

DESIGN DOCUMENTATION REPORT The Dalles Dam, Columbia River North Fish Ladder Rock Wall Stabilization	
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**US Army Corps
of Engineers®**

Portland District

Design Documentation Report

**THE DALLES DAM
COLUMBIA RIVER**

NORTH FISH LADDER ROCK WALL STABILIZATION



September 30, 2015

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The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

Executive Summary

The purpose of this Design Documentation Report (DDR) is to provide a record of design decisions, assumptions, and methods related to the stabilization of rock cuts along The Dalles Dam North Fish Ladder that forms the side walls of a portion of the fish ladder, between weirs No. 77 and 132. Mechanical weathering over the last 50+ years has caused areas of the steep rock cuts to become unstable creating project life safety and operability concerns. In addition, the open rock joints along the rock faces have allowed brush and trees to establish, which causes additional destabilization of these rock cuts. The objective of the project is to successfully stabilize the rock cuts along the North Fish Ladder, between weirs No. 77 to 132. Successful stabilization of these faces will include a combination of scaling, rock anchors/bolts, and small shotcrete walls with anchors between weirs 120 and 123.

This DDR includes discussion of considered alternatives. The preferred alternative evaluated in this DDR would not significantly alter the existing fish ladder channel, adversely impact the ladder weirs and orifices, or encroach into the channel's minimum 24 foot design width. The proposed work is generally considered to be maintenance activity, and is not intended to modify the existing fish ladder structure, or change ladder performance or operation. The work proposed in this DDR is not intended to permanently stabilize the rock lined fish channel. With time, the exposed rock slopes will continue to weather and future stabilization measures will likely be required. The proposed stabilization work is intended to substantially reduce the rock fall hazards from its current level for at least 20 years.

The proposed design includes rock scaling; localized rock anchors/bolts; and construction of three shotcrete walls with mesh, rebar and rock anchor support, as shown on Plate 1. It is anticipated that scaling will be required for about 22,000 sf of rock cut, with a total scaled rock volume of about 220 cy. A total of 100 rock anchors are anticipated, with average depths of 12 feet; plus an additional 24 anchors to support the shotcrete walls. The construction cost with contingency for this design is estimated to be approximately \$873,000. The total fully funded project cost, which includes design, construction, and administration of the contract is currently estimated to be \$1.1 million.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

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Appendix E Fish Passage O&M Coordination Team (FPOM) Emails
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PERTINENT PROJECT DATA

PERTINENT PROJECT DATA		
THE DALLES LOCK AND DAM - LAKE CELILO		
GENERAL		
Location	Columbia River, Oregon and Washington, River Mile 192	
Drainage area	Square miles	237,000
RESERVOIR – LAKE CELILO (elevations referenced to 1929 datum 1947 adjustment)		
Normal minimum pool elevation	Feet, msl	155
Normal maximum pool elevation	Feet, msl	160
Maximum pool elevation (PMF regulated, 2009)	Feet, msl	178.4
Minimum tailwater elevation	Feet, msl	76.4
Maximum tailwater elevation (PMF regulated, 2009)	Feet, msl	127.2
Reservoir length (to John Day Dam)	Miles	23.5
Reservoir surface area – normal maximum power pool (EL 160.0)	Acres	9,400
Storage capacity (EL. 160.0)	Acre-feet	332,500
Power drawdown pool (EL. 155)	Acre-feet	53,500
Length of shoreline at full pool (EL. 160.0)	Miles	55
FLOOD CONDITIONS		
Probable maximum flood (unregulated)	- feet ³ /s	2,660,000
Probable maximum flood (regulated)	- feet ³ /s	2,060,000
Standard project flood (unregulated)	- feet ³ /s	1,580,000
Standard project flood (regulated)	- feet ³ /s	840,000
100-year flood event (regulated)	- feet ³ /s	680,000
SPILLWAY		
Type	Gate-controlled Gravity Overflow	
Length	Feet	1,447
Elevation of crest	Feet, msl	121
Deck elevation	Feet, msl	185
Number of gates, 50-ft Tainter gates	23	
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

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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/Rise (typical)	1v:16h	
North ladder length	Feet	1,761
East Ladder length	Feet	1,801
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

*Note: National Geodetic Vertical Datum of 1929 (NGVD29) = North American Vertical Datum of 1988 (NAVD88) - 3.3 feet.

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Acronyms and Abbreviations

°C/°F	degrees Centigrade/degrees Fahrenheit
AASHTO	American Association of State Highway and Transportation Officials
AWS	Auxiliary water supply
cfs	cubic feet per second
cm/s	centimeters per second
DAHP	[Washington] Department of Archaeology and Historic Preservation
DDR	Design Documentation Report
DM	Design Memorandum
EA	Environmental Assessment
EM	Engineer Manual
ER	Engineer Regulation
ESA	Endangered Species Act
ft ²	square foot/feet
ft ³	cubic foot/feet
ft-lb/s	foot-pounds per second
ft/s	foot (feet) per second
FPOM	Fish Passage O&M Coordination Team
FPP	Fish Passage Plan
FY	fiscal year (October 1 through September 30)
GQAR	Government Quality Assurance Representative
HECP	Hazardous Energy Control Program
HTRW	Hazardous, Toxic and Radiological Waste
IBC	International Building Code
in.	inch(es)
k _h	horizontal seismic coefficient
kip	1000 pounds
ksf	kips per square foot
lbs/ft ³	pound(s) per cubic foot
lbs/in ³	pound(s) per cubic inch
LFRD	Load and Resistance Factor Design
MCE	maximum credible earthquake
MDE	maximum design earthquake
mph	miles per hour
mps	meters per second
NAD	North American Datum
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OBE	operating basis earthquake

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O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PDT	Product Delivery Team
PGA	peak ground acceleration
PPE	Personnel Protection Equipment
psf	pounds per square foot
psi	pounds per square inch
QAP	Quality Assurance Plan
RM	river mile
RO	regulating outlet
SA	spectral acceleration
SLOPES	standard local operating procedures for endangered species
THPO	Tribal Historic Preservation Office
TM	Technical Manual
UFC	Unified Facilities Criteria
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1. INTRODUCTION AND PURPOSE

1.1. SCOPE AND PURPOSE

The Dalles Dam is the second dam upstream from the mouth of the Columbia River. The vast majority of Columbia Basin salmon and steelhead, including seven Endangered Species Act (ESA) listed fish populations, must pass this dam in order to arrive at their spawning grounds. Since 2009, over 1 million adult salmon (estimates range from 1.1 to 1.3 million) have passed through the fish ladders at The Dalles each year. The adult fish passage facilities at The Dalles Dam consist of the north fish ladder and the east fish ladder (Figures 1 and 2). The majority (about 80%) of all adult salmon and steelhead that pass the dam do so via the east fish ladder (3 entrances), with the remaining passing through the north fish ladder (1 entrance). A larger proportion of fish use the east ladder because of the presence of a deep, submerged canyon, which is the original river's thalweg, that leads directly to the east fish ladder entrance and favorable attraction flows. However, the north fish ladder is crucial to provide an alternative passage for fish, and allows continuous passage when the eastern ladder is off-line.

The Dalles Dam North Fish Ladder, between weirs No. 77 and 132, is comprised of vertical to near vertical rock cuts to form the fish ladder side walls (Figures 3 through 5). Mechanical weathering over the last 50+ years has caused areas of the steep rock cuts to become unstable creating project life safety and operability concerns. In addition, the open rock joints along the rock faces have allowed brush and trees to establish causing acceleration of the destabilization of these rock cuts.

Rock fall issues pose life safety hazards to personnel who enter the ladder during required annual maintenance. A primary reason workers enter the ladder is to inspect the ladder, and to remove vegetation and debris from along the ladder. The only method of vegetation removal allowed requires workers to be in the ladder pulling, cutting, and removing; herbicides are not allowed in the fish ladder. This method of vegetation removal often loosens and dislodges rock that could fall onto workers. In addition, large rock fall could also damage the concrete weirs in the fish ladder, thus affecting the operability of the ladder.

The objective of the project is to successfully stabilize the rock cuts along the North Fish Ladder, specifically between weirs No. 77 and 132. Successful stabilization of these faces will include a combination of scaling, rock anchors/bolts, and 8 foot high concrete retaining walls between weirs 120 and 123. This project has also considered options for permanent vegetation control along the slope, including utilizing secured tarps or plastic to inhibit plant growth, or covering the entire rock face with shotcrete.

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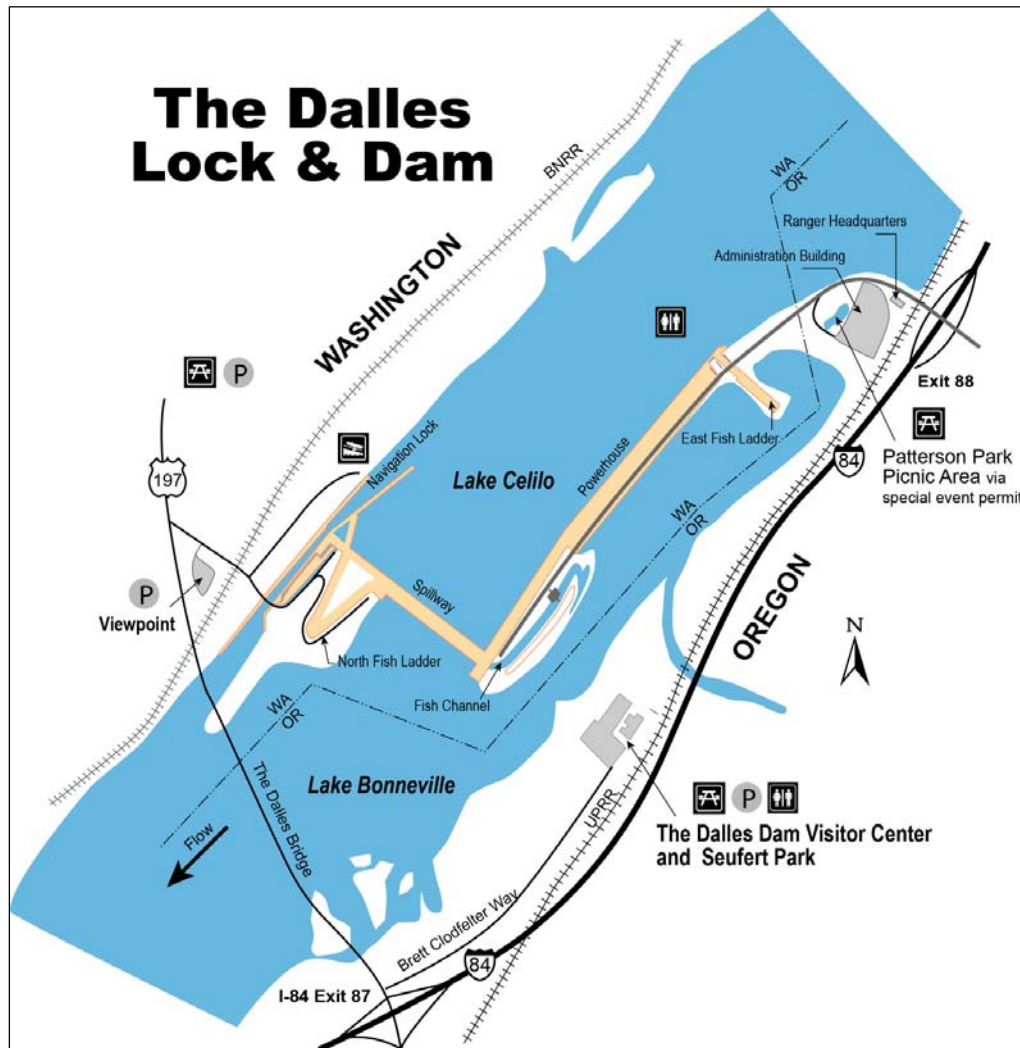


Figure 1 – Location map of The Dalles Lock & Dam

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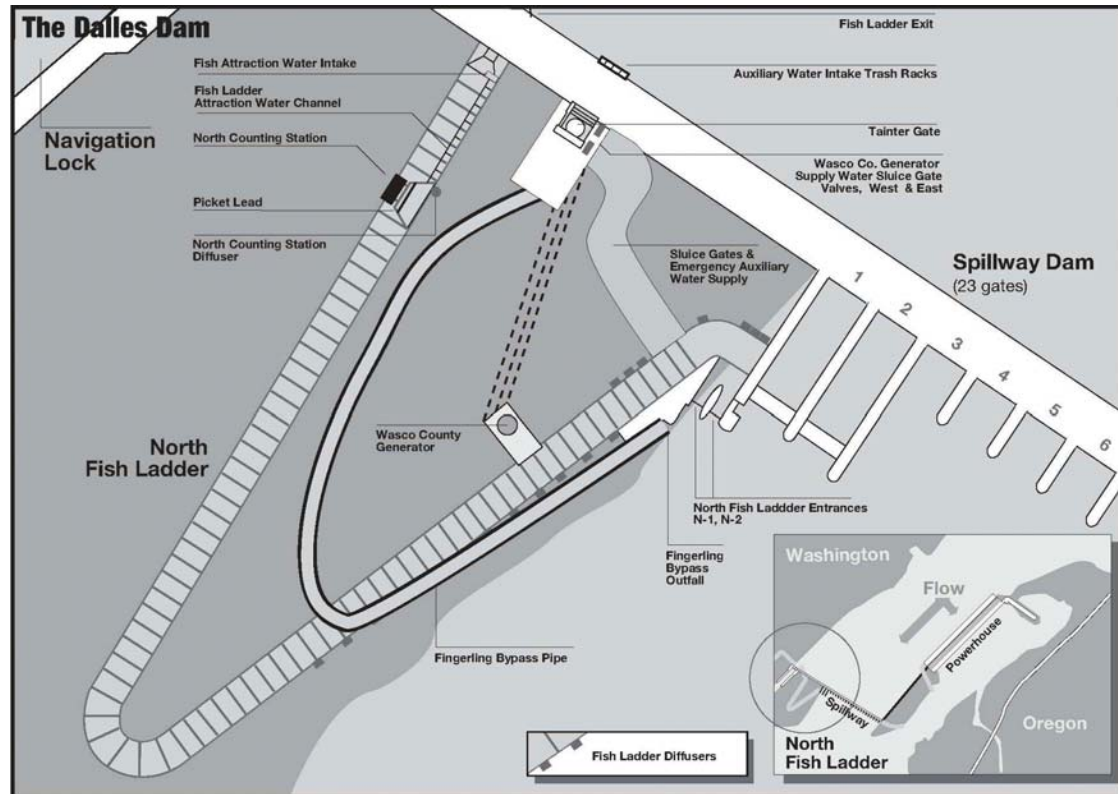


Figure 2 – Site map of the North Fish Ladder

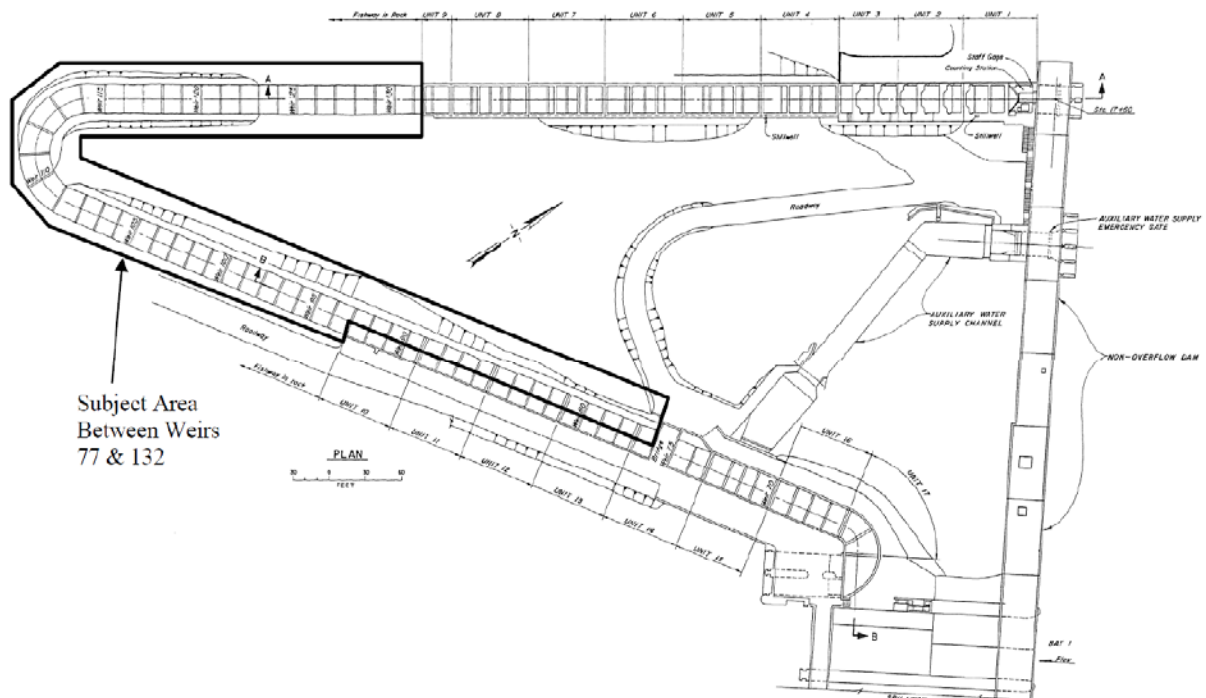


Figure 3 – Plan view of the north fish ladder showing the project area, between weirs No. 77 & 132

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1.2. REFERENCES

USACE, Mar. 1954, Navigation Lock, North Fishway and Non-Overflow Dam Between Lock and Spillway; USACE Portland District, Supplement No. 1 to Design Memorandum (DM) No. 6.

USACE, Jan. 1981, North Fishway Powerhouse and Intake; USACE Portland District, Design Memorandum (DM) No. 25.

USACE, Jan. 1985, The Dalles Lock and Dam, Navigation Lock, North Fishway and Non-Overflow Dam Between Lock and Spillway; USACE Portland District, Supplement No. 2 to Design Memorandum (DM), No. 6. "North Fish Ladder Counting Station and Weir Modification".

1.3. GENERAL DESCRIPTION

The north fish ladder (fishway) system, located between the navigation lock and the spillway, provides a migration route for those adult fish that present themselves at the fishway entrance at the north side of the spillway. The system is composed of an entrance, an auxiliary water supply system, a fish ladder, a counting station and exit water control section at the upper end of the ladder (Figure 2).

1.3.1. Location

The Dalles Dam is located on the Columbia River at the head of Bonneville Lake, 192.5 miles upstream from the mouth of the river and 3 miles east of The Dalles, Oregon. Portland, the largest population and industrial center on the Columbia River, is located 97 river miles below The Dalles Dam. The Oregon-Washington state boundary lies along the main Columbia River channel, dividing the project between the two states (Figure 1). The North Fish Ladder rock stabilization project is in the state of Washington. The North Fish Ladder is located between the navigation lock and spillway dam section (Figure 2).

The North Fish Ladder is 1,761 feet long, 24 feet wide (somewhat wider between weirs No. 77 and 132 due to the variability of the rock cut walls), and has a slope of 1V on 16H. Normal flow in the ladder is 150 cfs which is regulated by a telescoping weir located in the upstream end of the ladder.

1.3.2. History

Construction of the dam was started in February 1952 and the rockfill closure dam was completed in April 1957. The last of the main powerhouse units 1 through 14 began operation in October 1960. Powerhouse units 15 through 22 began operation between December 1972 and October 1973. In the mid. 1980's, the fish ladder weirs (No. 70 through 151) were modified to reduce flows, and to improve fish passage, and the fishway auxiliary water supply (AWS) system was modified.

On 24 February 2014, an initial site visit was completed by NWP Design and Operations staff to observe and evaluate the rock cut stability issue along the north fish ladder. The results of this site visit, and preliminary recommendations, are presented in a 26 February 2014 Trip Report (Appendix A). This trip report provides a good summary of the rockfall issue, cause, and recommended mitigation options. A Second site visit was also completed in February 2015.

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1.3.3. Project Authorization

Construction of The Dalles Lock and Dam was authorized by the Flood Control Act of 1950, in accordance with the Report of the Chief of Engineers in House Document 531, 81st Congress, 2nd Session. The Dalles Lock and Dam were constructed in the 1950's and early 1960's. The first hydroelectric power went on line in September 1957 and this project was dedicated in October of 1959. This project falls under non-routine O&M.

1.3.4. Existing North Fish Ladder

Adult fish passage facilities at The Dalles Dam are composed of a north shore fish ladder that passes fish collected at the north end of the spillway, and an east fish ladder that passes fish collected at the south end of the spillway and across the downstream face of the powerhouse. This project only addresses the north fish ladder.

North Wasco PUD operates a small hydropower facility constructed in 1991 that utilizes the north fishway ladder auxiliary water supply. Adult fishway criteria associated with this facility are monitored and maintained during daily fishway inspections. A backup auxiliary water supply system, unscreened for juveniles, has been upgraded to facilitate its use if required.

The north fish ladder is a minimum of 24 feet wide (slightly wider where rock cuts form side walls) and extends from weir No. 70 to weir No. 153 on a 1 vertical on 16 horizontal slope. The original weirs were 6-foot-high and 16-foot centers, and had a full 24-foot wide crest, with two orifices each (25 inches wide by 26 inches high) flush with ladder floor and centerline and located 3 feet from the outside walls.

In the mid. 1980's, the fish ladder weirs No. 70 through 151 were modified to reduce flows, and to improve fish passage. Criteria included: a minimum of 80 cfs discharge, normal operating head on weirs at 1 ft.; and minimum orifice size of 18 inches and beveled edges. The weir crest was raised 2 ft. in the center at a length of 18 ft. leaving two 6 ft. long overflow weirs adjacent to the sides of the fish ladder walls. Bevels were included on non-overflow and overflow weirs. Baffles (18 in.) were added upstream to improve flow condition in pools and provide resting areas with lower velocities. The orifice dimensions and locations remained the same.

Two different operations are followed to effectively pass native species (i.e., fall/spring/summer/ Chinook salmon, sockeye salmon, coho salmon, and lamprey) and shad (non-native). Delaying the migration of native species is known to potentially increase stress and mortality of these species. Therefore it is important to pass non-native migratory species such as Shad to reduce bottlenecks in fishways thus reducing upstream migration delays. The two operations that are normally used during the fish passage season include: 113 cfs with 1 ft. of head over the weirs providing plunging flow preferred by salmonids; and 130 cfs with 1.3 ft. (15 inches) of head over the weirs providing streaming flow preferred by shad.

Adult fish count periods and peak passage timing at the Dalles Dam are from April 1st to October 31st. Consequently, annual maintenance of adult facilities is scheduled between December 1st through the end of February (winter maintenance period), to minimize impacts on upstream migrants. Only one ladder at The Dalles Dam (North or East) is dewatered at a time unless otherwise coordinated through Fish Passage O&M Coordination Team (FPOM).

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This project is limited to the portion of the fish ladder where the ladder side walls are formed by vertical to near vertical rock cuts, rather than concrete walls, which includes the area between weirs 77 and 132 (Figure 3). From weirs 77 to 92, only the northern wall is rock cut; the southern wall is concrete. In this area of the ladder, reinforced concrete struts support the upper part of the southern concrete wall, and are abutted into the north rock cut (Figure 4). From weirs 92 to 132, both walls are formed in rock cut (Figure 5). The rock cuts vary in height from approximately 12 feet at the southwestern part of the ladder, to approximately 30 feet at the northernmost part of the ladder.



Figure 4 – Photograph looking north-northeast towards section of fish ladder between weirs No. 77 and 92. Note concrete struts supporting wall to the right of the photo.

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Figure 5 – Photograph looking northwest towards the northern section of fish ladder.

1.3.5. Proposed North Fish Ladder Maintenance Work

Because of the age of the excavated channel cuts, all rock faces along the fish ladder are in some need of scaling efforts, especially the northern segment of the fish ladder. During rock scaling efforts, existing vegetation along the cuts will also be removed.

In some areas of the fish ladder, again primarily at the northern segment of the ladder, scaling efforts alone may not fully eliminate the risk of future rock fall. Therefore, localized rock anchors (or bolts) will be required to support larger, potentially, unstable rock masses in place. Rock anchors will generally be field located, following initial scaling efforts, to secure rock masses that may be unstable, as determined based on their jointing patterns and occurrence of past rock failures.

Lastly, there are three segments, approximately 48 linear feet between weirs No. 120 to No. 123, that have experienced erosion as the result of water flow over the weir. Continued erosion can

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result in the undermining of the upper rock face, and larger rock failures could occur that could damage the weir structures. In these areas, shotcrete walls are proposed, which will be secured by wire mesh and rock bolts.

The proposed work is generally considered to be maintenance activity. Although, installation of new rock anchors and construction of shotcrete walls are proposed, this work is intended to maintain the stability of the originally designed fish ladder walls, rather than modifying the existing fish ladder structure, or changing ladder performance or operation. The work proposed in this DDR is not intended to permanently stabilize the rock lined fish channel. With time, the exposed rock slopes will continue to weather and future stabilization measures will likely be required. The proposed stabilization work is intended to substantially reduce the rock fall hazards from its current level for at least 20 years.

1.4. AGENCY COORDINATION

Agency coordination is conducted through either Fish Passage Operations and Maintenance (FPOM) or the Fish Facility Design Review Work Group (FFDRWG) regional forum. Members include representatives from the Action Agencies, Federal and State fisheries managers, and Columbia River Inter-Tribal Fish Commission (CRITFC). FPOM Agency review was completed during the 90 percent ITR/BCOES DDR review phase (Appendix E).

1.5. ALTERNATIVES ANALYSIS

In general, the rock cut design along the north fish ladder has performed reasonably well during the past approximately 60 years. Although, there has been periodic rock fall during the ladder's history, only recently has the rock fall been a significant concern. Based on site observations, the more recent increased rock fall risk is primarily the result of weathering of the exposed rock face over time, in conjunction with the presence of vegetation which has loosened rock blocks and fragments. This process is the natural consequence of the age of the rock cuts, and periodic slope maintenance should be anticipated.

As part of the initial scoping effort for this DDR, several alternatives were considered to help reduce the general risk of rockfall into the ladder. These included: no action, scaling, installation of rock anchors/bolts, installation of rockfall screening, covering unstable rock with shotcrete, and regrading cuts to a flatter and more stable condition. This DDR also considered three alternatives for localized rock cut stabilization between weirs 120 and 123, including: no action, shotcrete wall with anchors, and cast-in-place concrete wall with anchors. Lastly, potential options were evaluated for permanent vegetation control, to be considered for the future. The considered alternatives were evaluated based on the following required selection criteria:

- The selected alternative shall reduce rock fall hazards in the fish ladder
- The proposed work shall fall within the project Authorization
- The proposed work shall fall within routine or non-routine O&M activities
- The proposed work shall not modify the intent or operation of the fish ladder
- The proposed work shall not modify the original fish ladder design
- The selected alternative shall not prevent existing routine O&M activities from being performed

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- The proposed work shall effectively mitigate for rock fall for at least 20 years
- The selected alternative shall be the least costly alternative that complies with the above criteria

1.5.1. Considered Alternatives

No Action: The rock cuts along the fish ladder have performed reasonably well during its history. However, as there is the potential for serious injury to Project personnel from rock fall hazards during normal operation and maintenance activities, the 'no action' alternative was not selected as a preferred alternative.

Scaling: Scaling the exposed rock cuts is considered the easiest and most cost effective option to reduce the rockfall hazard in the area of the north fish ladder. It is anticipated that once the cuts are scaled, and loose rock removed, the rock cuts will remain generally stable for many years without additional slope stabilization efforts. In addition, vegetation removal can be performed at the same time as scaling efforts. Scaling the slopes is also required prior to performing the other considered alternatives, with the possible exception of re-grading the cuts to a flatter condition. Scaling was selected as a preferred alternative because of its relatively low cost and effectiveness.

Rock Anchors/Bolts: Utilizing rock anchors or bolts is commonly used when unstable rock blocks or masses exist that cannot be easily removed. Based on site observations, there are a number of rock blocks or masses larger than 3 feet in diameter that appear to be unstable. If these blocks/masses were to fail, they could threaten workers' safety and cause damage to the weir structures. Because of the large size of these blocks, removal (i.e. scaling) would be difficult without damaging the weirs. Therefore, stabilizing these blocks/masses with rock anchors or bolts was selected as a preferred alternative, in conjunction with scaling, to help stabilize the rock cuts.

Installation of Rockfall Screening: Rockfall screening uses a wire mesh with supporting anchors and cables to cover an unstable rock slope, to help protect workers and structures from falling rock. Screening can be designed to help support rock block in-place, but is mostly used to slow the downward momentum of failed rock and retain failed material. Although rockfall screening would reduce the rockfall risk, screening is expensive, and requires periodic maintenance to remove accumulated rock and repair damaged screened sections. The presence of the screening may also reduce the ability of workers to effectively clear vegetation, and could increase vegetation growth, since accumulated material behind the meshing tends to promote plant growth. The screening and accumulated debris could also create shadows in the fish ladder that could impact fish passage. Because of the high installation cost, maintenance requirements, and potential for fisheries impact rockfall screening was not selected as a preferred alternative.

Covering Slopes with Shotcrete (not to be confused with the proposed shotcrete walls between weirs 120 and 123): Covering the unstable slopes with shotcrete would both mitigate for future rockfall hazards and help control vegetation along the cuts. However, simply applying shotcrete to the slope would not be a long term solution since the shotcrete adhesions to the rock surface would reduce with time, resulting in spalling and failure of the shotcrete itself. Therefore, an effective shotcrete design would require using wire mesh reinforcement and rock anchors to

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secure and support the shotcrete facing to the slope. In addition, drainage behind the shotcrete would likely be required to prevent pore pressure buildup. The cost associated with facing the rock cuts with shotcrete is high, would likely alter the original design and functionality of the fish ladder channel, and is generally beyond the scope and authorization of this project. With the above considerations, covering the slopes with shotcrete was not considered a preferred alternative.

Regrading the Rock Slopes: Regrading the rock slopes to a flatter, more stable, condition would help eliminate the rockfall hazard. However, regrading the slopes would significantly impact other structures and roads adjacent to the fish ladder, would significantly alter the original design of the fish ladder channel, and is outside the authorization of this project. Therefore, regrading the rock slopes to a flatter condition was not considered a preferred alternative.

Three alternatives were considered for the rock cut sections between weirs 120 and 123, which are experiencing erosion and undercutting as the result of water flow in the fish ladder. These alternatives included: No action, construction of a shotcrete wall with anchors, and construction of a cast-in-place concrete wall with anchors.

No Action: Water flow in the fish ladder has caused significant erosion and undercutting along a bedding plane between weirs 120 and 123. This erosion has caused undercutting of several feet in one location, which threatens to cause failure of the overlying rock face, which can damage the weir. Because of the fractured nature of the rock above the eroded section, it was determined that installing rock anchors alone would not protect the weirs from future rock failure. Because of the rock fall threat to the weirs, and potential for human injury, the 'no action' alternative was not selected as a preferred alternative.

Shotcrete Wall with Anchors: Shotcrete is mortar or concrete conveyed through a hose and pneumatically projected at high velocity onto a surface. The force of the jet impinging on the surface compacts the material. Properly applied shotcrete is a structurally sound and durable construction material which exhibits excellent bonding characteristics to existing concrete, rock, steel, and many other materials. It can have high strength, low absorption, good resistance to weathering, and resistance to some forms of chemical attack. Many of the physical properties of sound shotcrete are comparable or superior to those of conventional concrete or mortar having the same composition. Shotcrete walls are typically reinforced with wire mesh, steel/synthetic fibers and/or rebar, and secured to the rock face by anchors or bolts. Shotcrete walls are generally more cost effective and easier to construct in confined spaces, or where irregular rock surfaces are present than conventional concrete walls. Because of the ease of construction, and lower construction cost, the use of shotcrete walls was selected as a preferred alternative over that of formed walls. The walls will be reinforced with rebar rather than fibers, to prevent fiber ingestion by fish.

Additionally, there are hydraulic benefits to the shotcrete wall with anchors alternative. As shown in Plate 1, the shotcrete walls with anchors should have minimum encroachment into the pool as compared to the cast-in-place option. It is imperative that the new shotcrete walls not impact the flow through adjacent weirs and orifices that provide the appropriate hydraulics for

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the pool downstream. Appendix D investigates the impact of reducing pool volume to the point of failing fish passage criteria of the pool.

Cast-in-place Concrete Wall with Anchors: A conventional cast-in-place concrete wall could be selected as a permanent wall in front of the rock face. However, the use of shotcrete is advantageous in situations when formwork is cost prohibitive or impractical and where forms can be reduced or eliminated, access to the work area is difficult, thin layers or variable thicknesses are required, or normal casting techniques cannot be employed. Additional savings are possible as shotcrete requires only a small, portable plant for manufacture and placement. Shotcreting operations can often be accomplished in areas of limited access to make repairs to structures. Therefore, the use of a conventional cast-in-place concrete wall was not selected as a preferred alternative.

1.5.2. Selected Alternative

Based on the discussion above (Section 1.5.1), the selected (or preferred) alternative includes a combination of rock scaling; localized rock anchors/bolts; and construction of three shotcrete walls with mesh, rebar and rock anchor support, as shown on Plate 1. The selected alternative design is discussed in this DDR.

1.5.3. Permanent Vegetation Control Options

1.5.3.1. GENERAL

On an annual basis, during the in-water work (IWW) period, the fish ladder is drained and workers enter the ladder to perform routine maintenance. This routine annual maintenance includes removal of vegetation along side walls and rock debris in the channel. Because the use of herbicides is not allowed in the fish ladder, workers need to access the side wall cuts using ladders, physically cut the vegetation with hand tools, and remove the vegetation by hand. This process can loosen unstable rocks, resulting in rockfall that can endanger workers. In addition, fractures and joints in the rock allow the plant roots to penetrate as they grow. The growing roots exert a huge force on the rock, widening the joints, and breaking the solid rock into fragments and blocks. This weakens the rock over time and makes the exposed cuts even more prone to root penetration and freeze-thaw mechanical weathering. The plants along the cut walls accelerates the weathering process of the cut face, and therefore slope stabilization efforts are required more frequently where plants are present.

Providing permanent vegetation control along the fish ladder would likely significantly alter the channel design and appearance, and is generally out of the scope of this project. However, two vegetation control options are presented here for future consideration; (1) using plastic or burlap tarps secured by rock bolts to cover the cuts to discourage plant growth, or (2) using shotcrete to cover the cuts to form a barrier that would prevent plant establishment.

