US Army Corps
of Engineers
Portland District

Design Documentation Report

Bonneville Second Powerhouse Auxiliary Water Supply Backup System

Design Documentation Report

Columbia River, Washington

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Northwest Hydraulic Consultants • CivilTech

SYLLABUS

This Design Documentation Report (DDR) describes the design, construction, operation and maintenance of the selected scheme to improve fishway operations at the Bonneville Second Powerhouse, in an emergency when a fish unit fails or is taken out of service. This work is performed under Project No. DACW57-97-D-0004, Task Order No. 0023.

This document is preceded by the *Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study* (Alternative Study) dated September 2000 under Project No. DACW57-97-D-0004, Task Order No. 0013, Modification No. 001304. The Ice and Trash Sluiceway has been used as a backup AWS supply, however future modifications to this structure and biological concerns have eliminated this option. The Alternative Study considered a variety of very costly AWS backup supply systems to replace the Ice and Trash Sluiceway backup. However, the Alternative Study concluded that effective backup to the AWS supply was best achieved by making improvements to the existing AWS and developing an operations plan to optimize the AWS when one Fish Unit is out of service. This operations plan defines configurations for: setting flow from the remaining turbine, positioning fishway entrance gates, and closing floating orifice gates and selected diffuser gates depending on the tailwater elevation.

At the end of the Alternative Study, scope was added to include consideration of alternatives developed in the *Bonneville Second Powerhouse Fish Unit Debris Study Reconnaissance Report*, Final, July 20, 2000, which was conducted by the Walla Walla COE. This study described the problems caused by debris buildup on the trashracks and sediment entrainment in the AWS system.

The DDR recommends the following:

AWS Improvements

- Stockpile crucial spare parts for the Fish Units (turbines).
- Block off the lower trashrack panels at the Fish Unit intakes to better control sediment transport into the AWS.
- Replace the existing trashracks and trashrake with new continuous bar trashracks and an automatic traveling gripper rake system.
- Place a log barrier in front of the Fish Unit intakes.
- Install two sets of level transducers across the diffuser grating at the A and B Diffuser Gates in order to monitor clogging.

Operations Plan

- Perform annual soundings immediately upstream of the Fish Unit intakes and dredge during the in-stream work window (December through February if required).
- Outfit the floating orifice gates with aluminum sliding closure plates that can be installed into guides mounted around the orifices. Plates would be installed by raising the floating orifice gates up to the EL 55 deck level.
- Test and verify the recommended operations plan after modifications to the floating orifices have been made.
- Implement the proposed operations plan, in the event of a Fish Unit turbine failure, to modify gate settings, close floating orifices, closes selected gates, and regulate flow at the remaining Fish Unit Turbine.

- Abandon use of the Ice and Trash Sluiceway as a backup to the AWS.

The DDR describes a number of different alternative capital and operational improvements to the AWS. The costs for the improvements considered are listed below:

Cost Summary

Item	Alternative 2 Cost
Floating Orifice Closure	$181,972
Stockpile Crucial Spare Parts	$129,945
Portable Gate Actuator	$9,605
Operations Plan Verification Testing	$47,850
Automatic Traveling Grip Rake	$1,785,180
Blanking off Lower Trashrack Panels	$132,250
Diffuser Grating Monitoring System	$86,688
Total	$2,373,490

The DDR does not recommend a comprehensive schedule for completing the proposed improvements. These improvements are comprised of several independent tasks, which may best be implemented under separate contracts or added to other projects. The DDR identifies critical durations and dates related to each item. This information will allow the USACOE flexibility in implementing the DDR recommendations.

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PERTINENT DATA

Item	Data
Dam	
Dam Location	Columbia River, Oregon and Washington, River Mile 145.2
Forebay Deck EL	90 fmsl
Tailrace Deck EL	55 fmsl
Maximum Operating Reservoir Level Elevation	77 fmsl
Maximum Pool Elevation	87.5 fmsl
Maximum Tailwater Elevation	35 fmsl
Minimum Tailwater Elevation	7 ft fmsl
Fishway	
Fish Turbines	2- Escher Wyss Turbines
Maximum Flow	3000 cfs per unit
Intake Invert	-22.52 fmsl
Trashrack Area	2530 sf per unit
Fishway Main Entrances	4 – South Downstream Entrance (SDE), South Upstream Entrance (SUE), North Downstream Entrance (NDE), North Upstream Entrance (NUE)
Gate Type	Three leaf telescoping weir.
Main Entrance Invert EL	- 3 fmsl
Main Entrance Width	12 ft
Flow @ Main Entrances	Varies with tailwater. Approximately 1200 cfs per gate.
Floating Orifice Gates	12 total (20 slots)
Location	Access from El 55 fmsl tailrace deck
Width	8 ft
Length	42 ft
Weight	Approximately 12,000 lbs
Orifice Width	8 gates – 2 ft wide, 4 gates – 4 ft wide
Orifice Height	6 ft
Flow Through Orifices	Varies with head difference across the orifice. Approximately 90 cfs per orifice.

ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
ASME	American Society of Mechanical Engineers
AWS	Auxiliary Water Supply, American Welding Society
B2	Bonneville Second Powerhouse
CENWP	Corps of Engineers Northwest Division Portland District
CMAA	Crane Manufactures Association of America
cf	Cubic feet
cfs	Cubic feet per second
DDR	Design Documentation Report
EL	Elevation
EMT	Electrical Metallic Tubing
fmsl	Feet mean sea level
fpm	Feet per minute
fps	Feet per second
FPP	Fish Passage Plan
H	High
HDC	Hydraulic Design Center, US Corp of Engineers – Portland
HP	Horse power
ID	Identifier
in	Inch
IEEE	Institute of Electrical and Electronic Engineers
IMC	Intermediate Metal Conduit
kW	Kilowatt
NEC	National Electrical Code
NEMA	National Electrical Manufactures Association
NFPA	National Fire Protection Code
NDE	North Downstream Entrance
NUE	North Upstream Entrance
PVC	Poly vinyl chloride
PE	Polyethylene
lb	Pound
lbs	Pounds
pcf	Pounds per cubic feet
psf	Pounds per square feet
psi	Pounds per square inch
PRM	Progress Review Meeting
RGS	Rigid Galvanized Steel
SDE	South Downstream Entrance
SUE	South Upstream Entrance
sf	Square feet
scfm	Standard cubic feet per minute
Stn Stl	Stainless Steel
kcfs	Thousand cubic feet per second

UHMW	Ultra High Molecular Weight
USACE	United States Army Corps of Engineers
V	Volt
W	Wide

SECTION 1 -- INTRODUCTION

1.1 SCOPE AND PURPOSE

a. General. Regional fisheries agencies and tribes have asked the Portland District to address deficiencies in the emergency backup supply to the Auxiliary Water System (AWS) for the fishway at the Bonneville Second Powerhouse (B2). Historically when a Fish Unit fails the Ice and Trash Sluiceway is gated off to force water into the AWS to serve as a backup water supply. Three deficiencies have been identified with this procedure. These deficiencies include:

(1) Inadequate Discharge

(2) Adult Salmonid Fallback and Stranding

(3) Juvenile Salmonid Entrainment into the AWS

Furthermore, future modifications to the Ice and Trash Sluiceway for the Corner Collector Improvements will preclude operating the Sluiceway in an AWS backup mode. The B2 AWS Backup Design Documentation Report (DDR) considers alternatives and recommends specific system modifications to improve the reliability of the existing AWS system and provide an operations plan in the event of a Fish Unit failure.

b. Objectives. The scope of the DDR encompasses several objectives. Some of these objectives are new to this report and some are carried forward from the "Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study", September 2000. These objectives are listed below as they relate to system improvements for increasing the reliability of the AWS and to an operation plan for optimizing the Fishway while a Fish Unit is out of service.

(1) System Improvements

(a) To develop a strategy that prevents juvenile or adult salmonids from entering or being entrained within the auxiliary water system channel upstream of the diffuser grates.

(b) To refine the crucial spare parts list, with the help of Project personnel in order to limit fish unit downtime.

(c) To produce a design to mitigate problems caused by debris entering the AWS.

(d) To investigate methods to decrease sediment accumulation in the AWS.

(e) To investigate the feasibility and cost of monitoring diffuser rack clogging by installing pressure transducers and integrating them into the existing fish unit control and monitoring system.

(2) Operation Plan

(a) To be able to meet NMFS criteria within the fishway, in the event of a fish turbine failure.

(b) To develop a plan for operating the entrance gates, the diffuser gates, and the AWS to minimize criteria violations in the fishway. It is envisioned that this plan will be adopted by the agencies for inclusion in the Fish Passage Plan (FPP).

(c) Design closures at the floating orifice entrances and rehabilitation of existing gates and/or their controls.

1.2 AUTHORIZATION

a. This study is authorized under Appropriation 96x3122, Construction General, Columbia River Mitigation. This work is mandated by the 1998 Supplemental Biological Opinion and the 2000 Biological Opinion, Measures Nos. 125 and 127.

1.3 PROJECT DESCRIPTION

a. Main Features. The main features studied in this DDR, beginning at the forebay and ending at the tailrace, are as follows (See Plates 1 and 2):

(1) New trashracks, and trashrakes for fish unit intakes located on the north end of B2. The fish units supply the water entering the AWS.

(2) Stockpile spare parts for two fish turbines which supply water to the AWS.

(3) Four New pressure transducers (two pairs) installed at key locations in adult fishway system. (See Plates 14 and 15)

(4) Floating orifice closure mechanisms for 12 floating orifices (located along the tailwater side of the powerhouse).

(5) Operations plan to optimize fishway conditions during times when only one fish turbine is working.

1.4 AGENCY COORDINATION

The NMFS attended the 60% and 90% Progress Review Meetings (PRM) of the DDR. Their input at these meetings was considered and acted upon. Additionally, the ODFW attended the 60% PRM.

1.5 PROJECT REFERENCES

a. *Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study*, September 2000.

b. *Bonneville 2nd Powerhouse Fish Unit Debris Study Reconnaissance Report, Final*, July 20, 2000.

c. *Fish Passage Plan*, Corps of Engineers Projects, February 2000.

d. *Bonneville Second Powerhouse Computer Model and Hydraulic Evaluation of the Fishway Facility Adult Bypass System*, October 1998.

e. *Design of Small Dams,* U.S. Bureau of Reclamation.

f. *Fisheries Handbook of Engineering Requirements and Biological Criteria* (1991).

SECTION 2 -- BACKGROUND

2.1 GENERAL

a. Previous Studies. Two previous studies/reports, listed in Section 1.5, developed alternatives to address the shortcomings of the AWS, fish unit trashracks, fish unit trashrakes, and diffuser rack blockage. The first, *Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study*, September 2000, addressed the issue of providing a backup supply of water for the fishway if one of the fish turbines were to fail. Historically, should a fish unit fail or be taken out of service for maintenance, the Ice and Trash Chute doubled as the inlet for the backup AWS. By placing stoplogs at the exit, the chute was backwatered to spill water over a weir, down a shaft, and into the south end of the AWS conduit. This weir is positioned along the side of the channel in the upper reach of the chute. However, for compliance with the *2000 Fish Passage Plan* (FPP), this can only occur between September 1 and March 31 to reduce the impact on fish. When the chute is serving as a backup system, adults can fall back into the chute trashrack and become stranded. Juveniles can be impinged on, or entrained through the trashrack, then carried into the chute and the AWS. Furthermore, this backup source can only supply about 2000 cfs as it is presently configured. The chute will form the intake and the outfall for the Corner Collector. At that time the chute will no longer be available for use as backup to the AWS. The corner collector outfall is being studied at this time. The report is titled *Bonneville Second Powerhouse High Flow Outfall Bypass System DDR.*

b. The FPP Outlines Criteria For Fishway Operations. The FPP sets minimum and maximum limits to fishway channel velocities and velocities through the AWS diffusers. Minimum and maximum values are stated for the water surface differentials between the fishway and the tailwater, and between the tailwater elevation and the elevation of the entrance weir crests. The AWS backup system must be flexible and able to respond to varied conditions. Model studies show that criteria specified in the FPP are not met in all cases as the system is currently operated. A compromise must be reached that accommodates physical limitations of the fishway system and the broad range of tailwater elevations encountered at the site.

2.2 FISH UNIT DOWN TIME

a. Reduction of Fish Unit Down Time. Another aspect of improving fish passage at B2 is to develop strategies to reduce the down time of the fish unit turbines. Scheduled maintenance outages are typically 2 to 4 weeks each year, according to maintenance records. However, a breakdown could put a turbine out of commission for an extended period of time. This situation would leave the ladders short on water and violating operating criteria as detailed in the FPP. A failure of Fish Unit 2 resulted in the a loss of service from September 1997 through mid-May 1998 for major overhaul work. One strategy to reduce downtime is to develop a list of spare parts. The *Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study* compiled parts lists based on manufacturer's recommendations and discussion with project personnel. This DDR presents a parts list developed in coordination with the project staff at B2.

2.3 TRASHRACK DEBRIS ACCUMULATION

a. General. The second report listed in Section 1.5, *Bonneville 2nd Powerhouse Fish Unit Debris Study Reconnaissance Report*, Final, July 20, 2000, was conducted by the Walla Walla COE. The report began an investigation into debris loading on the fish unit trashracks, and sediment accumulation throughout the fishway. This report presented a number of problem areas and potential solutions. Solutions to these problems are considered further in the DDR phase in order to identify a preferred alternative.

b. Current Method To Clean Trashrack. The trashracks are frequently clogged with debris. At times the head differential across the trashrack exceeds 3-feet. The existing trashrake is inefficient for removing small debris, which becomes lodged between the trashrack bars. The clear space between the bars is 7/8 of an inch. This narrow spacing is required to preclude debris from clogging the 1-inch clear openings in the diffuser gratings. The current method for cleaning the trashracks involves shutting down the Fish Units for approximately 3 hours each night to allow debris to drift away from the fish unit trashracks. The cleaning is implemented when 1.5 to 3-feet of differential is observed across the trashracks. This cleaning method reportedly results in higher maintenance cost and increased risk of emergency shut downs. *Bonneville 2nd Powerhouse Fish Unit Debris Reconnaissance Report, Final,* July 20, 2000 states that thermal cycling, brake wear, and wear due to bearing oil film thickness on start-up are the major causes of the increased risk to the fish units.

2.4 SEDIMENT ACCUMULATION IN FISHWAY

a. General. Sediment accumulation within the B2 Adult Fishway Auxiliary Water System has been an ongoing problem. In particular, the flood in 1996 resulted in heavy deposits across the Powerhouse forebay and throughout the Fishway AWS. *The Bonneville 2nd Powerhouse Fish Unit Debris Study Final* - July 20, 2000 describes over 18,000-CY removed from the forebay (7,400-CY upstream of the Fish Units) and 2000 CY of material was removed from the AWS after this event.

b. Sediment Gradation. A sample of the sediment removed from the AWS shows a distribution of: fine gravels, sands, and silt, including fragments of clam-shells. A sieve analysis of this sample is presented by Figure 2-1 Sediment Gradation Curve. This curve indicates that 7 percent of the sample is fine gravel, 4 percent coarse sand, 13-percent medium sand, 54-percent fine sand, and 11-percent silt, and clam shells were also present. The makeup of this sample is indicative of material transported by bedload movement. During full operation of the Second Powerhouse main units, forebay velocities in excess of those recommended to prevent scouring are present. Observations and sampling of material in the AWS was prevented during the 2001 work period due to excessive leakage during dewatering efforts of the North Fishway monoliths. Efforts to sample sediment in the AWS should be made during future maintenance. Further study may be necessary to better ascertain the source and conveyance of sediment accumulations in the AWS.

c. Bathymetry and Soundings. Bathymetry and sounding data of the forebay since 1997 indicate the tendency for sediment to accumulate up to 10-feet above the invert in front of the Fish Unit intakes. Plates 3 through 6, present the original forebay grade after construction, the 1997 post-dredge soundings, the 1998 bathymetry, and the 2000 soundings. Plates 7 through 9 show composite sections A, B, and C for these data. Section A depicts the area of greatest sediment build-up in front of the south Fish Unit 2 intake. Section B is through the south Fish Unit 1 intake (adjacent to the Main Unit 18). This section shows decreased sediment. Section C is through Main Unit 18 and depicts a more gradual forebay invert slope and a clear intake invert. As of March 2000, sediment has built up to an elevation 2 to 12 feet above the invert of the Fish Unit intake (invert elevation: –22.52-fmsl). The steep forebay slope, especially evident in front of the Fish Units, filled in after dredging and buried the lower portion of the Fish Unit trashracks. Table 2-1 - Forebay Sediment Movement presents the volume change in the forebay area adjacent to the Fish Unit intakes. Material upstream of the Fish Units appears to fill in the area dredged out next to the intakes. Volumes are calculated by comparing forebay invert surfaces generated in the "Microstation In-Roads" program from point data obtained by the various surveys. These surfaces are presented on Plates 4 – 6. The extent of the evaluation area is depicted within the dashed lines shown on these plates.

