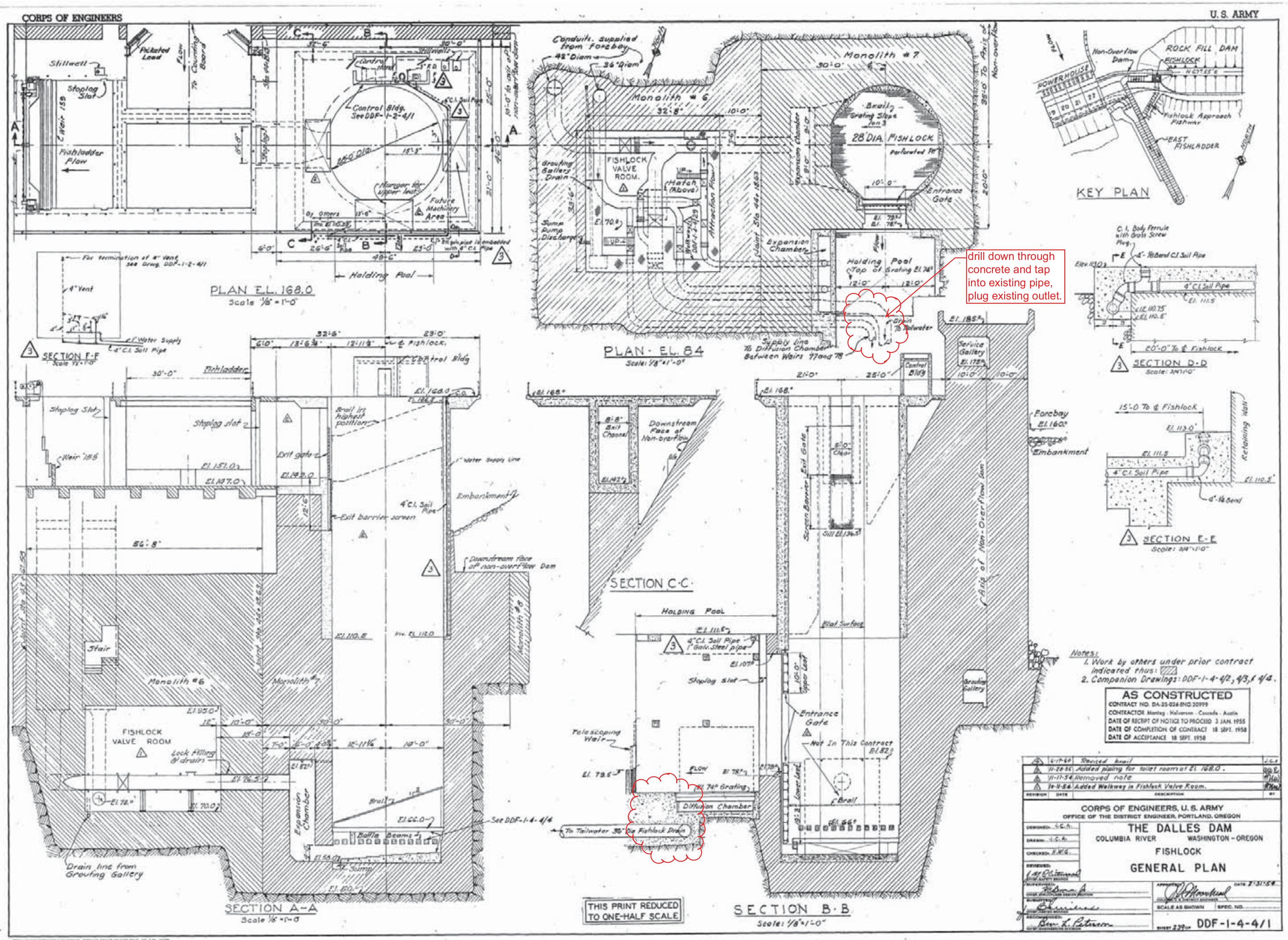
THE DALLES DAM
EAST FISH LADDER
AUXILIARY WATER SYSTEM
BACKUP LETTER REPORT

SHEET IDENTIFICATION
02
SHEET 2 OF 2

DATE AND TIME PLOTTED: $$$DATE$$$$ $TIME | BY USERNAME: TAM NGUYEN | SHEET NAME: PLAN VIEW POWER HOUSE

DESIGN FILE: 1_ENGINEERING_DWGS_CADD\SHEET FILES2% SUBMITTAL DRAWINGS\BASE DRAWINGS\


CORPS OF ENGINEERS
U. S. ARMY
AS CONSTRUCTED
CONTRACT NO. DA-35-026-ENG-20999
CONTRACTOR Morley - Halvorson - Cascade - Austin
DATE OF RECEIPT OF NOTICE TO PROCEED 3 JAN. 1955
DATE OF COMPLETION OF CONTRACT 18 SEPT. 1958
DATE OF ACCEPTANCE 18 SEPT. 1958
Isolation valves
Energy Dissipating Valves
Isolation valves
Wall supports to counteract dynamic hydraulic force
Strong backs
5/8" Plate
Motorized Butterfly Valve
36" Pipe Support
42" Pipe Support
18" Manhole Pipe Support
30" Pipe Support
18" Motorized Gate Valve
18" Hand operated Butterfly Valve
18" Hand operated Gate Valve
42" Motorized Butterfly Valve
Pipe Support
Dresser Coupling
4" Pipe with blind Flange
Elev 74.0
Sump - 3'-4" x 5' deep.
PLAN - VALVE ROOM
Scale: 1/2" = 1'-0"
NOTES + SPECIFICATIONS
Pipe thickness - 42", 36" + 30" - 3/8" thick; 18" - 1/4" thick.
Flanges to be standard 125 lb cast iron size except for thickness.
Flange thickness - 42", 36", + 30" - 1 1/4" thick; 18" - 7/8" thick.
18" Butterfly Valves to withstand pressure loss of 35 #/in²