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1.5.3.2. *TARPS*

Construction method: Following initial scaling and vegetation removal, rock bolts would need to be installed at a defined spacing, with fasteners, to secure tarps in-place. Tarps will also likely need to be supported by ropes or cables between bolts.

Pros: Less expensive than shotcrete. Tarps can be removed, and easily replaced.

Cons: Requires rock bolt anchors. Wind can easily damage tarps. Damaged tarps fragments can fall into fish ladder. Wind-blown tarps would also impact and vibrate against rock face which could loosen rocks resulting in rock fall, and could impact fish. There could also be visual concerns. Tarps may require wire cables/ropes between rock anchors. Sunlight will also likely degrade/damage tarps.

1.5.3.3. *SHOTCRETE*

Construction method: As discussed in Section 1.5, following scaling, vegetation removal, and rock anchor installation, shotcrete would be sprayed onto the rock face. May require installations of a wire meshes secured with rock bolts. Shotcrete could be colored using color additives to match color of rock face.

Pros: Would be less susceptible to damage caused by wind and rain activity. Would provide long term vegetation control. Would also help prevent future rock fall and would slow weathering of the rock face.

Cons: Likely more costly than tarps. Cannot be easily removed. If reinforcing mesh is not used, there is a risk that a section of the shotcrete could loosen and fall into the fish ladder.

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2. BIOLOGICAL CONSIDERATIONS AND CRITERIA

2.1. GENERAL

2.1.1. Pertinent Data

Adult fish passage facilities at the Dalles Dam consist of a north and east fish ladder. The adult passage facilities are operated year-round with the majority of the fish passage occurring from April 1st through October 31st. Annual maintenance on the adult passage facilities is scheduled from December 1st through February 28th (winter maintenance period). During the winter maintenance period, only one of the adult passage facilities (north or east ladder) is taken out-of-service at a time, allowing continued adult passage during the maintenance period (USACE, 2015).

2.1.2. Purpose

This section lists the biological criteria for the north ladder rock stabilization project at The Dalles Dam. Guidelines for the design of fishways are provided by the National Marine Fisheries Service (NMFS). As stated by NMFS (2011):

The purpose of a fish ladder is to convert the total project head at the passage impediment into passable increments, and to provide suitable conditions for fish to hold, rest, and ultimately pass upstream. The criteria provided in this section have been developed to provide conditions to pass all anadromous salmonid species upstream with minimal delay and injury.

2.1.3. Fish Species of Concern

The adult passage facilities at The Dalles Dam has the following species passing throughout the year: spring, summer, fall Chinook salmon (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), steelhead (*Oncorhynchus mykiss*), coho (*Oncorhynchus kisutch*), and Pacific lamprey (*Entosphenus tridentatus*).

The morphology and swimming abilities of salmonids and lamprey are very different and need to be considered when making modifications to the ladder. Salmonids are known to be strong swimmers, for example adult Chinook salmon passing a Columbia River dam had swimming speeds ranging from 80 to 106 cm/s (Brown et al., 2006). Conversely, Pacific lamprey are relative weak swimmers (sustained swimming of 10-30 cm/s), but are able to employ a “burst and attach” behavior to navigate high-velocity and high-turbulence environments (Keefer et al., 2013; Robinson and Bayer 2005). Examples of higher velocity features found in fishways include entrance weirs, overflow weir crests, and submerged orifices. At these locations, lamprey attach to the substrate and either inch forward using their sucker-like mouths or periodically burst forward, resting in between forward bouts. Based on telemetry study results, the north fish ladder passes about 38% of the total lamprey passing The Dalles Dam, however, lamprey passage efficiency through the overflow weir section of the north ladder is very high (>90%) compared to other fishway segments at The Dalles Dam (Keefer et al. 2013). This is thought to be partially because of the rock wall creating a more natural migration route for lamprey due to the structural heterogeneity of the unique basalt rock

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walls and the hydraulic conditions they create on a micro scale (Sean Tackley, personal communication). As such, creating a more uniform surface along the fishway walls could potentially negatively affect lamprey passage conditions in the ladder.

2.1.4. Water Temperature Considerations

As temperatures in adult passage facilities reach 70°F, then all fish handling activities must be coordinated with regional fisheries managers.

2.2. BIOLOGICAL CRITERIA AND PASSAGE CRITERIA

Modifications (e.g., shotcrete, fencing, or tarps) made below the water line in the fishway must not negatively impact fish passage and consideration must be made not only to salmonids but also to lamprey and shad. Potential negative effects could include noise and vibration from tarps flapping in the wind, texture of shotcrete and the filling of fractures in the rock wall, and microscale changes in the hydraulics.

Shotcrete placed below the waterline will be finished to ensure smooth surfaces with protrusions not exceeding more than $\frac{1}{8}$ ". The color of the shotcrete will match the existing concrete in the fish ladder as closely as possible.

2.3. REFERENCES

Brown, R.S., D.R. Geist, M.G. Mesa. Use of electromyogram telemetry to assess swimming activity of adult spring Chinook salmon migrating past a Columbia River Dam. Transactions of the American Fisheries Society, 135:2, 281-287.

Keefer, M.L., T. C. Clabough, M. A. Jepson, E. L. Johnson, C. T. Boggs, and C. C. Caudill. 2013. Adult Pacific Lamprey passage: Data synthesis and fishway improvement prioritization tools. Report to U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, 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.

USACE (U. S. Army Corps of Engineers). 2015. 2015 Fish Passage Plan. USACE, Portland District, Portland, Oregon.

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3. GEOTECHNICAL DESIGN

3.1. GENERAL

This chapter describes expected provides preliminary geologic and geotechnical design parameters for The Dalles North Fish Ladder rock stabilization project. The information and recommendations presented in this chapter are based on existing references and a brief field visits. Additional information gained through more detailed site observations and measurements, including measurements of joint orientations, is needed and recommended to confirm assumptions and provide a basis for geotechnical design prior to development of plans and specifications.

3.2. REFERENCES

- a. Tolan, T. L., and Reidel, S. P., 1989, Structural map of a portion of the Columbia River flood-basalt province; The Geological Society of America, Special Paper 239.
- b. USACE, Apr. 1956, Foundation Report, The Dalles Dam – Part I: Introduction and Spillway; USACE Portland District.
- c. EM 1110-1-2907 Rock Reinforcement
- d. EM 1110-1-2908 Rock Foundations

3.3. GEOLOGY

The Dalles Dam is located on the western margin of the Columbia Basin where it abuts the Cascade Range. The Columbia basin is filled with up to about a maximum of 5,000 feet of Miocene age Columbia River Basalt Group (CRBG). The Columbia River Basalt Group consists of flood-basalts which were erupted from fissures in eastern Oregon and Washington and western Idaho from approximately 16.5 to 6 million years ago. The bedrock exposed along the bottom and side walls of the fish ladder is likely the Wanapum Basalt Member of the CRBG, approximately 15 to 14.5 million years old.

In the vicinity of the dam, the formation is about 3,000 feet thick, and consists of multiple flow-on-flow layers with little or no intervening soil horizons between flows (Figure 6). Individual flows range between 60 to 100 feet thick. In the area of the north fish ladder, 5 distinct flows have been mapped (Figures 6 and 7). These flows have been designated as flows N, O, P-1, P, and Q (from bottom to top). The flows generally dip to the southwest at about 2 degrees. Steeper dips, and a few reverse dips, occur adjacent to fault; these steeper dips are not found in the area of the north fish ladder.

Many of the jointing patterns and textures of the flows were developed during the cooling process. The top surface of some flows may have a smooth or ropy characteristic if the molten material stopped flowing before the top surface cools and solidifies. If the top surface solidifies while the interior was still molten and moving, the top surface may have been disrupted or fragmented forming a flow breccia crust. Flow breccia is generally lower strength rock quality. At The Dalles, flow breccias are a small

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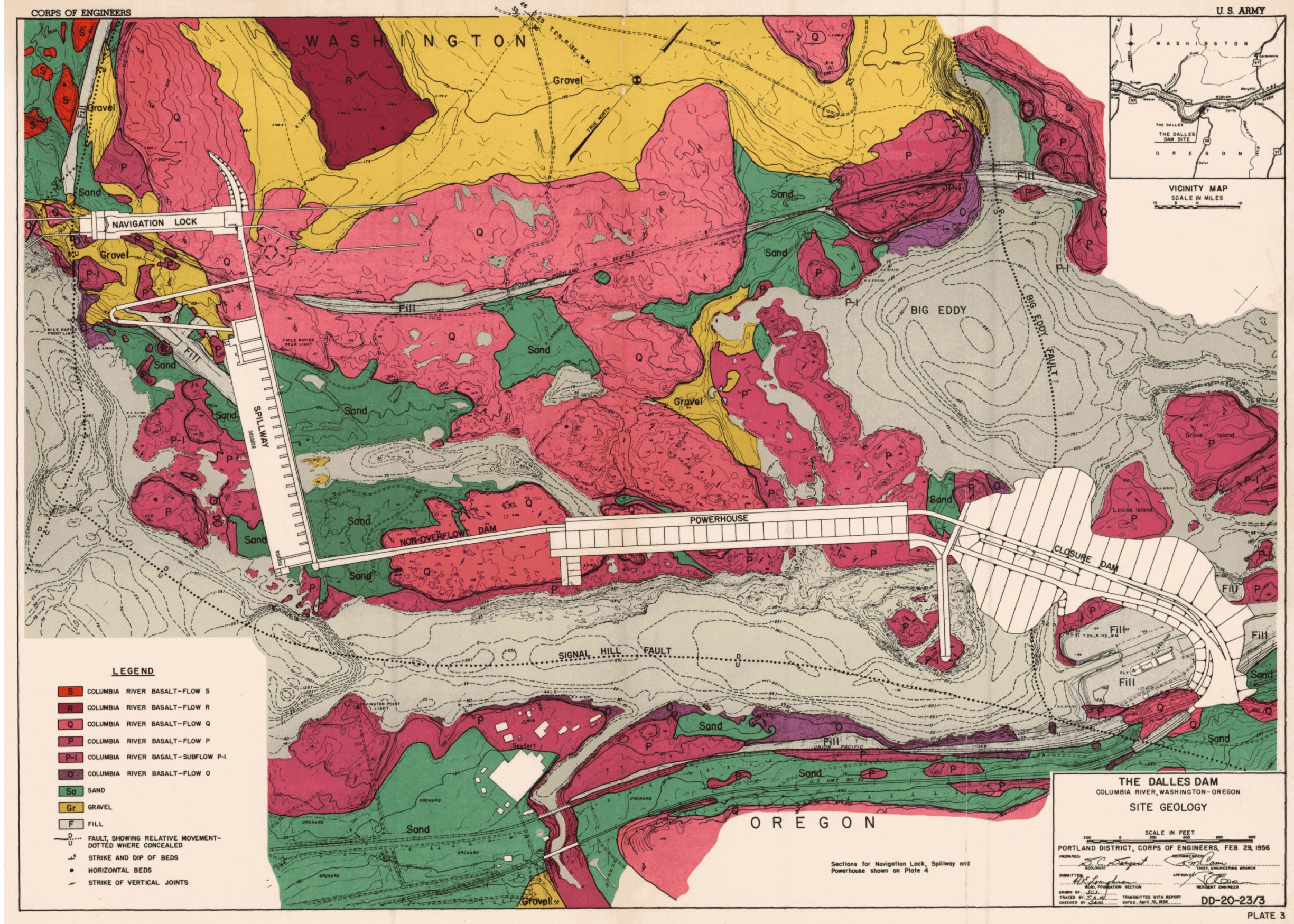


Figure 6 – Site geology map from Sheet DD-20-23/3.

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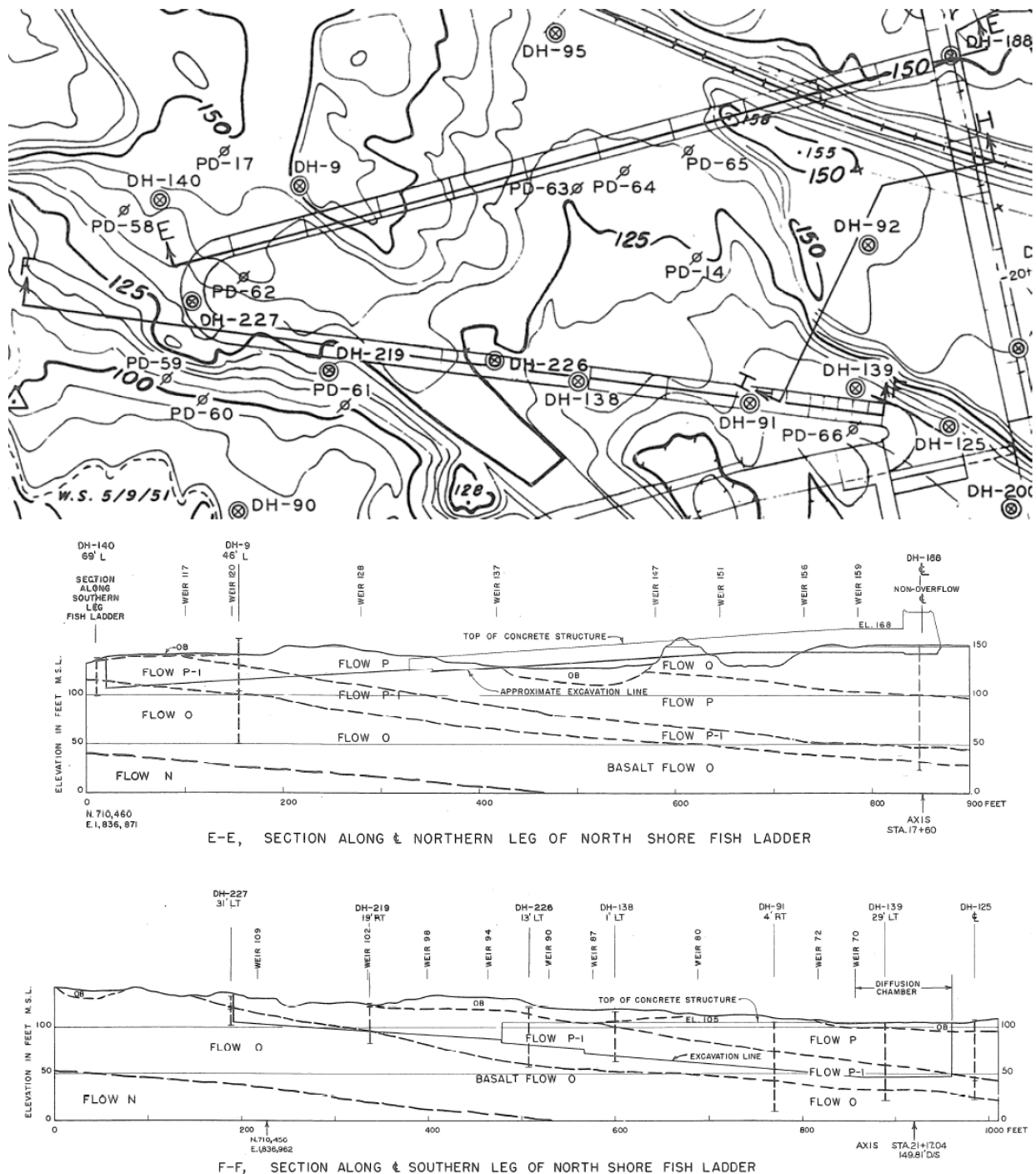


Figure 7 – Boring location map (above) and geologic sections (below). Drawings from parts of Sheet DDG-1-9-6/1 and Sheet DDG-1-9-6/7. Topographic contours show topography prior to dam construction. Approximate excavation line of fish ladder shown in the section.

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percentage of the total rock mass and they generally were removed when exposed in the foundation. The interior of the flows typically form a more dense rock. However, tree casts voids or open lava tube can be found in isolated areas.

3.3.1. Joints and Fractures

The Columbia River Basalt developed a common set of characteristic patterns of fractures and distribution of vesicles (bubbles) in flows as it cools. A single flow may be comprised of one or more subflows, where more fluid molten lava overran a partially cooled and solidified lobe. As the molten lava cooled, gas bubbles tend to form and the bubbles rose and concentrate towards the top, forming a 5 to 15 foot vesicular zone that is typically more porous and weaker than the underlying rock. In addition, the cooling and solidifying rock mass thermally contracts and tension fractures. These cooling fractures tend to form coherent patterns in the large mass or flow.

A molten lava flow cools from both the top and bottom towards the center, which is the last to solidify. Typically, the top of a flow has two types of fractures. First, there are vertical fractures spaced 1 to 6 feet apart. These fractures are randomly oriented and form crude polygonal columns, and are typically wavy.

In addition to the vertical fractures, there may be horizontal fractures that form 6-inch to 2-foot thick slabs parallel to the top of the flow. There may be 0 to 3 inch voids beneath the slabs. With increasing depth below the top of a flow, intensity of fracturing decreases. The horizontal fracture spacing increases to 4 to 8 foot spacing and the fracture surfaces become more wavy and tighter. Also, there are generally no large voids present below the horizontal fractures. At greater depths within the flow, fractures may begin to form more organized columnar fracture patterns or curvilinear patterns. Vertical fractures continue from the top and bottom cooling zones. The center of a flow is the densest with the widest fracture spacing. The center may be columnar or equi-dimensional blocks measuring 3 to 8 feet across. Near the base of each flow, cooling fractures become more closely spaced sub-horizontal/horizontal due to rapid cooling at the bottom contact. Occasionally, there may be a little flowage at a late stage which will crack and form fissures up to about one foot wide and feet long. These may be filled with later secondary minerals or may remain open.

3.3.2. Faults and Structures

Locally, the CRBG is deformed into a smaller structural sub-basin about 10 miles wide. The northern edge is bounded by the Columbia Hills anticline/fault which has folded and faulted the basalt (Figure 8). The main fault passes about four miles north of the dam and has on the order of 1,500 feet of displacement. The age of faulting is mostly Miocene through Pliocene, but more recent faulting may have occurred. The Columbia Hills anticline/fault is segmented by a series of northwest trending strike-slip faults.

Three primary faults have been mapped in the immediate vicinity of the site; the Big Eddy fault, the Threemiles fault, and the Signal Hills fault (Figure 9). These faults have offsets of fifty to three hundred feet. Minor faults were also found in the foundation excavations of every structure. These minor faults generally had offsets of only a few inches, and were related to low angle thrusts.

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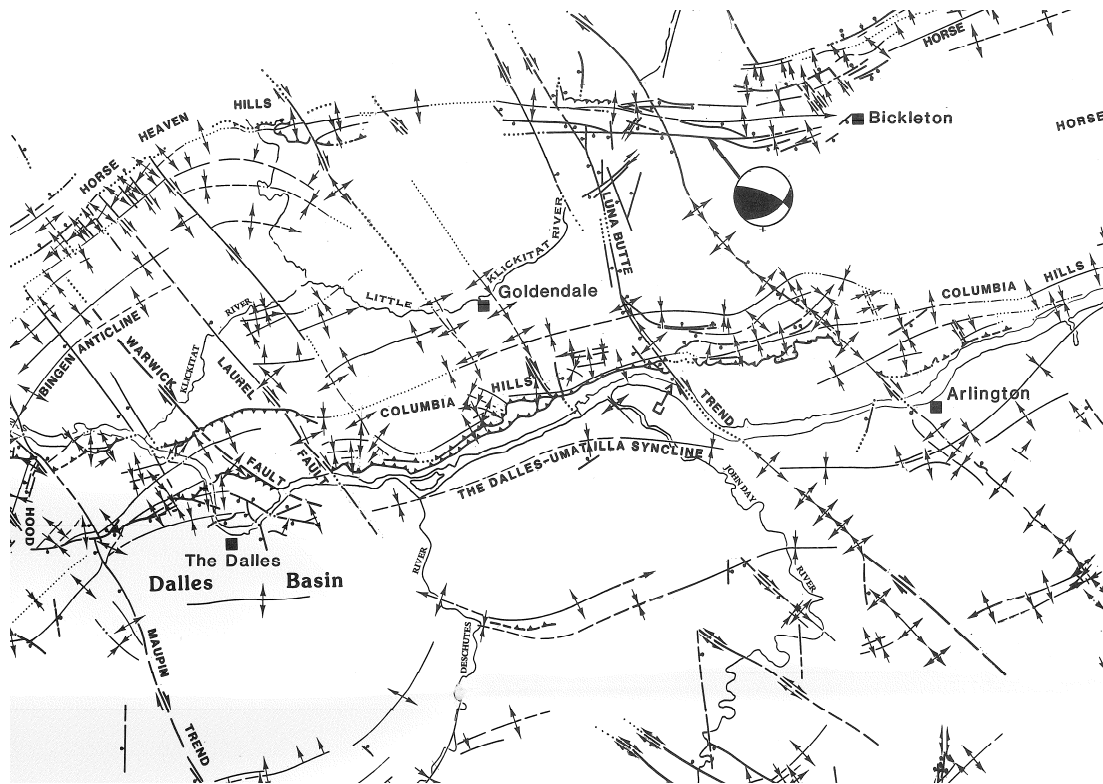


Figure 8 – Regional structural map. From Tolan and Reidel (1989).

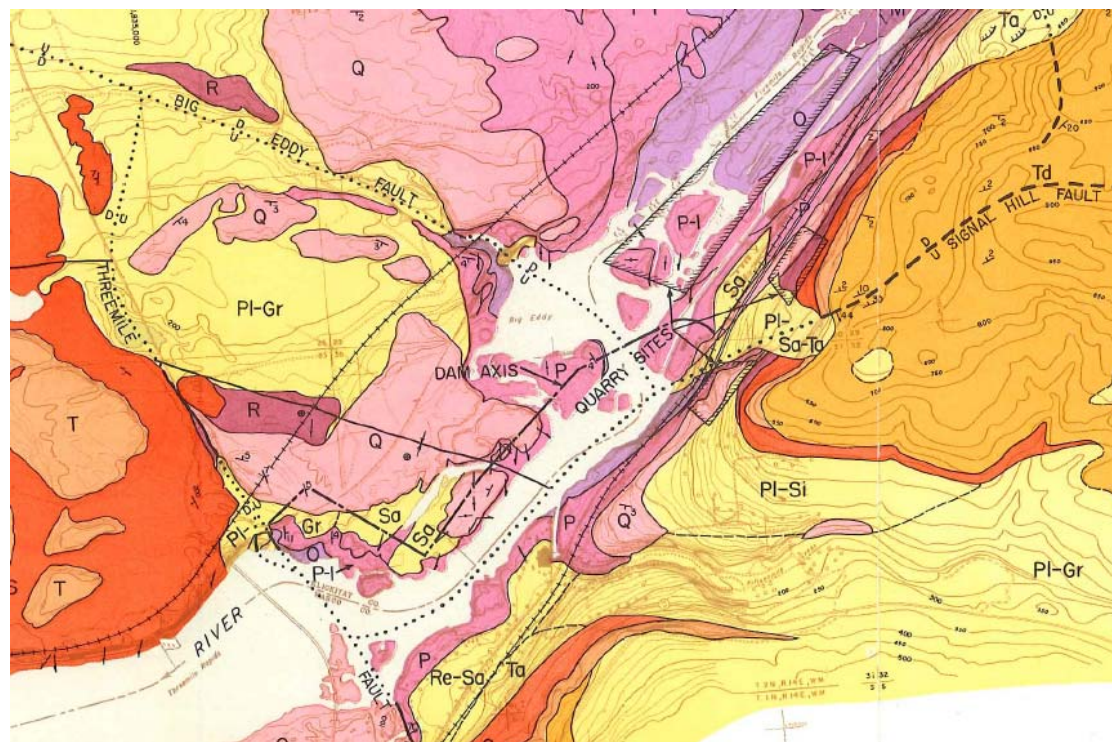


Figure 9 – Geologic Map showing faults in the vicinity of the dam site. Map from part of Sheet DD-20-23/1.

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3.4. GROUNDWATER CONDITIONS

Ground water in the basalt is likely obtained primarily from interflow zones, with internal fractures and joints being a secondary source. Interflow zones are generally much more fractured/jointed than the central parts of the flows, and may have minor sedimentary beds which can be sources for groundwater. However, interflow paleosols, if present, can act as confining or semi-confining layers. The relatively high permeability of the interflow zones can provide high flow rates. However, because the interior of the flows tend to be denser than the interflow zones, vertical permeability of the rock tends to be much lower, which can reduce the recharge rate to the rock unit and the vertical movement of groundwater between individual flows. This variation in permeability can cause some zones within the aquifer to behave in a confined to semi-confined manner.

In the subject area, the top of the shallowest groundwater aquifer is believed to be at or within several feet above the tailwater elevation. During stormy weather conditions, the groundwater table can locally rise, possibly by several feet or more. In addition, perched groundwater is more likely during rainy weather.

When water is actively flowing through the fish ladder, the groundwater likely rises in the basalt immediately near the fish ladder, as the result of water recharge from the ladder. When water flow in the ladder is stopped, the groundwater table in the basalt lowers, but likely takes several hours to several days before achieving equilibrium. At the time of the February 2014 and 2015 site visits, water seepage was observed emanating from rock joints along the ladder side wall cuts; about 8 to 12 feet above the bottom of the latter.

3.5. PROJECT ENGINEERING GEOLOGY

3.5.1. Discontinuities

The term discontinuity refers to any mechanical “break” in a rock mass having zero or reduced tensile strength relative to the surrounding intact rock. It is a collective term that includes joints, bedding planes, folds, shear zones and faults. In general, most of the rock fragments and blocks that are causing the stability concern along the ladder, have been formed by the presence of the rock discontinuities.

As part of the early 1980’s modification of the north shore fishway auxiliary water supply (AWS) system, mapping of fractures and joints were completed in the area of the AWS channel to determine the predominant joint orientations. The water supply channel is located in the area of the North Fish Ladder (Figure 10). Because the modified channel was cut in the same lava flows as the north fish ladder (Flows P and Q), the measured joint orientations are believed to be similar to that found in the ladder.

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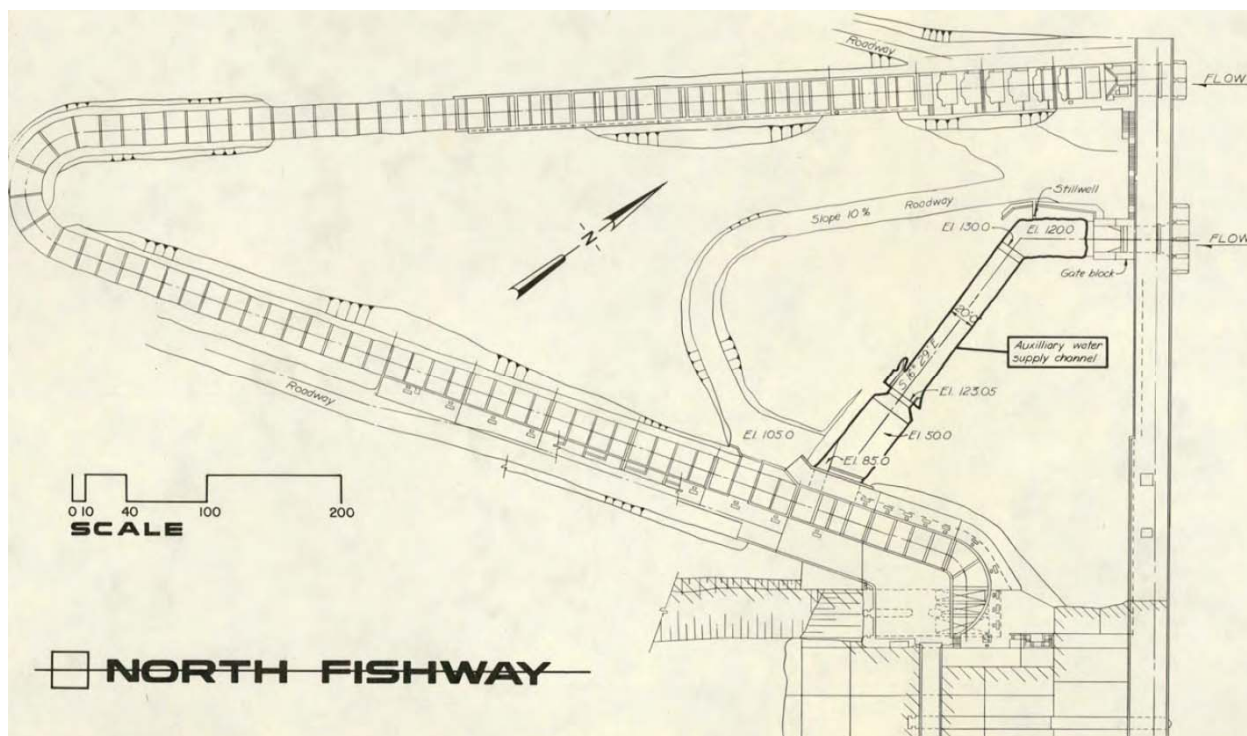


Figure 10 – Site plan shows the locations of the Auxiliary Water Supply channel relative to the north fish ladder. From DM-25 (part of Sheet DD-20-41/1).

Fracturing in the basalt rock exposed in the north fish ladder and AWS channel generally consist of widely spaced primary fractures (cooling joints) and close to moderately spaced secondary fracture which bisect the blocks formed by the primary fractures. The fractures are tight to slightly open and often curve away from the vertical toward the bottom of a flows. Based on mapping completed in the AWS channel, fracture surfaces are generally smooth, and are typically stained with iron oxide or coated with an altered secondary mineral. Average fracture spacing ranged from 0.7 feet to 1.6 feet with an overall average spacing of about 1 foot. However, intact blocks or boulders which have weathered from the exposed rock cut faces in the fish ladder are commonly greater than 2 feet diameter, and can be up to 6 feet in diameter (Figure 11).

In addition, an average fracture frequency of 1.7 fractures per foot was obtained from three core borings completed in the AWS area. Rock quality designation (RQD) was determined for the full depth of rock penetrated by these borings, which indicated that the rock quality was fair to good, with a range of 75 to 90% recovery.

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Figure 11 – Photograph looking south towards the southern fish ladder rock cut near weir 130. Rock blocks up to 6 feet in diameter have weathered out of the cut face in this area.

During the AWS channel work, field measurements were made on a total of 152 fractures at four outcrop locations. The data was plotted on a Schmidt equal area stereo net and contoured (Figure 12). The plot of polar density contours indicate a roughly vertical (80 to 90 degrees) joint dominance. The strike of the joints is generally variable, but indicates a strike preference of about N84°W and N53°E. An approximately horizontal joint set is also present, which most often occurs in the upper portion of the flows. The primary joint sets are provided in Table 1.

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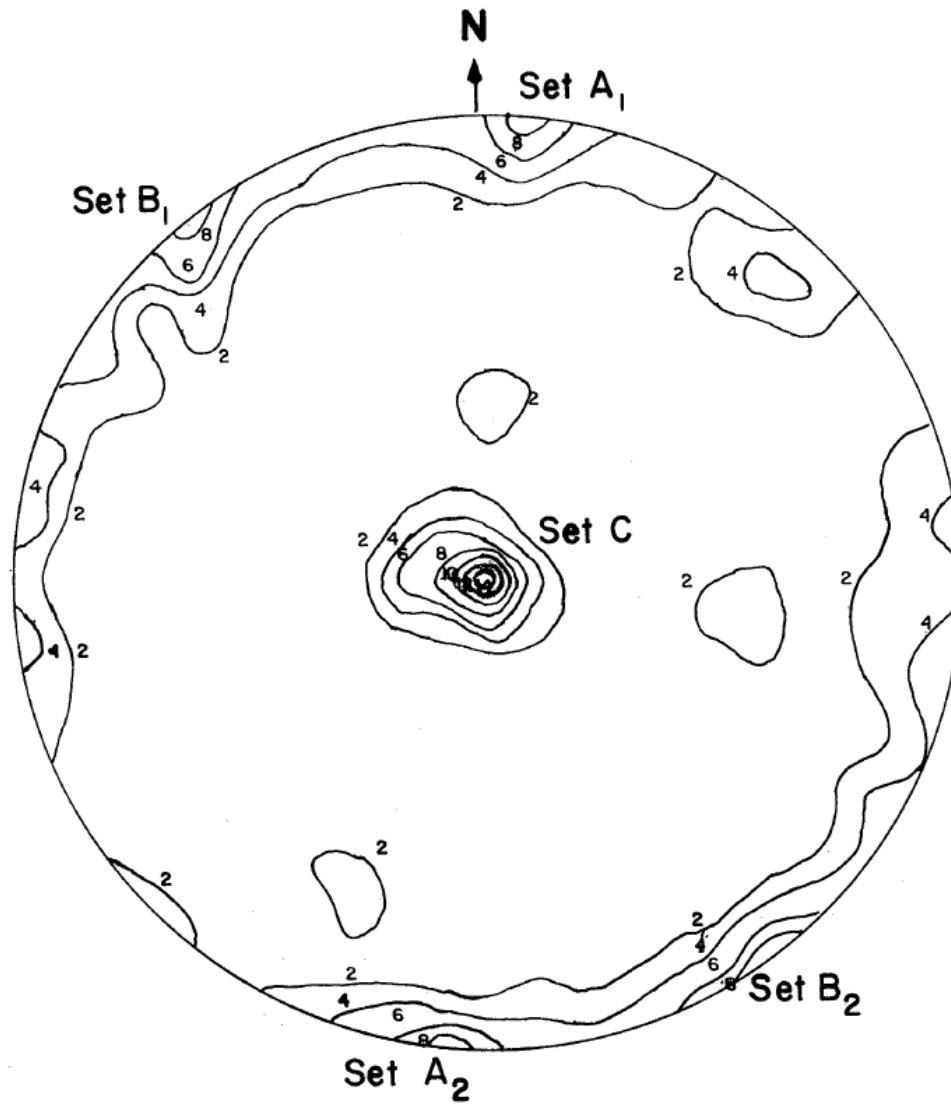


Figure 12 – Polar plot of 152 fracture orientations completed in the auxiliary water supply channel adjacent to the North Fish Ladder. Plot from DM No. 25.

Table 1 - Joint Set Orientations

Joint Set	Strike	Dip
A ₁	N84°W	80°SW
A ₂	N84°W	84°NE
B ₁	N53°E	80°SE
B ₂	N53°E	84°NW
C	N10°E	15°SE

*Please note that Joint sets A1 and A2, and B1 and B2, appear to be the same joint sets. However, these joint sets were reported as different sets in DR No. 25.