Table 2-1
Forebay Sediment Movement

	In-fill, CY	**Scour, CY**
1997 Post Dredge to 1998	960	530
1998 to 2000	1400	790

d. Blocking Lower Fish Unit Trashracks. The relatively rapid burying of the lower portion of the Fish Unit trashrack suggests blocking the lower trashrack with blank panels. Existing trashrack panels are 13.5-feet high. Blanking off an entire trashrack section will provide a new intake invert elevation of –9-fmsl. Methods described in the United States Department of Interior Bureau of Reclamation publication titled *Design of Small Dams* were used to estimate headloss through the trashracks. The headloss characteristics of the existing trashrack are shown on Figure 2-2 Existing Trashrack Headloss. Headloss during normal fish turbine flow, 2845-cfs, is low at 0.06 feet of head when the trashrack is relatively clean. Figure 2-3 Proposed Trashrack Headloss depicts the estimated headloss when the lower trashrack panel, (one out of the five of the existing panels are blanked off). If the trashrack is kept reasonably clean, then blanking the lower trashrack panel will not result in excessive headloss. An evaluation by the Hydroelectric Design Center determined that the Fish Units could be operated while blocking off the bottom trashracks without significant loss in turbine performance.

e. Dredging Program. Given the bedload movement from the 1997 post-dredge soundings to the 1998 bathymetry, the invert of the trashracks was buried with up to 10-feet of sediment within a single season. In-water work should only be performed during the December through February timeframe. Therefore, dredging alone does not appear to be a feasible alternative. Dredging of the forebay upstream of the Fish Unit intake will be necessary regardless of the implementation of other improvements. The degree and frequency of the dredging necessary will be dependent on the amount of trashrack, which is blanked off.

f. Internal AWS Sediment Control. Re-suspension of sediment within the AWS has been suggested as a possible alternative to pass sediment through the fishway with air or water jets. Velocities in the AWS Conduit can fall to as low as 0.2 fps and the conduit invert is at –34-fmsl. The lowest fishway invert elevation through which water can discharge to the tailrace is 3 fmsl. This requires that sediment, including coarse sands and fine gravel, be lifted at least 30 vertical feet up through the diffuser chambers and grating. Implementing a system, which would suspend the sediment material in the low velocity AWS conduit and transport it up through the diffusion system and out the fish collection channel fishway entrances is unpractical. Furthermore, if the velocities were high enough to flush the material through the AWS, the diffuser grating would inhibit the flushing of gravel size material.

g. Measuring Fishway Diffuser Grating Clogging. The existing method to determine if the diffuser grating is becoming clogged requires a diver to make direct observations. An automated system would provide a much better means of monitoring and anticipating problems due to clogging of the diffuser grating. The existing level monitoring system can determine the head difference between the AWS conduit and the Fish Collection Channel. Unfortunately, this system is inadequate to determine if clogging of the diffuser grating is occurring. The AWS conduit pressure/level transducer and the collection channel pressure/level transducer are bubbler types. The bubblers are installed in the El. 28 gallery, and send their signals back to the main control board (SA24) located beside the fish turbines. SA24 subtracts the tailwater elevation signal from the collection channel level signal and displays the difference on the front panel. In like manner the water elevation differential between the AWS and the fish collection is calculated and displayed. The air supply to the bubblers does not have enough pressure to overcome the static head generated by a high tailwater. Consequently, both bubblers give incorrect readings when the tailwater is at a high elevation. Furthermore the differential measurements include the loss across the diffuser gates and orifices. The typical differential between the AWS Conduit and the Fish Collection Channel is 1 to 1.5-feet, therefore the loss resulting from clogging of diffuser grating can only be determined indirectly. Small changes of head resulting from diffuser grating clogging would not be nearly as apparent as with a direct measurement method and significant diffuser grating clogging could go unnoticed.

h. Proposed Diffuser Grating Monitoring. Directly measuring the pressure upstream and downstream of the diffuser gratings provides the most reliable and accurate means of determining head differential across the grating. Normal headloss across the diffuser gratings is nearly zero. Therefore, clogging would become apparent with a grating headloss differential of only a few inches. Consequently the direct measurement method is the only alternative considered in this report for monitoring clogging of the diffuser grating.

2.5 ALTERNATIVES DESCRIPTION

a. General. A list of the alternatives developed in this DDR is included below with a description of each. The alternatives are separated by improvements to increase AWS reliability and alternatives pertaining to the plan for operating the Fishway with only one Fish Unit in service.

b. System Improvements

(1) Stockpile Crucial Spare Parts. Crucial, frequently used, or long lead time parts for the fish units are recommended to be kept on hand. This will significantly reduce down time for repairs. Recommendations are made for the parts list in Section 9.

(2) Block Lower Portion Of Trashrack. Blocking the lower trashrack panel is proposed to prevent sediment bedload movement into the AWS. This improvement is necessary, because of the rapidity of sediment infill in front of the fish units, and the need to avoid dredging while the fishway is in operation.

(3) Trashrack Debris Accumulation and Diffuser Rack Clogging.

(a) The existing trashrake is shown on Picture H1 in the Appendix H. This rake is ineffective at removing debris and tends to mash it into and through the trashrack. This problem is complicated by the narrow spacing of the trashrack. A clear spacing of 7/8-inch is used. This narrow spacing is required in order to keep the openings through trashrack smaller than the openings through the diffuser gratings. However, the relatively narrow spacing is difficult to clean. An effective cleaning system is critical to preventing the AWS diffuser gratings from clogging.

(b) During the sediment removal effort in 1997 a number of the diffuser gratings were found clogged with debris. As a result of the increased pressure from clogging, badly corroded fasteners failed and a number of grating panels detached from the structural supports. To prevent this problem from reoccurring, use of the existing trashrake has been abandoned. Currently, the trashrack is cleaned by shutting down the Fish Unit Turbines and allowing debris to float away, perhaps into the adjacent Main Unit 18.

(c) Two alternative trashrakes were considered in the 90% DDR; a manual telescoping rake mounted on a gantry, and an automatic monorail supported gripper rake. At the 90% PRM, a decision was made to move forward with the automatic monorail supported gripper rake. The 90%

PRM meeting report is included in Appendix I. Each of these systems utilizes UHMW teeth on the rake head, which partially penetrates the trashrack to lift debris off the bars. The existing bars are only 1.25-inches deep. This bar depth is not adequate to allow the rake teeth to penetrate, because the teeth will hang up on the horizontal members supporting the vertical trashrack bars. The velocity of water within the forebay acting on the proposed rakes is a design concern. A three-dimensional model by CENWP was used to evaluate velocities immediately upstream of the Fish Unit intakes. "Table 2-2, Forebay Velocity at Fish Unit Intakes" presents the design velocities at 3-feet upstream of the Fish Unit trashrack face. The velocities presented are increased by a safety factor of 2.0 from the magnitude generated by the model. The "normal" velocity component is perpendicular to the face of the trashrack and positive in the direction of the powerhouse. The "parallel" velocity component is across the face of the trashrack and positive in a northeasterly direction (away from the Main Unit intakes). See Plate 7 for the location of the points, A through J, in cross section. The location of the velocity in plan are at the respective midpoint of each intake for each fish unit (i.e. 1-South is the southerly intake bay for Fish Unit 1). The resultant velocities are not excessive and will not require special consideration in design of the trashrakes.

Table 2-2
Forebay Velocity at Fish Unit Intakes, fps

Point	El.	1 -South		1-North		2 -South		2-North	
		Normal	Parallel	Normal	Parallel	Normal	Parallel	Normal	Parallel
A	74	-0.2	-1.5	0.0	-0.2	0.0	-0.8	-0.1	-1.3
B	70	0.2	0.5	0.2	1.0	0.1	0.0	-0.1	-0.8
C	60	0.4	2.7	0.2	1.9	0.2	1.7	0.1	0.0
D	50	0.4	3.2	0.2	2.9	0.2	2.4	0.2	0.2
E	40	1.4	3.6	1.1	3.6	1.1	3.4	1.2	1.6
F	30	1.8	3.4	1.6	3.4	1.7	3.4	1.8	2.1
G	20	2.1	2.7	1.8	2.9	1.9	2.9	2.1	2.1
H	10	2.4	2.3	2.1	2.5	2.2	2.4	2.2	2.2
I	0	2.8	2.2	2.5	2.4	2.5	2.2	1.5	1.8
J	-10	3.1	2.4	2.8	2.5	2.7	2.3	1.7	2.5

(d) Both proposed trashrake improvements require a new trashrack. Because of the unusually narrow clear opening required for the trashrack (7/8-inch), the bars must align with bars of the panels. To insure proper trashrake operation, the fabrication of the replacement trashrack should be by the manufacturer of the trashrake cleaner.

(e) Alternative trashrack materials such as fiber reinforced plastics or high density polyethylene have a number advantages over steel such as corrosion resistance, non-icing, lighter weight, and hydraulic efficient profiles. The main disadvantage is strength. Icing is not an issue since the existing trashracks are always submerged at least 25 feet. The lighter weight is no advantage for the existing configuration. The more hydraulically efficient polyethylene bars are offset by the lower strength. The lower strength results in a thicker bar, which in turn cause a significantly greater occluded area of the trashrack. The loss of open area causes higher velocities through the trashrack. With the existing trashrack, the loss of open area defeats the greater hydraulic efficiency of the individual bars. Furthermore, the elliptical bar shape of the composite trashrack will exacerbate clogging with fir cones and drift-wood. Neither proposed cleaning system is compatible with composite trashrack. No further consideration will be given to alternative trashrack materials.

(f) Automatic Traveling Grip Rake. This rake scheme consists of replacing the existing trashracks and trashrake with a monorail mounted traveling gripper rake similar to that manufactured by Brackett Green. See Plates 12 and 13.

(g) Blocking off the Lower Trashrack Panel. In order to decrease sediment movement into the AWS, and reduce dredging frequency, a blank panel can be welded over the bottom section of the fish unit intake trashracks. This modification is proposed regardless of the cleaning system. See Plate 12.

(h) Log Barrier. Large floating logs can accumulate in the forebay adjacent to the Fish Unit intakes. This is particularly true during the higher spring flows when debris loading on the trashracks if heaviest. Although the proposed cleaning system can remove logs, the primary concern is cleaning the smaller material from the submerged trashracks. Removing a potentially large raft of logs from the forebay, before the trashracks could effectively be cleaned, could pose a significant problem. The Project reports that logs have a tendency to accumulate in the area next to the Fish Units. A log barrier would permit either rake to enter the forebay and clean the trashracks without encountering logs. This barrier would consist of a reinforced plate rigidly mounted to the piers between the Fish Unit Intakes. A decision was made at the 90% PRM to move forward without a log barrier. Existing methods of log removal will be employed. A log barrier could be added at a later date if surface debris is a significant problem for removal, handling, and disposal.

(4) Install Pressure Gage in AWS Conduit. Clogging of the diffuser racks is currently difficult to monitor without visual inspection, either by a diver or when the system is taken out of service. Although the existing grating fasteners have been replaced with stainless steel fasteners, the problem of clogging can still present both structural and operational problems. To better monitor potential clogging, pressure transmitters to measure the differential pressure across the diffuser gratings are proposed. The differential will be measured by

a set of two sensors, immediately above and below a given grating. Two locations for each set of transmitters will be used: one at the south end of the Fishway next to the B Diffusers and one at the north end in the junction pool below the fish ladder. Plates 14 and 15 depict this system.

c. Operation Plan

(1) AWS Operations Alternative. This alternative examines methods to improve conditions in the fishway during a fish turbine outage through changes in fishway operations and minor modifications of fishway components. Through the use of the Bonneville Second Powerhouse Fish Ladder Model, recommended settings for the floating orifice gates, the main gates, the diffuser gates, and the fish turbines are presented to allow operators to optimize fishway hydraulics for a range of tailwater elevations.

(2) Floating Orifice Gate Closure Schemes. As a part of implementing the proposed operation plan, the floating orifices need to be closed. There are 12 floating orifices installed on the downstream side of the Fish Collection Channel at Bonneville Second Powerhouse. See Photos H-10 through H-12 in Appendix H. Each floating orifice gate is assembled out of two sections. The upper section consists of a bulkhead type roller gate, 8 ft. wide by 21.75 ft. long with a floatation chamber attached that is 6 ft. deep and 3.8 ft. wide. The floatation chamber allows the gate to rise and fall with the powerhouse tailwater. The upper portion of each gate has a 6-ft. high orifice located 7 ft. below the top of the floatation chamber. Eight of the floating orifices are 2 ft. wide, whereas four are 4 ft. wide. The floatation chamber maintains the top of the orifice approximately 3 ft. below the tailrace water surface and about 4.5 ft. below the water surface in the Fish Collection Channel. The lower portion of the floating orifice gate has no openings, extends 22.25 feet below the upper section. The two sections are bolted together. When the gates are removed from their slots, the gantry crane lifts the upper section above the deck. After the lower section of the gate has been dogged off, the gate sections are unbolted and separated.

(a) Four alternative schemes for closing these orifices were presented in the 60% DDR. They included:

i) Alternative 1 –Slide Gate Mounted to Floating Orifice (Upstream Side) with air driven actuator.

ii) Alternative 2 – Slide Gate Mounted to Floating Orifice (Downstream Side) with air driven actuator.

iii) Alternative 3 –Lower a Bulkhead mounted Stab Plate from Above.

iv) Alternative 4 – Permanent Closure.

(b) The Preferred Alternative at the 60% Level was Alternative 3 – Lower Bulkhead From Above. The clearance between the downstream face of the floating orifices and deck opening was a significant concern during the development of this alternative. It was agreed that measurements be taken at each gate to confirm adequate clearance between the tailrace side of the gate and the concrete opening in the deck at EL 55 before the 90% submittal. *Site Visit Report – Floating Orifice Measurements, C-Diffuser Gates, and Raceways for Level Transmitters in the Transportation Channel at Monolith 1N.* in Appendix J describes this effort. This site visit confirmed the existence of adequate clearance for this alternative.

(c) Alternative 3 modified for the 90% Submittal. As originally conceived, this alternative involved inserting a stab plate into guides on the downstream face of the floating orifice gates by lowering the plates onto the gates with a mechanical lifting device from the EL 55 deck. A field effort was undertaken to verify that the stab plate would fit. During the course of the investigation (see June 7, 2001 field report), a modification to the concept was developed with input from Bonneville Project staff. The modified alternative consists of removable aluminum slide plates, placed by hoisting the floating orifice above the deck with a gantry crane or boom truck, and installing the slide plates at the deck level. Then the floating orifices would be lowered back into position. A line fixed to the top of the top of the slide plate would extend up to the deck and be dogged off. This would allow the slide plate to be pulled without removing the floating orifice gate. Several observations led to this modification. These include the following:

i) A slide plate on the downstream side of the floating orifice gate could be readily installed at deck level.

ii) The riggers expressed concern about sediment fouling gate slots over an extended period of time and inhibiting stab plate installation.

iii) Raising the floating orifices gates to the deck level would allow slots for the slide plates to be cleaned out.

iv) The total length of time to remove all the floating orifices was just over 5 hours. Most of the time involved mobilizing, removing deck slabs, and re-arranging bulkheads. Installing slide plates on the floating orifice gates at deck level would likely take the same length of time as the measurements took. This duration is estimated to be at most 2 hours longer than *Alternative 3 – Lower Bulkhead From Above* described in the 60% DDR.

v) If fouling of the slots occurred (for the slide gates or stab plates), the slots would need to be cleaned out at the deck level with a pressure washer.

vi) Proper seating of the stab plates would be difficult to determine from the deck level.

vii) The floating orifice gates would need to be pulled up to the deck level if improper seating was observed.

viii) Removal of the floating orifice gates did not require the fish units to be shut down. The flow was throttled back during the June 7th field work and the floating orifice gate was readily lifted to the deck level and readily re-installed.

ix) The slide gates would be less than half the size of the stab plates, making them much easier to handle, easier to store, and would be less expensive.

x) No modification to the floatation chamber is anticipated under the new alternative. Aluminum slide plates would be relatively lightweight and would not require adding additional buoyancy to the floating orifice gate floatation chamber. This would also reduce the cost.

xi) A lifting cable on the gates would allow removal of the slide gate without lifting the floating orifice gate to the deck level. Only the deck slabs would be removed; the bulkheads hanging in the adjacent slot would not need to be handled. Two blocks and a weight will prevent slack cable from dangling in the collection channel (see Plate 10). With the modified alternative, the slide gate removal process will take less time than removing the stab plates as envisioned in the 60% DDR.

(3) Diffuser Gates. The diffuser gates control the flow from the AWS into the fish collection channel. Results from the Bonneville Second Powerhouse Fish Ladder Model indicate the operation of the Fishway, with only one Fish Unit, can be improved by closing diffuser gates at the south end of the fishway (B and C diffusers, see Appendix F Figure F-1). This forces more water into the fishway at the north end and increases velocities in the fish collection channel. The ability to effectively operate the gates during an emergency condition has been a concern. To address this concern, the gates were evaluated at the project. The results of this evaluation are presented in the following sections.