18" Butterfly Valves to have 15 1/2" diameter vanes with rounded edges in 18" body; Vanes to rotate 30° and valves to be used to regulate flow at 25 CFS and up.
1/4" Felt between pipe and supports.
42" Motorized Valves to be stand mounted
Manhole Cover (streamlined)
Section cut from 42" O.D. Pipe
SECTION A-A
Scale: 1" = 1'-0"
Elev 76.5
Elev 73.0
ELEVATIONS - 42" PIPE SUPPORT
Scale 1" = 1'-0"
Notes
4 Required
All welds 1/4" Fillet
All Material 1/2" Plate
32 - 3/4" Anchor bolts required
ELEVATIONS - 36" PIPE SUPPORT
Scale 1" = 1'-0"
Notes
3 Required
All Welds 1/4" Fillet
All Material 3/8" Plate
24 - 3/4" Anchor bolts required
ELEVATIONS - 18" PIPE SUPPORTS
Scale 1" = 1'-0"
Notes
8 Required
All welds 3/16" Fillet
All Material 1/4" Plate
64 - 1/2" Anchor bolts required
Steel Pipe + Fittings 18" and over, in place.
Steel Pipe + Fittings over 12" and under 18", in place.
Valves, 8" and over, in place.
42" Motorized Valves, in place.
42" Valves, in place.
18" Motorized Valves, in place.
ELEVATIONS - 30" PIPE SUPPORT
Scale 1" = 1'-0"
Notes
1 Required
All welds 1/4" Fillets
All Material 3/8" Plate
8 - 3/4" Anchor bolts required
Note added
CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON
THE DALLES DAM
COLUMBIA RIVER WASHINGTON - OREGON
EAST FISHLOCK
VALVE ROOM PIPING
SCALE AS SHOWN
DDF-1-3-4.1/9