3.5.2. Failure Type and Kinematic Analyses

Based on site observations of the north fish ladder slopes, the primary block failure types are wedge to planar-wedge (Figure 13). Both types of failures are primarily controlled by the orientation and the spacing of the discontinuities with respect to the slope face. There are also indications of the occurrence of toppling type failures in some locations, where columns of rock, formed by steeply dipping discontinuities in the rock, rotates about a fixed point causing rock fall. In general, the fragments and blocks that fail are a few inches to a few feet diameter. However, large failures are possible, which can mobilize blocks up to 6 feet diameter (Figure 11).



Figure 13 – Photograph looking west towards the northern part of the fish ladder, showing recent rock fall.

Kinematic analysis is a method used to analyze the potential for the various modes of rock slope failures (plane, wedge, toppling failures), that occur due to the presence of unfavorably oriented discontinuities. Kinematic analysis can be used to assess the likelihood of rock failures, and to assist in design to mitigate for future failures. The stability of the existing rock cuts was analyzed using the fracture/joint orientation data obtained from the 1981 North Fishway Powerhouse and Intake Design Memorandum No. 25. Although a total of 152 fracture orientations were measured for the 1981 study, only the 5 primary average joint set orientations were provided in the DM (Table 1); the actual measured orientations were not provided, but a contour polar plot is available (Figure 12).

The fish ladder cuts generally strike in two directions, (1) N33°E along the northern ladder section, and (2) N56°E along the southern ladder section. The cuts along the west bend of the fish ladder are

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variable. Although the side wall cuts vary, they generally slope into the channel at about 80 degrees, but can be near vertical.

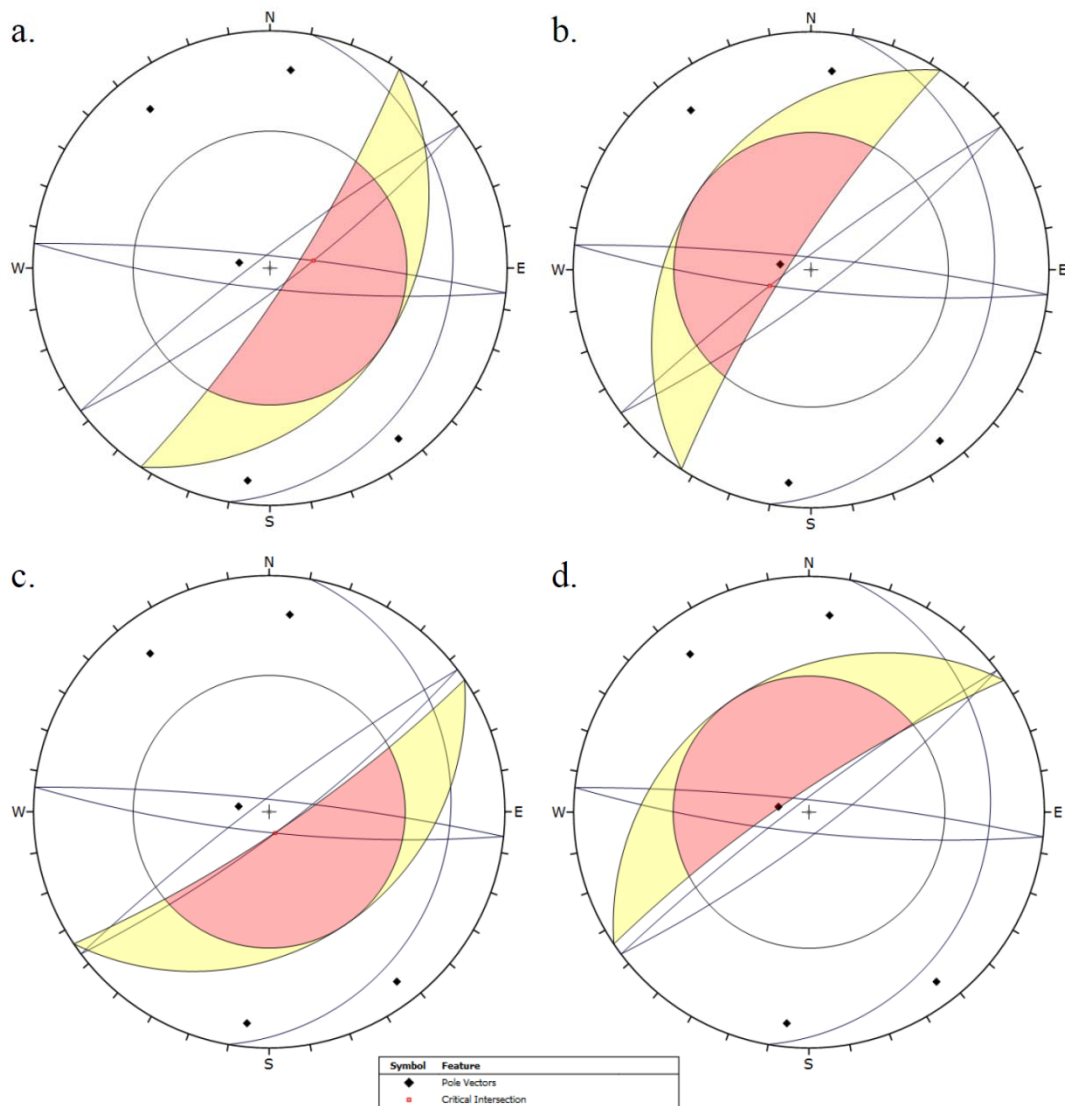


Figure 14 – Stereographic plots showing requirements for wedge failures for the north (a, b) and south (c, d) fish ladder sections. Joint intersections within the red shaded areas indicate that wedge failures are possible. Central circle represents an assumed joint friction angle of 30 degrees.

3.6. ROCK DESIGN PARAMETERS

During the early 1980's geologic and geotechnical investigation for the auxiliary water supply (AWS) channel, five representative core samples of basalt collected from Flows P-1 and O were tested for various physical parameters, including unit weight, unconfined compressive strength, Poisson's ratio and modulus of elasticity (Table 2).

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Table 2 - Report of Tests on Basalt Cores

Core No.	Description	Depth (ft.)	Unit Weight (pcf)	Modulus of Elasticity (psi) x 10 ⁶	Poisson's Ratio	Compressive Strength (psi)
1	Dense Basalt	68.5-69.4	173.5	8.54	0.218	25,700
2	Vesicular Basalt	74.1-75.5	158.5	7.26	0.223	12,790
3			160.4	8.28	0.259	7,180
4			156.0	6.32	0.198	10,330
5		78.3-79.5	158.5	3.24	0.227	6,260
6			155.4	5.82	0.191	8,960
7		Slightly Vesicular Basalt	82.7-84.1	167.2	6.23	0.205
7A	168.5			6.52	0.238	19,700
8	168.5			7.54	0.207	19,500
9	88.5-89.8		168.5	7.33	0.174	23,200
10			169.1	7.55	0.196	25,010
Average			164.0	6.78	0.212	15,260

In addition to the laboratory test values, DM No. 25 provided the following bedrock properties:

Point Load Index

Range: 288-1661 psi (6912-39,864 psi unconfined compressive strength)

Average: 1042 psi (25,000 psi unconfined compressive strength)

RQD: Fair to Excellent (Average = 71.87 = Fair)

Fracture Frequency: 1.7 fractures/ft. (from boreholes)

Fracture Spacing: 0.1 ft. to 4.8 ft. (Average = 1.2 ft.)

3.7. ROCK SLOPE STABILIZATION METHODS

To stabilize the rock slopes along the north fish ladder channel, three preferred rock slope stabilization methods were selected; (1) rock slope scaling, (2) use of rock anchors and dowels to support isolated rock blocks or masses, and (3) construction of shotcrete walls with supporting anchors to protect eroding rock surface from flowing water in the channel. These methods are further discussed below.

3.8. ROCK SLOPE SCALING

Rock scaling is generally defined as the removal of loose rock from slopes. This process is commonly accomplished by removing loose surface rock material using pry-bars, picks, or similar hand held tools. Where large sections of rock, or large boulders, require removal, a variety of techniques can be utilized including winching, air bags/pillows, and power tools. Removal of trees and other vegetation is commonly included in the scaling process. Temporary rockfall protection measures are often used in the rock scaling and rock removal process. In the area of the north fish ladder, the concrete fish ladder weirs can be damaged as the result of rockfall.

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It is anticipated that significant scaling will be required for about 8,500 sf of rock cut (primarily at the northern section of the ladder), moderate scaling will be required for about 10,000 sf of rock cut, and minor scaling will be required for about 3,500 sf of rock cut. The total cubic yardage of material scaled is estimated at about 220 cy.

3.9. ROCK ANCHORS AND DOWELS

A rock anchor, or rock bolt, is a tensioned reinforcement element consisting of a rock, a mechanical or grouted anchorage, and a plate and nut for tensioning or for retaining tension applied by direct pull or by torquing.

A rock dowel is an untensioned reinforcement element consisting of a rock embedded in a mortar or grout filled hole. Once installed, stress is developed passively in the element as rock movements take place. Although the installation of tensioned fully grouted elements is preferred for rock reinforcement, some conditions may make desirable the installation of fully grouted untensioned elements (such as rock dowels). In the north fish ladder, rock dowels are preferred for those areas below the water line, where fish can be present. Because rock dowel do not require a plate and nut to pre-tension, the dowel can be installed completely in the rock, with no elements extending beyond the face of the rock, which can impact water flow and/or be a hazard to fish.

3.9.1. Rock Reinforcement Design

The analytical methods used for assessing the stability of rock cuts and slopes are direct developments from structural analysis and applied mechanics. Their complexity ranges from the simple case of a block sliding on a surface of known frictional resistance to highly complex finite element solutions that include the effects of slippage along discontinuities and fracture of rock blocks. The analysis of the stability of a rock structure requires the behavior of the structure to be stated in terms of its geometry, the load deformation characteristics of its materials, the virgin in situ stresses, the geological characteristics of the rock, and the conditions induced by the excavation. Such statements may range from a simple case, such as a rock block on the surface under gravity load, to the highly indeterminate conditions associated with intersections of underground openings. Because the main hazard along the north fish ladder is related to individual rock fall blocks, the more simple case of rock block stability under gravity loading was considered.

For preliminary design, there are a number of empirical guidelines for rock reinforcement design. EM 1110-1-2907 provides guidance for minimum length and maximum spacing for rock reinforcement, as summarized in Table 3.

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Table 3 - Minimum Length and Maximum Spacing of Rock Reinforcement (per EM 1110-1-2907)

Parameter	Empirical Rules
Minimum Length	Greatest of: a. Two times the bolt spacing b. Three times the width of the critical and potentially unstable rock block
Maximum Spacing	Least of: a. $\frac{1}{2}$ the bolt length b. $1\frac{1}{2}$ the width of the critical and potentially unstable rock block c. 6 ft.
*Greater spacing than 6 feet would make attachment of surface treatment, such as chain link fabric, difficult.	

The design and analysis of anchor systems include determination of anchor loads, spacing, depth, and bonding of the anchor. Safety factors are determined by considering failures within the rock mass, between the rock and grout/anchor, and yield of the anchor.

For those anchors supporting unstable rock masses, the load on each anchor will be dependent on the mass of the rock mass being supported, minus the resistance forces applied along the joint surfaces. Factors which contribute to this include, (1) the irregularities of joints are nominal, (2) the resistance force against sliding along joints is low, (3) the angle the joints make with the surface of the excavation is small, and (4) the force of gravity tends to induce motion of the block. Blocks present along the roof of an excavation may be entirely free to fall, but blocks along a wall would likely have to slide or rotate along the joints at its sides and base before fallout could occur.

It is anticipated that only isolated rock anchors/bolts will be needed to secure discrete unstable blocks or rock masses. The use of a gridded rock bolt pattern, with pre-defined 'maximum' spacings, is not proposed. For larger rock masses, 2 to more anchors may be required to adequately support the mass.

The depth of a single anchor in competent rock, containing few joints, may be computed by considering the shear strength of the rock mobilizing around the surface area of a circular cone within an apex angle; an apex angle of 90 degrees may be assumed for preliminary design, per EM 1110-1-2908. However, for a single anchor in fractured rock, the strength of the rock mass cannot typically be relied upon to provide the necessary resistance, and the strength of the material is more like a granular soil than competent rock. In general, the rock behind unstable rock blocks or masses to be secured along the fish ladder channel is considered competent rock, and therefore the shear strength of the rock, beyond the unstable block or mass, may be assumed. For preliminary design, in areas of the fish ladder where rock anchors are necessary, the unstable rock masses should be assumed to extend back from the rock face a minimum of 3 feet, to a maximum of 6 feet. The depth of the anchor beyond this point should be determined based on the shear strength of the competent rock. For the shotcrete wall designs, the rock within 3 feet of the shotcrete wall facing should be considered non-competent rock, and should be considered to have zero resisting forces.

For preliminary design, rock anchor lengths should be designed assuming three times the potential unstable rock block/mass size. Because the large rock blocks at the site typically range from 3 to 6

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feet in diameter, the rock anchor lengths would vary from 9 to 18 feet long. Because unstable rock blocks smaller than about 3 feet diameter would likely be safely scaled without damaging the weir structures (using shielding), securing rock blocks smaller than 3 feet diameter is not currently proposed.

The anchors should be grouted to their full length. If mechanical anchors are used to initially seat the anchor, the seated anchor should be then grouted in place. The bond length that defines the anchor socket shall be determined by the required resisting forces. It should be assumed that the potential failure surface within the supporting competent rock will initiate at the midpoint of the grouted socket.

It is anticipated that 100 rock anchors will be required, installed at average depths of 12 feet. An additional 24 anchors will be needed for the shotcrete walls, as detailed in Section 5 (Structural Design).

3.10. RETAINING STRUCTURES

Although much of the fish ladder rock cuts are undergoing rockfall primarily as the result of weathering and gravitational forces, there is one section of ladder, between weirs 120 and 123 (south wall) where water flow has caused erosion of the lower rock cut, forming undercuts that could destabilize overlying rock masses (Figure 15; also see Figure 1 and Photos 6 & 7 of Appendix A). In this area, the contact between flows P-1 and P dip down below the waterline, and this weaker zone is more easily eroded by water. The contact between these flows is generally a baked zone, and consists of very broken, scoriaceous basalt. An existing concrete wall exists on the south side of the channel, between weirs 119 and 120, which appears to have been constructed in conjunction with fish ladder weir modifications completed in the 1980's. This existing wall was likely constructed to help protect the cut from water erosion along the same contact. In addition, rock stabilization work completed in 1998, in the AWS plunge pool area, included filling an erosion cavity (approximately 8' high, by 16' wide, by 14' deep) with dental concrete; this cavity formed along this P/P-1 contact (Appendix B, Sheets DDG-0-5-5 and DDG-5-1-1).

Based on site observations, continued water erosion along this contact zone, between weirs 120 and 123, could result in a rock failure that could damage the weirs. Therefore, wall structures (shotcrete walls) are proposed in this area. There would be three separate wall segments, one between weirs 120 and 121, one between weirs 121 and 122, and one between weirs 122 and 123. The top of the walls will be at the top of the non-overflow portion of the weirs; making the walls approximately 8 feet high. Between weirs 120 and 121, part of the weathered flow contact extends above the non-overflow portion of the weirs; in this area the contact has been eroded and forms as 1 to 2 foot overhang. Shotcrete or dental concrete may need to extend above non-overflow elevation in this area to fill this gap.

Prior to wall construction, the exposed rock face will need to be scaled and cleaned of loose rock material. Along the contact, removal of rock could extend back from the adjacent rock face several feet; this volume will need to be filled with shotcrete. Additional excavation may be required to provide the minimum wall thickness, without impacting the weirs or flow criteria.

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The walls should be designed assuming hydrostatic pore pressures to the top of the walls, with no water loading inside the channel. Lateral loads from the bedrock may be assumed to be zero.

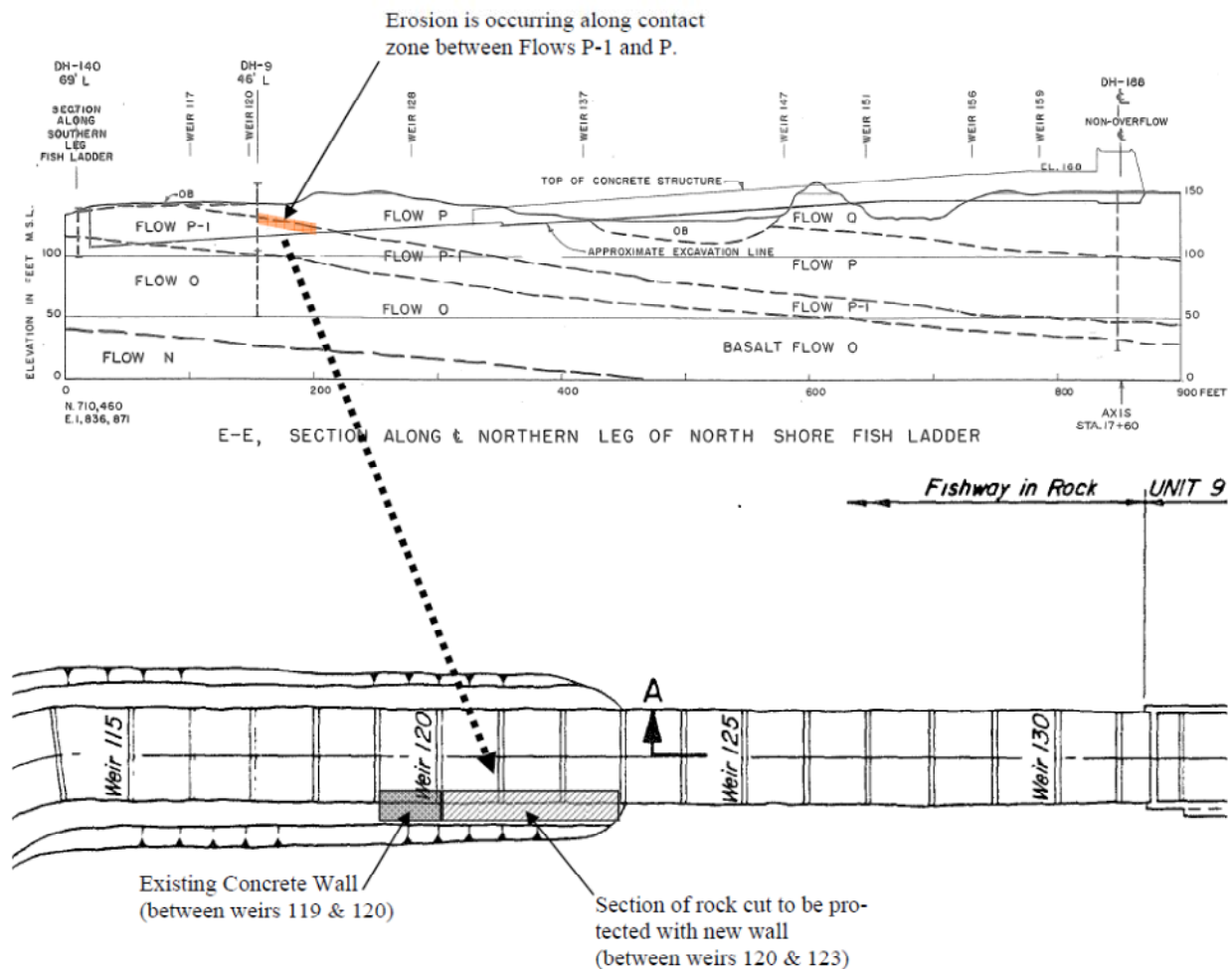


Figure 15 – Plan and section showing proposed shotcrete wall locations.

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4. HYDROLOGIC AND HYDRAULIC DESIGN

4.1. GENERAL

The principal hydraulic considerations are to maintain passage criteria within the fish ladder. Any increase or decrease in weir or orifice width or depth would alter the geometry and modify the design flows required for fish passage. If any modifications radically change discharge, velocities, pool volumes, or energy dissipation per pool it would bring the ladder out of criteria. Significant changes to these parameters would not be acceptable.

4.2. REFERENCES

- Hydraulic Design References
 - Hydraulic Evaluation of Lower Columbia River Adult Bypass System: The Dalles East Fishway.
 - Anadromous Salmonid Passage Facility Design; National Marine Fisheries Service Northwest Region, July 2011.
- Hydraulic Evaluation of Lower Columbia River Adult Bypass System: The Dalles North Fishway
 - 2015 Fish Passage Plan (FPP): U.S. Army Corps of Engineers, northwestern Division Lower Columbia & Lower Snake River Hydropower Projects; CENWD-PDW-R
 - Fisheries Handbook of Engineering Requirements and Biologic Criteria: Fish Passage Development and Evaluation Program, Corps of Engineers, North Pacific Division , Portland, Oregon, 1990
 - The Dalles Lock and Dam Columbia River, Washington and Oregon Design Memorandum No. 6; Navigation Lock, North Fishway and Non-Overflow Dam Between Lock and Spillway
 - DM #5 Supplement No. 2; North Fish Ladder Counting Station and Weir Modifications January 1985.

4.3. HYDROLOGIC DESIGN/CONSIDERATIONS

4.3.1. Design Project Outflows and Elevations

Fish ladders are designed to work with fluctuations in the forebay flow at the exit of the ladder, and fluctuations in the tailrace at the ladder entrance. Below are Project outflows and elevations that impact operation of the fish ladders (also see Tables 4 and 5):

Normal Forebay Operating Range: 155-160 ft.
Tailrace Rate of Change Limit: 3 ft./hr.

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Powerhouse Maximum Discharge Range: 275-300 kcfs (Assumes approximately 99% operations and some units out of service)

Spillway Hydraulic Capacity: 2290 kcfs

The Dalles Mean Daily Flow – data in cfs (Table 5)

Table 4 - Tailwater Information at The Dalles Given Discharge and Bonneville Forebay

Tailwater Information at The Dalles Given Discharge and Bonneville Forebay					
Gauge 10 Water Surface Elevation					
Kcfs	FB 70	FB 72	FB 74	FB 76	FB 78
50	70.37	72.31	74.26	76.23	78.19
75	70.82	72.69	74.59	76.50	78.43
100	71.43	73.21	75.03	76.88	78.76
150	72.99	74.56	76.20	77.90	79.65
200	74.87	76.23	77.68	79.21	80.81
250	75.81	77.08	78.45	79.91	81.44
300	77.69	78.80	80.02	81.33	82.73
350	79.61	80.58	81.67	82.84	84.12
400	81.54	82.39	83.36	84.42	85.58
450	82.75	83.60	84.55	85.59	86.75
500	84.59	85.37	86.23	87.20	88.26
550	86.42	87.13	87.92	88.82	89.80
600	88.22	88.87	89.62	90.47	91.35
650	90.00	90.61	91.31	92.09	92.91
680	91.06	91.65	92.32	93.06	93.84
FB is Bonneville Forebay Elevation					

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Table 5 - The Dalles Mean Daily Flow - data in cfs

The Dalles Mean Daily Flow - data in cfs												
Percent	Observed for Water Years WY1974 - WY2014											
Exceedence	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
99%	119,700	106,000	73,340	74,360	66,429	68,550	79,616	90,900	97,166	98,785	95,350	92,629
95%	164,000	136,000	89,800	87,150	75,345	78,050	94,490	107,000	112,000	114,000	112,000	115,000
90%	192,000	160,900	107,000	93,300	80,990	85,100	104,000	117,000	121,000	121,000	119,000	127,970
85%	207,100	178,000	120,000	101,000	85,335	89,700	109,205	122,000	127,000	125,000	124,000	140,000
80%	217,000	190,720	132,000	107,000	89,500	93,300	113,000	127,000	133,880	130,000	130,000	148,980
75%	224,000	204,400	142,000	114,000	93,100	97,300	117,000	131,000	138,125	134,000	135,000	156,000
70%	233,000	215,000	150,000	118,000	95,970	101,000	120,000	135,000	143,000	139,000	142,000	166,000
65%	241,100	231,000	157,000	123,000	99,000	104,000	122,000	138,000	149,000	146,000	149,000	175,135
60%	250,000	245,620	164,000	127,000	102,000	106,000	124,000	141,000	154,000	150,920	158,000	185,000
55%	258,000	261,000	171,000	131,950	104,505	109,950	126,000	145,000	160,000	156,000	165,350	198,000
50%	265,000	274,000	178,000	135,000	108,050	113,000	128,000	148,000	165,000	165,000	173,000	213,000
45%	273,000	285,000	185,000	140,000	111,000	115,000	131,000	152,000	171,000	172,000	182,000	224,000
40%	283,000	299,000	194,000	144,000	114,000	118,000	133,000	157,000	177,000	181,000	191,000	234,000
35%	294,000	314,000	205,450	149,000	117,000	121,000	136,000	161,500	183,000	189,010	202,000	243,970
30%	311,800	331,000	215,000	155,000	120,000	125,000	140,000	167,000	190,000	197,000	216,000	254,000
25%	324,350	344,000	227,000	162,000	123,825	128,000	144,000	172,700	197,000	203,750	227,000	266,000
20%	344,000	358,000	241,000	172,000	128,000	132,000	147,680	179,000	203,180	212,320	238,800	281,000
15%	362,000	373,585	257,150	181,000	133,000	136,000	153,000	188,500	211,000	224,000	255,000	296,000
10%	384,000	405,000	275,300	196,300	140,000	142,000	160,190	200,000	224,110	236,000	285,700	315,040
5%	413,000	458,065	315,000	214,500	151,550	152,000	172,550	221,000	252,465	275,435	322,300	341,865
1%	499,786	565,491	406,500	243,000	185,927	176,580	200,420	258,300	322,895	374,530	369,210	409,014
Maximum	526,800	588,000	496,000	261,000	244,000	214,000	291,000	323,600	379,000	408,400	412,100	458,900
Average	277,301	280,384	188,506	140,449	109,969	113,531	131,056	154,407	171,134	191,384	187,797	216,505
Median	265,000	274,000	178,000	135,000	108,050	113,000	128,000	148,000	165,000	188,000	173,000	213,000
Minimum	95,900	75,500	53,900	55,600	59,300	61,100	62,200	75,500	75,200	77,500	83,300	65,600

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4.4. HYDRAULIC DESIGN CRITERIA

4.4.1. Entrance and Fish Ladder Criteria

- Elevation of entrance weir crest or sluice opening invert should be 8 feet below tailrace level (or entrance submergence ≥ 8 feet).
- The fishway entrance hydraulic drop (entrance head) should be between 1-1.3 depending on the species present. In general, ladder head should be 1.0 foot (± 0.1 feet). If the shad fish numbers exceed criteria specified in the Fish Passage Plan, then the ladder head should be raised to 1.3 feet (± 0.1 feet).
- Attraction flow from the fishway entrance should be between 5% and 10% of fish passage design high flow (NFMS, 2011). Auxiliary water supply systems provide add-in water needed to attract fish to the ladder entrance and lower ladder pools.
- In order to maintain proper attraction flow, per The Fish Passage Plan, channel velocities should be between 1.5 and 4 feet per second (ft/s), 2 ft/s optimum.
- Appendix D (Hydraulic Calculations) explores the impact of wall stabilization design that could reduce the required pool volume for fish passage as seen below.

NMFS Criteria for adult salmon require that the *fishway* pools have a minimum water volume to allow for resting areas of:

$$\frac{\gamma \cdot Q \cdot H}{\left(4 \text{ ft} - \frac{\text{lbs}}{\text{sec}}\right) / \text{ft}^3}$$

where

V = pool volume, in cubic feet (ft^3)

γ = unit weight of water, 62.4 pounds (lbs) per ft^3

Q = *fish ladder* flow, in ft^3/s

H = energy head of pool-to-pool flow, in feet

4 ft-lb/sec = the energy dissipation factor (EDF)

- Calculations in Appendix D show that a considerable reduction in volume would be necessary to bring the pool below the required total volume for appropriate energy dissipation (on the order of a reduction in pool width of 9 ft). However, changes to the lengths of the weirs and/or the dimensions of the orifices would change the flow characteristics and bring the ladder out of criteria. Therefore it is imperative that the modified walls do not encroach into the pool enough to influence the dimensions of the weirs and orifices. As noted in Plate 1 the recommended design will not encroach into the adjacent weirs and orifices.
- Although the proposed shotcrete coverage on the rock walls will likely have a smoother roughness (or 'n' value), we don't anticipate that the hydraulics will be out of criteria. The

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natural roughness of the individual pools from No. 77 to 132 vary throughout, and it is assumed that when constructed the design criteria was consistent with the upstream pools with smooth concrete walls.

4.4.2. Lamprey Criteria and Passage Considerations

Pacific lamprey is a species of special concern to the USACE and agency partners. Existing fish ladders, which were designed for salmon and steelhead passage, generally perform relatively poorly for adult Pacific lamprey. In accordance with the 2008 Columbia Basin Fish Accords, the USACE is committed to improving adult lamprey passage at all Columbia and Snake River dams and ensuring that any future modifications consider potential impacts on adult lamprey passage. While lamprey passage criteria are less refined than those for salmonids, the following must be considered when evaluating alternatives and making design decisions:

- 4-inch minimum radius on all outside corners (>180 degree in change in bearing in any surface) of fish passage openings, wherever weir opening is not flush with sidewall or orifice opening is not flush with floor.
- Ramping from floor to raised orifices, with a maximum ramp slope of 45 degrees.
- The mean critical swim speed (speed at which physical exhaustion occurs) for Pacific lamprey is 0.85 meters per second (2.8 ft/s; Mesa et al. 2003) and laboratory experiments suggest that most adult lamprey will not pass weir orifices or other constrictions at velocities of 2.5 to 3.0 meters per second (8.2 to 9.8 ft/s; Keefer et al. 2010). Therefore, velocities through weir orifices or count slots should be no greater than 8 ft/s.
- For passage structure features associated with velocities approaching 8 ft/s (see above), such as weir orifices and vertical slots, the distance through which lamprey must pass should be minimized and existing ladder geometry should be maintained. Of particular concern are high-velocity passage distances that approach or exceed the body length of a typical adult Pacific lamprey (15-25 inches).
- All edges should be smooth to the touch to prevent injury.
- Similar to fish ladder criteria, as noted in Plate 1, the recommended design will not encroach into the adjacent weirs and orifices.

4.4.3. Lamprey References

- a. 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. Technical Report 2011-5 of Idaho Cooperative Fish and Wildlife Research Unit to U.S. Army Corps of Engineers, Portland District.
- b. Keefer, M.L., W.R. Daigle, C.A. Peery, H.T. Pennington, S.R. Lee, and M.L. Moser. 2010. Testing adult Pacific lamprey performance at structural challenges in fishways. *North American Journal of Fisheries Management* 30:376–385.

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- c. Mesa, M.G., J.M. Bayer, and J.G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. *Transactions of the American Fisheries Society* 132: 483–492.
- d. NOAA Fisheries. 2008. Anadromous Salmonid Passage Facility Design. Northwest Region, Portland, Oregon.

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5. STRUCTURAL DESIGN

5.1. GENERAL

Construction of a shotcrete wall with rock bolts between weirs 120 and 123 will be used to protect the cut against water erosion and scour. This chapter describes consideration and criteria for the structural design of The Dalles North Fish Ladder Rock Wall Stabilization.

5.2. REFERENCES

- a. EM 1110-2-2005 Standard Practice for shotcrete.
- b. EM 1110-2-2100 Stability Analysis of Concrete Structures.
- c. EM 1110-2-2104 Strength Design for Reinforced-Concrete Hydraulic Structures.
- d. EM 1110-1-2907 Rock Reinforcement
- e. FHWA0-IF-03-017, GEOTECHNICAL ENGINEERING CIRCULAR NO. 7, Soil Nail Walls
- f. American Concrete Institute (ACI), ACI 350-06, Code Requirements for Environmental Engineering Concrete Structures.
- g. American Concrete Institute (ACI), ACI 318-14, Code Requirements for structural Concrete
- h. American Society of Civil Engineers (ASCE), ASCE 07-10, Minimum Design Loads for Buildings and Other Structures.
- i. American Society of Concrete Contractors, Guide for Surface Finish of Formed Concrete.
- j. American Institute of Steel Construction (AISC), 14th Edition Steel Construction Manual (LFRD and ASD).
- k. American Welding Society (AWS), Structural Welding Codes for Steel and Aluminum.
- l. U.S. Geological Survey (USGS) 2002 National Seismic Hazard Maps.

5.3. ENGINEERING PROPERTIES OF CONSTRUCTION MATERIALS

- Anchor Rods: ASTM F1554 Grade 55, $f_y = 55,000$ psi.
- Shotcrete compressive strength of 4.5 ksi at 28 day , in accordance with ASTM C42/C42M
- Reinforcement steel: ASTM A615 Grade 60
- Wire Reinforcement in accordance with ASTM A82/A82M or ASTM A1064/A1064M.
- Nuts: ASTM A563.
- Washers: ASTM F436

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5.4. DESIGN LOADS

a. Dead Loads

Dead loads consist of the weight of concrete, metal, and fixed equipment. Concrete unit weight is assumed to be 150 lb/ft³. Steel unit weight of 0.283 pounds per cubic inch is based upon AISC values for structural plates and shapes.

b. Hydrostatic Loads

The hydrostatic loads against the structure include internal and external pressures for all design load conditions. The unit weight of water is assumed to be 62.4 lb/ft³. The Shotcrete surface will be subject to a maximum of 8 feet of hydrostatic load (the full height of the surface treatment).

5.5. STRUCTURAL DESIGN

This section covers stabilization of the The Dalles North Fish Ladder Rock Wall Stabilization; the rock cut, above the fish ladder. All of the The Dalles North Fish Ladder Rock Wall Stabilization structural elements are designed to meet the strength, stability, and serviceability requirements outlined in applicable design references listed above.

Hydraulic Structures: Concrete structures /shotcrete surface will be considered hydraulic structures with the appropriate load factors, as defined in EM 1110-2-2104 and ACI 350.

All reinforced shotcrete hydraulic surface must satisfy both strength and serviceability requirements. In the strength design method this is accomplished by multiplying the service loads by appropriate load factors and for hydraulic structures multiplying by an additional hydraulic factor, $H_f = 1.3$. The hydraulic factor is applied to the overall load factor equations. This increased loading is then used for obtaining the required nominal strength for the hydraulic structures. The hydraulic factor is used in lieu of performing an additional serviceability analysis.

The stability analysis of hydraulic Shotcrete surface must be performed using unfactored loads in accordance with EM 1110-2-2100 Stability Analysis of Hydraulic Structures. The unfactored loads and the resulting reactions are then used to determine the unfactored moments, shears and thrusts as critical sections of the structure. The unfactored moments, shears, and thrusts are then multiplied by the appropriate load factors, and hydraulic factors, when appropriate, to determine the required nominal strengths to be used in establishing the section properties.