(a) Assessment of B Diffuser Gates. The B diffuser gates consist of; two manually actuated 72-inch wide by 72-inch high gates (B1and B2), two motor actuated 72-inch wide by 72-inch high gates (B3 and B4), and four motor actuated 36-inch wide by 72-inch high gates (B5 through B8). Plate 2 depicts the location of these gates. The larger gates use a 1.6-hp motor on the actuator and the smaller gates use a 0.7-hp motor. The proposed operation of the B diffuser gates in the Bonneville Powerhouse 2 Adult Fishway Auxiliary Water System (AWS) will result in higher than normal pressure head across the gates. Potentially 2 to 3 feet of head may develop, whereas the normal range is 1 to 1.5-feet. Limited information was available from the Project and the gate actuator vendor, Limitorque, recommended larger actuator motors. A test was performed to simulate emergency operation conditions while measuring the current in the actuator motors. Only in the extreme case with 3.3 feet of head across the gates did the motor current exceed the motor rating. The excess current only lasted a few seconds as the gate opened from a fully closed position. This excess current was at most 4-percent higher for the larger actuators and 1-percent higher for the smaller actuators. A portable electric motor actuator is recommended to operate the two manual gates (B1and B2). This actuator would also service to operate a gate with a failed actuator.

(b) Assessment of C Diffuser Gates. The C diffuser gates consist of 10 manually actuated 36-inch wide by 60-inch high gates located along the length of the powerhouse. Plate 2 depicts the location of these gates. The gates are positioned by turning an operator nut inside a box mounted flush with the deck on the tailrace side of the powerhouse. The operator turns a hollow shaft, which acts on the threaded portion of a 2-inch diameter gate stem, pulling the stem into the shaft as the gate is raised. The as built drawing (BDP-1-3-2/70) indicates that the design condition for these gates is a 5-foot operating differential. The Project operations staff reports that all the gates are operable by either a hand held actuator (referred to as a “mule”) or a drill motor with a operator nut adapter. The proposed portable gate actuator for the B Diffuser Gates could also serve to operate the C diffuser gates.

(c) Rehabilitation Plan. Testing the gates indicated that the existing actuators would perform adequately up to the proposed head conditions. No rehabilitation or upgrades are recommended. No further consideration of this alternative will be given in this DDR.

(4) Main Entrance Gate Controls. The Operational Alternative requires that the NUE gate be closed while the remaining three gates respond automatically to the tailwater elevation. The control capabilities for the main gates were assessed during a site visit. No work on main gate controls will be undertaken in this DDR.

SECTION 3 -- BIOLOGICAL BASIS

3.1 GENERAL

a. This section deals with biological and fish behavior characteristics of the target species, both juvenile and adult. The assumptions stated below deal with seasonality of passage and project operational criteria. In general, the system will be designed to minimize adult and juvenile entrainment. Entrainment is reduced by no longer using the ice and trash chute as a source for auxiliary water.

3.2 JUVENILE ENTRAINMENT

a. Ice and Trash Chute. Currently, when a fish unit fails or is taken out of service for maintenance, the Ice and Trash Chute doubles as the inlet for the backup AWS. Water is introduced into the AWS by placing stoplogs at the end of the chute. The water can then spill over a weir, down a shaft, and into the south end of the AWS conduit. The weir is positioned along in the upper reach of the Ice and Trash Chute. When the chute is serving as a backup water supply system, juveniles can be impinged on, or entrained through the trashrack, then carried into the chute and the AWS. This traps the juveniles behind the diffuser gratings leading to the fish collection channel. The design outlined in this DDR eliminates the Ice and Trash Chute as source for backup auxiliary water. This will eliminate the primary entry point for juvenile migrants.

b. Fish Unit Intakes. The intakes to the fish units are protected by trashracks with a clear space of 7/8 inch. Theoretically a juvenile migrant could enter the AWS through the intake and wind up on the wrong side of the diffuser gratings. However, the top of the intake is at elevation 40 fmsl and the bottom of the intake is at elevation –22.5 fmsl. The forebay water surface design range is between 71 and 77 fsml. This intake is considered to be too deep to attract juvenile migrants. Consequently, the intake is considered to be deep intake and does not require fish screen protection.

3.3 ADULT PASSAGE PERIOD

a. There are no extended times during the year when adult passage is not an issue. Typically the ladders run all year; however, one fishway ladder may be removed from service at a time during the in-water work period. As defined in the Bonneville Dam section of the FPP, the in-water work period is December 1 through February 28.

b. Shad. Shad normally show up at Bonneville during the later part of May and continue strong through the month of June. Numbers normally drop off significantly by the first two weeks in July. The fish ladders are operated during the shad run with the water over the weirs increased by 0.3 ft (1.3 ft total) to help them move over the weirs and to minimize their holding. However the operation of the main entrances and the collection channels are not changed when the shad are migrating. For construction of the AWS backup facilities it is assumed that the ladders and Juvenile Bypass System (JBS) facilities can be taken out of service during this period. In addition, all work in the water will be scheduled for this period.

3.4 ADULT PASSAGE CRITERIA

a. Criteria for Adult Passage Set Forth in the FPP for the B2 Project. The following pertain to the entrances and the powerhouse collection channel:

(1) Head on all entrances should be: 1ft to 2 ft (1.5 ft preferred).

(2) A water velocity of 1.5 fps to 4 fps (2 fps preferred) shall be maintained for the full length of the powerhouse collection channel.

(3) Operate weir crests at elevation 1 ft (fully lowered) for tailwater elevations up to 14 ft. For tailwater elevations greater than 14 ft, operate weir crest 13 ft or greater below tailwater.

(4) Operate all 12 powerhouse floating gate fishway entrances.

b. Floating Orifices. The first three criteria were are considered important for providing favorable hydraulic conditions in the fishway. The numerical model, used to explore various operating scenarios (see Section 4), tracks each of these variables. The DDR recommends that a method to temporarily close the 12 floating orifice gates be installed and operated at times when only one fish turbine is providing water to the AWS. This presents an as yet unquantified risk to upstream migrants by reducing the number of entry points into the fishway, which could delay the upstream migrants. However, it may be the case that closing the floating orifices could be beneficial in reducing adult fallback by preventing fish that enter the south entrances from exiting through the floating orifices along the powerhouse collection channel. Studies detailing the use of the floating orifices have been undertaken. Results have not been published. There is a consensus among the fish agencies, and the COE that the risk to adult fish passage posed by closing the floating orifice gates is acceptable during times of emergency operations.

SECTION 4 -- HYDRAULIC DESIGN

4.1 HYDRAULIC DESIGN CRITERIA

a. General. The hydraulic assumptions state the water levels and flows used as constraints in developing the concept designs for the features at the project. The flows and water levels are divided into two types, maximum design and operating. The maximum design values are those used in designing the structure and assessing the stability and forces acting on it. The operating values are those for which the structure is designed to operate and perform its intended purpose. These can be both minimum and maximum values.

b. Flows. The following are the design flows for which the structures are designed. These flows represent the total river discharge.

(1) Maximum Design Discharge.

(a) 100-year Flood: 700 kcfs

(b) Maximum Inflow: 1,250 kcfs

(2) Operating Discharge.

(a) Maximum for Fish Passage: 515 kcfs (10-Year Flood)

(b) Minimum for Fish Passage: 60 kcfs at each Powerhouse

c. Spill Priority. The Spillway has priority over the powerhouses depending on seasonal juvenile passage requirements.

d. Spill Periods. Spill for fish passage occurs from April through August when 120 kcfs is spilled at night and 75 kcfs is spilled during the day.

e. Powerhouse Operations. The Second Powerhouse operates as a priority over the B1 between March 1st and June 20th. The First Powerhouse has priority over B2 between June 21st through August 31st. Priority shifts back to the Second Powerhouse between September 1st and November 30th. First Powerhouse flows of at least 60 kcfs are maintained to provide favorable tailwater conditions for juvenile out-migration. If the B2 is operated, it must also maintain flows of at least 60 kcfs. The flows at both powerhouses can be reduced below 60 kcfs to minimum unit loading, if needed to achieve the desired spill (FPP Sections 2.2.2 and 2.2.3). Because of higher river flows, more turbines typically run in the spring.

f. Water Levels and Velocities. The following criteria, detailed in the FPP, were used for guidance in developing the auxiliary water supply (AWS) backup alternatives and for the evaluation of the alternatives:

(1) Water surface difference at ladder entrances: 1.0 ft to 2.0 ft, 1.5 ft preferred.

(2) Unsubmerged water depth on fish ladder weir:

  (a) 1.0 ± 0.1 ft during the non-shad passage season (August 15 through May 14)

  (b) 1.3 ± 0.1 ft during the shad passage season (May 15 through August 15)

(3) Submerged fish ladder and fish-collection-channel transportation velocities: 1.5 to 4.0 fps, 2.0 fps preferred.

(4) Diffuser inflow to fishway, average velocity: 0.26 to 0.50 fps.

(5) Entrance weir depth:

  (a) The entrance weir crest shall be fully lowered (crest at 1 fmsl) for tailwater elevations ≤ 14 fmsl.

  (b) Operate weir crests 13 ft or greater below tailwater for tailwater elevations >14 fmsl.

(6) Floating orifice operation. Operate all 12 of the proposed floating orifice gates. This criteria could be relaxed for emergency conditions.

(7) Hierarchy of criteria. At the 60% Combined Report Progress Review Meeting (PRM) for the Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study, a hierarchy of criteria was stated by the agencies. The hierarchy is listed in order of decreasing importance:

  (a) Entrance velocity (i.e. head across the entrance).

  (b) Entrance gate submergence.

  (c) Channel velocity.

  (d) Diffuser velocity.

g. <u>Headwater and Tailwater Operating Levels</u>. The operating water levels for headwater and tailwater are shown on Table 4-1.

Table 4-1
AWS Design Operating Water Levels

	All Alternatives fmsl)
Maximum	
Bonneville 2 Tailwater	35
Bonneville 2 Headwater	77
Minimum	
Bonneville 2 Tailwater	7
Bonneville 2 Headwater	71

h. Tailwater Annual Exceedance Curve. Figure 4-1 presents the annual exceedance curve for the tailwater based on a 10-year time period beginning in 1989. The period of record was chosen to encompass the current spill regime. This figure depicts the percent of the time a given tailwater elevation was exceeded during the time period evaluated.

i. Columbia River Combined Probability Flow Profiles. Figure 4-2 depicts the Columbia River Combined Probability Flood Profiles starting approximately 100 miles downstream of the Bonneville Dam. This figure is dated June 1, 1994. The basic data were developed by CENWP, January 17, 1986 and revised by CENPD-PE-WM, November 1987 by G. Holmes.

j. Additional Criteria.

(1) Corner Collector. The proposed Corner Collector project will use the Ice and Trash Chute for a juvenile outfall channel. The alternatives considered for the AWS backup will not compromise operation of the Corner Collector project. Any disturbances of the forebay flow patterns that are concentrating the juvenile migrants in other than the southwest corner of the forebay are prohibited.

4.2 REFERENCES

a. Fisheries Criteria. *2000 Fish Passage Plan*

b. Computer Programs. *Bonneville Second Powerhouse Fishway Numerical Model,* October 1998. Northwest Hydraulic Consultants.

c. Texts.

(1) Brater E.F. and H.W. King, *Handbook of Hydraulics, Sixth Edition.* McGraw-Hill. 1976.

(2) Miller, D.S. *Internal Flow Systems.* BHRA. 1990.

(3) Fisheries Handbook, Milo Bell. U.S. Army Corps of Engineers, North Pacific Division. 1991.

4.3 AWS OPERATIONS ALTERNATIVE

a. General. This section provides a discussion of the hydraulic analysis and results required for the development of the operations manual. The operations manual provides procedures for adjusting fish turbines, floating orifice gates, diffuser gates, and main entrance gates when only one turbine is operating. A numerical computer model of the Bonneville Second Powerhouse fishway was used to develop the operational alternatives. Appendix E contains a more detailed discussion of the numerical computer model. The Corps of Engineers report entitled *Bonneville Dam Second Powerhouse – Computer Model and Hydraulic Evaluation of The Fishway Facility Adult Bypass System* (October 1998) provides extensive background on the development of the numerical computer model.

b. Fishway Numerical Hydraulic Computer Model.

(1) The numerical computer model was originally developed by NHC for the Corps of Engineers, Portland District, under contract number DACW 57-96-D-0016. This program was developed as a fishway management tool for project operators to help determine appropriate operating settings for the fishway given limited input data collected for the fishway by project personnel and by automatic recording instruments. Original calibration and verification of the numerical computer model was achieved with field data collected during five site visits. The original numerical computer model was also verified with September 1999 and November 2000 field data. A more detailed discussion of calibration methods and verification results is found in Appendix E.

(2) The numerical computer model computes the following detailed hydraulic characteristic information from user-supplied input data:

- Discharge and channel velocities at selected locations throughout the fishway
- Discharge and velocities through the diffusers
- Entrance weir discharge and head differential over the entrance weirs
- Discharge and velocity of the flow through the submerged floating orifices
- Discharge through Auxiliary Water Supply ('fish') turbines
- Discharge, velocity, and head loss through all segments of the AWS

c. Application of Numerical Computer Model.

(1) The B2 fishway numerical computer model was used for the *Bonneville Second Powerhouse Auxiliary Water System Backup Alternative Study (Sept 2000).* The computer simulations showed that operational changes could be performed

to improve the hydraulic conditions in the fishway during an emergency operating condition, which occurs when just one turbine is running. The operational alternatives consist of manipulating the main entrance weir gates, floating orifice gates, and diffuser gates to optimize hydraulic conditions in the main entrances, the collection channel, and the diffuser gratings.

(2) With only a single turbine operating, the total discharge available to the AWS is significantly decreased (by about 50%), and as a consequence, the head differential over each main entrance gate and over the floating orifice entrances decreases, and the collection channel velocity also decreases. This condition causes these parameters to fall well out of normal operating criteria, jeopardizing the successful passage of adult fish upstream. However, with manipulation of the various flow control systems in the AWS and collection channel, the operational alternative can meet most of the fishway operating criteria.

(3) There are 43 openings between the AWS and the diffusers, which supply the discharge to the fishway. Twenty of the openings are controlled with sluice gates and the others are ungated. The 43 openings are located at numerous points throughout the fishway and on the downstream portion of the fish ladder (see Figure F-1 in Appendix F for locations of fishway features). There are also four main entrance gates, located at the North and South ends of the powerhouse. In addition, there are 12 floating orifice entrances located along the powerhouse collection channel. For the purposes of this discussion, the diffuser gates and entrance gates are categorized as follows:

- NUE and NDE are the North Upstream and North Downstream Main Entrance Gates, respectively.
- A-1 through A-10 diffusers are located at the entrance to the north fish ladder at the north end of the powerhouse in the junction pool area. A-1 through A-4 diffusers were each originally provided with control gates; however, two of the gates have since been removed (A-1 and A-2). Diffusers A-5 through A-10 are not currently provided with control gates.
- B-1 through B-8 diffusers are those located immediately south of the powerhouse portion of the collection channel fishway. All of these diffusers currently are equipped with control gates.
- SDE and SUE are the South Downstream and South Upstream Main Entrance Gates, respectively.
- Powerhouse diffusers C-1 through C-10 (numbered south to north) are those located along the length of the powerhouse collection channel fishway. All of these diffusers currently have functioning gates.
- FO1 through FO20 are the Floating Orifice Entrances, numbered south to north. Twenty openings were constructed for floating orifices; however, only twelve of the openings include floating orifices and the others openings are closed. All twenty of the openings are numbered.
- Ladder Diffusers D-1 through D-15 are located in the fish ladder section of the fishway, and are controlled by overflow weirs. Operational changes

to these diffusers would require major structural modifications because the overflow weirs operate sequentially as the tailwater elevation rises. The total flow contributed to the system through the ladder diffusers is minimal compared to the other diffusers.

(4) The numerical computer model was used to determine the settings for the diffuser gates, floating orifices, and main entrance weir gates necessary to meet the fishway operating criteria. A large number of runs were made for several different categories of flow control system settings. The computer model runs were organized into six Model Run Types:

- Model Run Type 1 – Baseline Case - 2 Turbines – Normal Operation with both fish turbines, all main entrances open, all floating orifice gates open, and all diffusers open.
- Model Run Type 2 – Baseline Case – 1 Turbine – Emergency Operation with one fish turbine, all main entrances open, all floating orifice gates open, and all diffusers open.
- Model Run Type 3 – Main Entrance Gates only – Same as Model Run Type 2, but varying the number of main entrance gates open.
- Model Run Type 4 – Floating Orifice Gates only – Same as Model Run Type 2, but varying the number of floating orifice gates open.
- Model Run Type 5 – Diffusers only – Same as Model Run Type 2, but varying the number of diffuser gates open.
- Model Run Type 6 – Combinations – Same as Model Run Type 2, but combinations of varying number of main entrance gates open, varying number of floating orifice gates open, and varying number of diffuser gates open.

(5) Numerous numerical computer model runs are documented in a previous report entitled *Final Report for Bonneville Second Powerhouse Auxiliary Water Supply System, Backup Alternative Study* dated September 2000. The following nomenclature was developed to organize the numerical computer model runs in those previous reports and is also used in this report. A.X.Y.Z, where 'A' represents the Model Run Type (1, 2, 3, 4, 5, or 6) 'X' is a consecutive number identifying an individual computer model run within a specific Model Run Type 'A.' 'Y' indicates the target head differential across the main entrance gates, and 'Z' indicates the tailwater elevation of the particular model. For example, a model run numbered 3.3.15.8 represents Model Run Type '3' (Main Entrance Gates only), the '3rd' model run of that Type, with target head differential of 1.5 ft, at tailwater elevation 8.0 ft.