CORPS OF ENGINEERS
U.S. ARMY
PLAN EL. 168.0
Scale 1/8" = 1'-0"
PLAN - EL. 84
Scale: 1/8"=1'-0"
KEY PLAN
SECTION D-D
SECTION E-E
SECTION F-F
SECTION C-C
SECTION A-A
Scale 1/8" = 1'-0"
SECTION B-B
Scale: 1/8"=1'-0"
drill down through concrete and tap into existing pipe, plug existing outlet.
Notes:
1. Work by others under prior contract indicated thus:
2. Companion Drawings: DDF-1-4-4/2, 4/3, & 4/4.
AS CONSTRUCTED
CONTRACT NO. DA-35-026-ENG-20999
CONTRACTOR Montag - Halvorson - Cascade - Austin
DATE OF RECEIPT OF NOTICE TO PROCEED 3 JAN. 1955
DATE OF COMPLETION OF CONTRACT 18 SEPT. 1958
DATE OF ACCEPTANCE 18 SEPT. 1958
Revised brail
Added piping for toilet room at El. 168.0.
Removed note
Added Walkway in Fishlock Valve Room.
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON
THE DALLES DAM
COLUMBIA RIVER WASHINGTON - OREGON
FISHLOCK
GENERAL PLAN
SCALE AS SHOWN
DDF-1-4-4/1
THIS PRINT REDUCED TO ONE-HALF SCALE

2

Appendix I

Project Photographs

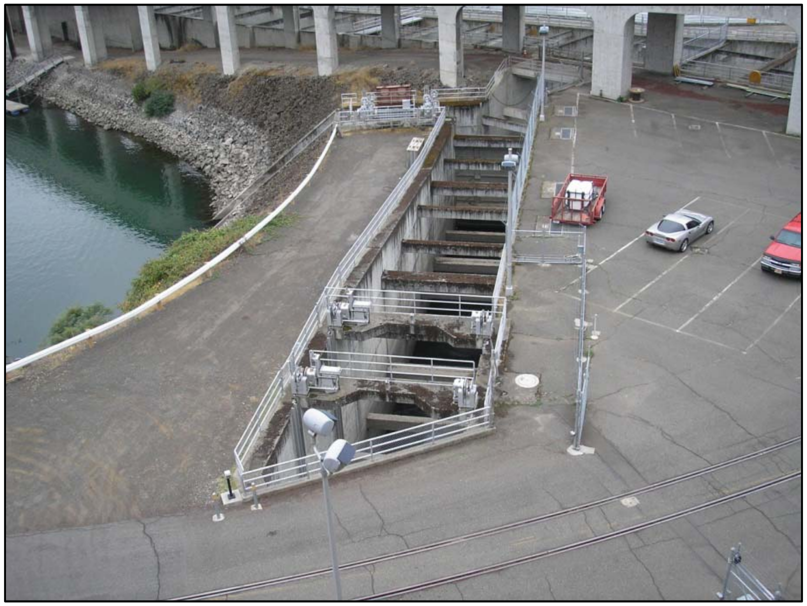
Appendix I – Project Photographs

P otograp 1. View o E isting Concrete is loc .

P otograp 2. Loo ing upstrea at East is Ladder, ote is loc to le t side o p oto.

P otograp . View o East is Ladder.

Appendix I – Project Photographs



P otograp 4. View o is wa pproac C annel.

P otograp 6. View o op o Da , Oregon in ac ground.

P otograp . View o Interior o is loc

P otograp 7. op o is loc , e uip ent and s all uilding to e de olis ed.

Appendix I – Project Photographs

P otograp 8. pstrea ace o concrete onolit s.

P otograp 10. pproac C annel.

P otograp . is loc and pproac C annel.

P otograp 11. View o downstrea onolit .

Appendix I – Project Photographs

P otograp 12. Potential align ent o pipes or Low Level Inta e.

P otograp 1 . is loc at ground level.

P otograp 14. pproac C annel on rig t, is loc in ac ground, di user valve grading in oreground.

Appendix I – Project Photographs

P otograp 1 . pical View in Valve oo .