The basic requirements for the stability of the different features of this Project are as follows:

- The structure should be safe against overturning at the base, and at any horizontal plane within the structure.
- The structure should be safe against sliding on any plane within the structure on any rock seam within the contact.

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The analysis and design of shotcrete walls must consider two distinct limiting conditions: Strength Limit States and the Service Limit States.

- Strength limit states: These limit states refer to failure or collapse modes in which the applied loads induce stresses that are greater than the strength of the whole system or individual components, and the structure becomes unstable. Strength limit states arise when one or more potential failure modes are realized. The design of a shotcrete wall should ensure that the system is safe against all of the potential failure conditions classified as:
 - External failure mode;
 - Internal failure mode; and
 - Facing failure mode.
- Service limit states: These limit states refers to conditions that do not involve collapse, but rather impair the normal and safe operation of the structure. The major service limit state associated with shotcrete walls is excessive wall deformation.

For the description of the failure modes see reference FHWA0-IF-03-017, GEOTECHNICAL ENGINEERING CIRCULAR NO. 7, Soil Nail Walls.

5.6. FEATURES

Shotcrete walls with rock bolts will be designed between water flows and existing rocks to stabilize and prevent any further deterioration of existing rock surface. The shotcrete walls are required to be constructed between weirs 120 and 123 against the surface of existing rock wall. The walls will contain rock bolts, wire mesh for temporary shotcrete and reinforcement steel for permanent Shotcrete (Plate 1). The rock anchors consist of the passive reinforcement of existing rock by installing closely spaced steel bars, which are subsequently encased in grout. The face of the permanent shotcrete will be trowel smooth surface. Where the walls connect to the existing weirs, the walls shall be curved to minimize sharp corners, to assist lamprey passage.

The Shotcrete wall facing can be considered a continuous reinforced concrete slab where the hydrostatic loading acting on the facing and the supports are the tensile forces in the rock bolts and flexural moments in the facing section. Similarities in the loading mechanism between wall facings and continuous concrete slabs supported on columns, suggest that conventional concrete slab analysis and design can be applied to the design of shotcrete wall facing.

The design calls for a minimum 4 inch thick reinforced temporary facing, and an outer 6 inch thick reinforced permanent facing (Figure 16; Plate 1). Excavation of rock may be required to provide the minimum 10 inch design thickness. If rock excavation creates deep holes in the exposed rock face, those holes may need to be backfilled with dental concrete prior to wall construction. A thinner (less than 4 inches thick) basal temporary facing may be desirable, and can be considered for the final design, provided that all design criteria are met.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

5.7.

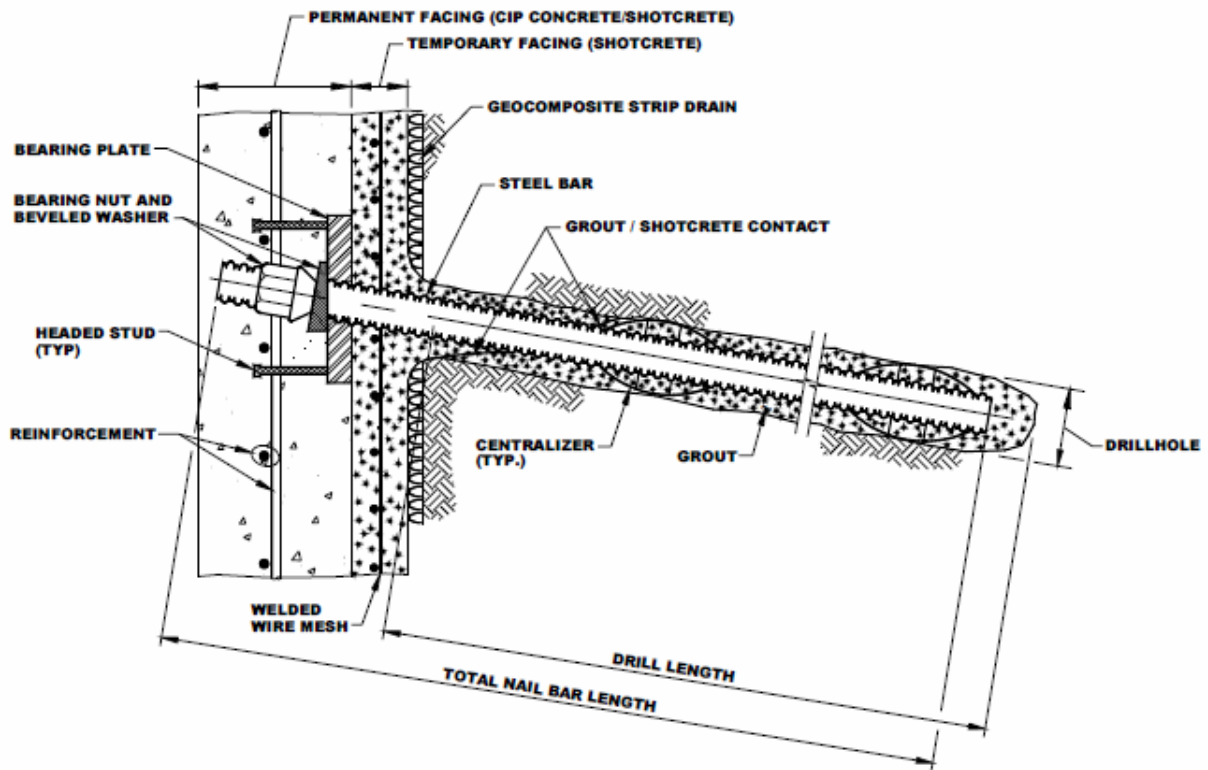


Figure 16 - Main Components of a Typical Rock Bolt

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

6. ENVIRONMENTAL AND CULTURAL RESOURCES

6.1. GENERAL

This chapter outlines the environmental and cultural resources and permitting requirements as they may apply to The Dalles Dam North Fish Ladder Rock Stabilization Project. During plans and specifications, the design will be further refined.

6.2. ENVIRONMENTAL PLANNING

Typically, it is during this phase that environmental clearance documents are prepared to satisfy the various environmental laws and regulations that U.S. Army Corps of Engineers (USACE) must comply with prior to constructing the facilities or modifying operations to improve the facility operation. USACE is required to comply with numerous Federal laws, rules, and regulations, as well as potential additional requirements under state and/or local jurisdictions.

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

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

The consultation process may also encompass sections of the Fish and Wildlife Coordination Act; Magnuson-Stevens Act (Essential Fish Habitat); Bald and Golden Eagle Protection Act; several cultural resource laws including the National Historic Preservation Act; Archaeological Resources Protection Act; Native American Grave Protection and Repatriation Act; Antiquities Act; Archaeological and Historic Preservation Act; Executive Order 11988, Flood Plain Management; Executive Order 11990, Protection of Wetlands; Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance; Comprehensive Environmental Response, Compensation, and Liability Act; Resource Conservation and Recovery Act; Toxic Substances Control Act; Federal Insecticide, Fungicide, and Rodenticide Act; and Migratory Bird Treaty Act.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

7. CONSTRUCTION

7.1. GENERAL

This section presents the basic construction considerations, restrictions, and coordination of the major feature construction for The Dalles North Fish ladder Rock Fall Stabilization. A product development and construction schedule is located in Appendix C.

7.2. SCHEDULE

7.2.1. General

Funding for this project is unknown at this time. The assumption is that this contract will be fully funded. The acquisition strategy is assumed to be a small business set aside completed construction contract.

7.2.2. In-water Work Period

As outlined in The Fish Passage Plan, the in-water work period for The Dalles Dam and the Columbia River is from December 1 to February 28. However, if a timeframe has to be outside of the in water work window or both fish ladders are dewatered at the same time, per the Fish Passage Plan (FPP) (Section 4.2.2), here is what is required:

Non-Routine Maintenance. Maintenance of all fish-related facilities will be carried out as described below. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated through FPOM on a case-by-case basis by Project and CENWP-OD biologists. The CENWP-OD biologists will be notified as soon as possible after it becomes apparent that maintenance and/or repairs are required. The Operations Project Manager has the authority to initiate work prior to notifying CENWP-OD when delay of work will result in unsafe situations for people, property, or fish. Information required by CENWP-OD includes: (see also FPP Chapter 1 - Overview for the Memo of Coordination (MOC) template):

- i. Description of the problem.*
- ii. Type of outage required.*
- iii. Impact on facility operation.*
- iv. Length of time for repairs...*
- v. Expected impacts on fish passage.*

7.2.3. Fish Ladder Shutdown Period

[Schedule needs to be discussed with project biologist to ensure both fish ladders will not be dewatered at the same time during the in water work period and if it is necessary to have both dewatered, coordination with FPOM will have to occur.]

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

7.2.4. Weather

Construction is scheduled to occur between December and February. Crane work may be impacted due to highs. Though high winds are more common in the summer must it is still a high probability that wind will shut down crane work. This will be a factor in the contractor's crane and equipment plan and could cause schedule delays.

Cold weather could also cause scheduling delays. The average high in December is 42 F and the average low in December is 29 F. Specialized grout and concrete may be required to complete this work in the required work window.

7.3. EXCAVATION AND DEMOLITION

7.3.1. Excavation

Excavation of the rocks will be a mixture of some sort of crane or long reach excavator and by hand. Cranes will likely be staged between the two fish ladder sections, or along the existing access road south of the fish ladder. Rocks small enough to be lifted by man can be placed in buckets and lifted out of each weir section. Large stone may require hydraulic equipment. Hydraulic equipment staged in the fish ladder will need to be small enough to fit and operate between the weirs. Material will be removed from site. The weir structures will need to be protected from falling rock during scaling operations.

7.3.2. Demolition

No demolition of existing structures is anticipated.

7.4. RESTRICTED ACCESS

7.4.1. Access Road

Access to the jobsite will be from the Washington side of the Columbia River off highway 14, there is adequate road access for the Contractor to get setup and access the fish ladder. Temporary access road may need to be constructed between the fish ladder sections to provide crane access.

It is anticipated that equipment, including cranes, may need to cross the existing access bridge adjacent to and south east of the PUD Powerhouse. The Contractor will be required to verify that this bridge is adequate to support equipment loading. Note that the north bridge abutment was reinforced in 1998 with rock bolts, as shown in Appendix B (Sheets DDG-5-1-14, DDG-5-1-15, and DDG-5-1-16).

7.4.2. Public Access

There will be no public access during construction. All visitors to the site will be required to make prior arrangements through the USACE construction office and will be required to be escorted by personnel with site access and sign in upon arrival, also attend a safety briefing for each visit.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

7.5. CONTRACTOR OPERATIONS

7.5.1. Contractor Work, Office, Staging, Parking

The Dalles Dam has plenty of space for staging material and temporary construction offices (Figure 17). The staging area should be placed in a location that will minimize the impact on the Operating Project staff.

7.5.2. Environmental Controls

All federal, state, and local laws and regulations will be complied with concerning this work. All runoff from construction site activities will be controlled with best management practices provided by the contractor and approved by the Government, along with controls implemented under the NPDES permit and the Erosion and Sediment Control Plan. Capture of job site runoff in retention ponds will allow settlement of sediments and removal of contaminants.

7.6. QUALITY ASSURANCE AND CONTRACTOR QUALITY CONTROL

7.6.1. Quality Assurance

Quality assurance will be accomplished by a well programmed policy as covered in the Resident Office Quality Assurance Plan (QAP). The QAP will be augmented by a site-specific QAP Supplement prepared by the Construction Project Engineer. Staffing of the quality assurance surveillance will be by assigning one Project Engineer and a suitable number of Government Quality Assurance Representatives (GQAR) to perform the day to-day surveillance, which purpose is to assure adherence to specification requirements for quality and safety. The PDT will periodically travel to the site to participate in partnering meetings, periodic scheduling meetings, and to observe the work as part of required engineering during construction protocols.

7.6.2. Contractor Quality Control

Contractor quality control will be monitored by the Quality Assurance Team, Project Engineer and GQAR(s), as part of the QAP and QAP Supplement requirements. The contractor will be required to follow the guidelines of Division 1 specifications, particularly the sections on Quality Control System, Submittal Procedures, and Contractor Quality Control. These sections specify criteria for outlining the work to be performed and for communicating the quality to the workers performing the work. A Quality Manager is required to be on the contractor staff with the responsibility for executing all quality related matters, which include preparing submittals and conducting the three phases of control for each definable feature of work.

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Figure 17 - Site plan showing anticipated work limits, staging areas and crane placement areas.

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8. OPERATIONS AND MAINTENANCE

8.1. GENERAL

The north fish ladder is operated in accordance with the annual Fish Passage Plan (FPP). Any deviation from the requirements of the FPP must be coordinated through the Fish Passage Operation and Maintenance regional forum.

8.2. FEATURES

Flow into the fish ladder is controlled by vertical slot weirs and one valve in the upper section of the ladder. A count station for visual counting is between this flow control section and the remaining downstream overflow weirs. Approximately 25% of the overflow weirs are within a concrete lined portion of the ladder. The remainder is excavated into basalt. Wasco Co PUD turbine provides attraction water to the lower portion of the ladder. A backup overflow system (original construction) provides redundancy for the PUD turbine. Attraction flow is provided via diffuser valves and through grating on the floor of the lower portion of the ladder. There are two entrance openings available, but only one is operated due to amount of available attraction flow. The operating entrance has a telescoping weir to maintain criteria depth and differential at the entrance.

8.3. MAINTENANCE

Routine maintenance is primarily done during 1 month within the winter maintenance season (December 1 – February 28). The fish ladder and channel below tailwater elevation is normally dewatered for inspection. Preventative maintenance is completed on count station moving parts, diffuser valves and the entrance weir. Inspections are completed on all portion of the ladder. Maintenance is also completed during passage season if needed and accessible.

8.4. SAFETY

All work is completed under the Hazardous Energy Control Program (HECP) clearance program to assure worker and equipment safety. Prework safety meetings are also mandatory. Safety Personnel Protection Equipment (PPE) is required during all work. Project safety office reviews work plans.

8.5. ENVIRONMENTAL

All environmental protection requirements are applied during all work. Project environmental section reviews all work plans.

8.6. DOCUMENTATION

All operation of fishway components are recorded with 3 daily fishway inspection to assure FPP compliance. All maintenance of fishways are documented through FEM for work history and funding sources.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

8.7. TRAINING

All personnel working on fishway must complete HECP training and confined space training.

8.8. COMMISSIONING

Following construction, it is anticipated that water flow in the fish ladder, in the area of the new shotcrete walls, will need to be observed and monitored to ensure flows are as anticipated. This initial flow of water will also help remove any remaining work related sediments or contaminants in the fish ladder prior to fish ladder operations for fish passage.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

9. COST ESTIMATING

9.1. GENERAL

This section presents the cost estimate for the The Dalles North Fish ladder Rock Fall Stabilization, as presented in this DDR. The total project cost (design and construction) estimated at the 90% DDR phase is \$1.1 million including a 21.9% contingency. The risk analysis and total project cost summary sheet can be found in Appendix C.

The scope of work includes removal of rock in the north fish ladder as well as stabilize the rock walls so further erosion will not occur. Rocks will be removed by hand and hydraulic equipment. Shotcrete wall will be construction, and will include installation of rock anchors, wire mesh and rebar.

9.2. CRITERIA

Engineer Regulation 1110-2-1302, Engineering and Design Civil Works Cost Engineering, provides policy, guidance, and procedures for cost engineering for all Civil Works projects in the USACE. For a project at this phase, the cost estimates are to include construction features, lands and damages, relocations, environmental compliance, mitigation, engineering and design, construction management, and contingencies. The cost estimating methods used are to establish reasonable costs to support a planning evaluation process. The design is at the 90% DDR level and the cost estimate is at a similar level.

9.3. BASIS OF THE COST ESTIMATE

The cost estimate is based on engineering calculations from the design team and data presented in the DDR. The estimate is calculated with the Micro Computer Cost Estimating System (MCACES) MII, using historical data, labor and equipment crews, quantities, production rates, and material prices. Prices are updated for July 2014 in MII, and escalated to the midpoint of construction on the total project cost summary sheet.

9.4. COST ITEMS

The cost estimates includes costs for engineering for plans and specifications, construction costs, engineering during construction, construction management for supervision and administration, escalation costs, and contingency to account for unforeseen details at this level. Other possible costs are not shown separately, such as lands and damages, relocations, cultural resources, environmental mitigation, environmental compliance and hazardous, toxic and radiological waste (HTRW) costs. These costs are either not applicable or integrally part of the construction costs and are included in the construction features. Escalation costs to account for inflation are applied according to Engineer Manual (EM) 1110-2-1304, Civil Work Construction Cost Index system.

9.5. CONSTRUCTION SCHEDULE

Detailed information about the construction schedule can be found in Section 10 of this DDR. Overtime is anticipated due to the short in-water work window. Assume 50 hour work weeks will be used to complete the work.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

9.6. ACQUISITION STRATEGY

The cost estimate assumes competitive pricing will be obtained by a single phase request for proposals with a best value source selection. Competition will be restricted to small business.

9.7. SUBCONTRACTING PLAN

The cost estimate assumed that the prime contractor will be experienced in heavy civil construction and that no subcontracting will be needed.

9.8. PROJECT CONSTRUCTION

Access to the project will be from highway 14 in Washington. This allows road access directly to the site by trucks, equipment and personnel.

Steel and concrete materials required for the project are readily available by commercial sources. The nearest established suppliers are in the Portland area about 60 miles from the site. The cost estimate assumes concrete will be trucked to the site from concrete plants in the Portland area. The estimate assumes inclusion of the Buy American Act.

Weather was a factor when calculating the potential risk for this job. The Abbreviated Cost Risk Analysis has account for cold and windy weather that may cause delay or need for specialized material for construction.

9.9. FUNCTIONAL COSTS

Planning Engineering and Design (30 Account). Engineering and design costs are determined from the budgets for the expected design and engineering effort. These costs include engineering costs for design and development of a contract package (plans and specifications), Portland District review, contract advertisement, award activities, and engineering during construction. This effort is estimated to cost \$XX million for the plans and specifications phase. The cost of all design phases is estimated to cost \$XX million.

Construction Management (31 Account). Construction management costs are determined from the budget of the expected effort for supervision, administration and quality assurance for the construction contract. This effort is estimated to cost \$XX million.

Annual Operations and Maintenance. Annual operations and maintenance costs are not anticipated.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX A 2014-02-24 Trip Report



**U.S. Army Corps of Engineers
Portland District**

MEMORANDUM FOR RECORD (TRIP REPORT)

MEMORANDUM FOR: Bryan Mason, P.E. (CENWP-OD-D)

DATE: 26 February 2014

SUBJECT: 24 February 2014 North Fish Ladder Rockfall Observations

Prepared by: Christopher Humphrey, C.E.G. (CENWP-EC-DG)

On 24 February 2014, Chris Humphrey (engineering geologist) and Bryan Mason observed rock cuts, exposing basaltic rock, along the north fish ladder of The Dalles Dam. Reportedly, rockfall along the steep cuts of the fish ladder is an on-going problem, and is considered a safety concern when workers are in the ladder doing maintenance.

The cuts were excavated at the time of the construction of the fish ladder. Since construction, the cuts have experienced extensive chemical and mechanical weathering. In particular, fracture and joint fillings have weathered creating openings (or apertures) along the rock face, reducing the connectivity and bond between individual rock fragments or blocks. Roots and freeze/thaw activity has also opened up discontinuities in the rock; along with animal activity (burrows, etc.). This has resulted in unstable rock fragments and blocks, causing the observed rockfall.

The most significant rock fall hazard lies north-northwest of the main ladder switchback (Figure 1). In this area, mitigation measures are recommended to reduce the risk of rockfall. These measures include vegetation removal, scaling, localized installation of rock anchors, and construction of concrete walls. The cuts along the switchback, and east-southeast of the switchback, appear in more stable condition, but are still in need of some localized scaling efforts.

There is an area of the ladder, near the footbridge, that has unstable rock, including large unstable rock blocks (Figure 1 and photo 8). Unfortunately, it is likely that any scaling or rock anchor activity completed in this area could cause rock fall that could damage the fish ladder. Therefore, this area of the fish ladder could simply monitored, with special precautions given to personnel who work in this area of the ladder.

Vegetation Removal

At the time of our observations, there were significant blackberry growth along cut slopes, and numerous small trees. It is recommended that all the vegetation along the rock cuts be removed. If allowed, herbicides should be used to permanently kill and control the unwanted vegetation. If herbicides are not allowed, the vegetation removal should be periodically completed to reduce the risk of mechanical weathering due to roots and tree fall. It is recommended that vegetation be removed prior to or in conjunction with scaling efforts.

Scaling

Because of the age of the excavation, all rock faces along the fish ladder are in some need of scaling efforts, but is especially needs at the northern segment of the fish ladder, as shown on Figure 1. The scaling should effectively remove debris and loose rock fragments that are at risk of falling. The scaling should be completed by trained personnel who are experienced with scaling rock slopes.

Rock Anchors

Figure 1 and photo 2 shows an area of the fish ladder that has experienced rock block fall as the result of jointing in the rock that slope steeply down towards the fish ladder. In this area of the site scaling alone may not fully eliminate the risk of future rock fall. Therefore, localized rock anchors will likely be required to hold larger, unstable rock blocks in place.

Concrete Wall

There is one section of the ladder where water flow has caused erosion of the lower rock cut, essentially undercutting the slope (See Figure 1 and photos 6 & 7). Continued erosion can result in larger rock fall that could damage the ladder. In this area of the ladder some kind of concrete wall will likely be required to protect the cut from on-going erosive forces. The wall could be supported by rock anchors.

Prior to implementing any rock stabilization work, a qualified engineering geologist or geological engineer should be hired to evaluate the cuts in detail, and develop a stabilization design/plan.



Figure 1 - Aerial photo showing north fish ladder and areas of interest.



Photo 1 - looking north up fish ladder.



Photo 2 - Showing areas of recent rock block fall. Localized rock anchors are required.



Photo 3 – Showing large rock blocks that may be at risk of toppling. Localized rock anchors may be required.



Photos 4 & 5 – Sections of rock cut needing vegetation removal and scaling.



Photos 6 & 7 – Area of lower rock cut being eroded and undermined by water flow. This area of cut may require construction of a concrete wall structure to protect lower rock cut for further erosion.



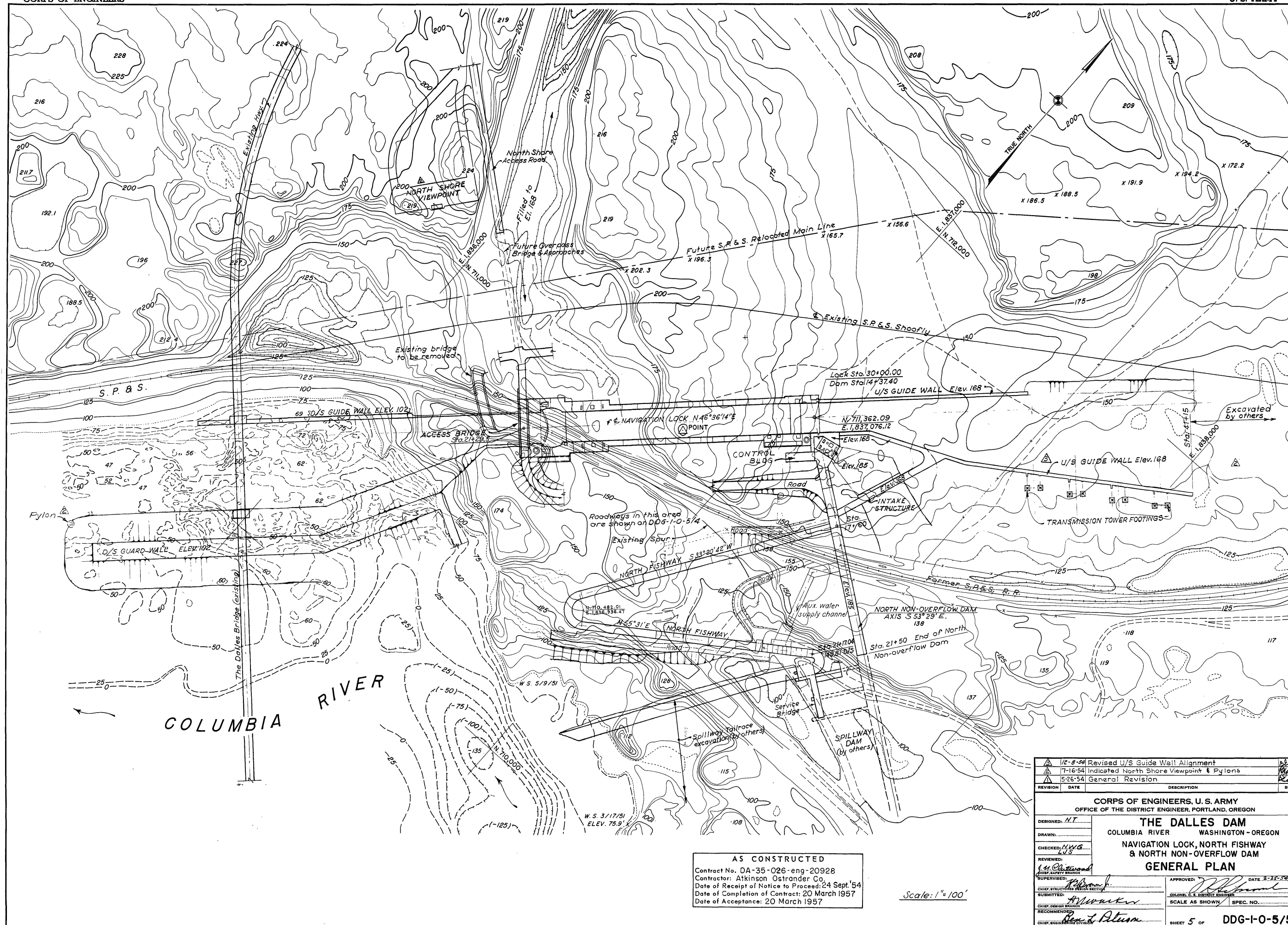
Photo 8 – Area of unstable rock blocks, near footbridge. Although these blocks appear unstable, it would be difficult to anchor or scale this area without threatening damage to the fish ladder. This area should be monitored, and any work in the area should be done to limit impacts to the slope. Workers access to this area should be limited.

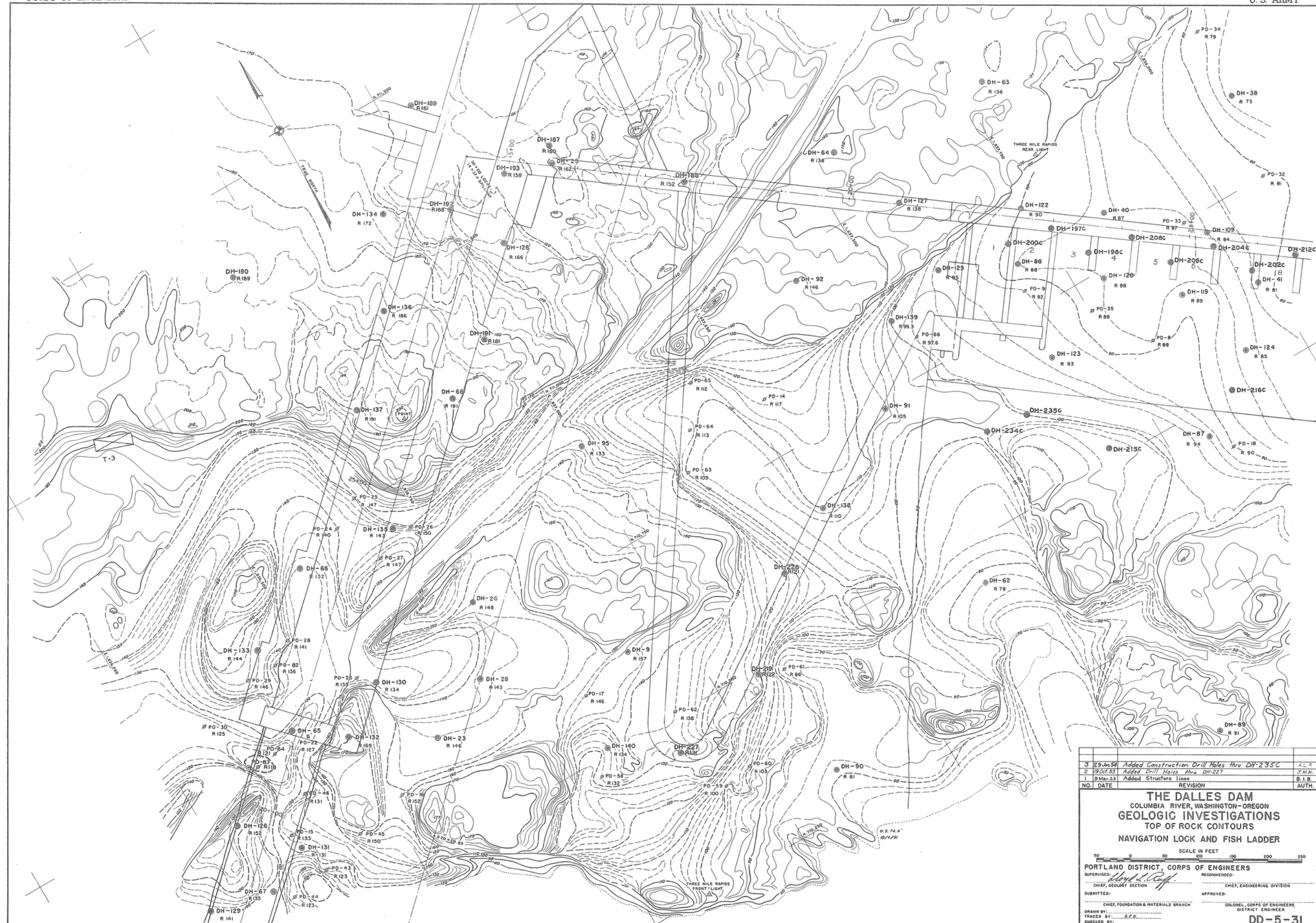


Photo 9 – Looking towards the southern section of the fish ladder.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX B Reference Plan Sheets





3	29 Jun 54	Added Construction Drill Holes thru DH-235C	A.L.S.
2	19 Oct 53	Added Drill Holes thru DH-227	J.M.W.
1	9 Mar 53	Added Structure Lines	B.I.B.
NO.	DATE	REVISION	AUTH.