(6) The fishway criteria used to assess the success of each numerical computer model simulation are listed in Section 4.1. As discussed in Section 4.1, a hierarchy of the criteria was developed in the previous reports.

d. Selection of Operations Alternatives

(1) Three operational configurations with one turbine operating were selected for further analysis in the *Final Report for Bonneville Second Powerhouse Auxiliary Water Supply System, Backup Alternative Study* dated September 2000. All three included closure of the floating orifices as a necessary modification. These three configurations were selected from the various alternatives studied because they provided the optimum hydraulic conditions in the fishway. In this report, the three operating scenarios are referred to as Configurations 1, 2, and 3.

- Configuration 1 includes the NU-E entrance gate closed, floating orifices closed, some of the B diffusers closed (number of B diffusers closed depends on the tailwater elevation).
- Configuration 2 includes all entrance gates open, floating orifices closed, powerhouse diffuser gates C-1 through C-5 closed, and some of the B diffusers closed.
- Configuration 3 includes all of the entrance gates open, floating orifices closed, most of the B diffusers closed.

e. Numerical Computer Model Verification for Emergency Operating Scenario.

(1) The fishway numerical model was verified with new site data collected on February 28th, 2001 for the condition where all of the floating orifices were closed. This condition was not previously available during development of the original numerical computer model. The conditions tested in the field correspond to gate, weir, and turbine settings for Configurations 1 and 3 listed above, with a tailwater elevation of approximately 11.5 ft. The results of the numerical computer model verification are included in Appendix F.

(2) The modified numerical computer model with floating orifices closed produced a maximum difference of about 0.40 ft at one location between measured and predicted water surface elevations for this field test during verification. Water surface elevation measurements were taken in the junction pool and upstream of ND-E, SU-E, and SD-E. These water surface elevations were compared with those predicted by the numerical computer model. The difference between the measured and calculated values at the south downstream entrance was higher than the maximum differences determined for previous numerical computer models of the Bonneville Second Powerhouse Fishway and other projects (0.10 to 0.30 ft). However, the data collected for the floating orifice closure test included some uncertainties that may have contributed to the higher maximum difference of 0.40 ft at the south downstream entrance. Appendix F provides a detailed explanation of factors that may have contributed to the higher difference between the predicted and measured water surface elevation.

(3) The accuracy of the model at the extreme high and low tailwater elevations is difficult to estimate; however, we expect approximately the same accuracy as

noted in the verification of the original model throughout the original calibration range. The model was originally calibrated and verified for tailwater elevations ranging from 8.4 ft to 22.7 ft. The maximum difference between predicted and measured values in the original calibration and verification runs was approximately 0.23 ft. The majority of the differences were within 0.10 ft. These differences provide some indication as to the accuracy of the hydraulic model over this range of tailwater elevations. At tailwater elevations greater than 22.7 ft, some of the variables may change. Furthermore, only one verification was done for a closed floating orifice conditions. The combination of closing floating orifices and high tailwater elevations may require additional modifications to the numerical model coefficients. As a result, further verification of the model is recommended before implementation of the operations manual.

(4) Further calibration of the modified computer numerical model by means of adjusting loss coefficients was not considered necessary based on the first set of data for the floating orifice closed condition. With only one exception, the measured and predicted values were within the range of expected differences observed for this and other fishway numerical computer models. The one exception is considered to be a result of the inability to collect the tailrace elevations at all of the entrance staff gauges, which required estimating some of the tailrace elevations from other data that was taken. Additional testing would help clarify this assumption.

(5) Therefore, the numerical computer model was determined adequate to establish an emergency operating protocol; however, further field testing is recommended before the operations manual is adopted in the FPP. The recommendation to close the floating orifices is a recommendation that will remain unaffected with minor adjustments to the numerical computer model. However, some of the recommended diffuser gate settings or the exact elevation of a particular entrance weir could change with adjustments to the model.

f. Future Data Collection.

(1) As discussed, collecting data to verify the numerical computer model for a low, medium, and high tailwater should be done before the emergency operating plans are adopted by the FPP. After the floating orifice closure scheme is constructed, collecting data with the floating orifices closed would be an easier process. Presently, plates have to be welded over the floating orifices for the test, which would make verifying the numerical model at multiple tailwater elevations quite costly and time consuming.

(2) Collecting data for a closed floating orifice condition for one tailwater elevation could be done in one day. Water surface elevations would be collected in several locations to verify that the differences between the predicted and measured elevations are acceptable. Velocity measurements would be taken in

the collection channel. The velocity measurements should be taken at the north end, in the middle, and at the south end of the channel. Velocity measurements in the junction pool area are not necessary and would be difficult to take due to the complicated hydraulic characteristics of the junction pool. Velocity measurements in the north and south channels could be taken, but the velocities in these areas do not appear to be a concern at this point because the predicted velocities are typically well above the minimum criteria in those locations. Even if the numerical computer model predicted values are slightly low or high, the velocities would still meet criteria. Since the floating orifices would be closed and one turbine would be shut-down for the test, coordination with NMFS would be required. The test would be repeated for a low, medium, and high tailwater elevation.

g. Operations Table Development. The numerical computer model was used to predict the hydraulic conditions in the fishway for tailwater elevations ranging from 8.0 ft to 28.0. Tailwater elevations above elevation 28.0 ft were not modeled because these tailwater elevations are well above the original calibration and verification tailwater elevations used to develop the numerical model. Furthermore, Figure 4-1 shows that tailwater elevations above 28.0 ft occur less than 2 percent of the time. Table 4-2 provides a description of the initial computer simulations accomplished in this study, and the location of the output summaries and tables in Appendix F. These computer simulations were done to determine the optimum configuration for each one foot tailwater elevation increment between 8 ft and 28 ft. See Tables F-1 through F-21 for detailed information.

Table 4-2
Alternatives 1, 2, and 3

TW (ft)	Turbine Q (cfs)	Floating Orifice Gates Closed	South "B" Diffuser Gates Closed	Power-House "C" Diffuser Gates Closed	Main Entrance Gates Closed	Table ID (See App F)	Figure ID (See App F)
Configuration 1:							
8	2225	All	B5-8	None	NU-E	F-1	F-2
12	3230	All	B5-8	None	NU-E	F-5	F-8
16	3515	All	B5-8	None	NU-E	F-9	F-15
20	3520	All	B4-8	None	NU-E	F-13	F-22
24	3540	All	B4-8	None	NU-E	F-17	F-28
28	3160	All	B3-8	None	NU-E	F-21	F-34
Configuration 2:							
8	2950	All	B2-8	C1-5	None	F-1	F-3
12	3230	All	B2-8	C1-5	None	F-5	F-9
16	3515	All	B2-8	C1-5	None	F-9	F-16

20	3520	All	B2-8	C1-5	None	F-13	F-23
24	3540	All	B2-8	C1-5	None	F-17	F-29
28	3160	All	B2-8	C1-5	None	F-21	F-35
Configuration 3:							
8	2950	All	B2-8	None	None	F-1	F-4
12	3230	All	B2-8	None	None	F-5	F-10
16	3515	All	B2-8	None	None	F-9	F-17
20	3520	All	All	None	None	F-13	F-24
24	3540	All	All	None	None	F-17	F-30
28	3160	All	All	None	None	F-21	F-36

Note: The first letter of the Table ID and Figure ID corresponds to the appendix.

h. Operational settings for the computer simulations were designed to minimize the number and complexity of gate, weir, and floating orifice changes with varying tailwater elevation. This is expected to minimize project staff effort expended to meet the requirements established in this operations manual. As Table 4-2 shows, Configuration 1 requires three different south diffuser gate settings depending on the tailwater elevation. Configuration 2 requires the same south diffuser gate settings for the entire tailwater elevation range. Configuration 3 requires only one change in the diffuser gate settings in the middle of the tailwater elevation range. The tables and figures located in Appendix F provide the hydraulic conditions for each of the Configuration shown in Table 4-2.

i. One configuration was selected for each tailwater elevation shown in Table 4-2 by comparing the criteria to the predicted hydraulic conditions in the fishway. In some cases, the optimum configuration for an intermediate tailwater elevation was obvious because it fell within a range where the higher and lower tailwater elevation had the same optimum configuration. In other cases, the tailwater elevation fell into a range where the higher and lower tailwater elevations each had different optimum configuration. In this case, computer simulations were required to verify which configuration provided the optimum hydraulic conditions. Table 4-3 provides one recommended configuration for all tailwater elevations between 8.0 ft and 28.0 ft. An effort was made to minimize the closure of B-1 and B-2 because these gates are manually operated and take a considerable amount of time to open and close.

j. The recommended configurations provide predicted hydraulic conditions in the fishway that most closely meet the fishway criteria. The entrance head criteria was given the highest priority, as discussed in Section 4.1. All of the recommended configurations meet the entrance head criteria. The submergence criteria of 13.0 ft are nearly met at the higher tailwater elevations. Although submergence criteria are not met at lower tailwater elevations (10.0 to 17.0 ft), the entrance head drop criteria are met, which is consistent with the criteria priority established by the resource agencies.

k. The channel velocities met criteria in all of the recommended configurations, with the exception of the junction pool area. The channel velocity criteria are very difficult to meet in the junction pool area due to the complexity of the flow characteristics under any operating scenario. At the downstream end of the fish ladder (upstream end of junction pool), the total flow in the system is small. Farther downstream in the junction pool, the diffusers supply more water to the channel, which increases velocities. The diffuser velocity criteria were not met in any of the computer simulations and were given the lowest priority. Some of the diffuser velocities exceed 0.5 fps under existing conditions with two turbines. Diffuser velocities shown as 0 fps indicate that the diffuser is closed. In some cases, powerhouse diffuser velocities are greater than zero even though the diffusers are closed. This is due to the configuration of the diffuser chambers and the associated flow paths, which can cause reverse flow through diffusers in some cases.

l. The selected configurations for all tailwater elevations between 8.0 ft and 28.0 ft are shown in Tables 4-3 and 4-4. As shown in Table 4-3, only Configurations 1 and 2 are included in the Operations Plan. Configuration 3 results did not meet criteria as well as the other configurations. Table 4-3 includes the operations table with the appropriate diffuser gate and turbine settings. Table 4-4 provides a summary of the hydraulic conditions associated with the selected configuration for each tailwater elevation. The results of all of the computer simulations are included in Appendix F. Studying all of the configurations for the intermediate tailwater elevations was not required because the results for tailwater elevations 8, 12, 16, 24, and 28 indicated which configurations would provide the optimum results.

m. As discussed previously, an attempt was made to optimize the fishway criteria in the following order: 1) Entrance velocity (head drop across entrance weir) 2) Entrance gate submergence 3) Channel velocities 4) Diffuser velocities. Tables F-1 through F-21 in Appendix F show the minimum and maximum channel velocities. Figures F-1 through F-36 show where the channel velocities are out of criteria for each scenario examined.

Table 4-3
Operations Table

TW (ft)	Turbine MW	Turbine Q (cfs)	Floating Orifice Gates Closed	South "B" Diffuser Gates Closed	Power-House Diffuser Gates Closed	Main Entrance Gates Closed	Table ID	Figure ID
8	13.90	2950	all	B2-8	C1-5	None	F-1	F-3
9	13.95	3010	all	B3-8	C1-5	None	F-2	F-5
10	14.05	3090	all	B3-8	C1-5	None	F-3	F-6
11	14.15	3165	all	B3-8	C1-5	None	F-4	F-7
12	14.20	3230	all	B3-8	C1-5	None	F-5a	F-11
13	14.40	3340	all	B3-8	C1-5	None	F-6	F-12
14	14.40	3400	all	B3-8	C1-5	None	F-7	F-13
15	14.60	3520	all	B3-8	C1-5	None	F-8	F-14
16	14.30	3515	all	B3-8	C1-5	None	F-9a	F-18
17	14.20	3560	all	B3-8	C1-5	None	F-10	F-19

TW (ft)	Turbine MW	Turbine Q (cfs)	Floating Orifice Gates Closed	South "B" Diffuser Gates Closed	Power-House Diffuser Gates Closed	Main Entrance Gates Closed	Table ID	Figure ID
18	14.00	3575	all	B5-8	None	NU-E	F-11	F-20
19	13.60	3535	all	B5-8	None	NU-E	F-12	F-21
20	13.30	3520	all	B4-8	None	NU-E	F-13	F-22
21	13.00	3510	all	B4-8	None	NU-E	F-14	F-25
22	12.70	3505	all	B4-8	None	NU-E	F-15	F-26
23	12.40	3505	all	B4-8	None	NU-E	F-16	F-27
24	12.20	3535	all	B4-8	None	NU-E	F-17	F-28
25	11.60	3535	all	B4-8	None	NU-E	F-18	F-31
26	11.10	3365	All	B4-8	None	NU-E	F-19	F-32
27	10.60	3285	All	B4-8	None	NU-E	F-20	F-33
28	10.00	3160	All	B3-8	None	NU-E	F-21	F-34

Table 4-4
Recommended Alternative Summary Table

	Normal Operating Scenario	Emergency Operating Scenario				
Tailwater Elev. (ft)	**Summary of hydraulic conditions under normal operations** (two turbines operating)	**Selected Alternative**	**Summary of Hydraulic Conditions with Emergency Operating Alternative** (one turbine operating)	**Floating Orifices Closed**	**Entrance Weir Gates Closed**	**Diffuser Gates Closed**
8	• Entrance head drop meets criteria • Low channel velocities along short section at south end of powerhouse and in junction pool • Some diffuser velocities exceed 0.5 fps	Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 1.00 ft meets criteria • Collection channel velocities meet criteria along most of powerhouse. Channel velocities are low at junction pool and high along the north channel • Approximately 28.5 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8
9		Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 1.00 ft meets criteria • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8
10		Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 2.00 ft (criteria required weir Elev. 1.00 ft) • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8
11		Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 2.50 ft (criteria required weir Elev. 1.00 ft) • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8

	Normal Operating Scenario	Emergency Operating Scenario				
Tailwater Elev. (ft)	**Summary of hydraulic conditions under normal operations** (two turbines operating)	**Selected Alternative**	**Summary of Hydraulic Conditions with Emergency Operating Alternative** (one turbine operating)	**Floating Orifices Closed**	**Entrance Weir Gates Closed**	**Diffuser Gates Closed**
12		Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 3.40 ft (criteria required Weir Elev. 1.00 ft) • Channel velocities meet criteria except in junction pool and in short section of Unit 8 • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5
13		Alternative 2	• Entrance head drop meets criteria • Entrance Weir Crest Elev. 4.00 ft (criteria required Weir Elev. 1.00 ft) • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5
14	Note: Submergence requirements change at tailwater elevation 14.0 ft. 13.0 ft of submergence is required for tailwater elevations greater than 14.0 ft.	Alternative 2	• Entrance head drop meets criteria • Submergence is 9.5 ft instead of 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5
15		Alternative 2	• Entrance head drop meets criteria • Submergence is 10.0 ft instead of 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5
16	• Entrance head drop meets criteria • Submergence criteria is met • Low channel velocities along short section of powerhouse and in junction pool • Some diffuser velocities exceed 0.5 fps	Alternative 2	• Entrance head drop meets criteria • Submergence is 10 ft instead of 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 22 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5

	Normal Operating Scenario	Emergency Operating Scenario				
Tailwater Elev. (ft)	**Summary of hydraulic conditions under normal operations** (two turbines operating)	**Selected Alternative**	**Summary of Hydraulic Conditions with Emergency Operating Alternative** (one turbine operating)	**Floating Orifices Closed**	**Entrance Weir Gates Closed**	**Diffuser Gates Closed**
17		Alternative 2	• Entrance head drop meets criteria • Submergence is 10.0 ft instead of 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 20 percent of the diffuser velocities exceed 0.5 fps	All	None	B3 thru B8 C1 thru C5
18		Alternative 1	• Entrance head drop meets criteria • Submergence is 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 25 percent of diffuser velocities exceed 0.5 fps	All	NU-E	B5 thru B8
19		Alternative 1	• Entrance head drop meets criteria • Submergence is 13.0 ft • Channel velocities meet criteria except in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B5 thru B8
20		Alternative 1	• Entrance head drop meets criteria • Submergence is 11.80 to 12.50 ft • Channel velocities low in junction pool • Approximately 25 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
21		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 25 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8

	Normal Operating Scenario	Emergency Operating Scenario				
Tailwater Elev. (ft)	**Summary of hydraulic conditions under normal operations** (two turbines operating)	**Selected Alternative**	**Summary of Hydraulic Conditions with Emergency Operating Alternative** (one turbine operating)	**Floating Orifices Closed**	**Entrance Weir Gates Closed**	**Diffuser Gates Closed**
22		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 23 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
23		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 19 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
24	• Entrance head drop meets criteria • Submergence criteria is met • Low channel velocities along Unit 11 section of channel and in junction pool • Some diffuser velocities exceed 0.5 fps	Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 19 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
25		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 17 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
26		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 17 percent of the diffuser velocities exceed 0.5 fps	All	NU-E	B4 thru B8
27		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 15 percent of the diffuser vellocities exceed 0.5 fps	All	NU-E	B4 thru B8

	Normal Operating Scenario	Emergency Operating Scenario				
Tailwater Elev. (ft)	**Summary of hydraulic conditions under normal operations** (two turbines operating)	**Selected Alternative**	**Summary of Hydraulic Conditions with Emergency Operating Alternative** (one turbine operating)	**Floating Orifices Closed**	**Entrance Weir Gates Closed**	**Diffuser Gates Closed**
28		Alternative 1	• Entrance head drop meets criteria • Submergence is 12.80 ft • Channel velocities low in junction pool • Approximately 15 percent of the diffuser velocities exceed 0.5 fps	All	NUE	B3 thru B8

n. Since it may be difficult for project personnel to change from Configuration 1 to 2 between tailwater elevations 17.0 ft and 18.0 ft, a sensitivity analysis was done to determine the hydraulic conditions that would result if the configuration is not changed at the selected break point. Additional computer simulations were done to provide the hydraulic characteristics associated with both Configurations 1 and 2 for tailwater elevations between 15.0 ft and 20.0 ft. Sensitivity Analysis Table located in Appendix G provides the results associated with both Configurations 1 and 2 for this tailwater elevation range. The results of these additional computer simulations show that the powerhouse collection channel velocities would meet criteria with either configuration for this range of tailwater elevations. The only difference would be that the entrance head drops meet criteria more closely in the recommended configuration for each tailwater elevation. As discussed previously, the entrance head criteria were given the highest priority when selecting the optimum configuration for each tailwater elevation. Outside of the 15.0 ft to 20.0 ft range, operating at configurations other than the most selected configuration is not recommended because the recommended configuration does provide significantly better results at some tailwater elevations.