THE DALLES DAM
COLUMBIA RIVER, WASHINGTON-OREGON
GEOLOGIC INVESTIGATIONS
TOP OF ROCK CONTOURS
NAVIGATION LOCK AND FISH LADDER

SCALE IN FEET
0 50 100 150 200 250

PORTLAND DISTRICT, CORPS OF ENGINEERS

SUPERVISED BY: *W. L. Ruff* RECOMMENDED BY: *W. L. Ruff*

CHECKED BY: *W. L. Ruff* CHIEF, GEOLGY SECTION

SUBMITTED BY: *W. L. Ruff* CHIEF, ENGINEERING DIVISION

CHECKED BY: *W. L. Ruff* CHIEF, FOUNDATION & MATERIALS BRANCH

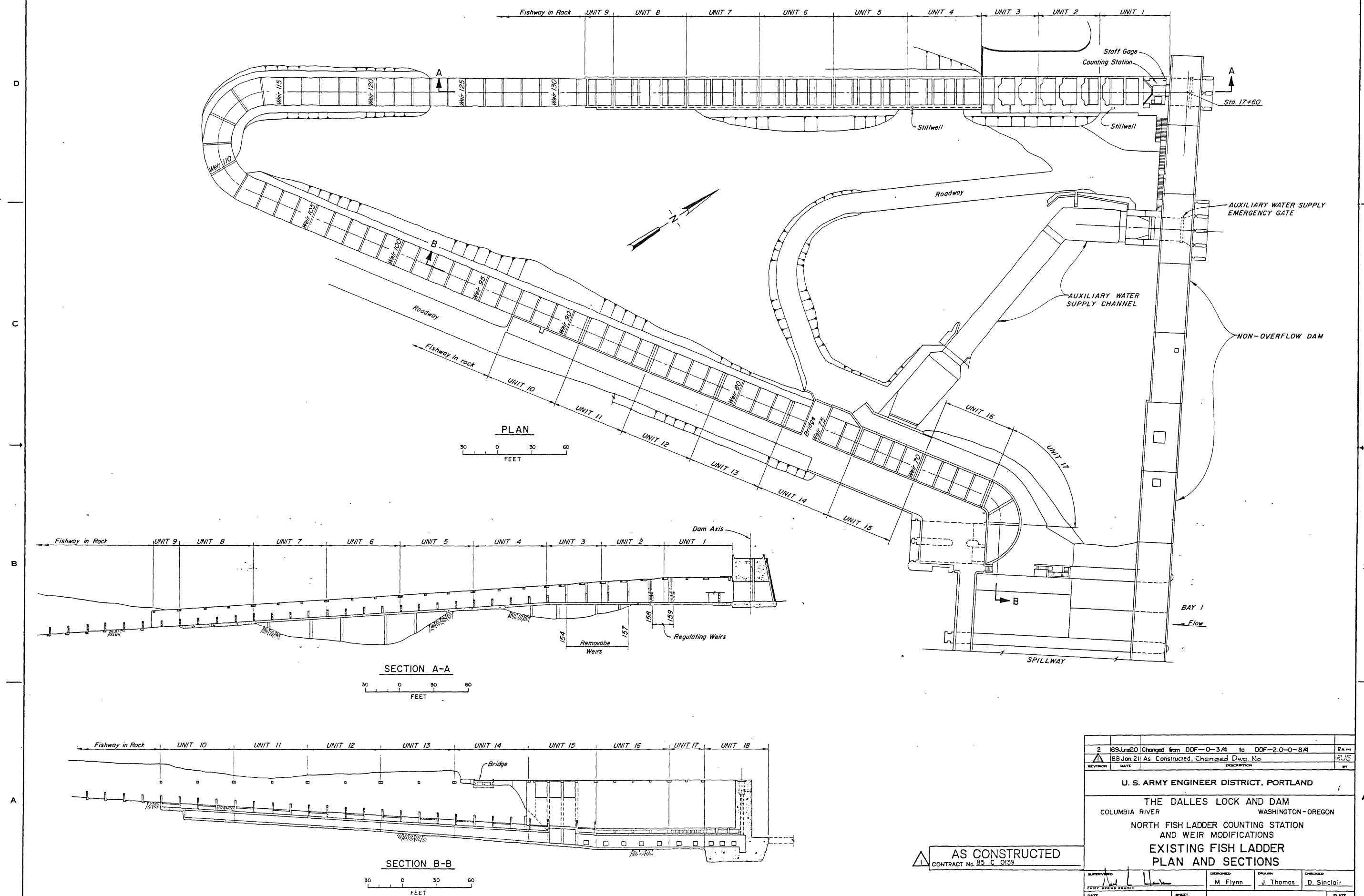
DRAWN BY: *W. L. Ruff* GOLDHILL, CORPS OF ENGINEERS

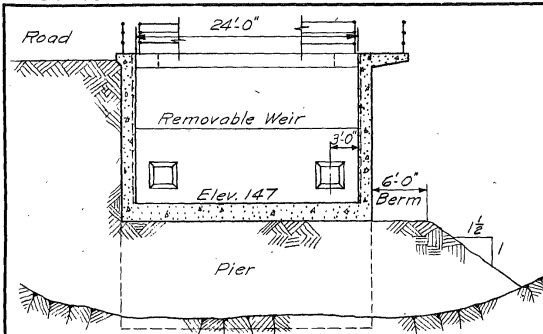
TRACED BY: *W. L. Ruff* DISTRICT ENGINEER

CHECKED BY: *W. L. Ruff*

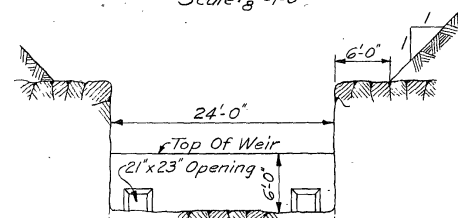
DD-5-31

To accompany 17 March 1954 SUPPLEMENT to Design Memorandum No. 6, Navigation Lock, North Fishway, and Non-Overflow Dam between Lock & Spillway

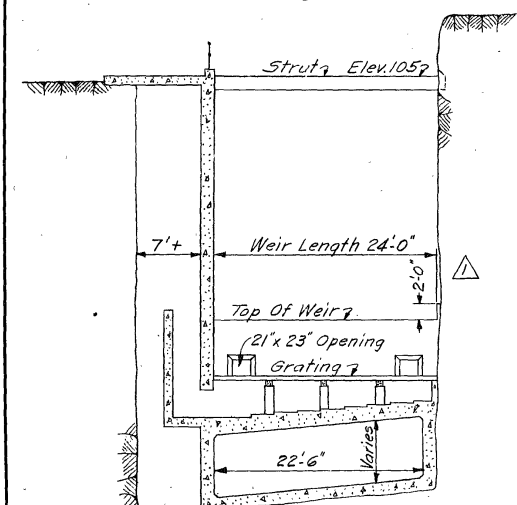




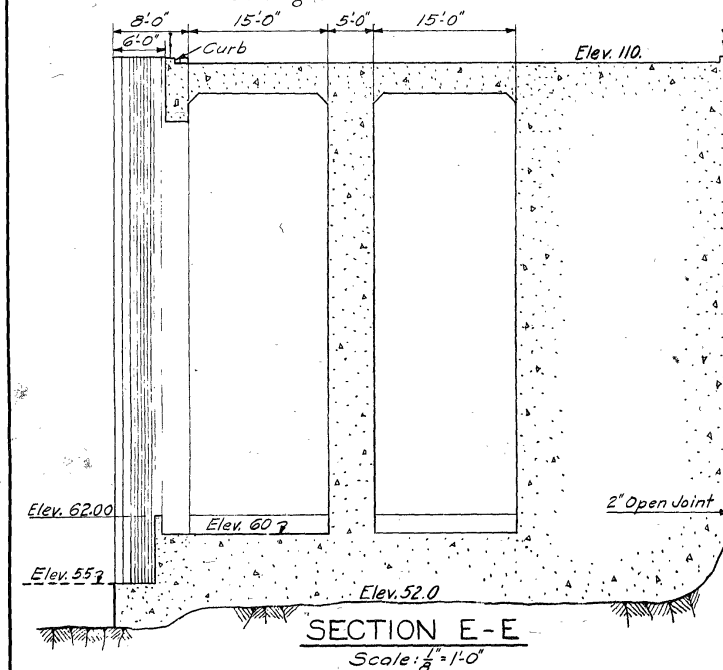
SECTION B-B

Showing Typical Fishway on Piers
Scale: $\frac{1}{8}$ " = 1'-0"

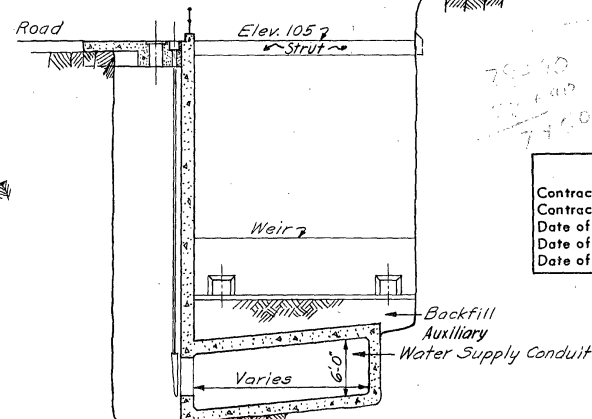
SECTION C-C

Showing Typical Weir in Rock Cut
Scale: $\frac{1}{8}$ " = 1'-0"

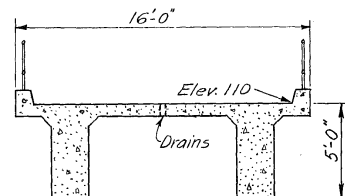
SECTION D-D

Showing Typical Diffusion Chamber
Scale: $\frac{1}{8}$ " = 1'-0"

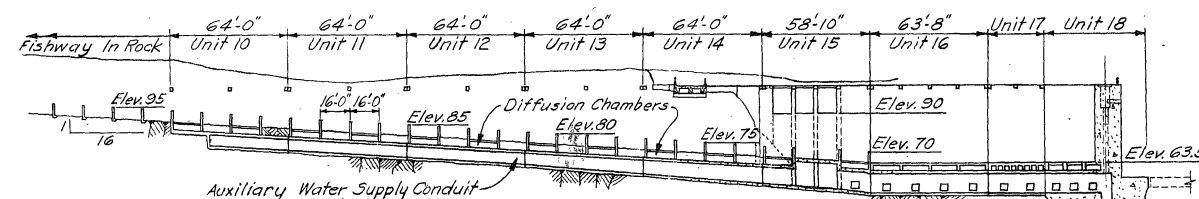
SECTION E-E

Scale: $\frac{1}{8}$ " = 1'-0"

SECTION H-H

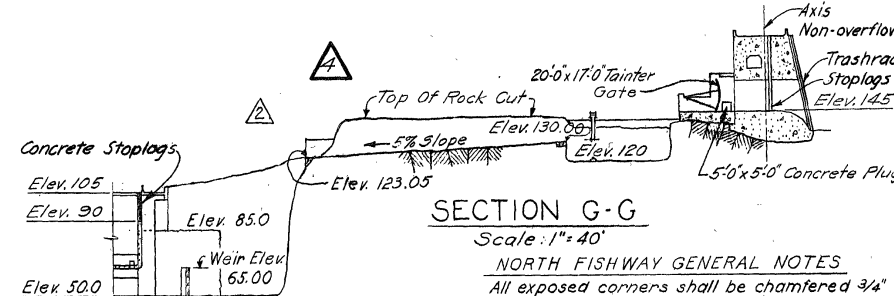
Typical Thru Gate Opening
Scale: $\frac{1}{8}$ " = 1'-0"

SECTION J-J

Showing Typical Section Thru Service Bridge
Scale: $\frac{1}{4}$ " = 1'-0"

SECTION F-F

Scale: 1" = 40'-0"



SECTION G-G

Scale: 1" = 40'-0"

NORTH FISHWAY GENERAL NOTES

All exposed corners shall be chamfered $\frac{3}{4}$ " and all re-entrant angles shall have $1\frac{3}{4}$ " fillets, unless otherwise noted.

Minimum coverage of reinforcing bars shall be 4" where concrete is placed against rock, and 2" elsewhere, unless otherwise shown.

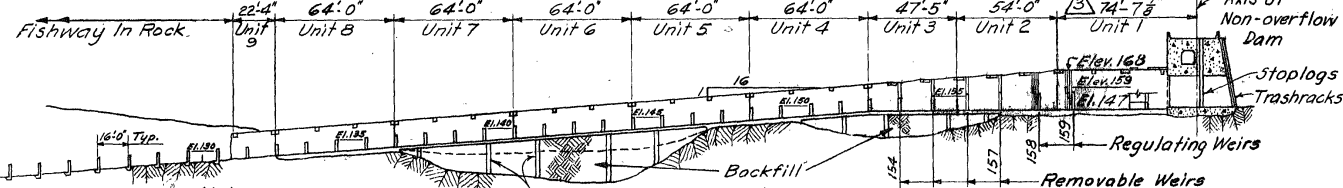
Embedment and lap length of reinforcing bars shall be a Min. of 30 bar diam. unless otherwise shown.

In general, splices in vertical reinforcing steel in the walls of the fishway shall be at every 20 or 30 feet, depending upon the location of horizontal construction joints.

Horizontal reinforcing steel in the walls of the fishway shall, in general, not be spliced more than once between expansion joints.

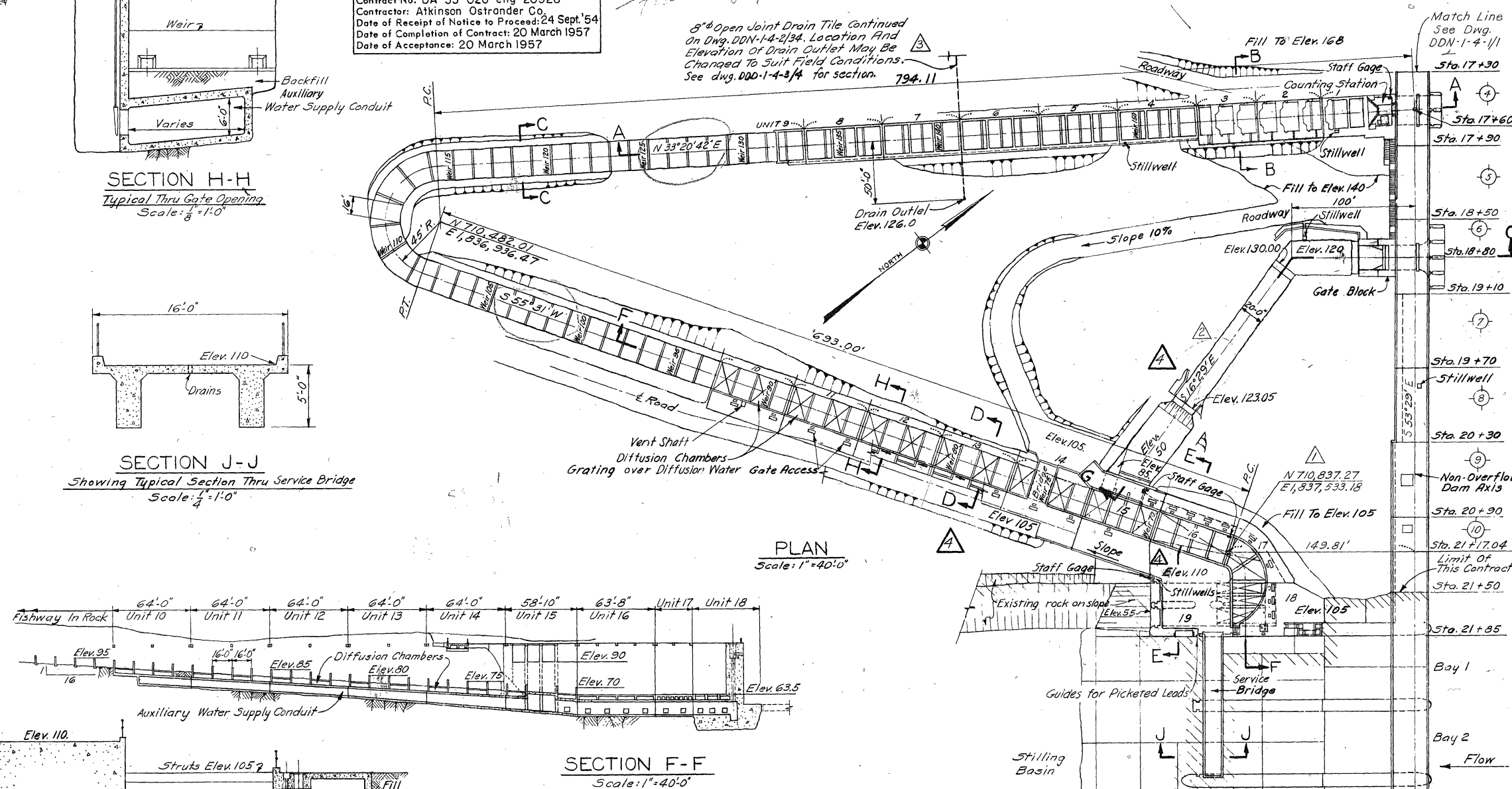
All concrete in North Fishway - (16)
All reinforcing steel - (19)
For reference drawings see DDF-1-4-2/2

AS CONSTRUCTED
Contract No. DA-35-026-eng-20928
Contractor: Atkinson Ostrander Co.
Date of Receipt of Notice to Proceed: 24 Sept. '54
Date of Completion of Contract: 20 March 1957
Date of Acceptance: 20 March 1957



SECTION A-A

Scale: 1" = 40'-0"

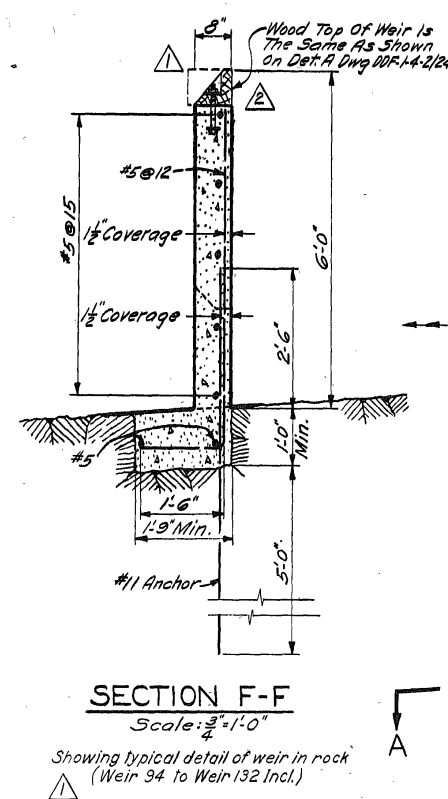
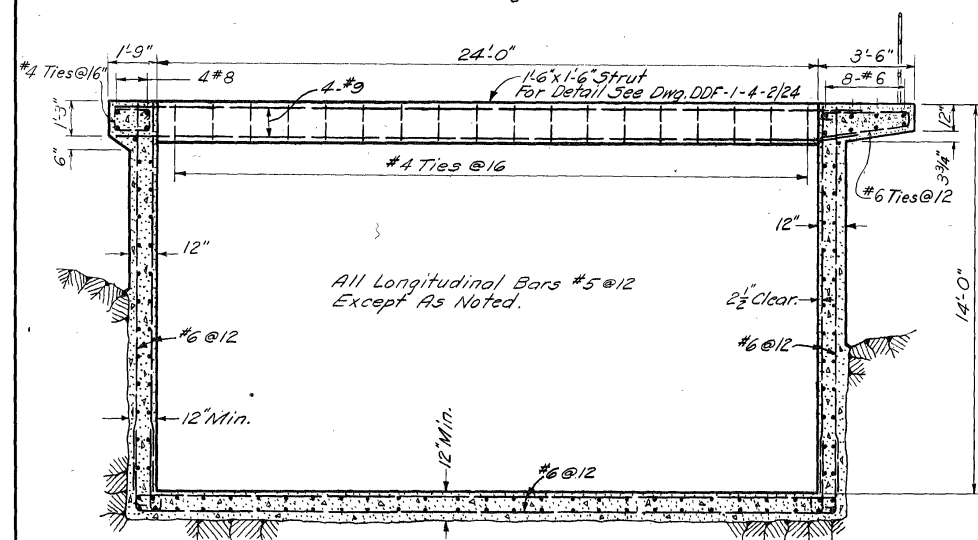
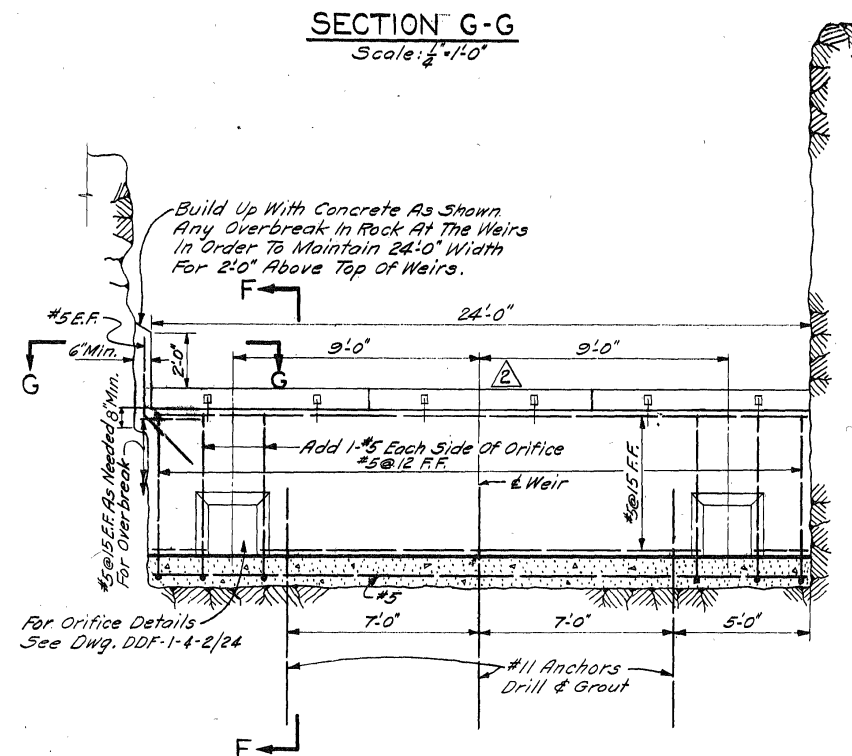
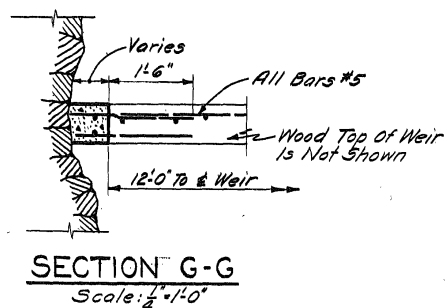


PLAN

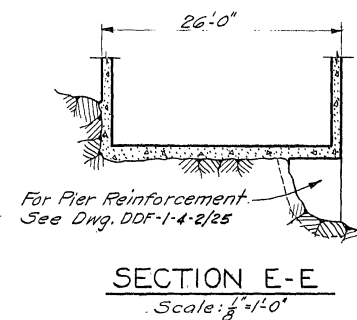
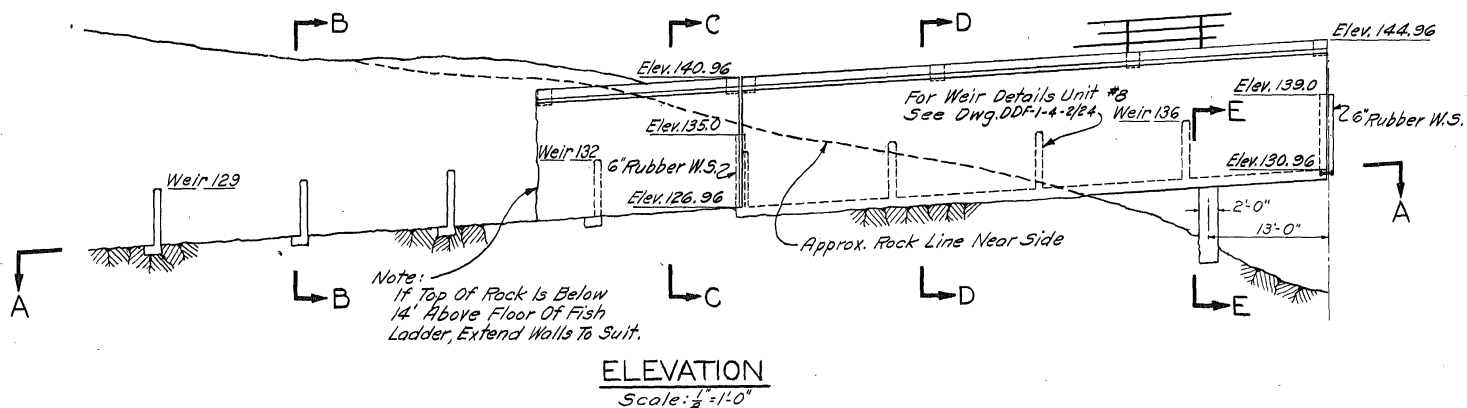
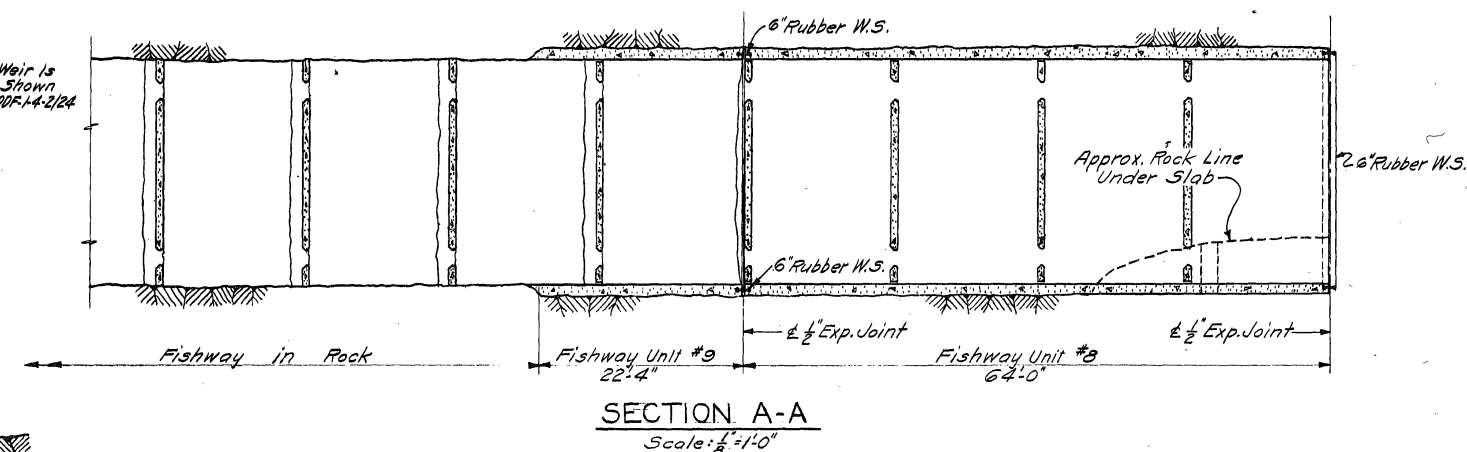
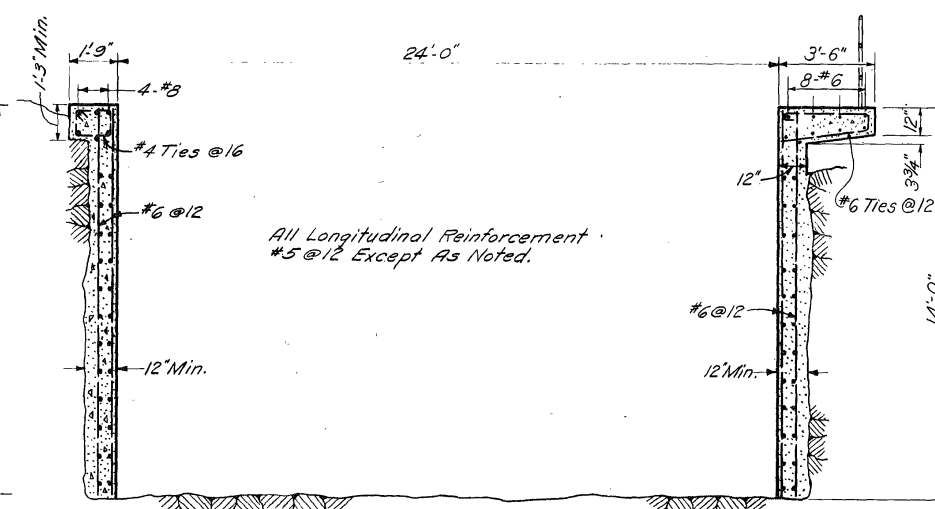
Scale: 1" = 40'-0"

REVISION	DATE	DESCRIPTION	BY
1	9-7-54	Rev. Stillwells Unit 19; Deck Unit 10-15, & Added Ret. Walls. B.L.W.	B.L.W.
2	11-30-54	Corrected Dim. in Sec. A-A, Showed 8" Drain Tile	B.L.W.
3	3-5-54	Removed W.S. Channel Roof	B.L.W.
4	7-16-54	Added Coordinates, note, corr. dimension in Sec. D-D	B.L.W.

CORPS OF ENGINEERS, U. S. ARMY	
OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON	
DESIGNED: N.T.	DRAWN: J.A.J.
CHECKED: N.T.	REVIEWED: (Signature)
SUPERVISOR: (Signature)	
SUBMITTED: (Signature)	
RECOMMENDED: (Signature)	
APPROVED: (Signature)	
DATE: 2-23-58	
SCALE AS SHOWN SPEC. NO.	
SHEET 202 OF DDF-1-4-2/1	



SECTION C-C
Scale: $\frac{3}{8}" = 1'-0"$



Reference Drawings
Unit 1 to 9 Plan & Sections & Notes Dwg. DDF-1-4-2/22

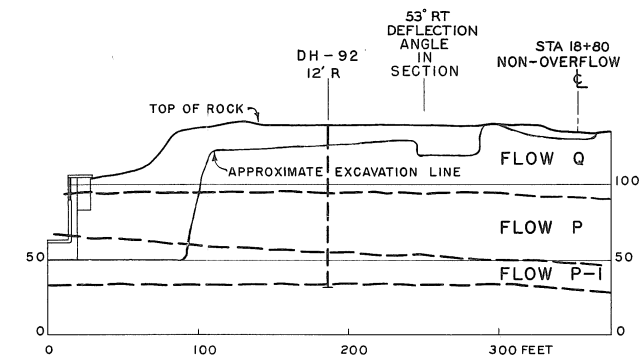
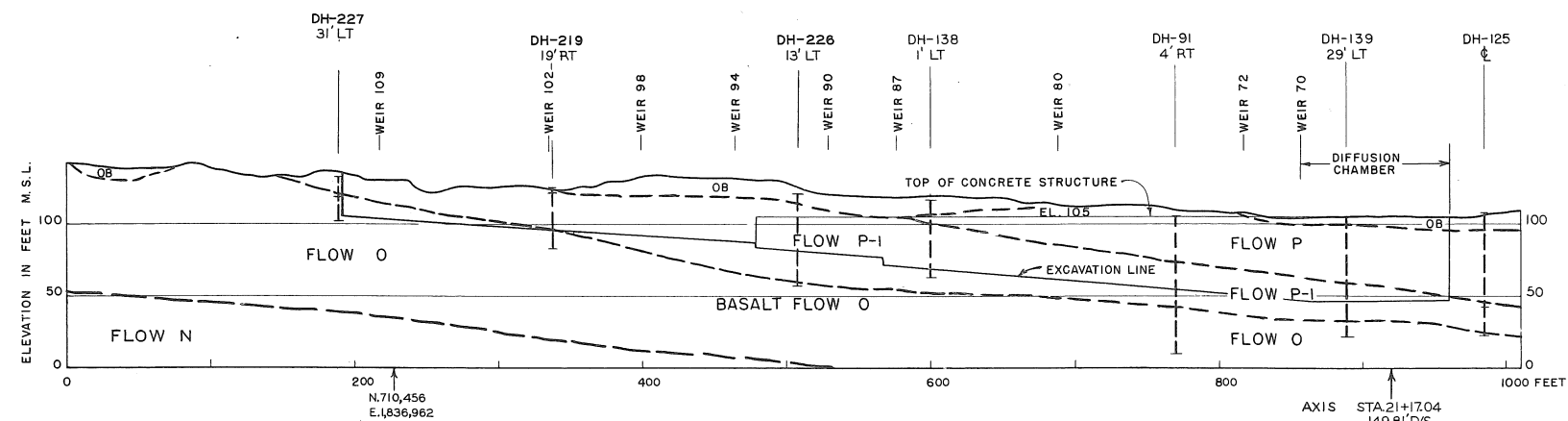
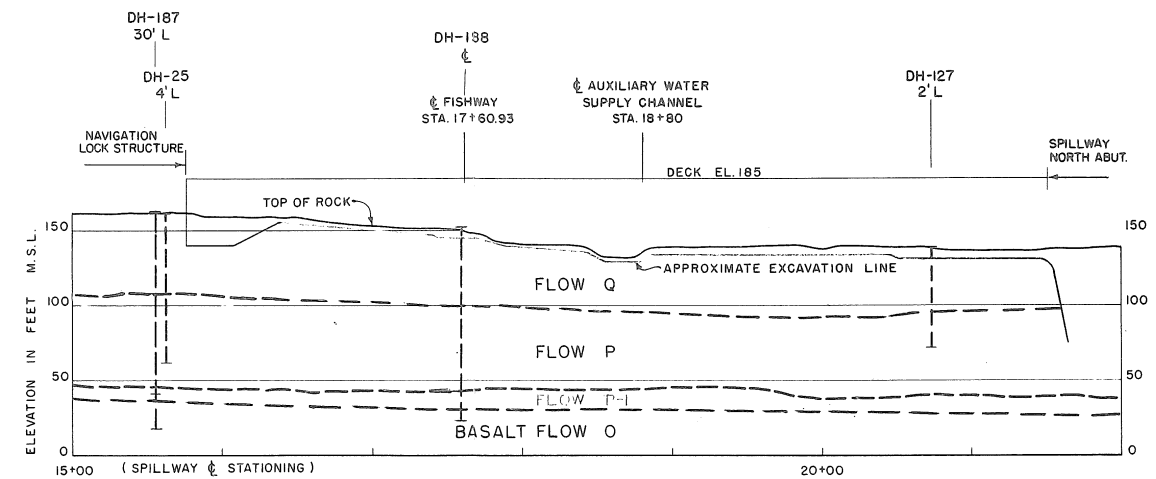
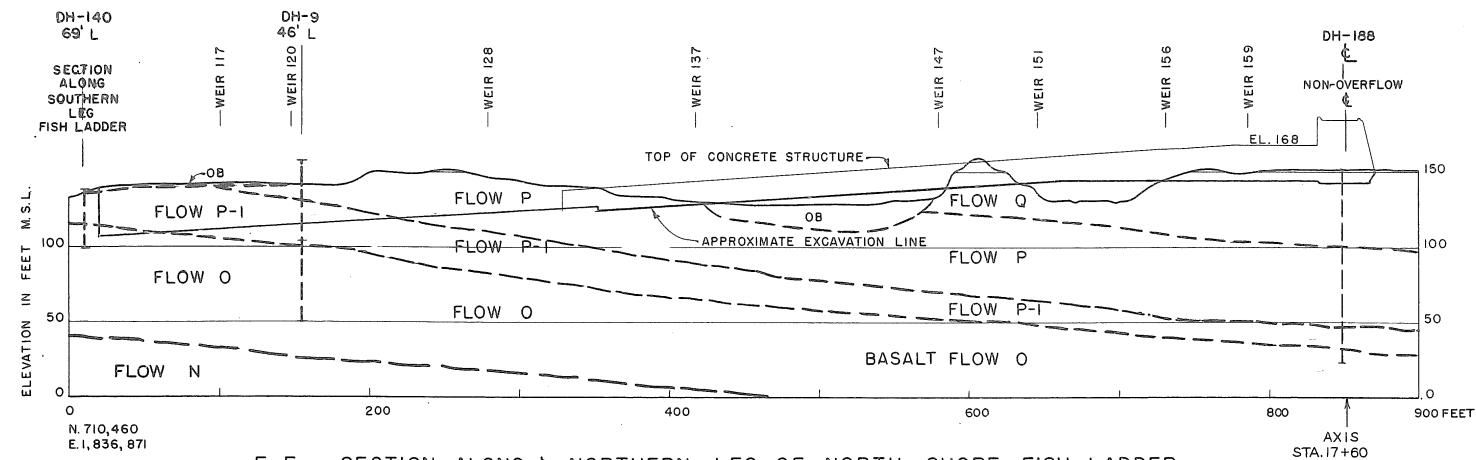
AS CONSTRUCTED
Contract No. DA-35-026-eng-20928
Contractor: Atkinson Ostrander Co.
Date of Receipt of Notice to Proceed: 24 Sept. '54
Date of Completion of Contract: 20 March 1957
Date of Acceptance: 20 March 1957

DESIGNED: F.M.B.	CHECKED: M.T.	REVIEWED: J.A.J.	DATE: 2-15-55
SUBMITTED: J.A.J.			
RECOMMENDED: J.A.J.			
APPROVED: J.A.J.			
DATE: 2-15-55			
SCALE AS SHOWN SPEC. NO.			
SHEET 226 OF DDF-1-4-2/23			

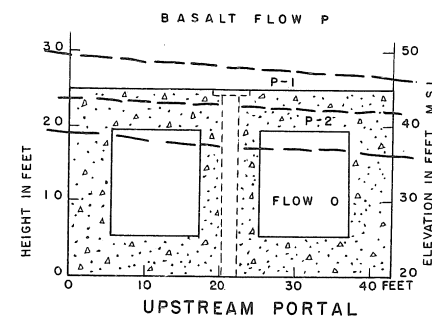
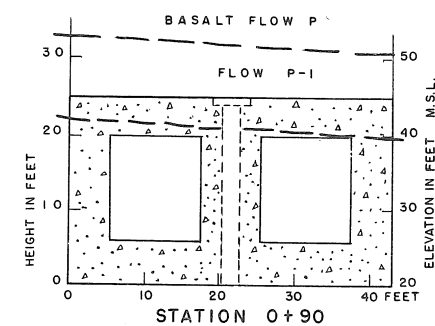
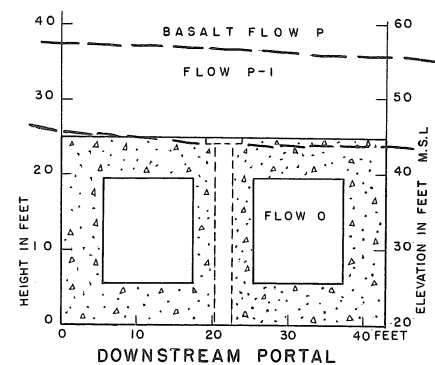
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON

THE DALLES DAM
COLUMBIA RIVER WASHINGTON - OREGON

NORTH FISHWAY
UNITS 8 & 9



NOTE:
IT IS UNDERSTOOD THAT THE INTERPRETATION OF
SUBSURFACE CONDITIONS AS CONTAINED IN THIS
DRAWING IS ONLY A DIAGRAM OF ASSUMED GEOLOGIC
CONDITIONS AND SHOULD NOT BE USED BY THE
CONTRACTOR AS RELIABLE FOR THE BASIS OF ESTIMATES



NAVIGATION LOCK - INTAKE TUNNEL
GEOLOGIC SECTIONS

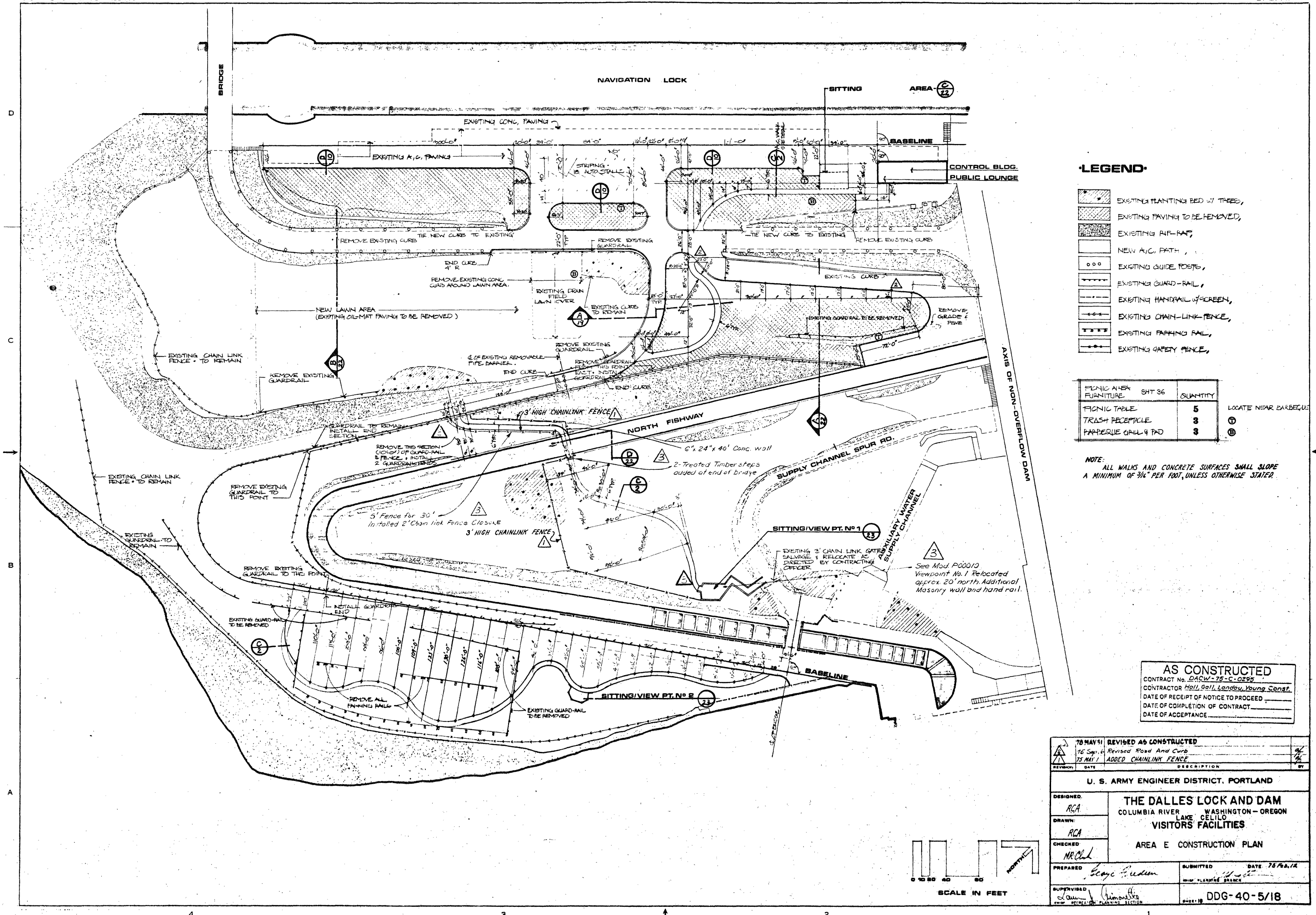
LEGEND

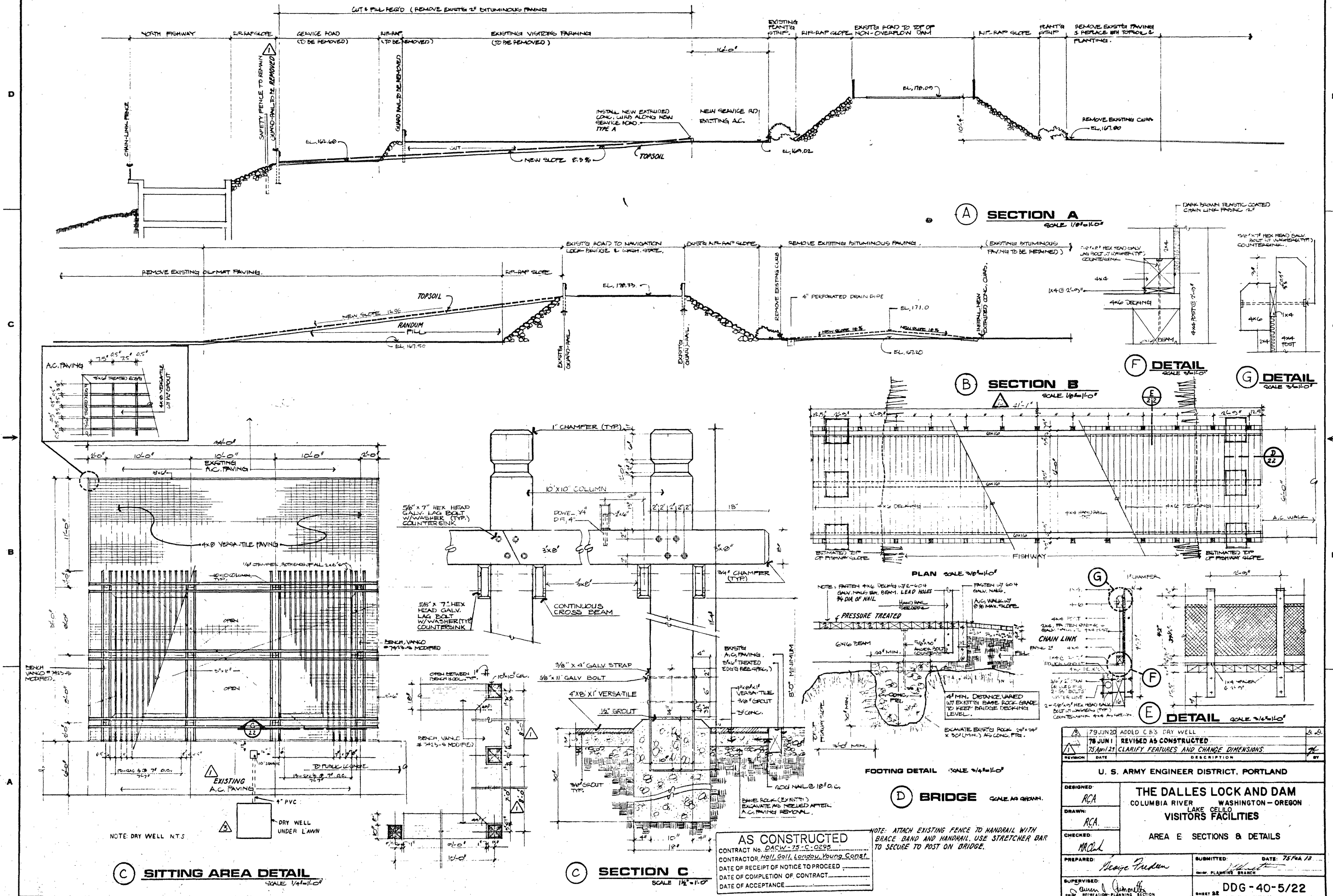
- OB OVERBURDEN, SILT, SAND OR GRAVEL
- DH-25 CORE DRILL HOLE WITH OFFSET SHOWN
- APPROXIMATE CONTACT OF BASALT FLOWS.

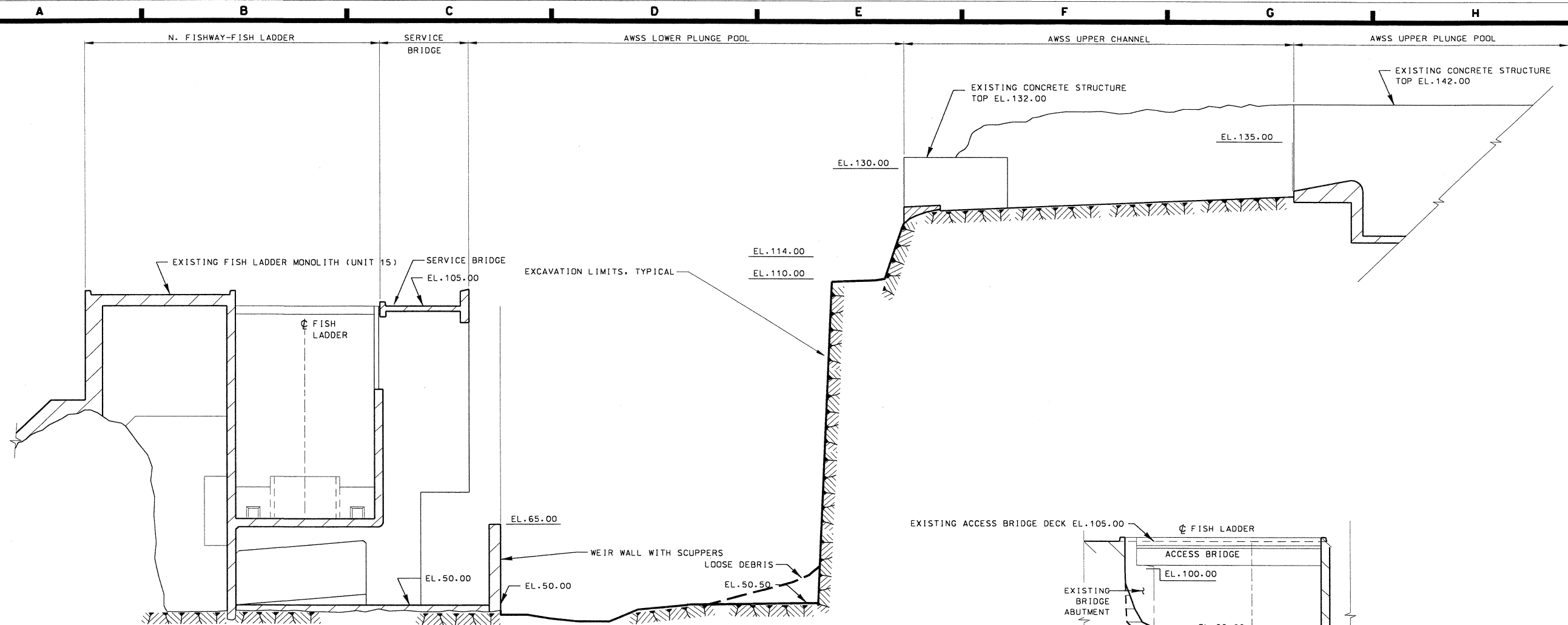
REVISION	DATE	DESCRIPTION	BY
CORPS OF ENGINEERS, U. S. ARMY OFFICE OF THE DISTRICT ENGINEER, PORTLAND, OREGON			
THE DALLES DAM COLUMBIA RIVER, WASHINGTON - OREGON GEOLOGIC INVESTIGATIONS NON-OVERFLOW DAM & FISH LADDER NAVIGATION LOCK TO SPILLWAY GEOLOGIC SECTIONS			
DESIGNED: J.W.A.C.	DATE: 2-25-54		
TRACED: F.E.W.	APPROVED: J.W.A.C.		
CHECKED: D.L.S.	COLONEL, U.S. DISTRICT ENGINEER		
PREPARED:	SCALE AS SHOWN		
REVIEWED: J.W.A.C.	SPEC. NO.		
SUPERVISED: J.W.A.C.	SHEET 322 OF		
CHIEF, SAFETY BRANCH	DDG-1-9-6/7		
CHIEF, GEOLOGY SECTION			
SUBMITTED: Paul Thumbe			
CHIEF, CONSTRUCTION & MATERIALS BRANCH			
RECOMMENDED: J.W.A.C.			
CHIEF, ENGINEERING DIVISION			



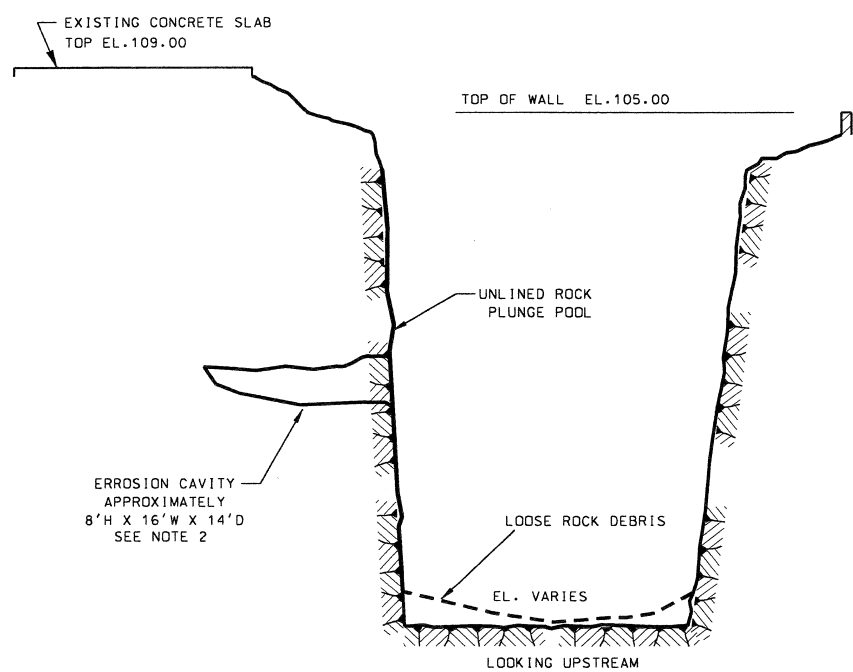




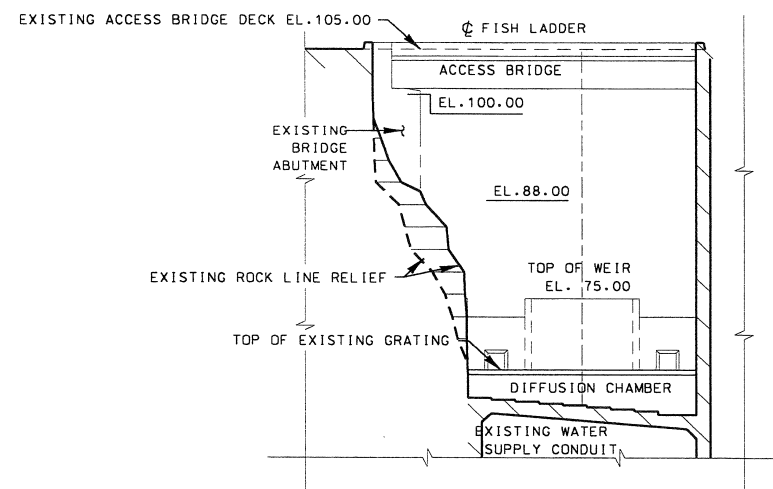




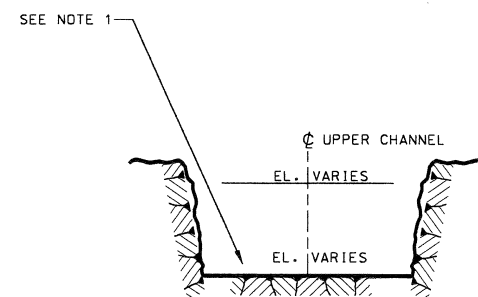
AWSS PROFILE **A**
G4



SECTION **B**
G4



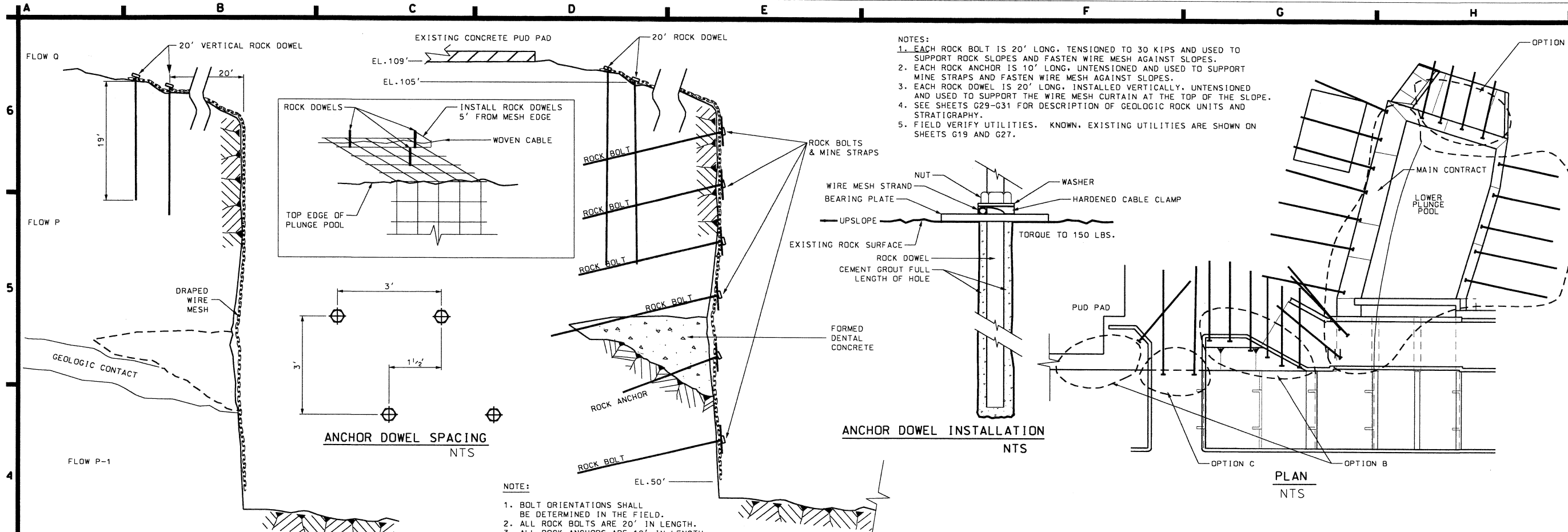
SECTION **D**
G4



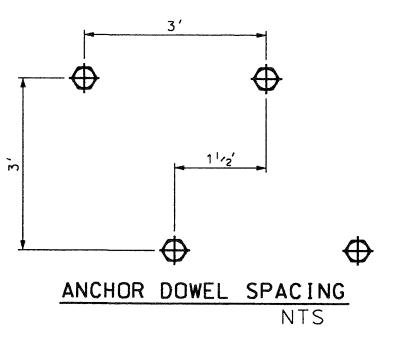
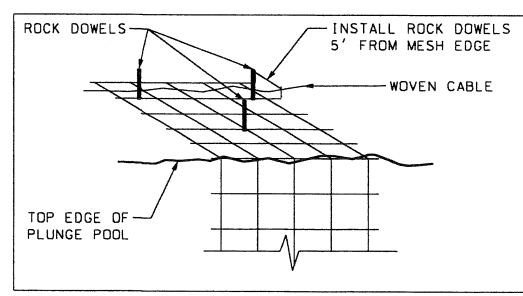
SECTION **C**
G4

- NOTES:
1. CLEAR OUT ALL LOOSE DEBRIS IN UPPER CHANNEL.
 2. SIZE OF EROSION CAVITY IS APPROXIMATE.
 3. EXCAVATION LIMITS SHOWN ARE AS ORIGINAL CONSTRUCTION. MANY EXCAVATION SURFACES HAVE CHANGED DUE TO EROSION.

US Army Corps of Engineers Portland District	
Designed by: T. AMUNDSON Drawn by: D. SWANSON Checked by: T. AMUNDSON Submitted by: RONALD C. MASON, P.E. Ch., Geotechnical Engineering Br.	Date: 30 SEP 98 CADD File Name: DDG005F001F01.dgn Technical Manager: T. AMUNDSON
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON	
COLUMBIA RIVER OREGON - WASHINGTON THE DALES DAM PROJECT NORTH FISHWAY AUXILIARY WATER SUPPLY SYSTEM REPAIR GENERAL SITE PLAN SECTIONS	
DRAWING STATUS: CONTRACT IFB	
DRAWING NO. DDG-0-5/5	
SHEET G5	



- NOTES:
1. EACH ROCK BOLT IS 20' LONG, TENSIONED TO 30 KIPS AND USED TO SUPPORT ROCK SLOPES AND FASTEN WIRE MESH AGAINST SLOPES.
 2. EACH ROCK ANCHOR IS 10' LONG, UNTENSIONED AND USED TO SUPPORT MINE STRAPS AND FASTEN WIRE MESH AGAINST SLOPES.
 3. EACH ROCK DOWEL IS 20' LONG, INSTALLED VERTICALLY, UNTENSIONED AND USED TO SUPPORT THE WIRE MESH CURTAIN AT THE TOP OF THE SLOPE.
 4. SEE SHEETS G29-G31 FOR DESCRIPTION OF GEOLOGIC ROCK UNITS AND STRATIGRAPHY.
 5. FIELD VERIFY UTILITIES. KNOWN, EXISTING UTILITIES ARE SHOWN ON SHEETS G19 AND G27.

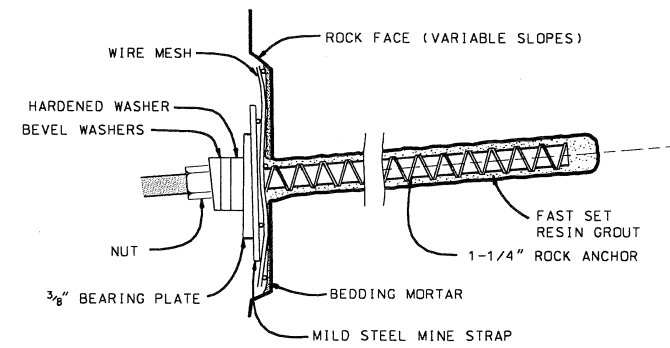


ANCHOR DOWEL SPACING
NTS

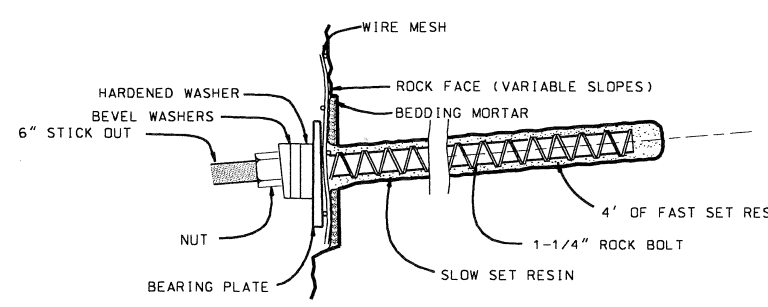
- NOTE:
1. BOLT ORIENTATIONS SHALL BE DETERMINED IN THE FIELD.
 2. ALL ROCK BOLTS ARE 20' IN LENGTH.
 3. ALL ROCK ANCHORS ARE 10' IN LENGTH.

TYPICAL SECTION OF INSTALLED AND ANCHORED MESH
NTS

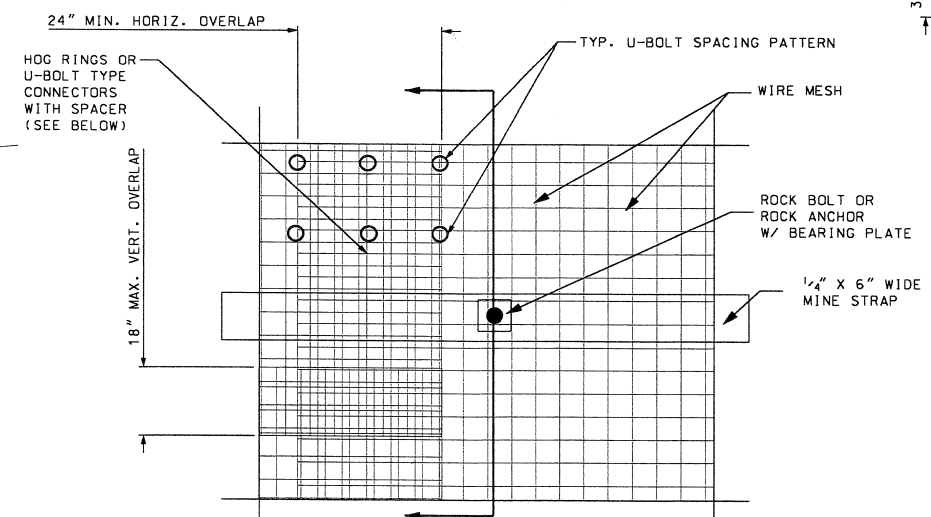
TYPICAL SECTION WIRE MESH INSTALLATION
NTS



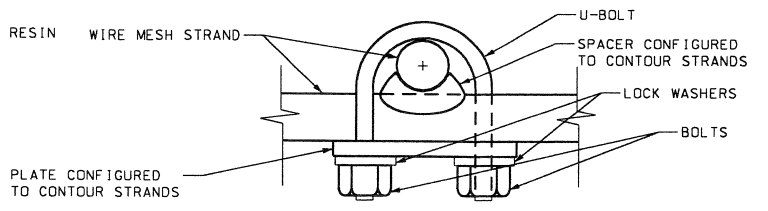
10' ROCK ANCHOR, MINE STRAP & WIRE MESH INSTALLATION DETAIL
NTS



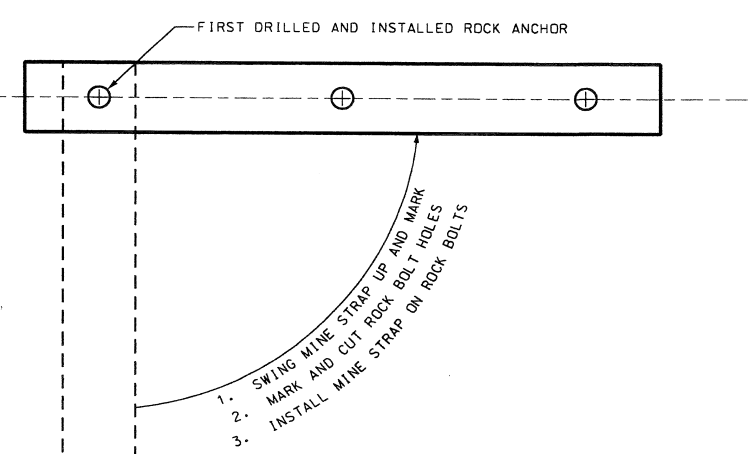
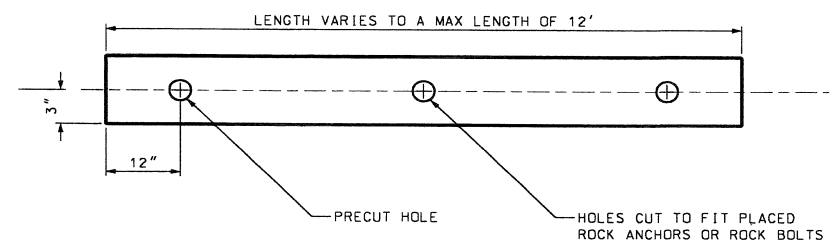
20' ROCK BOLT AND WIRE MESH INSTALLATION DETAIL
NTS



MINE STRAP & WIRE MESH INSTALLATION PLAN VIEW
NTS

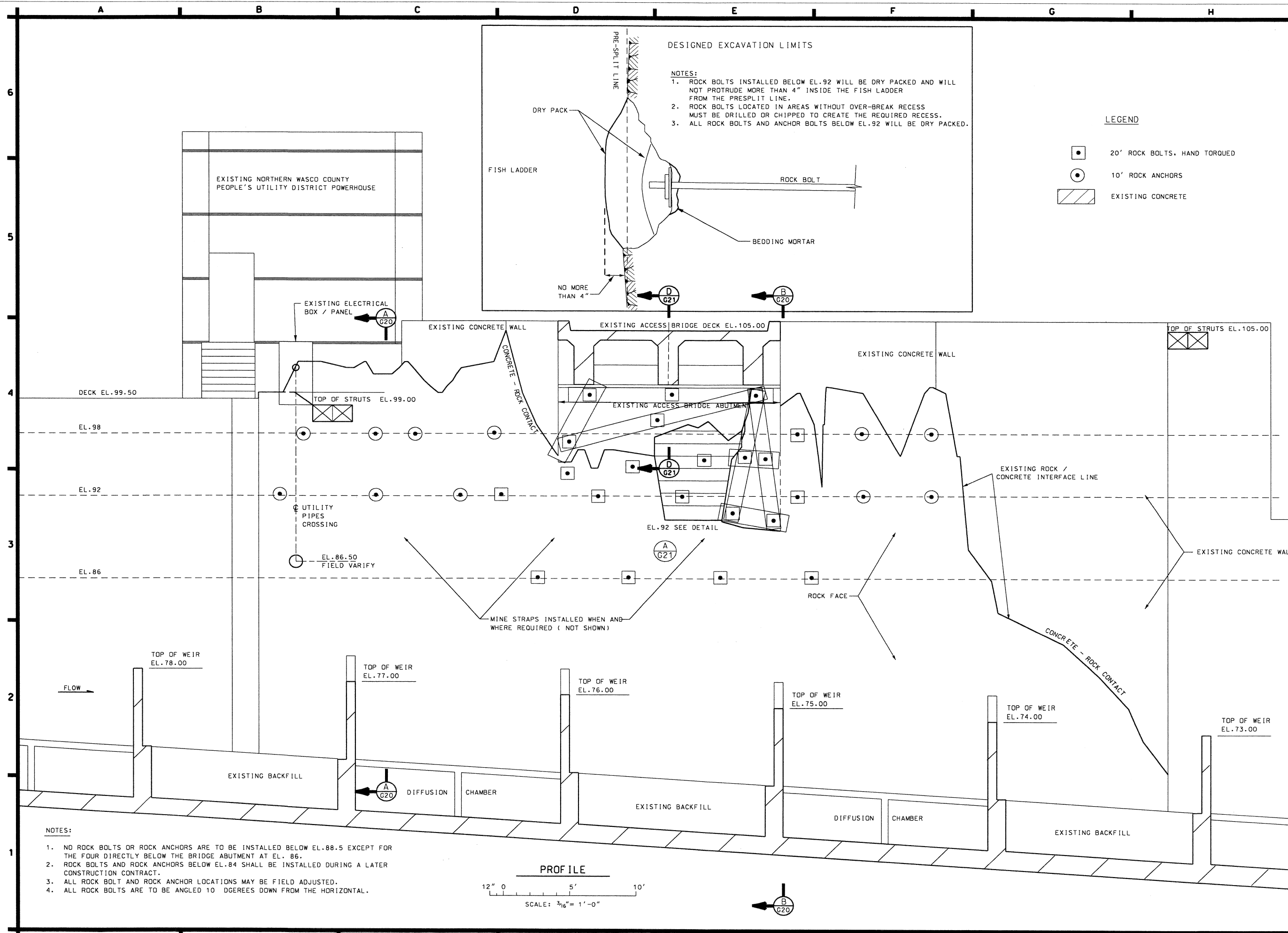


U-BOLT CONNECTOR WITH SPACER DETAIL
NTS



DETAIL OF MINE STRAP INSTALLATION
NTS

Date: 30 SEP 98 Drawn by: T. AMUNDSON Checked by: P. HUEBSCHMAN Submitted by: RONALD C. MASON, P.E. Ch. Geotechnical Engineering Br.	CADD File Name: DDG06F001F01.DGN Technical Manager: T. AMUNDSON
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON	
COLUMBIA RIVER THE DALES LOCK AND DAM NORTH FISH LADDER AWS REPAIR GEOTECHNICAL GENERAL ROCK REINFORCEMENT & SLOPE STABILIZATION DETAILS	
DRAWING STATUS: CONTRACT IFB	
DRAWING NO. DDG-5-1/1	
SHEET 66	



DESIGNED EXCAVATION LIMITS

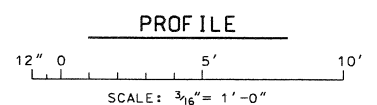
NOTES:

1. ROCK BOLTS INSTALLED BELOW EL.92 WILL BE DRY PACKED AND WILL NOT PROTRUDE MORE THAN 4" INSIDE THE FISH LADDER FROM THE PRESPLIT LINE.
2. ROCK BOLTS LOCATED IN AREAS WITHOUT OVER-BREAK RECESS MUST BE DRILLED OR CHIPPED TO CREATE THE REQUIRED RECESS.
3. ALL ROCK BOLTS AND ANCHOR BOLTS BELOW EL.92 WILL BE DRY PACKED.

LEGEND

- 20' ROCK BOLTS, HAND TORQUED
- 10' ROCK ANCHORS
- EXISTING CONCRETE

- NOTES:
1. NO ROCK BOLTS OR ROCK ANCHORS ARE TO BE INSTALLED BELOW EL.88.5 EXCEPT FOR THE FOUR DIRECTLY BELOW THE BRIDGE ABUTMENT AT EL. 86.
 2. ROCK BOLTS AND ROCK ANCHORS BELOW EL.84 SHALL BE INSTALLED DURING A LATER CONSTRUCTION CONTRACT.
 3. ALL ROCK BOLT AND ROCK ANCHOR LOCATIONS MAY BE FIELD ADJUSTED.
 4. ALL ROCK BOLTS ARE TO BE ANGLED 10 DEGREES DOWN FROM THE HORIZONTAL.