SECTION 5 -- STRUCTURAL DESIGN

5.1 STRUCTURAL DESIGN CRITERIA

a. Structural Materials

(1) Structural steel: ASTM A36

(2) Steel plates: ASTM A242

(3) Welds: AWS Structural Welding Code-steel, AWS D1.1

(4) Aluminum Plate: ASTM B209 (Alloy 5083)

(5) Stainless Steel: ASTM A316

b. Design Loads

(1) General Structural Safety Factor used for Steel and Aluminum Design: 1.7

(2) (2) Hydrostatic Head across Floating Orifice Gate Closures, ft: 2

This load was determined by nhc using the fishway numerical model. Additionally, the FPP specifies that the maximum head across the fishway main entrance gates not exceed 2 feet.

(3) Hydrostatic Head across Fish Unit Trashrack, ft: 20.0

(4) Soil Load acting on Blank Fish Unit Panel, pcf: 130

(5) Maximum Deflection across Floating Orifice Gate Closures, in: 0.25

c. Densities

(1) Concrete- 150 pcf.

(2) Steel- 490 pcf.

(3) Water- 62.4 pcf.

(4) Aluminum – 165 pcf.

5.2 REFERENCES

a. Engineer References:

(1) American Society of Steel Construction, Ninth Edition

(2) EM 1110-2-2105, Design of Hydraulic Steel Structures, updated 5/31/94

(3) Specifications for Aluminum Structures – Allowable Stress Design

b. Referenced Reports and Literature:

(1) Custom Molded UHMW-PE Specifications

5.3 FLOATING ORIFICE CLOSURE

a. Slide Plate Mounted to Floating Orifice

(1) In the development of a closure scheme for the floating orifice openings, many alternatives were investigated. These alternatives are briefly described in the background section of this DDR. The recommended closure system (see Plate 10) consists of:

(a) Channel guides welded to the face of each floating orifice.

(b) A closure plate inserted into the guides.

(c) Plate is inserted when the floating orifice (FO) is raised to deck level.

(d) A tag line from the gate to the deck level to allow removal without lifting the FO.

(2) The closure plates will be fabricated from aluminum so they will be light and easy to handle. The small plates (8 total) will be 0.25 by 26 by 76-inches and weigh approximately 50-lbs. The large plates (4 total) will be 0.625 by 50 by 76-inches and weigh approximately 230-lbs. The installation operation will be done at eye level so there will be positive confirmation that the plate is inserted properly. The existing deck gantry crane will be used to raise the floating orifices and to lift the deck cover slabs. The weight added to the floating orifice is minimal, and no modification is required to the flotation tank. A tag line will be attached to each closure plate so it can be easily removed without raising the floating orifice gate.

5.4 TRASHRACK DEBRIS ACCUMULATION

a. Load Capacity of Existing Trashracks. The trashrack consists of two structural elements, the bar grating and the supporting member. The bar grating is the critical element. Spacing of the bars must match the teeth of the trashrake in order for the rake to penetrate the trashrack for proper cleaning. If the trashrack were clogged with debris, it has a maximum capacity of 1,250 psf (20 feet of differential head) based on the bar grating capacity. The capacity is based on the normal allowable working stress, which is approximately half of the ultimate load.

5.5 DIFFUSER RACK CLOGGING

a. Diffuser Grating Configuration. The diffuser rack assembly consists of three structural elements. They are the bar grating, the bar grating attachment bolts and the supporting beams. See Plate 11 for typical framing details. If the diffuser rack were to become plugged with debris the hydraulic force would increase to the point where a structural failure would occur. Each element in the diffuser rack system has a different failure load.

b. Diffuser Grating Fasteners. The gratings are fastened with stainless steel 2 ¼" x 3/8" button head bolts with a 1.5" x 4" flat bar retainer on top (4 per grating panel). This 308 stainless steel is stronger than the mild steel bolts previously used. The button head bolt was used strictly for "fish friendly" purposes. This was to eliminate the protrusion and any sharp edges that may exist with a hexagon bolt. The bar grating attachment bolts have a capacity of 600 psf (9.6 feet of differential head).

c. Bar Grating Capacity. The bar grating panel capacity is indeterminate. However, engineering judgment indicates that the grating panels can withstand far greater differential head than the support beams to which they are attached.

d. Support Beam Capacity. The support beams have a capacity of 130 psf (2.2 feet of differential head). The capacity as stated is based on the allowable working stress. The actual failure load would be approximately two times the working stress level. The support beams are considered the weak link should the diffuser gratings fail due to clogging.

5.6 BLANK TRASHRACK PANEL

a. Blank Panel Modification to Existing Trashracks. The lower panel of each trashrack intake is proposed to be blanked off to effectively raise the invert of the Fish Unit intake from elevation –22-fmsl, 13.5-feet to elevation –9-fmsl. This will allow for a reasonable level of bedload to build up next to the intake without the material entering the AWS. The panels will be blanked off by welding a 0.375-inch thick plate onto the existing trashrack bars. This plate will be welded around the perimeter in addition to 2-inch long fillet welds at each bar at midspan between the horizontal supports, and at every tenth bar in front of each horizontal support. This modification will allow the old trashracks to safely withstand both soil loading up to the top of the blank trashrack and a 20-foot hydraulic differential load.

SECTION 6 -- MECHANICAL DESIGN

6.1 MECHANICAL DESIGN CRITERIA

a. Floating Orifice Closure – Slide Gate

(1)	Design Head (across gate):	2 feet
(2)	Nominal Gate Sizes:	

   (a) 24 inch W x 72 inch H

   (b) 48 inch W x 72 inch H

b. <u>Diffuser gates</u>

(1)	Maximum Head (across gate):	3 feet

c. <u>Trashrack Debris Accumulation</u>

(1)	Trashrack Design Differential Head:	20 feet
(2)	Trashrack Panels per Intake:	4 @ 19.854 feet W x 13.417 feet H
(3)	Trashrack Clear Opening:	0.875 inches
(4)	Trashrack Inclination:	8°
(5)	Rake Width:	6 feet
(6)	Maximum Debris Load:	1,000 lbs
(7)	Cleaning Cycle Time:	90 minutes

6.2 REFERENCES

a. <u>Engineer References</u>.

(1)	EM 1110-2-4205	Hydroelectric Power plant Mechanical Design, Change 1, 31 Jul 1996
(2)	EM 385-1-1	Safety and Health Requirements Manual, 03 Sep 1996
(3)	ER 1110-2-8159	Life Cycle Design and Performance, 31 Oct 1997
(4)	ASTM	American Society for Testing Materials

(5)	ASME	American Society for Mechanical Engineers
(6)	AWS	American Welding Society
(7)	NEMA	National Electrical Manufacturer's Association
(8)	CMAA	Crane Manufactures Association of America
(9)	IEEE	Institute of Electrical and Electronic Engineers
(10)	NEC	National Electric Code 1999 Edition Engineers

b. Texts.

(1) Handbook of Hydraulics, Ernest F. Brater, Horace William King, 6th Edition

c. Referenced Reports and Literature.

(1) Memorandum for Record: Data Report, Bonneville 2nd Powerhouse Fish Unit Debris Study, CEERD-HR-F (1110-2-1403b), 1 Aug 2000

(2) Bonneville 2nd Powerhouse Fish Unit Debris Study Reconnaissance Report, Final – 20 Jul 2000

d. Memorandums.

(1) *Montgomery Watson Site Visit Report: Diffuser B Gate Testing, January 3, 2001.*

(2) *Montgomery Watson Site Visit Report: Floating Orifice Measurements and Information gathering on existing raceways, and C Diffuser Gates, June 7, 2001.*

(3) *Montgomery Watson: B2 AWS DDR – Floating Orifice Gates, June 20, 2001*

6.3 FLOATING ORIFICE CLOSURE SCHEME.

a. This scheme consists of removable aluminum sliding closure plates, placed by hoisting the floating orifices gates up to the deck level and sliding nominally 6-feet tall slide plates into guides mounted on the downstream face of the floating orifice gates. The small slide gates (2-foot wide and weighing 50-lbs) could be installed by hand, whereas the larger slide gates (4-foot wide and weighing 230-lbs) will require the use of a small utility crane such as a boom truck. The floating orifices would then be lowered back into position. A tagline fixed to the top of the slide plate would extend up to just below the deck. This would allow the slide plate to be pulled without removing the floating orifice gate. Two blocks and a 10-pound weight are included on the tagline to prevent the slack cable from dangling in the collection channel during high tailwater conditions. This configuration is depicted in Section A on Plate 10.

The length of each tagline cable is approximately 68-feet. The weight will hang at about elevation 52-fmsl during the minimum tailwater condition of 7-fmsl. At the maximum tailwater condition of 35-fmsl the weight would hang at elevation 38-fmsl. The total installation time is estimated at 5 to 7-hours. Removal of the slide gates is estimated at about 4-hours. The slide gates are depicted on Plate 10. The development of this alternative is described in the Memo titled, *B2 AWS DDR – Floating Orifice Gates, June 20, 2001* and included in Appendix I.

b. When the slide gates are not in use they will be stored in a rack. This rack is depicted on Plate 11. The rack is fabricated from 2-inch and 4-inch tube steel, flat bar and steel plate. The rack will be hot dipped galvanized after fabrication and include boxes on each side for storing the tagline assemblies. The rack includes lifting lugs on the top and fork lift slots on the bottom to facilitate transport. The total weight of the rack is approximately 1300-pounds empty and 2800-pounds filled. Slots will be lined with ¼-inch thick UHMW panels to prevent corrosion between the plates and the rack.

6.4 DIFFUSER GATES

a. Assessment from Site Visit. The B diffuser gates consist of two manually actuated 72-inch wide by 72-inch high gates (B1and B2), two motor actuated 72-inch wide by 72-inch high gates (B3 and B4), and four motor actuated 36-inch wide by 72-inch high gates (B5 through B8). The larger gates use a 1.6-hp motor on the actuator and the smaller gates use a 0.7-hp motor. The proposed operation of the B diffuser gates in the Bonneville Powerhouse 2 Adult Fishway Auxiliary Water System (AWS) will result in higher than normal pressure head across the gates. Potentially 2 to 3-feet of head may develop, whereas the normal range is 1 to 1.5-feet across the diffuser gates. Limited information was available from the Project and the gate actuator vendor, Limitorque, recommended upgraded actuator motors to accommodate the potential heads during emergency fishway operation. A test was performed to simulate emergency operating conditions while measuring the load on the actuator motors. Only in the extreme case with 3.8-feet of head across the gates did the motor current exceed the motor rating. The excess current only lasted a few seconds as the gate opened from a fully closed position. This excess current was at most 4-percent higher for the larger actuators (72" x 72" gates) and 1-percent higher for the smaller actuators (36" x 72" gates). Detailed test results are presented in the Site Visit Memorandum titled *Diffuser B Gate Testing*, January 3, 2000. This memorandum is included in Appendix J. A portable gate actuator is proposed to operate the two manually actuated gates.

b. Assessment of C Diffuser Gates. The C diffuser gates consist of 10 manually actuated 36-inch wide by 60-inch high gates located along the length of the powerhouse. Plate 2 depicts the location of these gates. The gates are positioned by turning an operator nut inside a box mounted flush with the deck on the tailrace side of the powerhouse. The operator turns a hollow shaft, which acts on the threaded portion of a 2-inch diameter gate stem, pulling the stem into the shaft as the gate is raised. The as-built drawing (BDP-1-3-2/70) indicates that the design condition for these gates is a 5-foot operating differential. The Project operations staff reports that all the gates are operable by either a hand held actuator (referred to as a "mule") or a drill motor with a operator nut adapter. The proposed portable gate actuator for the B Diffuser Gates could also serve to operate the C diffuser gates.

c. Rehabilitation Plan. Testing the gates indicate that the existing actuators will perform adequately up to the proposed head conditions. If greater head conditions are required, then the "Limitorque" actuator motors and torque spring assemblies will need to be upgraded.

6.5 MAIN GATE CONTROLS

a. No mechanical issues are associated with improvements to the fishway main entrance gate controls.

6.6 SEDIMENT ACCUMULATION

a. No mechanical issues are associated with improvements required for sediment accumulation.

6.7 TRASHRACK DEBRIS ACCUMULATION

a. Automatic Gripper Rake

(1) This rake uses a monorail mounted gripper rake to clean debris from the trashrack. The monorail extends across the length of the Fish Unit intakes, along the Erection Bay, to a post mounted on the deck of the Fingerling Evaluation monolith. A bin or truck will be located at the north end of the monorail for debris. Plate 12 depicts a section view of the improvements and Plate 13 a plan view. Typical debris accumulations include small driftwood, pine cones, weeds, grasses, and occasionally larger branches, sunken logs are a possibility but not common.

(2) Typically, the cleaner will operate automatically by positioning the gripper rake above a trashrack. The cleaner can be operated manually or automatically. The rake is lowered, while hanging free, down to a wedged shaped transition at the top of the trashrack (approximately 40-feet below the deck). This transition section will have guide bars, spaced approximately 3-feet on center to engage the rake teeth and guide them into the trashrack. The rake will partially penetrate the trashrack as it descends cleaning the trashrack. At the bottom the gripper rake closes and the inside rake moves away from the rack. The rake is then drawn back up the rack on rollers to the monorail. A detail of the rake, both descending and ascending the trashrack is depicted on Plate 13. Once in the top position, the rake travels to the north end of the monorail and empties the debris into a bin. The rake is then re-positioned and the process repeated.

The maximum debris load is 1,100-lbs (an "Ultra Duty" model is available with a 6,600-lb capacity). The maximum raking speed is 60-fpm vertically and 100-fpm horizontally along the monorail. Minimum estimated cycle time for both fish unit racks is 90-minutes (excluding offsite disposal). The frequency of cleaning will vary seasonally with the debris load in river. During spring runoff, a cycle of one to two times a day may be required. During the rest of the year a cycle of at least once a week should be practiced to prevent debris from packing into the bars. Actual frequency will need to be determined in the field based on the amount of debris removed.

(3) The standard actuator for opening and closing the gripper is hydraulic. Concerns were raised at the 90% PRM with the potential of hydraulic leaks, which may affect fish. To avoid this possibility, a pneumatic actuated system is proposed. This system will require five cylinders in lieu of the single hydraulic cylinder. This is required because the system will operate at approximately 125 psi of pressure instead of 1300 psi. The same size hose will be used (nominal 0.75 inch), to avoid an excessively large hose reel. This size air hose will result in a gripper opening and closing time of about 20-seconds as opposed to 6-seconds. This in turn lengthens the total cleaning cycle time from 80 minutes to 90 minutes. A cost increase of $12,000 is associated with this change and is included in the updated cost estimate.

(4) The UHMW teeth will be cast in approximately 12-inch long sections with a cross section depicted by the detail on Plate 13. Each tooth will be 0.625-inches wide at the face of the trashrack (in the descending/engaged position) and 0.25-inches wide at the trailing edge (the edge furthest into the trashrack). This configuration insures that the teeth will drop into the 0.875-inch wide space, rather than "ride down" the 0.375-inch wide face of the trashrack bars.

(5) A stainless steel plate perforated with 7/8-inch diameter holes will line the inside of both gripper jaws to enhance the retention of debris cleaned from the trashrack. In addition, the tips of each jaw will mate together to effectively enclose the debris. The ends must remain open to allow for removal of debris, which is longer than the rake. Furthermore, the rake can be adjusted to extend slightly beyond the invert of the trashrack and remove sediment deposited at the Fish Unit intake. By carefully examining the debris, the Project can be warned of possible sediment movement into the AWS.