US Army Corps of Engineers
Portland District

Date	Description
30 SEP 98	

Designed by: T. AMUNDSON

Drawn by: G. BERTRAND

Checked by: P. HUEBSCHMAN

Submitted by: T. AMUNDSON

Submitted by: T. AMUNDSON, P. E.
Ch. Geotechnical Engineering Br.

OREGON/WASHINGTON

THE DALLES LOCK AND DAM

NORTH FISH LADDER AWS REPAIR

GEOTECHNICAL FISH LADDER LEFT WALL

ROCK BOLT PATTERNS & DETAILS - OPTION B

DRAWING STATUS:

CONTRACT

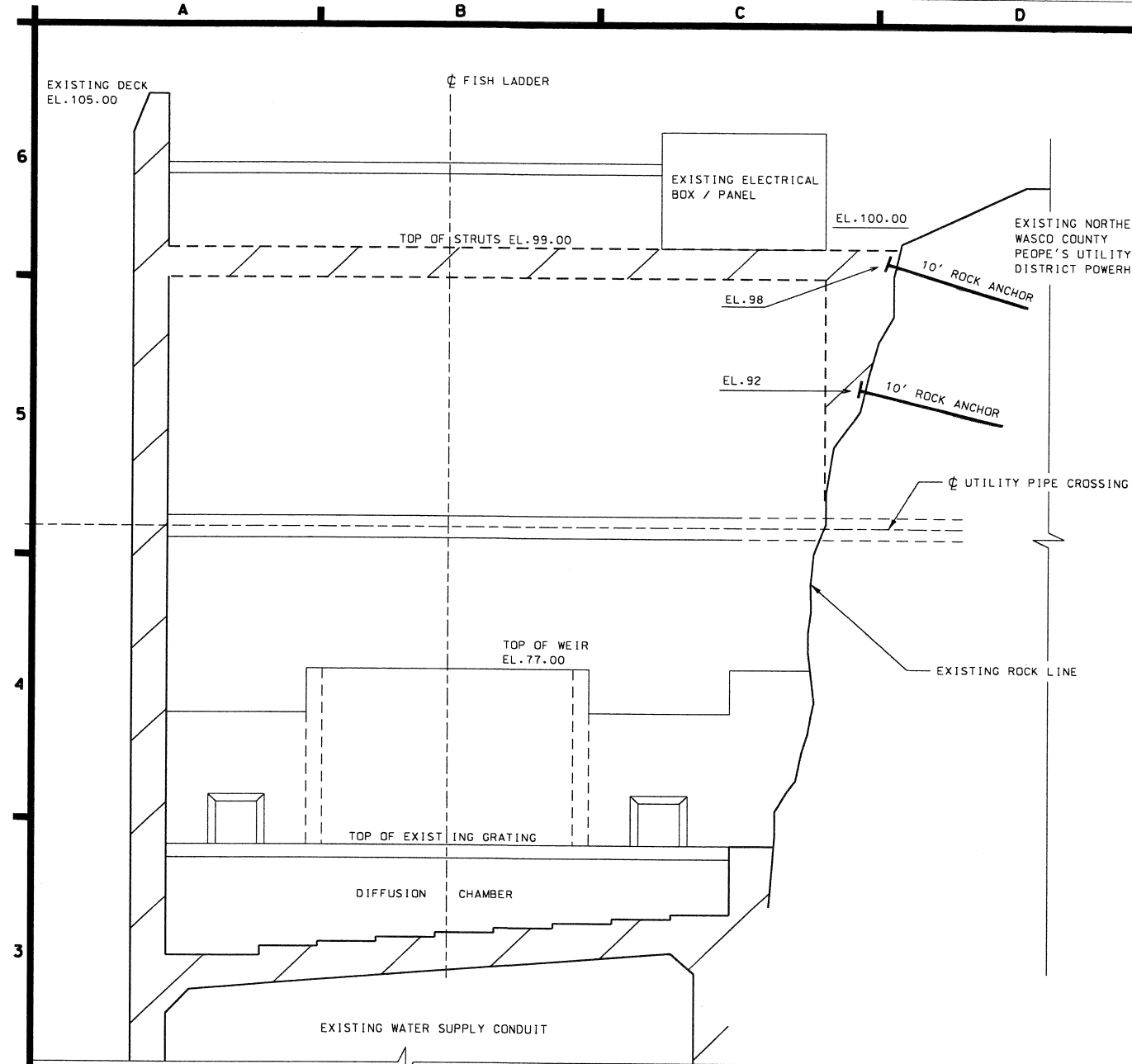
IFB

DRAWING NO.

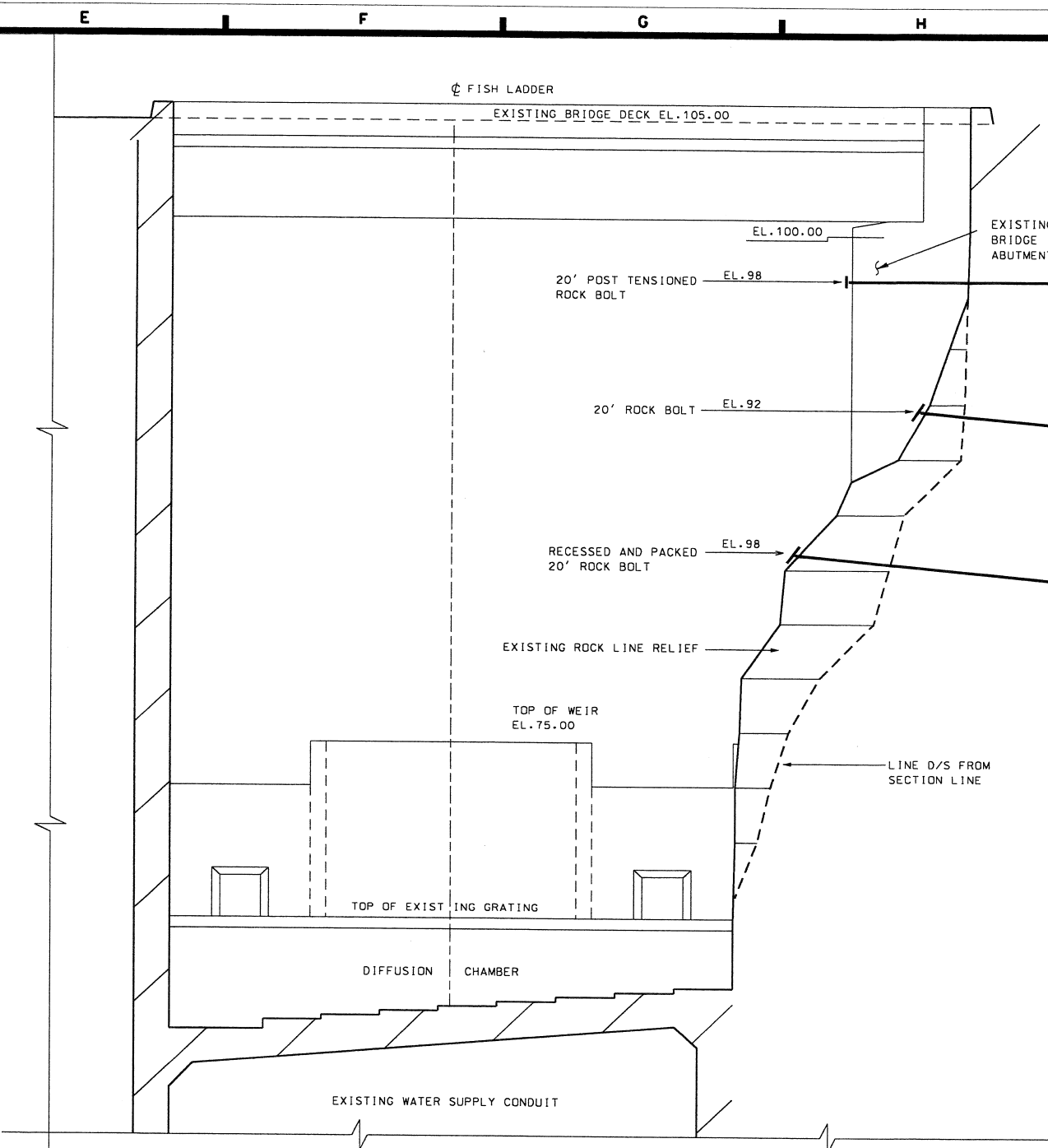
DDG-5-1/14

SHEET

G19



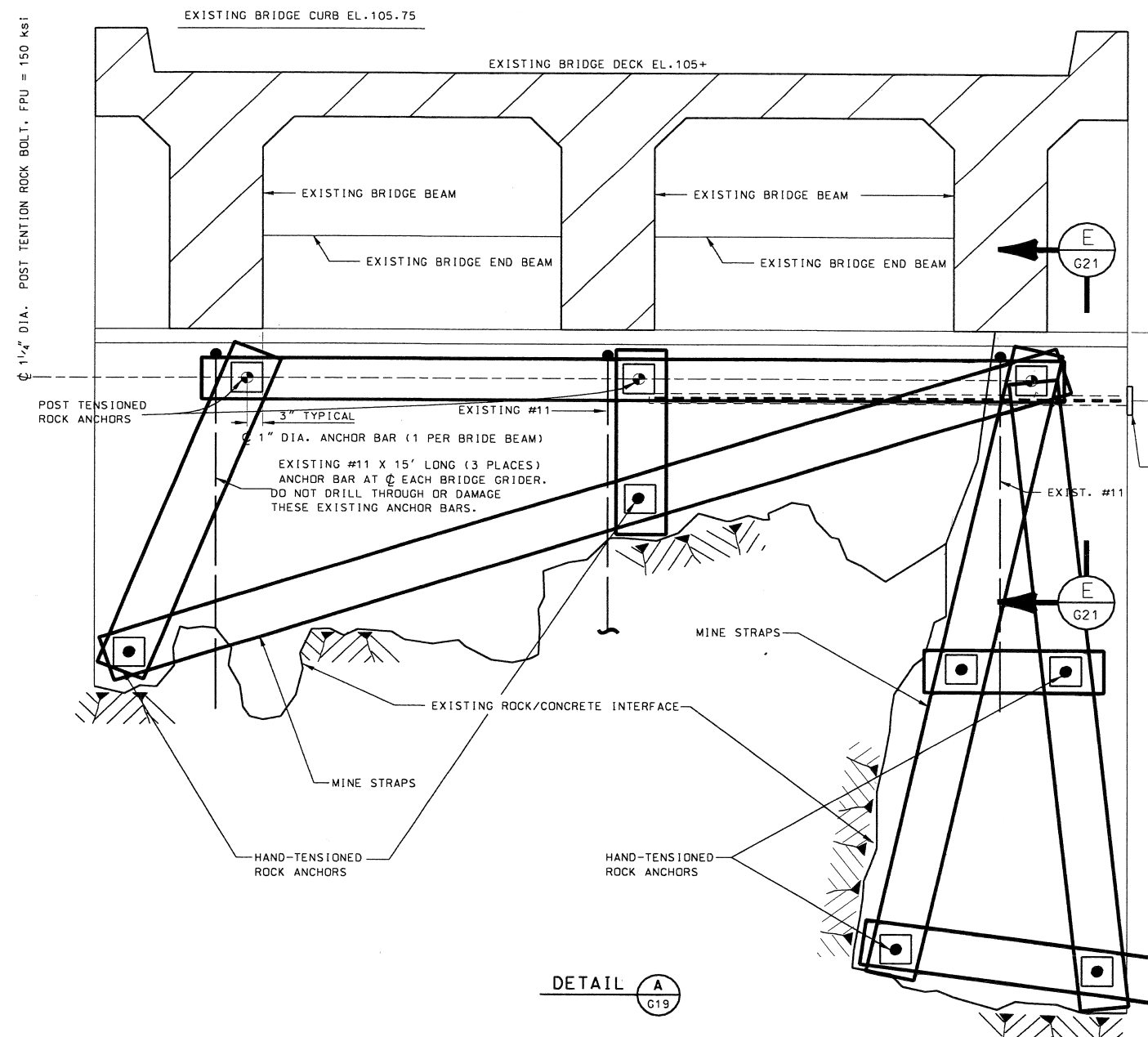
A
G19
SECTION A AT EXISTING UTILITY PIPES CROSSING
 12" 0 5' 10'
 SCALE: 3/16" = 1'-0"



B
G19
SECTION B AT EXISTING BRIDGE
 12" 0 5' 10'
 SCALE: 3/16" = 1'-0"

 US Army Corps of Engineers Portland District	
Designed by: T. AMUNDSON Drawn by: G. BERTRAND Checked by: P. RUEBSCHMAN Submitted by: RONALD C. MASON, P.E. Ch.: Geotechnical Engineering Br.	Date: 30 SEP 98 CADD File Name: ddg020f001f01.dgn Technical Manager: T. AMUNDSON
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON	
OREGON/WASHINGTON THE DALLES LOCK AND DAM NORTH FISH LADDER AWSS REPAIR FISH LADDER / ACCESS BRIDGE GEOTECHNICAL LEFT WALL OF FISH LADDER OPTION B	
DRAWING STATUS: CONTRACT IFB	
DRAWING NO. DDG-5-1/15 SHEET G20	

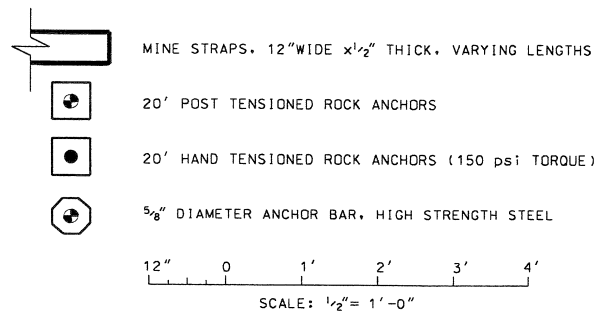
By	
Date	
Revision	
Designation	
Submitted by:	RONALD C. JASON, P.E. Ch., Geotechnical Engineering Br.
Checked by:	P. HUEBSCHMAN Technical Manager
Drawn by:	G. BERTRAND CADD File Name: ddg021f001f01.dgn
Designed by:	T. AMUNDSON Date: 30 SEP 98
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON	
ACCESS BRIDGE ABUTMENT PLAN AND ELEVATIONS - OPTION C	
DRAWING STATUS: CONTRACT IFB	
DRAWING NO. DDG-5-1/16	
SHEET G21	



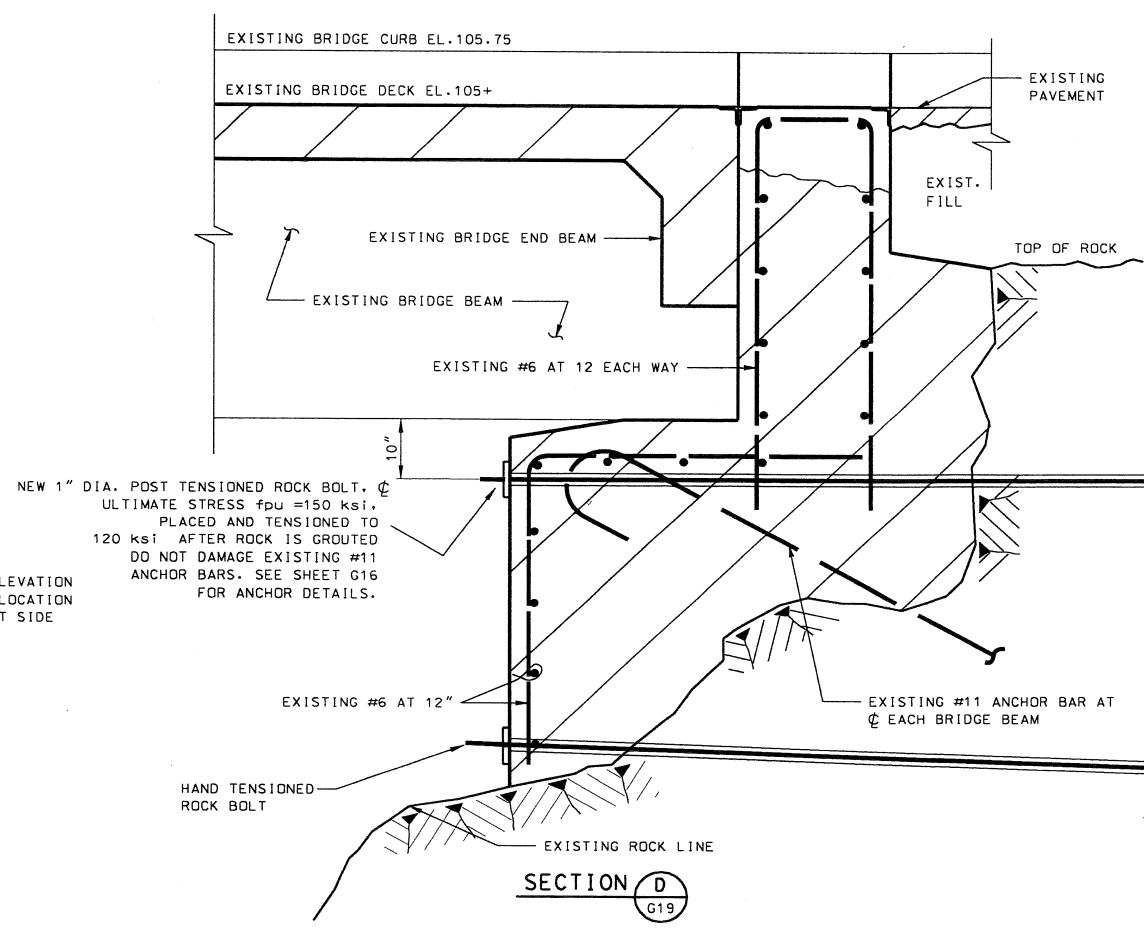
DETAIL A
G19

NOTES:

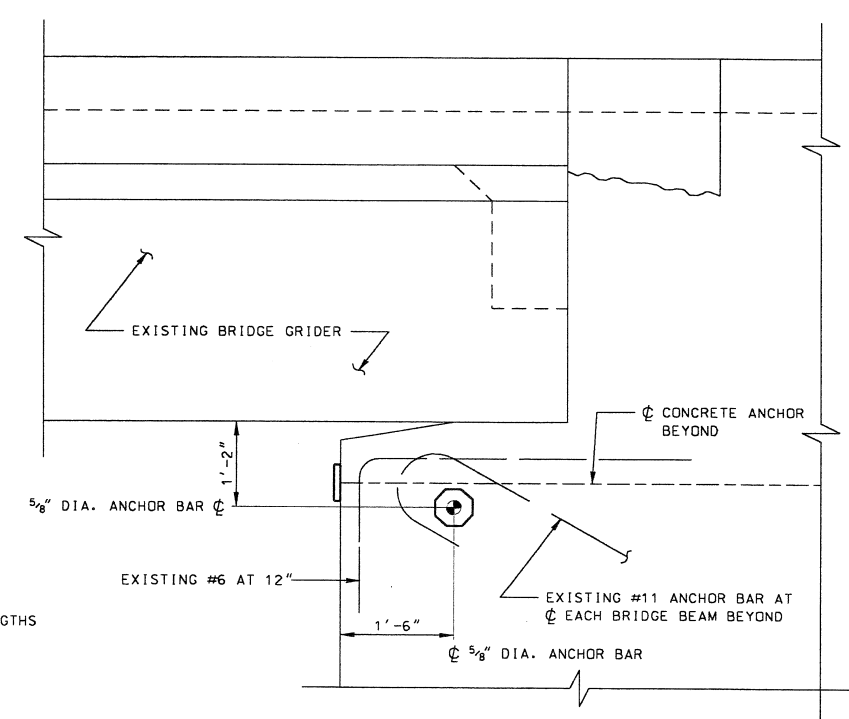
1. MINE STRAPS ARE ASTM 36 MILD STEEL.
2. 1 1/4" DIAMETER ROCK BOLTS ARE HIGH STRENGTH STEEL ASTM 615, GRADE 150.
3. 5/8" DIAMETER ROCK BOLTS ARE HIGH STRENGTH STEEL ASTM 615, GRADE 150.
4. ROCK BOLTS ARE UNTENSIONED, SEE SHEET G16 DETAIL FOR POST TENSIONED ANCHORS. TIGHTEN BOLT NUTS TO ONLY 150 PSI.
5. 5/8" DIAMETER ROCK BOLT REQUIRES A 12" X 12" X 1/2" BEARING PLATE ASTM 36 GRADE 150.



SCALE: 1/2" = 1'-0"



SECTION D
G19



EAST ELEVATION E
G21

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX C Cost Appendix



**US Army Corps
of Engineers®**
Portland District

The Dalles N. Fish Ladder Rock Stabilization DDR

Appendix C

Cost Engineering Package

August, 2015

Table of Contents

Narrative

Total Project Cost Summary (TPCS)

Construction Schedule

Risk Analysis

Narrative

TD N. Fish Ladder Rock Stabilization

Cost Estimate

Basis of Estimate

The basis for the estimate is given in the 100% DDR.

Estimate References

ER 1110-2-1302 (Civil Works Cost Engineering)

EP 1110-1-8 (Construction Equipment Ownership and Operating Expense Schedule)

ETL 1110-2-573 (Construction Cost Estimating Guide for Civil Works)

Project Location

The Dalles Dam, The Dalles, OR.

Overtime

It is anticipated that the contractor, will work five days per week, 10 hours per shift, one shift per day.

Construction Windows

Construction is scheduled to take place during the in-water work window of FY18 between 1 December 2017 and 28 February 2018.

Acquisition Strategy

The cost estimate assumes competitive pricing will be obtained by a single phase request for proposals with a best value source selection. Competition will be restricted to small business.

Subcontracting Plan

No subcontractors were assumed for this estimate.

General Estimating Information

Computation of Quantities. Quantities were provided by the design team and calculated by the cost engineer.

Equipment/Labor Availability. Equipment of the appropriate size would likely be available from the Portland, OR area.

Effective Dates for Labor, Equipment, Material Pricing. The effective date for all pricing is August 2015.

Equipment Rates. Equipment rates were obtained from the 2014 MII equipment region 8 database, which is derived from the equipment methodology in EP 1110-1-8.

Labor Rates. Labor rates were updated using recent Davis-Bacon rates for Klickitat County. Payroll tax and insurance rates were computed within MII. An overtime percentage was applied assuming the contractor will work five 10-hour days per week.

Overhead, Profit and Bond. Prime Contractor home office overhead was calculated based on similar HOOH rates for small contractors at 15% and job office overhead was calculated based on previous small business contracts at 10%. Profit was assumed at 8%. Bond was determined using the Class B rating in MII.

Functional Costs. Functional costs (i.e., Lands and Damages, Planning, Engineering and Design, and Construction Management) were not included as part of the construction cost but are included in the Total Project Cost Summary.

Contingencies. No contingencies were added to the MII estimate but were calculated on the Total Project Cost Summary.

Specific Estimating Details

Scaling and Rock Drilling. A crane was used in the estimate based on the location of the work being difficult to reach with any other equipment. Assumed this work would take place from a crane's man basket. Production rates were adjusted accordingly.

Production Rates. Scaling was assumed that 1 man could scale 1 CY/HR. Rock drilling assumed 3FT/HR.

Dewatering. Was not calculated in this estimate, it is assume the Project staff will have the ladder ready for the contractor in early December.

****** TOTAL PROJECT COST SUMMARY ******

Printed:9/8/2015
Page 1 of 1

PROJECT: TD N. Fish Ladder Rock Stabilization
PROJECT N 0
LOCATION: The Dalles Dam, The Dalles, OR

DISTRICT: NWP Portland District PREPARED: 9/8/2015
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

This Estimate reflects the scope and schedule in report; TD N. Fish Ladder Rock Stabilization 100% DDR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)					TOTAL PROJECT COST (FULLY FUNDED)					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST (\$K) C	CNTG (\$K) D	CNTG (%) E	TOTAL (\$K) F	ESC (%) G	COST (\$K) H	CNTG (\$K) I	TOTAL (\$K) J	Program Year (Budget EC): Effective Price Level Date:		TOTAL FIRST COST (\$K) K	INFLATED (%) L	COST (\$K) M	CNTG (\$K) N	FULL (\$K) O
										2016 1 OCT 15	Spent Thru: 8/26/2015 (\$K)					
06	FISH & WILDLIFE FACILITIES	\$572	\$154	26.9%	\$726	1.9%	\$583	\$157	\$740		\$100	\$840	4.5%	\$609	\$164	\$873
04		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
05		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
06		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
07		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
08		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
09		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
10		\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
CONSTRUCTION ESTIMATE TOTALS:		\$572	\$154		\$726	1.9%	\$583	\$157	\$740		\$100	\$840	4.5%	\$609	\$164	\$873
01	LANDS AND DAMAGES	\$0	\$0 -		\$0	-	\$0	\$0	\$0		\$0	\$0	-	\$0	\$0	\$0
30	PLANNING, ENGINEERING & DESIGN	\$129	\$10	7.8%	\$139	3.4%	\$133	\$10	\$144		\$0	\$144	5.0%	\$140	\$11	\$151
31	CONSTRUCTION MANAGEMENT	\$82	\$7	8.8%	\$89	3.4%	\$85	\$7	\$92		\$0	\$92	9.0%	\$92	\$8	\$101
PROJECT COST TOTALS:		\$783	\$171	21.9%	\$954		\$801	\$175	\$976		\$100	\$1,076	5.0%	\$842	\$183	\$1,125

CHIEF, COST ENGINEERING, Eileen Horiuchi

PROJECT MANAGER, Jeff Ament

CHIEF, REAL ESTATE, Enrique God

CHIEF, PLANNING, Laura Hicks

CHIEF, ENGINEERING, Lance Helwig

CHIEF, OPERATIONS, Dan Watsek

CHIEF, CONSTRUCTION, Karen Garmire

CHIEF, CONTRACTING, Tracy Wickham

CHIEF, PM-PB, Don Erickson

CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST: **100 % \$1,125**
ESTIMATED NON-FEDERAL COST: **0 % \$0**

ESTIMATED TOTAL PROJECT COST: \$1,125



The Dalles North Fish Ladder Rock Wall Stabilization

Thu 9/3/15

ID	Task Name	Duration	Start	Finish	Predecessors	November	December	January	February	March
1	TD N Fish ladder Rock Stabilization	72 days	Mon 11/20/17	Tue 2/27/18						
2	Contracting	8 days	Mon 11/20/17	Wed 11/29/17						
3	Award Contract	1 day	Mon 11/20/17	Mon 11/20/17						
4	NTP	7 days	Tue 11/21/17	Wed 11/29/17	3					
5	Construction	64 days	Thu 11/30/17	Tue 2/27/18	4					
6	Mobilization	5 days	Thu 11/30/17	Wed 12/6/17	4					
7	Site Prep	2 days	Thu 12/7/17	Fri 12/8/17	6					
8	Scaling	15 days	Mon 12/11/17	Fri 12/29/17	7					
9	Rock Removal	15 days	Wed 12/13/17	Tue 1/2/18	8SS+2 days					
10	Anchor Drilling	25 days	Wed 1/3/18	Tue 2/6/18	9					
11	Shotcrete	5 days	Wed 2/7/18	Tue 2/13/18	10					
12	Clean up	5 days	Wed 2/14/18	Tue 2/20/18	11					
13	Demob	5 days	Wed 2/21/18	Tue 2/27/18	12					

Project: TD N Fish Ladder Rock Stabilization.mpp
Date: Thu 9/3/15

Task		Project Summary	
Split		External Tasks	
Progress		External MileTask	
Milestone		Split	
Summary			

Abbreviated Risk Analysis

TD North Fish Ladder Rock Wall Stabilization

PED 90%

Meeting Date: 8-Sep-15

PDT Members

Note: PDT involvement is commensurate with project size and involvement.

Represents	Name
Project Management:	Jeff Ament
Planner:	NAME
Study Manager:	NAME
Contracting:	NAME
Real Estate:	NAME
Relocations:	NAME
OTHER:	NAME
Engineering & Design:	NAME
Technical Lead:	Chris Humphrey
Geotech:	Chris Humphrey
H&H	Karen Kuhn
Civil:	Jeremy Totten
Structural:	Mehdi Roshoni
Mechanical:	NAME
Electrical:	NAME
Cost Engineering:	Steve Straw
Construction:	Steve Straw
Operations:	Robert Cordie
Environmental:	Patricia Clinton
VE	NAME
DOT & PF Sponsor	NAME
DOT & PF Sponsor	NAME
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME
	NAME

Abbreviated Risk Analysis

Project (less than \$40M): **TD North Fish Ladder Rock Wall Stabilization**
 Project Development Stage/Alternative: **PED 90%**
 Risk Category: **Low Risk: Typical Construction, Simple**

Alternative: **Alt 1**

Meeting Date: **9/8/2015**

Total Estimated Construction Contract Cost = \$ **572,145**

	CWWBS	Feature of Work	Contract Cost	% Contingency	\$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	\$ -	0.00%	\$ -	\$ -
1	06 FISH AND WILDLIFE FACILITIES	Rock Scaling	\$ 160,218	38.21%	\$ 61,225	\$ 221,443
2	06 FISH AND WILDLIFE FACILITIES	Anchoring	\$ 314,409	22.89%	\$ 71,966	\$ 386,375
3				0.00%	\$ -	\$ -
4			\$ -	0.00%	\$ -	\$ -
5			\$ -	0.00%	\$ -	\$ -
6			\$ -	0.00%	\$ -	\$ -
7				0.00%	\$ -	\$ -
8			\$ -	0.00%	\$ -	\$ -
9			\$ -	0.00%	\$ -	\$ -
10			\$ -	0.00%	\$ -	\$ -
11			\$ -	0.00%	\$ -	\$ -
12	All Other	Remaining Construction Items	\$ 97,518	20.5%	\$ 20,864	\$ 118,382
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	\$ 85,135	7.78%	\$ 6,625	\$ 91,760
14	31 CONSTRUCTION MANAGEMENT	Construction Management	\$ 45,428	8.78%	\$ 3,991	\$ 49,419
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)				\$ -	

Totals						
	Real Estate	\$	-	0.00%	\$	-
	Total Construction Estimate	\$	572,145	26.93%	\$	154,055
	Total Planning, Engineering & Design	\$	85,135	7.78%	\$	6,625
	Total Construction Management	\$	45,428	8.78%	\$	3,991
	Total	\$	702,708	23%	\$	164,671

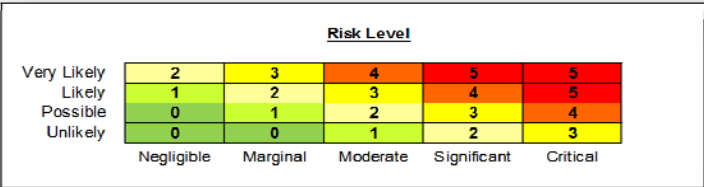
	Base	50%	80%
Range Estimate (\$000's)	\$703k	\$801k	\$867k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analysis. Must include justification. Does not allocate to Real Estate.