(6) This system requires a trashrack with deeper bars than the existing racks (currently 1.25-inches deep) in order for the UHMW teeth to partially penetrate the trashrack to avoid the structural support backing bars. The tight, 7/8-inch clear spacing also dictates UHMW plastic teeth to reduce friction, wear, and allow for ready replacement. New trashrack panels will be continuous for each intake with an epoxy protective coating. This will require four 13.5-feet panels for a total height of 53-foot at each entrance, with the lower trashrack panels (13.5-feet) are blocked off. This configuration results in a new trashrack invert of –9-fmsl. Trashrack panels will be self-aligning with tapered pins as they are

placed in the trashrack slots. A wedge shaped transition section will mate with the top of the trashrack to direct the free hanging rake onto the trashrack.

6.8 DIFFUSER RACK CLOGGING

a. No mechanical issues are associated with improvements required for sediment accumulation.

SECTION 7 -- ELECTRICAL DESIGN

7.1 ELECTRICAL DESIGN CRITERIA

a. General

(1) Provide control of new equipment via local control panels.

(2) Provide remote indication of system status, and remote control by connecting the new equipment to the existing control and telemetry systems

(3) Provide features that allow the system to be inspected and maintained easily by project personnel.

(4) The existing grounding system from the North Substation will be used for accommodating the new equipment installation.

(5) Minimize interruptions to electrical systems resulting from construction.

(6) Minimize interruptions to control systems resulting from construction.

b. Power Distribution Equipment

(1) Seismic Zone 3 rated.

(2) The 480 VAC feeder to each load shall be designed for less than 3 percent voltage drop.

(3) Enclosures:

(a) Outdoor, corrosive, and wet areas - NEMA-4X, stainless steel or aluminum.

(b) Indoor - NEMA 12, painted steel.

(4) Local Control Panels and Controls

(a) Outdoor, corrosive, and wet areas - NEMA-4X, stainless steel or aluminum.

(b) Indoor - NEMA 12, painted steel.

c. Electric Motors

(1) Non-submersible motors will be in locations that are easily accessible for operation and maintenance.

(2) Motors less than 0.25 kW (1/3 HP) will be 110 volts, one phase, unless otherwise specified.

(3) Motors 0.25 kW (1/3 HP) and larger will be 460 volts, three phase, unless otherwise specified.

(4) Motors will be totally enclosed fan cooled (TEFC). All motors will be "premium efficiency" and rated for 1.15 service factor, class F insulation without exceeding class B temperature rise.

(5) Motors will be started with NEMA rated across the line starters combination motor starters with overload protection and 120 V control transformers, unless otherwise specified.

(6) Individual power factor correction capacitors for each motor will not be used.

d. Motor Safety Switches

(1) Motor safety/disconnect switches will not be used if possible. Safety switches are not required by code if the controller circuit breaker/disconnect can be individually locked open and is in sight of the motor controller (starter). Switches if used will be the heavy duty corrosion resistant type.

e. Raceway

(1) Exposed conduit - All exposed conduit will be rigid galvanized steel (RGS) except as noted.

  (a) Encased conduit will be Schedule 40 PVC.

  (b) Encased conduit will be 27mm (1") minimum size.

  (c) Flexible conduit will be liquid-tight with integral ground.

  (d) Exposed conduit will be 21mm (3/4") minimum size.

  (e) Exposed conduit that contain only grounding conductors will be schedule 80 PVC.

(2) All conduit concealed, buried, or encased in concrete will be Schedule 40 PVC.

(3) Encased conduit will be one-inch minimum size and will have an outer diameter not exceeding 1/3 of the concrete slab thickness. Where conduit emerges from concrete encasement, a PVC coated RGS elbow will be utilized for transition from the concrete.

(4) All conduit systems will be installed with full length copper grounding conductors, sized in accordance with NEC Article 250.

(5) Wire fills will not exceed the allowable per Appendix C10 of the '99 NEC. This table is for Schedule 40 PVC and is designated as the basis for conduit cross sectional area for all wiring on the project since it has the smallest available cross section for all the types of conduit.

(6) Intermediate metal conduit (IMC) or electrical metallic tubing (EMT) will not be permitted.

(7) Fittings will be malleable iron or gray-iron with zinc plating for galvanized conduit, and PVC for PVC conduit.

f. Wire and Cable

(1) Low Voltage Power and Lighting Cable:

(a) All wire rated for 600 volts in duct or conduit for all power and lighting circuits will be Class B Type XHHW cross-linked polyethylene insulation conforming to UL 44.

(b) All conductors will be stranded copper. Aluminum or non-stranded wire will not be permitted.

(c) Wire size for power circuits will not be smaller than No. 12 AWG. Control wiring will not be smaller than No. 14 AWG.

(d) Flexible power and control cables for submersible motors shall be armored.

(2) Instrumentation Cable:

(a) Instrumentation cable shall be rated 600 volts.

(b) Individual conductors shall be No 16 AWG.

(c) Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 AWG stranded tined copper drain wire, and a PVC outer jacket.

(3) Wire and Cable Identification:

(a) All cables will have an identifying marker at each end.

(b) All individual conductors, including those that are part of cables, will have a identifying marker at each end.

(c) Markers on all new wires will be black indelible computer printed text on white backgrounds of either the heat shrink type or self-laminating wrap-around type.

(d) Markers inside vendor furnished panels will be black indelible computer printed text on white backgrounds of the standard type furnished by the manufacturer.

g. Grounding

(1) Grounding system will conform to applicable requirements of National Electrical Code Article 250 and local codes. The ground system will be connected to the existing dam grounding system at the Second Powerhouse.

(2) Materials:

(a) Grounding loop conductors will be bare annealed copper conductors suitable for direct burial. Conductors will be #4/0 unless sized otherwise on Contract Drawings.

(b) Ground rods will be 21mm (3/4") diameter and 3m (10') long unless sized otherwise on Contract Drawings.

(c) Exposed conduit that contain only grounding conductors will be schedule 80 PVC.

(3) Installation:

(a) All raceways will include a stranded bare copper grounding conductor.

(b) Connection to ground electrodes and ground conductors will be exothermic welded where concealed and will be bolted pressure types where exposed.

(c) Copper bonding jumpers will be used to obtain a continuous metallic ground across non-conductive structural.

(4) Shield Grounding:

(a) Shielded power cable shall have its shield grounded at each termination in a manner recommended by the cable manufacturer.

(b) Shielded instrumentation cable shall be grounded at one end only ; this shall typically be at the "receiving" end of the signal carried by the cable.

h. Instrumentation

(1) Water level transducers will not project into the flow stream to avoid injuring fish and being damaged by debris. Ultrasonic level transducers with automatic air temperature compensation or pressure sensor types shall be used. Accuracy shall allow the facility to operate as required.

(2) Instrumentation for packaged equipment will be vendor furnished.

7.2 REFERENCES.

a. The electrical design will conform to the following U.S. Corp of Engineers and industry codes and standards.

b. Engineer References.

(1)	EM 385-1-1	US Army Corps of Engineers (USACE), Safety and Health Requirements Manual, Sept., 1996
(2)	ANSI C2-1997	American National Standard Institute, National Electrical Safety Code (NESC), 1997 Edition
(3)	NFPA 70	National Fire Protection Association, National Electrical Code (NEC), 1999 Edition
(4)	NFPA-101-HB85	Life Safety Code
(5)	TM 5-811-1	Departments of the Army and the Air Force, Electrical Power Supply and Distribution, 12 Sept 84
(6)	TM 5-811-2	Departments of the Army and the Air Force, Electrical Design, Interior Electrical System, 01 Sept 83

7.3 FLOATING ORIFICE CLOSURE SCHEMES

a. No electrical issues are associated with these alternatives.

7.4 DIFFUSER GATES

a. Testing of the gates indicate that the existing actuators will perform adequately up to the proposed head conditions. If greater head conditions are required, then the "Limitorque" actuator motors will need to be upgraded along with motors starter heaters, trip adjustments, or possibly the motor starter feeding the actuator.

7.5 MAIN GATE CONTROLS

a. The main gates for the fishway entrances, NUE, NDE, SUE, and SDE each have open/close/automatic control capability. This allows the gates to operate independent of each other; therefore, no additional improvements are necessary to accommodate emergency operation.

7.6 SEDIMENT ACCUMULATION

a. No electrical issues are associated with this section.

7.7 TRASHRACK DEBRIS ACCUMULATION

a. Automatic Gripper Rake.

(1) The "Bracket Green" automatic gripper rake cleaner uses a combination of a 5.5-hp motor for the hoist, two 0.5-hp motors for the traversing the monorail, and a 2-hp compressor for the gripper rake. This system requires a 40-amp, 480-volt, 3-phase power service.

(2) This service can be provided from an existing electrical panel located at deck level (90-fmsl) in a new building on the Fingerling Evaluation monolith. The new raceway would extend from the panel, out along the top of the forebay wall to a new junction box as shown on Plate 13. This raceway would consist of a 1.0-inch diameter RGS conduit.

(3) Power is distributed to the gripper rake trolley by a festooned cable running along the monorail. A control panel would be provided at the north end of the monorail next to the power junction box.

(4) A cleaning cycle can be initiated either manually, by remote input, on a timer, or by a preset water level differential across the trashrack. The differential signal will require new sensors upstream and downstream of the trashrack. A sonic level transmitter will be mounted on the outside of a monorail support column to measure the forebay level. The downstream side of the trashrack will be monitored by a loop powered pressure transducer, mounted in the visitors gallery at about elevation 61 with a pressure tap core-drilled through the wall to the intake gate slot, avoiding the three air induction pipes embedded in the wall. The intake gate slot will act as a stilling well to provide a more stable level reading. The difference between the two signals will provide the differential used for control.

7.8 DIFFUSER RACK CLOGGING

a. Diffuser Grating Monitoring System.

(1) The diffuser grating monitoring system consists of two sets of level transducers installed immediately above and below selected diffuser gratings located at the south end of the Fishway adjacent to the B Diffuser gates and at the north end in the junction pool below the fish ladder. These transducers are submersible 2-wire strain gauge devices, which generate a 4 to 20-mA current proportional to a range of 40-feet of water. The transducers require 12 to 30-VDC excitation voltage. This power for the transmitters is supplied by a new power supply

located in panel SA24 (located at elevation 5.0 in the Erection Bay). Power for the VO Module is supplied via the communication wiring from a new separate power supply module, which also passes along the communication-signal to the protocol converter module. The accuracy of the transducers will be 0.1-percent allowing 0.04-feet of resolution. Differential pressure across the diffuser grating in excess of 0.2-feet indicates clogging. Two feet of differential is the maximum allowed for safe loading. Plate 14 depicts the layout and details of the monitoring system. Plate 15 depicts a schematic of this system.

(2) Each level sensor is lowered through a 2-inch, schedule 80, PVC conduit mounted flush to the wall of the fish collection channel. Conduits and wiring for the sensors are terminated in a control panel located at approximately elevation 50.

(3) Each control panel encloses an analog input I/O module, which converts the current output from the level transducer to a digital signal. The module and level transmitters are powered over the communication wiring. Design is based on a "MTL I/O95" series input and communication module. Modules are looped together with a 2-wire communications "Transnet" cable. This cable terminates at the I/O Block and Power Supply module located in panel SA24. An "MTL" protocol converter is used to interface between the "MTL" power supply module and the existing "G.E. Fanuc" programmable logic controller with the Modbus protocol.

(4) The existing "G.E. Fanuc" programmable logic control currently interfaces with other AWS level control signals. This controller will be modified to include an upgraded CPU to allow the required serial communications, an analog output module, and a communications module. The upgraded controller will accept the new water levels at the diffuser grating, calculate differentials across the diffuser gratings, and output both collection channel level and grating pressure differential at each of the two locations.

(5) The digital displays of the levels and pressure differential will be added to the existing panel door with the existing AWS hydraulic information. Direct display of the collection channel level at each end of the powerhouse is a secondary benefit.

SECTION 8 -- CONSTRUCTION

8.1 FLOATING ORIFICE CLOSURE

a. Slide Plate Mounted to Floating Orifice.

(1) This alternative requires modification of the 12 existing floating orifice panels. The panels can be placed in 20 slots along the tailrace of the powerhouse. Plate 2 shows the location of the active slots. Slots FO-3, FO-4, FO-6, FO-8, FO-13, FO-15, FO-17, and FO-19 are inactive. Prior to modifying the floating orifice gates, 14-weeks should be allowed for fabricating slide plates, guides, and appurtenances. Existing bulkheads allow taking up to two floating orifices out of service at a time. The existing lifting device allows for pulling and installing bulkheads and orifices from the deck. The proposed modifications will require a week to perform. Therefore, the sequencing will involve exchanging two floating orifices with bulkheads, performing the modifications, re-installing the modified floating orifices and removing the bulkheads, then moving to the next set. This sequence will need to be repeated 6 times to modify all the floating orifices. This work will need to be performed during the in-water work period from December through February when the Fish Units can be shut down. With the bulkheads currently available the entire process will take about 6 to 8 weeks. This duration may conflict with other scheduled in-water work. If this is the case, then additional bulkheads will be required to allow work on more than 2 floating orifices at a time. If time constraints become an issue, it may be desirable to shut the fishway down during construction to allow work to proceed on all the floating orifice gates at once. The FPP requires that at least one fish ladder remain in operation at all times. A shut down of the Bonneville Second Powerhouse fish ladder would require coordination with Bonneville First Powerhouse to ensure that the requirements outlined in the FPP are met.

(2) The work to be performed on the floating orifices includes the following:

(a) Fabricate or purchase aluminum slide plates, slide plate guides and seals, tag lines, and other misc. parts.

(b) Exchange the floating orifice with the bulkheads.

(c) Weld slide plate guides around orifice.

(d) Pressure test panels for air-tightness and epoxy coat damaged areas, allow for paint cure time.

(e) Mount slide plate to orifice panel.

(f) Test slide plate assembly.

8.2 DIFFUSER GATES

a. Replace operating wheels on diffuser gates B1 and B2 with an operating wheel that has a nut in the center for operation with the portable actuator. Allow 6 week lead time for materials.

8.3 MAIN GATE CONTROLS

a. The existing main gate controls perform adequately during normal and anticipated emergency conditions. Therefore, no modifications are necessary.

8.4 SEDIMENT ACCUMULATION

a. Construction to manage sediment accumulation requires both dredging and blocking the lower portion of the Fish Unit trashrack. The majority of this work will be performed during the in-water work period. A 3 week lead time should be allowed for steel panel fabrication in addition to procurement and submittal review. The following activities will be required:

  (1) Weld plate onto the upstream face of the two spare trashrack panels and coat with epoxy paint. Allow one week for the coating to cure.

  (2) During the in-stream work period with the Fish Units shut down, the forebay area upstream of the Fish Unit intakes will be dredged to free the lower trashrack panels and clear this area of debris and excess sediment.

  (3) Remove the existing trashrack panels.

  (4) Weld plate onto the upstream face of two of the previously installed trashrack panels and coat with epoxy paint. Allow one week for the coating to cure.

  (5) Install the four blank panels in the bottom of the trashrack slots.

  (6) Surplus old trashrack panels.

8.5 TRASHRACK DEBRIS ACCUMULATION

a. Construction to manage sediment accumulation requires both dredging and blocking the lower portion of the Fish Unit trashrack. The majority of this work will be performed during the in-water work period. A 3 week lead time should be allowed for steel panel fabrication in addition to procurement and submittal review. The following activities will be required:

b. Automatic Gripper Rake.

(1) Installation of an automatic gripper rake cleaning system will require fabrication, electrical improvements, deck modifications, and a new trashrack system. The majority of this work will be performed during the in-water work period. A total lead time of 34 weeks should be budgeted for submittals and fabrication. The following activities will be required:

(a) Fabricate the automatic gripper rake, and new trashrack.

(b) Extend the new power service from the panelboard in the building on the Fish Evaluation Facility to a new Junction Box.

(c) Cut slots into the Erection Bay forebay wall to allow mounting of the monorail supports.

(d) Mount trashrake support monorail on the Erection Bay deck.

(e) After the sediment accumulation improvements are in place, install the new trashracks with the existing gantry crane.

(f) Mount the automatic gripper rake on the monorail and connect electrical power cable.

(g) Test and calibrate rake system.

8.6 DIFFUSER RACK CLOGGING.

a. Diffuser Grating Monitoring System.

(1) A majority of this work will need to be performed during the in-water work period while the Fishway is out of service. Work on this alternative includes the following:

(a) Acquire the conduit, wire, level transmitters, transmitter panels, G.E. Funac PLC modules, and other material. Typical lead times are 6 weeks.

(b) Re-program PLC to include logic for level transmitter communications; analog level outputs to digital displays, and digital outputs for high diffuser grating alarm lights.

(c) Install the level transmitter panels and associated conduit to the existing power house control wire cable-trays.

(d) Install control wiring from the Fish Unit control panel SA24 to each of the transmitter panels at Diffuser Gate B2 and Diffuser Gate A (located next to the junction pool).