TD North Fish Ladder Rock Wall Stabilization Alt 1

PED 90%
 Abbreviated Risk Analysis
 Meeting Date: 8-Sep-15



Risk Register

Risk Element	Feature of Work	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Impact	Likelihood	Risk Level
Project Scope Growth			Maximum Project Growth			40%
PS-1	Rock Scaling	Actual quantities could change when scaling begins. More or less rock could be removed when working in the field.	Quantities were calculated to the best of their ability for this type of work.	Moderate	Likely	3
PS-2	Anchoring	Drilling shafts for anchors could be difficult working from a man basket. Labor and consumables could increase due to rock density.	Standard construction practices, no concerns on drilling. Access could lead to labor increase.	Moderate	Unlikely	1
PS-12	Remaining Construction Items	Tying bar and preparing for shotcrete could be difficult with the terrain and wall contours needing to place concrete on.	Small area that needs cover should not provide to many issues.	Marginal	Possible	1
PS-13	Planning, Engineering, & Design	90% design level. Very confident in design.	Relatively easy work with tough working location.	Marginal	Unlikely	0
PS-14	Construction Management	Increased scope could lead to longer construction window and fish ladder outage.	Scope appears to be detailed and set.	Moderate	Unlikely	1
Acquisition Strategy			Maximum Project Growth			30%
AS-1	Rock Scaling	Cost estimate assumed a best value small business set aside. Potentially busy contractors would limit the number offers we get.	Lack of competition could increase the cost of the project.	Moderate	Possible	2
AS-2	Anchoring	Cost estimate assumed a best value small business set aside. Potentially busy contractors would limit the number offers we get.	Lack of competition could increase the cost of the project.	Moderate	Possible	2
AS-12	Remaining Construction Items	Cost estimate assumed a best value small business set aside. Potentially busy contractors would limit the number offers we get.	Lack of competition could increase the cost of the project.	Moderate	Possible	2
AS-13	Planning, Engineering, & Design	Cost estimate assumed a best value small business set aside. Potentially busy contractors would limit the number offers we get.	Lack of competition could increase the cost of the project.	Marginal	Unlikely	0
AS-14	Construction Management	Cost estimate assumed a best value small business set aside. Potentially busy contractors would limit the number offers we get.	Getting a contractor that is not familiar with scaling or rock drilling could delay and increase onsite management.	Marginal	Possible	1
Construction Elements			Maximum Project Growth			15%
CE-1	Rock Scaling	Work window of 3 months to do the work should be enough. Crane access will be tough to work with.	Weather could prove difficult to complete on time.	Moderate	Possible	2
CE-2	Anchoring	Work window of 3 months to do the work should be enough. Crane access will be tough to work with.	Weather could prove difficult to complete on time.	Moderate	Possible	2
CE-12	Remaining Construction Items	Work window of 3 months to do the work should be enough. Crane access will be tough to work with.	Weather could prove difficult to complete on time. Temperature for shotcrete may be an issue.	Moderate	Possible	2

CE-13	Planning, Engineering, & Design	Work window of 3 months to do the work should be enough. Crane access will be tough to work with.	Ops must dewater the ladder before access to give contractor as much time as possible.	Marginal	Unlikely	0	
CE-14	Construction Management	Work window of 3 months to do the work should be enough. Crane access will be tough to work with.	Crane picks and loading will need to be approved.	Marginal	Possible	1	
<u>Quantities for Current Scope</u>					Maximum Project Growth		20%
Q-1	Rock Scaling	Quantities calculated with appropriate methods. Low potential for them to increase or decrease by time of contract award.	Rock could slough off before construction or more rock could end up being scaled during construction due to the site conditions at the time.	Marginal	Likely	2	
Q-2	Anchoring	Quantities calculated with appropriate methods. Low potential for them to increase or decrease by time of contract award.	Number of anchors may be adjusted in the field due to current site conditions	Marginal	Likely	2	
Q-12	Remaining Construction Items	Confidence in shotcrete quantities very high.	The weirs that need it the most have been accounted for.	Marginal	Possible	1	
Q-13	Planning, Engineering, & Design	Quantities calculated with appropriate methods. Low potential for them to increase or decrease by time of contract award.	Would require more engineering.	Marginal	Unlikely	0	
Q-14	Construction Management	Quantities calculated with appropriate methods. Low potential for them to increase or decrease by time of contract award.	Longer construction period.	Marginal	Unlikely	0	
<u>Specialty Fabrication or Equipment</u>					Maximum Project Growth		50%
FE-1	Rock Scaling	Some sort of device will need to be fabricated to protect the weirs. Estimate assumes working from cranes man basket.	Could be made of wood or steel, this will be contractor design feature. Could be potential they come up with an expensive idea.	Moderate	Likely	3	
FE-2	Anchoring	Estimate assumes working from cranes man basket.	Should no issues with working from a man basket.	Marginal	Possible	1	
FE-12	Remaining Construction Items	Estimate assumes working from cranes man basket.	Should no issues with working from a man basket.	Marginal	Possible	1	
FE-13	Planning, Engineering, & Design	Will have to approve contractors design features.	Verifying that the design is appropriate may take additional time.	Marginal	Likely	2	
FE-14	Construction Management	Making sure the contractor protects existing weirs during scaling operation	No concerns with cost increase.	Negligible	Possible	0	
<u>Cost Estimate Assumptions</u>					Maximum Project Growth		25%
CT-1	Rock Scaling	Moderate confidence in production rate for work.	Estimate is heavily based on production rate assumptions. Any variance from it would increase or decrease the cost.	Moderate	Possible	2	
CT-2	Anchoring	Moderate confidence in production rate for work.	Estimate is heavily based on production rate assumptions. Any variance from it would increase or decrease the cost.	Moderate	Possible	2	
CT-12	Remaining Construction Items	Moderate confidence in production rate for work.	Estimate is heavily based on production rate assumptions. Any variance from it would increase or decrease the cost.	Moderate	Possible	2	
CT-13	Planning, Engineering, & Design	High confidence in quantity to scale.	No concerns with the cost estimate	Negligible	Unlikely	0	
CT-14	Construction Management	High confidence in quantity to scale.	No concerns with cost increase.	Negligible	Unlikely	0	
<u>External Project Risks</u>			Maximum Project Growth			20%	

EX-1	Rock Scaling	Potential weather, market conditions, and fuel cost could increase the cost.	Weather could cause delays. Market conditions could lead to lack of bidders reducing are ability for competitive pricing. Fuel rates are constantly in flux and could increase by the time of award.	Moderate	Unlikely	1
EX-2	Anchoring	Potential weather, market conditions, and fuel cost could increase the cost.	Weather could cause delays. Market conditions could lead to lack of bidders reducing are ability for competitive pricing. Fuel rates are constantly in flux and could increase by the time of award.	Moderate	Unlikely	1
EX-12	Remaining Construction Items	Potential weather, market conditions, and fuel cost could increase the cost.	Weather could cause delays. Market conditions could lead to lack of bidders reducing are ability for competitive pricing. Fuel rates are constantly in flux and could increase by the time of award.	Moderate	Unlikely	1
EX-13	Planning, Engineering, & Design	Potential weather, market conditions, and fuel cost could increase the cost.	Weather could cause delays. Market conditions could lead to lack of bidders reducing are ability for competitive pricing. Fuel rates are constantly in flux and could increase by the time of award.	Negligible	Unlikely	0
EX-14	Construction Management	Potential weather, market conditions, and fuel cost could increase the cost.	Weather could cause delays. Market conditions could lead to lack of bidders reducing are ability for competitive pricing. Fuel rates are constantly in flux and could increase by the time of award.	Negligible	Unlikely	0

Abbreviated Risk Analysis

<u>WBS</u>	<u>Potential Risk Areas</u>	Project Scope Growth	Acquisition Strategy	Construction Elements	Quantities for Current Scope	Specialty Fabrication or Equipment	Cost Estimate Assumptions	External Project Risks	Cost in Thousands
01 LANDS AND DAMAGES	Real Estate								\$0
06 FISH AND WILDLIFE FACILITIES	Rock Scaling	3	2	2	2	3	2	1	\$160
06 FISH AND WILDLIFE FACILITIES	Anchoring	1	2	2	2	1	2	1	\$314
All Other	Remaining Construction Items	1	2	2	1	1	2	1	\$98
30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	0	0	0	0	2	0	0	\$85
31 CONSTRUCTION MANAGEMENT	Construction Management	1	1	1	0	0	0	0	\$45

\$165

\$0

\$165

Total	<u>\$867</u>
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The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX D Hydraulic Calculations

ENGINEERING DESIGN SHEET

PROJECT: The Dalles Rock Wall Stabilization

OFFICE SYMBOL: CENWP-EC-HD

COMPUTED BY: ADL

DATE: 08/04/15

SUBJECT: Volume Reduction vs. Passage Requirements

CHECKED BY: SJS

SHEET: 1 OF: 3

Design head drop per ladder pool is 1.0 ft to 1.3 ft

This is based on which species of fish the flow is tailored to (1 ft for salmon, 1.3 ft for shad)

Similar to the Cougar and Minto Design, weir coefficients were calculated from data presented by NHC (2000)

The 24 foot wide Ice Harbor ladder with a 6' foot weir length and a 18 inch by 18 inch orifice was selected.

Design Coefficients:

Weir Coefficient = varies

Orifice Discharge Coefficient = varies (rounded orifice)

Data acquired from Cougar Fish Facility indicated coefficients used are accurate within $\pm 0.2\%$

In the case of submerged weir flow, the weir coefficients were modified using the Villemonte Equation.

Note: H = Flow depth (water level over the weir)

dH (Difference in head from pool to pool)

Salmon Flow Conditions

H =	1 ft	Cd =	0.67
Cw =	5.07	g =	32.2 ft/s ²
L =	6.0 ft	dH =	1 ft
		height =	1.5 ft
		width =	1.5 ft
		A =	2.25 ft ²
Q _{weir} =	30.4 cfs	Q _{orifice} =	12.1 cfs
2 weirs =	60.84 cfs	V _{orifice} =	8.0 ft/s
Q _{total} =	85.0 cfs	2 orifices =	24.20 cfs

Shad Flow Conditions

H =	1.3 ft	Cd =	0.67
Cw =	5.25	g =	32.2 ft/s ²
L =	6.0 ft	dH =	1 ft
		height =	1.5 ft
		width =	1.5 ft
		A =	2.25 ft ²
Q _{weir free} =	46.7 cfs	Q _{orifice} =	12.1 cfs
C _v =	0.956	V _{orifice} =	8.0 ft/s
Q _{weir} =	44.6 cfs	2 orifices =	24.20 cfs
2 weirs =	89.25 cfs		
Q _{total} =	113.4 cfs		

ENGINEERING DESIGN SHEET

PROJECT: The Dalles Rock Wall Stabilization

OFFICE SYMBOL: CENWP-EC-HD

COMPUTED BY: ADL

DATE: 08/04/15

SUBJECT: Volume Reduction vs. Passage Requirements

CHECKED BY:

SHEET: 2 OF: 3

Volume Requirements:

The following minimum volume requirements need to be satisfied for energy dissipation in the ladder pools, per NMFS (2011):

$$V = \frac{\gamma QH}{(4 \text{ ft} - \text{lbs} / \text{s}) / \text{ft}^3}$$

Where:

V = Required Volume (cubic feet)

Q = Fish ladder flow (cfs)

 γ = Unit Weight of Water, 62.4 lb/cubic foot

H = Head Differential Pool to Pool(ft)

	<u>Flow Rate</u>		<u>Head Differential</u>		<u>Required Volume</u>
Low Flow:	85 cfs	----->	1 ft	----->	1,326.6 cu ft
High Flow:	113 cfs	----->	1 ft	----->	1,769.8 cu ft

The following equation calculates the actual volume of the pool:

$$V_{act} = [WS_{el} - Z_i - (0.5 \times L_{pool} \times S)] \times W \times L_{pool}$$

Where:

Vact = Pool Volume (cubic feet)

WSel = Water Surface Elevation (ft)

Zi = Invert Elevation (ft)

Lpool = Length of Pool (ft)

S = Slope of Pool

W = Width of Pool (ft)

Lpool = 17.333333 ft

Actual W = 24 ft

S = 6.25%

	<u>Wsel - Zi</u>		<u>Actual Volume</u>
Low Flow:	7 ft	----->	2,686.7 cu ft
High Flow:	7.3 ft	----->	2,811.5 cu ft

<u>Pool Vol for Width Reduced to 15'</u>		
<u>Q & Width</u>	<u>Vol cu ft</u>	<u>Meet Req</u>
LoQ & 15ft	1,679	Yes
HiQ & 15ft	1,757	No

Summary:

Flow (cfs)	H (ft)	Vreq (ft3)	Vact (ft3)	Difference (ft3)
85.0	1	1,326.6	2,686.7	1,360.1
113.4	1	1,769.8	2,811.5	1,041.7

* Since the difference between required volume and actual volume is **smaller with the higher flow**, it will most likely control.

ENGINEERING DESIGN SHEET

PROJECT: The Dalles Rock Wall Stabilization

SUBJECT: Volume Reduction vs. Passage Requirements

OFFICE SYMBOL: CENWP-EC-HD

COMPUTED BY: ADL

DATE: 08/04/15

CHECKED BY:

SHEET: 3 OF 3

Volume Requirements (cont...):

The following tables will check how much the volumes of each pool can be decreased but still maintain compliance with the requirements:

Low Flow (Salmon 85 cfs)

Volume Reduction	Reduced Volume	Required Volume	Meets Requirement?
10%	2418.0	1326.55	YES
20%	2149.3	1326.55	YES
30%	1880.7	1326.55	YES
40%	1612.0	1326.55	YES
50%	1343.3	1326.55	YES
50.6%	1327.2	1326.55	YES
50.7%	1324.5	1326.55	NO

High Flow (Shad 113 cfs)

Volume Reduction	Reduced Volume	Required Volume	Meets Requirement?
10%	2530.3	1769.75	YES
20%	2249.2	1769.75	YES
30%	1968.0	1769.75	YES
37.0%	1771.2	1769.75	YES
37.1%	1768.4	1769.75	NO

Conclusion:

During the lower flow conditions for salmon, the pool volume can be reduced by up to 50.6% and still meet the NMFS requirements for energy dissipation in each pool. When the flow is increased for shad passage (with 1.3 ft of head above the weir), the volume of the pools can only be reduced by a maximum of 37% to maintain appropriate dissipation. Looking at in another way, if both side walls were coated with one ft of shotcrete it would result in less than 10% reduction in volume. It would take ~4.5 ft of shotcrete applied to both side walls to reduce the volume below the minimum required. Due to the irregularities of the ladder and the excess width in most areas, it is not expected that the addition of shotcrete to the walls of the fish ladder for rock stabilization will impact the ability of the fish ladder to meet NMFS pool volume criteria, as long as the length of the weirs or size of the orifices are not changed.

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX E

Fish Passage O&M Coordination Team (FPOM) Emails

Humphrey, Christopher C NWP

From: Walker, Ricardo NWP
Sent: Thursday, September 03, 2015 12:02 PM
To: Walker, Ricardo NWP; Mackey, Tammy M NWP; Bailey, John C NWW; Baus, Douglas M NWD; BPA Scott Bettin; Bill Hevlin; Charles Morrill (charles.morrill@dfw.wa.gov); Ed Meyer (ed.meyer@noaa.gov); Eppard, Matthew B NWP; Erick VanDyke; Fredricks, Gary; Haeseker, Steve; Jeffrey Brown - NOAA Federal; Joe Skalicky; Kiefer, Russell; Klatte, Bernard A NWP; Lorz, Tom; Lut, Agnes (BPA) - KEWR-4; Moody, Gregory P NWW; Paul Wagner; Richards, Steven P (DFW); Setter, Ann L NWW; Shutters, Marvin K NWW; trevor.conder@noaa.gov; Wertheimer, Robert H NWP; Wright, Lisa NWD
Cc: Bissell, Brian M NWP; Clinton, Patricia L NWP; Cordie, Robert P NWP; Cutts, Matthew E NWP; Derugin, Andrew G NWP; Dykstra, Timothy A NWD; Ebner, Laurie L NWP; Faulkner, Donald L NWD; Feil, Dan H NWD; Filan, Benjamin J NWP; Gallion, Darren G NWP; Gibbons, Karrie M NWP; Grosvenor, Eric NWP; Hausmann, Ben J NWP; Holm, Leanne NWP; Hutton, Rebecca E NWP; Keller, Paul S NWP; Khan, Fenton O NWP; Langeslay, Mike J NWD; Lear, Gayle HQ @ NWD; Medina, George J NWP; Ocker, Paul A NWD; Peters, Rock D NWD; Rerecich, Jonathan G NWP; Richards, Natalie A NWP; Royer, Ida M NWP; STEVENS, SETH T - DELETED; Stricklin, Eric T NWP; Tackley, Sean C NWP; Todd, Wayne NWD; Van der Leeuw, Bjorn NWP; Wells, Elizabeth R NWP; Zorich, Nathan A NWP; Zyndol, Miroslaw A NWP; Burgess, Oliver T NWW; Fielding, Scott D NWP; Fone, Kenneth R NWW; Francis, Michael NWW; Fryer, Derek S NWW; Hockersmith, Eric E NWW; Holdren, Elizabeth A NWW; Holecek, Dean NWW; Johnson, Bobby NWW; Juhnke, Steve D NWW; Juul, Steve T NWW; Pinney, Chris A NWW; Spurgeon, William F NWW; Tice, Benjamin J NWW; Trachtenbarg, David A NWW; Trumbo, Bradly A (Bradly) NWW; Aaron Jackson; Alan Brower; Ballinger, Dean; Bob Rose; 'Brandon Chockley'; Brian McIlraith; Chris Caudill (caudill@uidaho.edu); Chris_Peery@fws.gov; Darren Chase; Dave Benner; Statler, Dave; Derrek M Faber; Don Warf; 'Enrique Patino'; Erin Cooper; 'Fred Mensik' (lgrsmolt@gmail.com); Fryer, Jeff; Howard Takata ; jadoumbia@bpa.gov; Jen Graham; Jerry McCann; Kathryn Kostow; Kovalchuk, Greg; Martinson, Rick; Olaf Langness; Patrick Luke; Petersen, Christine H (BPA) - KEWR-4; Ralph Lampman; Roger Clark; Roger Dick Jr.; Rosanna Mensik; rreagan@usgs.gov; Scott Livingston; Shane Scott; Sears, Sheri; Skidmore, John T - KEWR-4; Thomas VanNice; Tom; Tom Skiles; Troy Humphrey; Tucker Jones; Whiteaker, John; \$250MEGA SB; Humphrey, Christopher C NWP
Subject: RE: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

FPOM team members,

You can also access the design documentation report, cover letter, and shotcrete wall design at the link below.

150910 TDD_RockFall_North_Fish_Ladder_90DDR_DQC

150910 DDR N Ladder TDA

150910 TDD_DETAILS_SHEET-LAYOUT Plate 1

http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2015_FPOM_MEET/2015_SEP/

Thank you,
Ricardo

-----Original Message-----

From: Walker, Ricardo NWP

Sent: Wednesday, August 26, 2015 3:20 PM

To: Mackey, Tammy M NWP; Bailey, John C NWW; Baus, Douglas M NWD; BPA Scott Bettin; Bill Hevlin; Charles Morrill (charles.morrill@dfw.wa.gov); Ed Meyer (ed.meyer@noaa.gov); Eppard, Matthew B NWP; Erick VanDyke; Fredricks, Gary; Haeseker, Steve; Jeffrey Brown - NOAA Federal; Joe Skalicky; Kiefer, Russell; Klatte, Bernard A NWP; Lorz, Tom; Lut, Agnes (BPA) - KEWR-4; Moody, Gregory P NWW; Paul Wagner; Richards, Steven P (DFW); Setter, Ann L NWW; Shutters, Marvin K NWW; trevor.conder@noaa.gov; Wertheimer, Robert H NWP; Wright, Lisa NWD
Cc: Bissell, Brian M NWP; Clinton, Patricia L NWP; Cordie, Robert P NWP; Cutts, Matthew E NWP; Derugin, Andrew G NWP; Dykstra, Timothy A NWD; Ebner, Laurie L NWP; Faulkner, Donald L NWD; Feil, Dan H NWD; Filan, Benjamin J NWP; Gallion, Darren G NWP; Gibbons, Karrie M NWP; Grosvenor, Eric NWP; Hausmann, Ben J NWP; Holm, Leanne NWP; Hutton, Rebecca E NWP; Keller, Paul S NWP; Khan, Fenton O NWP; Langeslay, Mike J NWD; Lear, Gayle HQ @ NWD; Medina, George J NWP; Ocker, Paul A NWD; Peters, Rock D NWD; Rerecich, Jonathan G NWP; Richards, Natalie A NWP; Royer, Ida M NWP; STEVENS, SETH T - DELETED; Stricklin, Eric T NWP; Tackley, Sean C NWP; Todd, Wayne NWD; Van der Leeuw, Bjorn NWP; Wells, Elizabeth R NWP; Zorich, Nathan A NWP; Zyndol, Mirosław A NWP; Burgess, Oliver T NWW; Fielding, Scott D NWP; Fone, Kenneth R NWW; Francis, Michael NWW; Fryer, Derek S NWW; Hockersmith, Eric E NWW; Holdren, Elizabeth A NWW; Holecek, Dean NWW; Johnson, Bobby NWW; Juhnke, Steve D NWW; Juul, Steve T NWW; Pinney, Chris A NWW; Spurgeon, William F NWW; Tice, Benjamin J NWW; Trachtenbarg, David A NWW; Trumbo, Bradley A (Bradly) NWW; Aaron Jackson; Alan Brower; Ballinger, Dean; Bob Rose; 'Brandon Chockley'; Brian McIlraith; Chris Caudill (caudill@uidaho.edu); Chris_Peery@fws.gov; Darren Chase; Dave Benner; Statler, Dave; Derrek M Faber; Don Warf; 'Enrique Patino'; Erin Cooper; 'Fred Mensik' (lgrsmolt@gmail.com); Fryer, Jeff; Howard Takata ; jadoubia@bpa.gov; Jen Graham; Jerry McCann; Kathryn Kostow; Kovalchuk, Greg; Martinson, Rick; Olaf Langness; Patrick Luke; Petersen, Christine H (BPA) - KEWR-4; Ralph Lampman; Roger Clark; Roger Dick Jr.; Rosanna Mensik; rreagan@usgs.gov; Scott Livingston; Shane Scott; Sears, Sheri; Skidmore, John T - KEWR-4; Thomas VanNice; Tom; Tom Skiles; Troy Humphrey; Tucker Jones; Whiteaker, John; \$250MEGA SB; Humphrey, Christopher C NWP
Subject: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization
(UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

FPOM team members,

Please find attached the Design Documentation Report titled, "The Dalles Dam, Columbia River north fish ladder rock wall stabilization" and cover letter. Please provide me with written comments by 17 September 2015.

Your continued support is appreciated.

Thank you,

Ricardo Walker
Fish Passage Section
Environmental Resources Branch
USACE Portland District
Ricardo.Walker@usace.army.mil
Office: 503.808.4709
Mobile: 509.987.4259

Classification: UNCLASSIFIED

Caveats: NONE

Humphrey, Christopher C NWP

From: Walker, Ricardo NWP
Sent: Friday, September 04, 2015 6:43 AM
To: Humphrey, Christopher C NWP; Ament, Jeffrey M NWP
Cc: Cordie, Robert P NWP; Kuhn, Karen A NWP
Subject: FW: [EXTERNAL] Re: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Chris,
I received Gary Fredricks (NOAA) comments today, found below, on the 90% DDR. I expect there will be some discussion at our next FPOM meeting (next Thursday) so I will plan on attending.

Ricardo

-----Original Message-----

From: Gary Fredricks - NOAA Federal [mailto:gary.fredricks@noaa.gov]
Sent: Thursday, September 03, 2015 4:09 PM
To: Walker, Ricardo NWP
Cc: Ed Meyer - NOAA Federal; Trevor Conder - NOAA Federal; Cordie, Robert P NWP; Mackey, Tammy M NWP
Subject: [EXTERNAL] Re: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Ricardo, I have reviewed the The Dalles Dam North Fish Ladder Rock Wall Stabilization 90% DDR and have a few comments for consideration of the PDT.

Overall, I don't have any concerns with the approach to stabilizing the ladder walls (scaling, rock bolts and shotcrete), however, I do have a few general concerns that will need to be discussed further as you go through the final design and implementation phases of the project.

Every effort should be made to complete the work within the in-water work period. Any work extensions will need to be discussed in FPOM (as noted in section 7.2.2.).

The east ladder should be in operation while the north ladder is out for this work. However, any critical east ladder maintenance work should still be accomplished, so this may shorten the work window for this project.

Any effects of this work on the hydraulic performance of the ladder should be minimal and should not have a negative affect on fish passage. From the statement: "Current anticipated design changes are not likely to substantially modify pool volumes but further analysis will be taken as the design is clarified" indicates that there may be additional hydraulic analysis as the final design is worked out. Please include us in the review process of any further analysis.

And finally, any contaminants from the construction work should be contained and removed from the ladder. The schedule should allow time for the ladder to run and allow flushing of any trace contaminants before the adult fish passage season starts.

I'm heading off on annual leave starting tomorrow and will not be at FPOM next week, so I really haven't had time to discuss these comments with anyone else in our office. Ed Meyer or Trevor Conder may have additional thoughts either via email or at the meeting.

Thanks, Gary

On Thu, Sep 3, 2015 at 12:02 PM, Walker, Ricardo NWP <Ricardo.Walker@usace.army.mil> wrote:

Classification: UNCLASSIFIED

Caveats: NONE

FPOM team members,

You can also access the design documentation report, cover letter, and shotcrete wall design at the link below.

150910 TDD_RockFall_North_Fish_Ladder_90DDR_DQC

150910 DDR N Ladder TDA

150910 TDD_DETAILS_SHEET-LAYOUT Plate 1

Blockedhttp://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2015_FPOM_MEET/2015_SEP/

Thank you,
Ricardo

-----Original Message-----

From: Walker, Ricardo NWP

Sent: Wednesday, August 26, 2015 3:20 PM

To: Mackey, Tammy M NWP; Bailey, John C NWW; Baus, Douglas M NWD; BPA Scott Bettin; Bill Hevlin; Charles Morrill (charles.morrill@dfw.wa.gov); Ed Meyer (ed.meyer@noaa.gov); Eppard, Matthew B NWP; Erick VanDyke; Fredricks, Gary; Haeseker, Steve; Jeffrey Brown - NOAA Federal; Joe Skalicky; Kiefer, Russell; Klatte, Bernard A NWP; Lorz, Tom; Lut, Agnes (BPA) - KEWR-4; Moody, Gregory P NWW; Paul Wagner; Richards, Steven P (DFW); Setter, Ann L NWW; Shutters, Marvin K NWW; trevor.conder@noaa.gov; Wertheimer, Robert H NWP; Wright, Lisa NWD

Cc: Bissell, Brian M NWP; Clinton, Patricia L NWP; Cordie, Robert P NWP; Cutts, Matthew E NWP; Derugin, Andrew G NWP; Dykstra, Timothy A NWD; Ebner, Laurie L NWP; Faulkner, Donald L NWD; Feil, Dan H NWD; Filan, Benjamin J NWP; Gallion, Darren G NWP; Gibbons, Karrie M NWP; Grosvenor, Eric NWP; Hausmann, Ben J NWP; Holm, Leanne NWP; Hutton, Rebecca E NWP; Keller, Paul S NWP; Khan, Fenton O NWP; Langeslay, Mike J NWD; Lear, Gayle HQ @ NWD; Medina, George J NWP; Ocker, Paul A NWD; Peters, Rock D NWD; Rerecich, Jonathan G NWP; Richards, Natalie A NWP; Royer, Ida M NWP; STEVENS, SETH T - DELETED; Stricklin, Eric T NWP; Tackley, Sean C NWP; Todd, Wayne NWD; Van der Leeuw, Bjorn NWP; Wells, Elizabeth R NWP; Zorich, Nathan A NWP; Zyndol, Mirosław A NWP; Burgess, Oliver T NWW; Fielding, Scott D NWP; Fone, Kenneth R NWW; Francis, Michael NWW; Fryer, Derek S NWW; Hockersmith, Eric E NWW; Holdren, Elizabeth A NWW; Holecek, Dean NWW; Johnson, Bobby NWW; Juhnke, Steve D NWW; Juul, Steve T NWW; Pinney, Chris A NWW; Spurgeon, William F NWW; Tice, Benjamin J NWW; Trachtenbarg, David A NWW; Trumbo, Bradley A (Bradly) NWW; Aaron Jackson; Alan Brower; Ballinger, Dean; Bob Rose; 'Brandon Chockley'; Brian McIlraith; Chris Caudill (caudill@uidaho.edu); Chris_Peery@fws.gov; Darren Chase; Dave Benner; Statler, Dave; Derrek M Faber; Don Warf; 'Enrique Patino'; Erin Cooper; 'Fred Mensik' (lgrsmolt@gmail.com); Fryer, Jeff; Howard Takata ; jadoumbia@bpa.gov; Jen Graham; Jerry McCann; Kathryn Kostow; Kovalchuk, Greg; Martinson, Rick; Olaf Langness; Patrick Luke; Petersen, Christine H (BPA) - KEWR-4; Ralph Lampman; Roger Clark; Roger Dick Jr.; Rosanna Mensik; rreagan@usgs.gov; Scott Livingston; Shane Scott; Sears, Sheri;

Skidmore, John T - KEWR-4; Thomas VanNice; Tom; Tom Skiles; Troy Humphrey; Tucker Jones; Whiteaker, John; \$250MEGA SB; Humphrey, Christopher C NWP

Subject: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

FPOM team members,

Please find attached the Design Documentation Report titled, "The Dalles Dam, Columbia River north fish ladder rock wall stabilization" and cover letter. Please provide me with written comments by 17 September 2015.

Your continued support is appreciated.

Thank you,

Ricardo Walker
Fish Passage Section
Environmental Resources Branch
USACE Portland District
Ricardo.Walker@usace.army.mil
Office: 503.808.4709
Mobile: 509.987.4259

Classification: UNCLASSIFIED

Caveats: NONE

Classification: UNCLASSIFIED

Caveats: NONE

--

Gary Fredricks
Columbia Hydropower Branch
Interior Columbia Basin Office
NOAA Fisheries, West Coast Region

Office: (503) 231-6855
Cell: (503) 351-3956

Classification: UNCLASSIFIED

Caveats: NONE

Humphrey, Christopher C NWP

From: Ebner, Laurie L NWP
Sent: Wednesday, September 09, 2015 11:20 AM
To: Humphrey, Christopher C NWP; Walker, Ricardo NWP
Cc: Kuhn, Karen A NWP; Askelson, Sean K NWP
Subject: RE: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

I will put them in Dr. Checks I just didn't want to do that if you didn't want them there.

Laurie Ebner
CENWP-EC-HD
Phone: 503-808-4880
Fax: 503-808-4875

-----Original Message-----

From: Humphrey, Christopher C NWP
Sent: Wednesday, September 09, 2015 11:16 AM
To: Walker, Ricardo NWP
Cc: Ebner, Laurie L NWP; Kuhn, Karen A NWP; Askelson, Sean K NWP
Subject: RE: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Ricardo and Laurie,

I will cut and paste these comments/questions into DrChecks in the active ITR/BCOES review. Alternatively, Laurie, you can cut and paste them in yourself if you want better control and backchecking authority (just let me know - I added you as a comment submitter).

Some of these look like they may have already been addressed, including the cost estimate in the executive summary. But we will go through these and make sure they are evaluated and addressed.

Laurie, we will contact you if we have any specific questions.

Thanks,
Chris

-----Original Message-----

From: Walker, Ricardo NWP
Sent: Wednesday, September 09, 2015 10:40 AM
To: Humphrey, Christopher C NWP
Cc: Ebner, Laurie L NWP; Kuhn, Karen A NWP; Askelson, Sean K NWP
Subject: RE: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Chris,

How do we want to address the comments below? Should they go into Dr. Checks?

Ricardo

-----Original Message-----

From: Ebner, Laurie L NWP

Sent: Wednesday, September 09, 2015 10:35 AM

To: Walker, Ricardo NWP; Kuhn, Karen A NWP; Askelson, Sean K NWP

Subject: RE: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

Review comments:

Do you want these in Dr. Checks or like this?

Technical

Executive Summary - don't we typically have a cost estimate by 90%?

Pertinent Data - under spillway height I would add something that says (185-55) to show how the 130 was calculated.

Section 1-1 - Fish prefer the east? How do you know they prefer the east? I would change prefer The majority of fish pass through the east ladder?

Section 1-4 - another reason for not wanting rockfall screens - the screens and captured rock could put shadows in the fish ladder impacting fish passage.

Section 1-4 - did you consider lining the ladder with a plastic like they use for chutes that transport logs?

Section 2.1.4 - 1/8" is really tight. How rough is the existing rock surface?

Section 4.3.1 I would eliminate the powerhouse capacity from this list. It is in the pertinent data list. We also would never assume the maximum capacity for any type of operations - we typically assume lower 1% operations and some units out of service - which puts us closer to 275 kcfs to 300 kcfs.

Section 4 - I think the two attached tables should be added to this section. One is monthly statistic on flow passed TDA and the other is the expected tailwater at the spillway given Q and Bonneville forebay.

Section 4.4.1 - do you need to mention something about attraction flow to the ladder?

Editorial:

Executive Summary - first paragraph - establish causing accelerating the destabilization .. I don't think causing belongs in the sentence.

There are some highlighted yellow text "For the 90% DDR design" - isn't this the 90% DDR?

Laurie Ebner

CENWP-EC-HD
Phone: 503-808-4880
Fax: 503-808-4875

-----Original Message-----

From: Walker, Ricardo NWP
Sent: Wednesday, August 26, 2015 3:20 PM
To: Mackey, Tammy M NWP; Bailey, John C NWW; Baus, Douglas M NWD; BPA Scott Bettin; Bill Hevlin; Charles Morrill (charles.morrill@dfw.wa.gov); Ed Meyer (ed.meyer@noaa.gov); Eppard, Matthew B NWP; Erick VanDyke; Fredricks, Gary; Haeseker, Steve; Jeffrey Brown - NOAA Federal; Joe Skalicky; Kiefer, Russell; Klatte, Bernard A NWP; Lorz, Tom; Lut, Agnes (BPA) - KEWR-4; Moody, Gregory P NWW; Paul Wagner; Richards, Steven P (DFW); Setter, Ann L NWW; Shutters, Marvin K NWW; trevor.conder@noaa.gov; Wertheimer, Robert H NWP; Wright, Lisa NWD
Cc: Bissell, Brian M NWP; Clinton, Patricia L NWP; Cordie, Robert P NWP; Cutts, Matthew E NWP; Derugin, Andrew G NWP; Dykstra, Timothy A NWD; Ebner, Laurie L NWP; Faulkner, Donald L NWD; Feil, Dan H NWD; Filan, Benjamin J NWP; Gallion, Darren G NWP; Gibbons, Karrie M NWP; Grosvenor, Eric NWP; Hausmann, Ben J NWP; Holm, Leanne NWP; Hutton, Rebecca E NWP; Keller, Paul S NWP; Khan, Fenton O NWP; Langeslay, Mike J NWD; Lear, Gayle HQ @ NWD; Medina, George J NWP; Ocker, Paul A NWD; Peters, Rock D NWD; Rerecich, Jonathan G NWP; Richards, Natalie A NWP; Royer, Ida M NWP; STEVENS, SETH T - DELETED; Stricklin, Eric T NWP; Tackley, Sean C NWP; Todd, Wayne NWD; Van der Leeuw, Bjorn NWP; Wells, Elizabeth R NWP; Zorich, Nathan A NWP; Zyndol, Mirosław A NWP; Burgess, Oliver T NWW; Fielding, Scott D NWP; Fone, Kenneth R NWW; Francis, Michael NWW; Fryer, Derek S NWW; Hockersmith, Eric E NWW; Holdren, Elizabeth A NWW; Holecsek, Dean NWW; Johnson, Bobby NWW; Juhnke, Steve D NWW; Juul, Steve T NWW; Pinney, Chris A NWW; Spurgeon, William F NWW; Tice, Benjamin J NWW; Trachtenbarg, David A NWW; Trumbo, Bradley A (Bradly) NWW; Aaron Jackson; Alan Brower; Ballinger, Dean; Bob Rose; 'Brandon Chockley'; Brian McIlraith; Chris Caudill (caudill@uidaho.edu); Chris_Peery@fws.gov; Darren Chase; Dave Benner; Statler, Dave; Derrek M Faber; Don Warf; 'Enrique Patino'; Erin Cooper; 'Fred Mensik' (lgrsmolt@gmail.com); Fryer, Jeff; Howard Takata ; jadoubia@bpa.gov; Jen Graham; Jerry McCann; Kathryn Kostow; Kovalchuk, Greg; Martinson, Rick; Olaf Langness; Patrick Luke; Petersen, Christine H (BPA) - KEWR-4; Ralph Lampman; Roger Clark; Roger Dick Jr.; Rosanna Mensik; rreagan@usgs.gov; Scott Livingston; Shane Scott; Sears, Sheri; Skidmore, John T - KEWR-4; Thomas VanNice; Tom; Tom Skiles; Troy Humphrey; Tucker Jones; Whiteaker, John; \$250MEGA SB; Humphrey, Christopher C NWP
Subject: Design Documentation Report for TDA N Fish Ladder Rock Wall Stabilization
(UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

FPOM team members,

Please find attached the Design Documentation Report titled, "The Dalles Dam, Columbia River north fish ladder rock wall stabilization" and cover letter. Please provide me with written comments by 17 September 2015.

Your continued support is appreciated.

Thank you,

Ricardo Walker
Fish Passage Section
Environmental Resources Branch
USACE Portland District
Ricardo.Walker@usace.army.mil
Office: 503.808.4709
Mobile: 509.987.4259

The Dalles North Fish Ladder Rock Wall Stabilization Design Documentation Report

APPENDIX F

Security Review (to be completed during P&S)