(e) During the in-water work period, install the two upper and lower level transmitter conduits. (The transmitter panels will need to be temporarily removed.)

(f) Upgrade the existing G.E. Funac PLC in control panel SA4 with a new 10 slot module rack, a new CPU, a communication module, and an analog output module, and a digital output module. Install "MTL" modules. Install digital displays for fish collection channel level and diffuser grating differential on the SA4 door. Install the diffuser grating alarm lights. Complete panel SA4 wiring of improvements.

(g) After all level transmitter conduits have been installed and the fishway re-filled with water; install the level transmitters and complete wiring.

(2) Test and calibrate diffuser grating monitoring system.

8.7 PROJECT SCHEDULE.

a. No explicit schedule is proposed for the improvements. The various items are relatively simple improvements, which tend to be independent of each other. This approach will allow the most flexibility in implementing the improvements.

SECTION 9 -- STOCKPILE CRUCIAL GENERATOR AND TURBINE PARTS

9.1 GENERAL

a. Identification of Parts for List. The list of parts to be stockpiled was identified by determining the failure mechanisms of the past and parts needed to repair common failures; identifying long lead time items (more than 30 days to acquire); and identifying parts, though locally available, that could be out of stock at a particular time. The costs of the parts and the likelihood that a part will be needed will influence the decision to buy and stock long lead time and locally available parts.

b. Inventory. Project staff completed an inventory of existing spare parts. The available parts were compared with the recommended spare parts lists assembled by turbine manufacturers. Project staff, including maintenance foremen, then compiled a list of crucial parts they feel should be assembled in order to expedite the process of turbine repair in event of a fish unit outage. Table 9-1 provides a list of the crucial parts.

Table 9-1
Crucial Spare Parts List

Description	Unit	Quantity
Metric Poly Pac Seals	Ea	3
Twin-Pump External Oil Cooling System	Ea	2
Governor Blade and Gate Distributing Valve Bushing and Plunger Assembly	Ea	2
Governor Actuator Screw Pump	Ea	1
Rotor Pole Keys	Set	2
Commutation rings	Set	1
XJ Breaker for Fish Units (refurbished)	Set	1
Auto Voltage Regulator	Set	1
Exciter Breakers	Set	1

c. Long Lead Time Parts. One long lead time spare part was identified: the Thrust Bearing Oil Coolers. The Thrust Bearing Oil Coolers can be replaced by an external pump cooling system. A twin pump, external oil cooler would provide reliability and redundancy to the cooling system.

d. 3-D Cam Controller. In a previous draft of this report, the 3D Cam Controller (controlling the wicket gate and blade angle) was identified as a crucial part in need of replacement. The existing 3D Cam Controller is old in cyber-years, and spare parts were thought to not be available. However, by spring of 2002, the 3D Cam Controllers at the First Powerhouse will be replaced with new units. The old 3D Cam Controllers contain identical parts as the fish unit 3-D Cam Controllers. It is the opinion of the Project staff that the old 3D Cam Controllers could serve as an adequate supply of spare parts for the existing 3D Cam Controllers at the fish units. The Project staff does not recommend the purchase of new ones. A back up system is in place. In the event of a 3D Cam Controller breakdown, an existing mechanical system could be used. The existence of a mechanical backup, and the existence of a large supply of spare parts, have removed the 3D Cam Controller from the crucial spare parts list.

e. Storage Area. Discussions with Project personnel indicate that the "+41" storage area or a drier piping gallery could be made available to accommodate the storage needs for the spare parts. If properly stored, the shelf life of many of the items on the spare parts list is not limited. Poly Pac Seals however deteriorate over time; a schedule for their replacement should be developed.

SECTION 10 -- OPERATIONS AND MAINTENANCE

10.1 FLOATING ORIFICE CLOSURE SCHEMES

a. Slide Plate Mounted to Floating Orifice.

(1) Maintenance would be accomplished at the time of the slide plate installation. The guides would be cleared of any fouling with a pressure washer.

10.2 DIFFUSER GATES

a. No changes in gate operations are anticipated when both fish turbines are in operation. For emergency operations when one turbine is out of service, refer to Appendix G – Operations Manual.

b. Except for the diffuser gates B1 and B2, the gates will be opened and closed by existing methods. An operating nut will be installed on gates B1 and B2 that will enable these gates to be actuated by an electric portable operator.

c. No change in diffuser gate maintenance procedures are anticipated.

10.3 MAIN ENTRANCE GATE CONTROLS

a. No changes are recommend to the current operation and maintenance of the existing Main Entrance Gate Control system.

10.4 DREDGING

a. An annual sediment monitoring program should be implemented. Dredging could then be scheduled during the in-water work period to clear sediment accumulation immediately upstream of the Fish Unit intakes. By blocking of the lower trashrack panel, a higher forebay invert elevation of –9.0-fmsl is acceptable. Anticipated annual dredging under this configuration is 200 to 400-cubic yards. Dredge material is typically barged downstream of the project and emptied into a deep portion of the channel.

10.5 TRASHRACK DEBRIS ACCUMULATION

a. Automatic Gripper Rake

(1) This trashrack cleaning system has separate electric motors for monorail travel, raising and lowering the gripper rake, and to drive a compressed air system for actuating the gripper rake. The system positions the rake above a section of trashrack and lowers the gripper rake down the trashrack to clean off debris.

The UHMW teeth on the rake partially penetrate the vertical trashrack bars to clean out debris. When the rake reaches the bottom, the teeth close together, and the rake is drawn back to the monorail on a roller. Debris is emptied into a bin (or truck) at the north end of the monorail and the rake is re-positioned. The process is completely automated and can be initiated by a timer, water level differential across the trashrack, or manually. The debris bin or truck will need to be emptied periodically. Woody debris and vegetation collected from trashrack cleaning is usually burned, when permitted, on the project site. Trash and rubbish are disposed offsite.

(2) Routine quarterly maintenance and inspection will be required for the hydraulic system, the trolley drive, the rake hoist, and wear of the trashrake head. Annual inspection of the trashrack, by divers, should be performed to insure that the system is cleaning properly. The entire system should be operated at least weekly to insure that the trashracks do not build up debris, which may be difficult to remove if left for longer periods of time.

(3) Large floating logs can accumulate in the forebay adjacent to the fish unit intakes. The proposed trashrack cleaner is capable of removing the logs. However, the primary purpose of the trashrack cleaner is to remove smaller debris that clogs the trashrack below the surface. Existing methods of removing a log buildup in the corner of the forebay should be continued in order to keep the surface area clear. This will allow trashrack cleaning to occur in a regular and timely manner.

10.6 DIFFUSER RACK CLOGGING

a. The differential pressure at each of the two monitoring locations (B Gates and A Gates) will be digitally displayed on the SA24 panel along with the existing operating parameters. Routine observations of the differential levels should be made at least on a weekly basis and more frequently during periods of high flow. Differential pressure greater than 2-feet is excessive, however 0.4-feet is indicative of clogging. Typically, the differential across the grating will be less than 0.01-feet. At the first indication of clogging, an inspection by divers should be initiated at both the diffuser grating and the trashrack.

b. Little maintenance is required for the system. However, quarterly inspections of the transducer performance should be performed. This will involve raising the transducer within the conduit a predetermined distance (approximately 2 feet) and comparing the change on the digital readout to insure proper operation. Clogging in the conduit may occur and require cleaning by snaking and flushing. A clogged or flattened vent tube in the transducer cable will require replacing the transducer.

SECTION 11 -- COST ESTIMATES

11.1 PROJECT DESCRIPTION

a. The B2 powerhouse at the Bonneville Project is located on the north side of the Columbia River at Mile 146 about 40 miles east of Portland, Oregon. The AWS supplies water to the adult fishway through diffuser chambers over a range of tailwater elevations. The focus of the B2 AWS Backup Alternative Study is to recommend system modifications to resolve deficiencies in the AWS backup water supply. Seven items are considered in this report. The major features of each item are discussed in detail in Section 2 of this report. Costs were developed for the following:

(1) Floating Orifice Closure

(2) Stockpile Crucial Turbine and Generator Parts

(3) Portable Gate Actuator

(4) Operations Plan Verification Testing

(5) Automatic Traveling Grip Rake and New Trashrack

(6) Blanking Off Lower Trashracks

(7) Diffuser Grating Monitoring System

b. This section summarizes the cost of each remedial alternative group and explains some of the major design features of each option within each group. Finally, in-water work periods, assumptions, and wage rates are discussed. See Appendix D for the MCACES Cost Summary Table for the estimate.

11.2 SUMMARY OF COSTS

a. Table 11-1 presents the costs in tabular form. The total project price is $2,373,490.

Table 11-1
Cost Summary

Item	Cost
Floating Orifice Closure	$181,972
Stockpile Crucial Spare Parts	$129,945
Portable Gate Actuator	$9,605
Operations Plan Verification Testing	$47,850
Trashrack Cleaning Schemes	
Automatic Traveling Grip Rake and Trashrack	$1,785,180
Blanking off Lower Trashrack Panels	$132,250
Diffuser Grating Monitoring System	$86,688
Total	$2,373,490

b. Project Description. A brief description of the work to be done in order to implement each alternative is provided below.

(1) Floating orifice closure. This alternative consists of 8 – 24 x 72-inch, low head (2-foot) aluminum slide plates and 4 – 48 x 72-inch, low head (2-foot) aluminum slide plates mounted on the upstream (collection channel side) of the floating orifice. To install the slide plates, the gates will be lifted to the deck at EL 55 and placed by hand with or without the assistance of a boom truck. A tag line attached to the plate will allow the slide plate to be removed without lifting the floating orifice gate to the deck level.

(2) Stockpile crucial spare parts. This scheme consists of buying spare turbine and generator parts for use immediately after a fish unit turbine goes off-line. Project personnel have reviewed inventory and accessed the likelihood of parts failures.

(3) Trashrack debris accumulation and diffuser rack clogging. The trashrack cost is based on steel weight for a trashrack similar to the existing racks, but with a deeper (2-inch) bar. Only 4 of the 5 panels will be replaced since the lower panels will be blanked off and re-used.

(4) Operations plan verification testing. Further testing to verify operation plan recommendations.

(5) Automatic Traveling Grip Rake and New Trashracks: This consists of replacing the existing trashracks and trashrake with a monorail mounted traveling gripper rake similar to the system manufactured by Brackett Green. Dredging will be required upstream of the intake. The existing trashracks will be removed, and the new trashrack and monorail type cleaner will be installed. Power will be extended to a junction box at the north end of the Fish Unit intake.

(6) Blanking Off Lower Trashrack Panels: This involves welding a blank panel onto the face of the bottom existing trashrack panel, thereby shortening the total trashrack length of each trashrack section.

(7) Monitor diffuser rack clogging. This item provides two sets of level transmitters, one at the A diffuser gates, adjacent to the North Upstream Entrance and one at the B Diffuser Gates adjacent to the South Upstream Entrance. Two transmitters are included at each location, upstream and downstream of the diffuser grating. Each level transmitter will connect to a local digital transmitter to communicate over a pair of communication wires with a central panel. Annunciation of the levels and alarms will be incorporated into the programmable logic controller in the SA24 panel.

11.3 BASIS OF THE ESTIMATE

a. The basis of the estimate is the *Final Submittal, Bonneville Second AWS Backup Design Documentation Report* and drawings submitted October 2001 (under Contract No. DACW57-97-D-0004, Task Order Case No. 0023).

11.4 CONSTRUCTION SCHEDULE

a. Anticipated construction work would take place between September 2003 and February 2004. Restrictions on in-water work apply between March and November of each year.

b. No overtime is anticipated during construction, but some double shifts may be necessary during in-water work periods.

c. The project will be accomplished using one construction acquisition plan.

11.5 SUBCONTRACTING PLAN

a. Not applicable.

11.6 CONTINGENCY AND ESCALATION

a. Each estimate includes a 20% contingency and 8% escalation. The escalation factor is based on the midpoint of construction for the project of October 2003. The indices for escalation were based on the Tri-Service Military Construction Program (CMP) Index for FY97 through 04 Program, dated January 1998. The construction project was expected to take one year to construct and require one in-water work period from December to February of 2003-2004.

11.7 PROJECT CONSTRUCTION

a. Project site access will be by an existing paved road to the B2 site and by barge on the Columbia River.

b. Construction Methodology: Construction of the different alternatives will require civil, structural, mechanical and electrical work to be performed in a sequenced and coordinated fashion.

c. Unusual Conditions: Cold winter weather when in-water work is allowed, high winds and rough water are conditions that make working on, and adjacent to the Columbia River and B2 difficult.

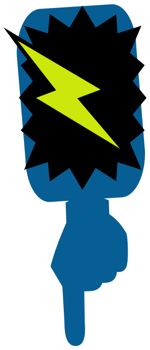
d. Equipment/Labor Availability and Distance Traveled: Construction equipment will be mobilized and demobilized by the general construction firm securing the contract. It is anticipated that the firm will be from the Oregon/Washington area.

e. Labor was assumed to be available without restriction considering the close proximity to the Portland area.

SECTION 12 -- CONCLUSIONS AND RECOMMENDATIONS

12.1 AWS OPERATIONS ALTERNATIVE

a. Emergency Operations Manual. The instruction in the emergency operations manual should be implemented when a fish turbine goes off line. Verification of the recommended emergency fishway settings should be undertaken at low, medium, and high tailwaters, before adopting the operations plan into the FPP.



FLOATING ORIFICE CLOSURE SCHEMES.

a. Aluminum Sliding Orifice Closure. Attaching a slide plate to the tailrace side of the floating orifice gates is the recommendation of this DDR. This concept is simple and cost effective. Installation can occur in one night shift. Installation can be accomplished by lifting the floating orifice gate to deck level and sliding the plates into the guides. This method allows visual inspection of the gate guides. If the guides are fouled, they can be pressure washed to ensure proper seating. Removing the plates can be accomplished by using a portable crane to pull up a tag line secured to the slide plate, while the floating orifice gates remain in position. Plates will be stored and transported in a steel rack.

12.3 SEDIMENT ACCUMULATION.

a. Block Lower Portion of Trashrack. Because of the rapid infilling of sediment in front of the Fish Units, a dredging program by itself would be insufficient. The sediment buildup that occurred between 1997 and 1998 demonstrates that the existing trashrack invert will be partially buried within a single season. Dredging should not occur during the operation of the AWS. Therefore, the frequency of dredging required would be once per year. Consequently, the sediment accumulation, alternative of blocking the lower portion of trashrack is the only feasible alternative.

12.4 TRASHRACK DEBRIS ACCUMULATION.

a. Trashrack Cleaner. Installation of the automatic traveling grip rake is recommended. The existing trash rack should be replaced with a trash rack designed by the same manufacturer that builds the trashrake. Pneumatic actuation of the gripper is recommended to avoid contamination of the fishway with hydraulic fluid.

12.5 MONITORING DIFFUSER RACK CLOGGING.

a. Recommendation. Installing a diffuser grating differential pressure monitoring system is recommended.

12.6 STOCKPILING CRUCIAL SPARE PARTS.

a. Recommendation. Proceed with the purchase and stockpiling of the spare parts listed in Section 9.

APPENDIX A

LIST OF REVISIONS

APPENDIX B

TECHNICAL REVIEW DOCUMENTS

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 1 of 2

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY

PROJECT **Bonneville 2 AWS Backup System**

90% DDR ITR Review

LOCATION

DATE 8/30/01

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY

NAME **Pete Wiedemann**

PHONE NUMBER **425-453-5005 ext. 5085**

☐ ARCHITECT ☒ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	Page i Operations Plan, second bullet	For added clarity consider changing "aluminum slide plates" to "aluminum sliding closure plates."		C	
2.	Para 1.4	No "Agency Coordination" text has been provided.		Noted	
3.	Para 6.3 a.	See Comment No. 1		C	
4.	Para 6.5	It is not clear what the main gates are. Should this be Fishway Main Entrance Gates?		C	
5.	Para 6.7.a.(2)	First sentence is unclear. Is the cleaner manually or automatically operated?		C – the cleaner can be operated either manually or automatically. This will be clarified.	
6.	Para 6.7.b.(4)	It is unclear as to how a toothed rake will be able to lift sediment.		This issue will be addressed with the manufacturer.	
7.	Para 8.1 a. (1)	In the fourth line, clarify what the "additional bulkheads" are.		C – " additional" has been changed to existing.	
8.	Paras 9.1 b.,c, & d	These three paragraphs are confusing. Para b. talks about crucial spare parts, but it's not clear if any of these parts are in the current inventory. Table 9-1 title should state "Crucial Spare Parts List". How do paragraphs. c and d. relate to the above? The two items discussed here are not listed in the table, but sound "crucial."		The word "cooling" has been added to paragraph c. Paragraph d explains that the project staff no longer requests a new 3D Cam Controller.	

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 2 of 2

DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☐ PLANS & SPECS ☒ CONCEPT ☐ PRELIMINARY ☐ FINAL	PROJECT **Bonneville 2 AWS Backup System** **90% DDR ITR Review**	LOCATION	DATE 8/30/01	

REVIEWER ☒ CH2M/MW JV ☐ AIR FORCE ☐ ARMY	NAME **Pete Wiedemann** PHONE NUMBER **425-453-5005 ext. 5085**	☐ ARCHITECT ☐ LAND ARCHITECT ☐ CIVIL ☐ SANITARY	☒ MECHANICAL ☐ ELECTRICAL ☐ STRUCTURAL ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
9.	Para 12.2 a (2) (i)	Since the potential release of hydraulic fluid into the fishway exists with both alternatives, should it be mentioned at all? This disadvantage can't be used to compare the two alternatives..		It was included to be sure it was discussed. With the decision to adopt Alt2, the gripper type rake, the issue becomes moot.	

REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

PAGE 1 OF 1

DESIGN DOCUMENT TYPE

☒ DESIGN MEMO ☒ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY ☐ **90%**

PROJECT Bonneville Second Powerhouse
Auxiliary Water Supply Backup System

LOCATION Bonneville second Powerhouse

DATE 9/14/01

REVIEWER

☒ NWP-OP-B
☐ AIR FORCE
☐ ARMY
☐

NAME Thomas P. Delaney

PHONE NUMBER 216-623-6003

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☒ STRUCTURAL
☐ SANITARY ☐

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	Para 5.1.b.1	Is the general structural safety factor used for aluminum and steel design?		Yes, this will be clarified in the text.	
2.	Para 5.5.a	What is the thickness of the bar grating for the diffuser rack?		C – Bearing bars are 3/16" x 1¼" – Details will be included on Plate 11.	
3.	Plate 10	In the detail callout in section B the aluminum closure plate is called out as UHMW.		C	
4.	Plate 10	In section B, won't the UHMW in the guides eventually begin to bind against the closure plate?		Lifting lags will be spread out further to insure an even vertical pull.	
5.	Plate 10	Why is the tack line for the new closure plate shown at an angle as it goes up to the deck at elevation 55?		The position of the tag line tie off point is arbitrary. It could be hung anywhere in the slot.	
6.	Plate 10	In detail 1, a 3/8" steel eye bolt seems kind of small.		The eye bolt only needs to support the weight of the cable and clearance is limited.	
7.					
8.					
9.					

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

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DESIGN DOCUMENT TYPE			PROJECT Bonneville Second Powerhouse AWS Backup System 90% Review	LOCATION Bonneville Second Powerhouse
☐ DESIGN MEMO	☐ CONCEPT	☐ FINAL		DATE 9/19/00
☐ PLANS & SPECS	☐ PRELIMINARY	☒ **DDR**		

REVIEWER			
☐ NHC	NAME Richard Regan	☒ Hydraulic	☐ MECHANICAL
☐		☐ LAND ARCHITECT	☐ ELECTRICAL
☐	PHONE NUMBER 206-241-6000 360-437-5153	☐ CIVIL	☐ STRUCTURAL
☐		☐ SANITARY	☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	Cover	The cover page should credit Northwest Hydraulic Consultants Inc. along with CH2M Hill / Montgomery Watson as a large portion of the work was accomplished by **nhc**		C – Cover will include nhc.	
2.	Figure 2.2	Is the title to this table incorrect? Should it be " …with Existing Trashrack" ?		C	
3.	Para. 2.4 f	Should include a discussion that even if the sediments could be suspended and flushed there is the issue of the diffuser grating that would block gravel size material.		C	
4.	Para. 2.4 g	Check the values for head loss between the AWS and the Collection Channel. 1 to 1.5 ft seems excessive.		Field measurements and numerical modeling indicate 1.0 to 1.5 ft is a reasonable range.	
5.	Table 2.2	This shows two 2-North columns, shouldn't one be 2-South?		C	
6.	Para 2.5 b (4)	The last sentence describes two sensors one upstream and the other downstream of a grate. Suggest that above and below in place of upstream and downstream.		C	
7.	Para 2.5 c (4)	Should specify which main gate will be closed.		C	
8.	Para.3.1	This study does not address juvenile entrainment, should the report include some discussion on this issue.		C – A discussion of the juvenile entrainment issue will be added to Section 3-2.	
9.	Table 3.2	Juvenile swimming speeds are listed here but are not used or discussed in the report. What purpose do the table serve?		C - Juvenile swimming speeds were included when screened intakes were being considered. The table will be removed.	

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 2 of 3

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☐ CONCEPT ☐ FINAL

☐ PLANS & SPECS ☐ PRELIMINARY ☒ **DDR**

PROJECT Bonneville Second Powerhouse AWS Backup System

90% Review

LOCATION Bonneville Second Powerhouse

DATE 9/19/00

REVIEWER

☐ NHC

NAME Richard Regan

PHONE NUMBER 206-241-6000
360-437-5153

☒ Hydraulic ☐ MECHANICAL

☐ LAND ARCHITECT ☐ ELECTRICAL

☐ CIVIL ☐ STRUCTURAL

☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
10.	Para 4.1 b (2)	Make clear that the operating discharge is total river discharge		C	
11.	Para 4.1 f (2)b	Dates given for Shad passage are also dates given in table 3-1 for all the other species. Suggest eliminating the dates.		Shad are not included in the table. This data is included in response to ITR comments.	
12.	Para. 4.3 e(4)	Suggest that the recommendation be made to add staff gages and repair and or extend the existing ones.		This is an operations and maintenance item decision. Project biologists should make this recommendation.	
13.	Para. 4.3 i	I don't understand how the selection was made from patterns shown on the table 4-2? This needs to be explained in more detail.		Text will be modified to clarify this statement.	
14.	Para. 5.3 a (2)	Is the removal of the plate accomplished with the Fishway in operation? If so has the load on the slide plate been determined and the lifting line been sized for this load?		The load is identified in 5.1b. Its source will be identified in same location. The lifting line and connection between the plate and the line will be specified during P&S.	
15.	Para 6.3 a	If both plates are the same height (6-ft) that the weight of the 2-ft wide one should be ½ of the 4 ft wide one,		The plates vary in thickness. See Plate 10, Section B.	
16.	Para 8.1 a (1)	With the fishway out of operation why do bulkheads have to be placed when a floating orifice is removed? Seems like as many orifices as needed can be removed at one time to accomplish the work in the allowed December through February time period.		Discussion is added to address this point.	
17.	Para 10.2 a	The word "in" appears to be missing in the first sentence.		C	
18.	Para 10.4 a	Should include an annual sediment monitoring program and only dredge when necessary.		C	

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 3 of 3

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☐ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY x **DDR**

PROJECT Bonneville Second Powerhouse AWS Backup System
90% Review

LOCATION Bonneville Second Powerhouse

DATE 9/19/00

REVIEWER

☐ NHC
☐
☐
☐

NAME Richard Regan

PHONE NUMBER 206-241-6000
360-437-5153

☒ Hydraulic ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	**DRAWING SHEET SPEC PARA**	**COMMENTS**	**REVIEW CONFERENCE** (A = Comment accepted) (If not accepted explain)	**DESIGN OFFICE** (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	**BACK CHECK BY** (Initials)
19.	Plate 10	Detail 2 shows a top seal. Question the need for the seal. A design with a minimum gap would be acceptable.		If a top seal is not included in the design, a UHMW strip should be included to separate dissimilar metals. This issue can be settled during plans and specs.	

11/05/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 1 of 2

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL

☐ PLANS & SPECS ☐ PRELIMINARY

PROJECT **Bonneville 2 AWS Backup Alternatives Study**

90% DDR ITR Review

LOCATION

DATE **5/9/01**

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY
☐

NAME **Al Giorgi**

PHONE NUMBER **425-883-8295**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☒ BIOLOGICAL

			ACTION TAKEN ON COMMENT		
ITEM NO.	**DRAWING SHEET SPEC PARA**	**COMMENTS**	**REVIEW CONFERENCE** (A = Comment accepted) (If not accepted explain)	**DESIGN OFFICE** (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	**BACK CHECK BY** (Initials)
1		General- The 90% appropriately treated matters identified at the 60% submittal. No new issues were apparent in this version.		Noted	-----
2					
3					
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REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

PAGE OF

DESIGN DOCUMENT TYPE

☒ DESIGN MEMO ☐ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY ☒ 90%

PROJECT Bonneville Second Powerhouse
Auxiliary Water Supply Backup System

LOCATION Bonneville second Powerhouse

DATE 8/22/2001

REVIEWER

☒ NWP-OP-B
☐ AIR FORCE
☐ ARMY
☐

NAME Patrick Hunter

PHONE NUMBER 541/374-4573

☐ ARCHITECT ☒ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	Para. 2.4 d.	Who is the Hydraulic Design Center and how did they determine the Fish Units could be operated with the lower trashrack blocked? Was this a physical model test or a computer model test? Was there a decrease in efficiency? Were there limits on flow?		C. Hydroelectric Design Center. Brian Moentenich compared the physical features and dimensions of the B2 to some units that had been modeled physically at WES. From these comparisons he concluded that there would not be a measurable effect on the turbine performance, assuming that the trashracks were kept clean. He stated that trash would probably accumulate more quickly and reccomended that more frequent monitoring of head loss across the trash racks be done.	
2.	Para 2.5(3) (c)	Says positive normal is in the direction of the powerhouse. This is unclear. Is it the same as the direction of the water flow?		Yes, this will be clarified.	
3.	Para 2.5(3)(d)	Do the trashrake manufacturers normally make trashracks also?		Yes, this will be clarified.	
4.	Para 2.5(3)(e)	Were calculations actually made to determine that alternative materials have to be so large that the velocities are unacceptable?		We did not calculate but used experience.An alternate material was installed at Naches. We have a sample and it is big. In order to get the same strength or resistance to bending, the clear space is much smaller as a ratio to the bar width than it is with a steel bar. The intake width is already set, leaving less area available to flow as it is taken up by the bar width.	
5.	Para 2.5(3)(e)	Why does an elliptical shape exacerbate clogging?		The clear space between two elliptical bars standing side by side forms the shape of a funnel. It is widest at the upstream edge and narrowest in the middle. This profile will tend to orient trash as it encounters the outer edge of the bars and then wedge the debris into the narrowest section of the rack, whereas a rectangular section tends to retain bebris on the face of the trashrack.	
6.	Para 2.5(3)(e)	Why is neither proposed trashrake compatible with an alternative material trashracks? The rakes are made of alternative materials.		The HDPE trashracks have a much lower strength than steel and require a deeper section with support bars through the middle in addition to the back supports. This configuration would interfere with the penetrating teeth of the rake.	

REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

PAGE OF

DESIGN DOCUMENT TYPE

☒ DESIGN MEMO ☐ CONCEPT ☐ FINAL

☐ PLANS & SPECS ☐ PRELIMINARY ☒ **90%**

PROJECT Bonneville Second Powerhouse
Auxiliary Water Supply Backup System

LOCATION Bonneville second Powerhouse

DATE 8/22/2001

REVIEWER

☒ NWP-OP-B
☐ AIR FORCE
☐ ARMY
☐

NAME Patrick Hunter

PHONE NUMBER 541/374-4573

☐ ARCHITECT ☒ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
7.	Plate 13	The parking location for Alt 1 blocks the roadway and prevents parking for at least 3 vehicles. Can the machine be parked slightly south in line with the retaining wall if required?		Yes	
8.	Para 6.7a(4) and b(5)	It isn't clear if there are four single trashracks, 53 foot lengtheach or four 13.5 foot trashracks in each slot. It would be difficult to handle a 53 foot long trashrack.		C - There are four 13.5-foot sections installed in each of four slots. Will clarify text.	
9.					

REVIEW COMMENTS

Page [ ] of [ ]

DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☐ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY ☒ **90% DDR**	PROJECT Bonneville 2nd Powerhouse AWS Backup DDR, 90%	LOCATION Bonneville Dam, OR/WA	DATE 8/16/01

REVIEWER		
☐ CENWP-EC-DX ☐ AIR FORCE ☐ ARMY	NAME Pat Jones PHONE NUMBER X4790	☐ ARCHITECT ☐ MECHANICAL ☐ LAND ARCHITECT ☐ ELECTRICAL ☐ CIVIL ☐ STRUCTURAL ☐ SANITARY ☒ COST

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number where correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	General	Suggest that Ed Zurawski of Montgomery-Watson check the next submittal of the estimate.	A	Agreed.	
2.	General	Please submit an electronic copy of the MCACES estimate to me. e-mail: patrick.t.jones@usace.army.mil	A	The electronic copy will be sent today.	
3.	MCACES Summary Sheets	There are several blanks on these sheets. Can you fill them in?	A	To reduce confusion, the summary totals of the various alternatives were covered to be blank.	
4.	Detail page 1	Looks like only 400 labor hours are included in this item. Note states it should include 500 hours of labor.	A	The estimate detail will be changed to reflect 500 labor hours to match the note.	
5.	Detail page 4	I can't find the referenced "attached spreadsheet."	A	The Seattle office will forward, as estimate backup, the spreadsheet detailing the costs for the spare parts.	
6.					
7.					
8.					
9.					
10.					

REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 1 of 1

DESIGN DOCUMENT TYPE

☒ DESIGN MEMO ☐ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY ☒ **90%**

PROJECT: Auxiliary Water Supply Backup System

LOCATION: Bonneville Second Powerhouse

DATE 8/29/00

REVIEWER

☒ CENWP-EC-DE
☐ AIR FORCE
☐ ARMY
☐

NAME Duncan Kwong
duncan.kwong@usace.army.mil

PHONE NUMBER (503)808-4920

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☒ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ HYDRAULIC

ACTION TAKEN ON COMMENT

ITEM NO.	**DRAWING SHEET SPEC PARA**	**COMMENTS**	**REVIEW CONFERENCE** (A = Comment accepted) (If not accepted explain)	**DESIGN OFFICE** (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	**BACK CHECK BY** (Initials)
1.	Para 7.7.a(3)	Please do not use any pole-mounted cable reel assemblies or any other pole mounted devices.		C – The alternative proposing this supply has been dropped.	
2.	Para 7.8.a(1)	Identify where is the 24 VDC power supply for the transducers coming from and where the 120VAC supply for the power supply is coming from.		C – Power supply will be separate from the MTL module and located in panel SA24.	
3.	Para 8.5.a(b)	The panel in the Fish Evaluation Facility is limited to 200A and when the two air compressors and air dryer are running there may not be sufficient power for a 50 hp motor.		C – This alternative has been dropped from the report.	
4.	Para 8.5.a(f) & (g)	Please do not use any pole mounted devices.		See note 1	
5.	Para 10.6	Identify where will the power for these transducers be coming from.		See note 2	
6.					
7.					
8.					
9.					
10.					

NPD Form 1110-2-E (Test), Feb 95 *Replaces NPD Form 32, which is obsolete.* *Proponent Office: CENPD-ET-PG*

File: G:\COE Portland\WO 23 Bonne 2 AWS DDR\Studies and Reports\Reports\DDR 10_01\Response Comments\90% comments\response to comments\response B2 AWS Backup System DDR 90% (Kwong).doc

REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

PAGE OF

DESIGN DOCUMENT TYPE

☒ DESIGN MEMO ☐ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY ☐ **90%**

PROJECT Bonneville 2nd Powerhouse Auxiliary Water Supply Backup System DDR – 90% Submittal

LOCATION

DATE 9/6/01

REVIEWER

☐ NWP-EC-D_______
☐ AIR FORCE
☐ ARMY
☐

NAME David Illias

PHONE NUMBER X4901

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐

ACTION TAKEN ON COMMENT

ITEM NO.	**DRAWING SHEET SPEC PARA**	**COMMENTS**	**REVIEW CONFERENCE** (A = Comment accepted) (If not accepted explain)	**DESIGN OFFICE** (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	**BACK CHECK BY** (Initials)
1.	Par. 1.2	The delivery order is not the proper authorization. Isn't it a particular BIOP measure.		C – This study is authorized under Appropriation 96x3122, Construction General, Columbia River Mitigation. This work is mandated by the 1998 Supplemental Biological Opinion and the 2000 Biological Opinion, Measures Nos. 125 and 127.	
2.	Par. 2.1	Isn't the corner collector outfall being studied at the present time. Reference to that study should be included in the text along with any other related study.		C – Will site report.	
3.	Par. 2.1.a	Citing that the 1996 flood event represent an extreme condition. Need to provide a more typical annual accumulation.		Quantitative information regarding typical accumulation is not available. Attempts to evaluate accumulations during the preparation of this report have been hampered by excessive leakage in the AWS during maintenance. This also has disrupted annual maintenance during the in water work period. Recommendations will be made to measure and record any sediment accumulation on an annual basis.	
4.	Par. 10.4	Is there a dredge material disposal site. Note where the dredge materials are disposed.		C – Discussion of dredge material disposal will be included.	
5.	Par 10.5.b	Is a debris truck required for this alternative. If so then it should be included in the cost estimate.		Existing equipment is anticipated to be used for debris disposal.	
6.	Par. 11.2	The alternative cost comparison should be based on annual costs and not just first costs. The annual cost should include labor required to operate alternative one		It was agreed at the 90% PRM to proceed with the gripper type trash rake for reasons other than cost.	
7.	General	The report should describe the type, size and estimated quantity of debris. The log boom (large debris barrier) will need to be removable in order to remove any large sinker logs. Also will the project crane be able to remove debris outside the barrier. Suggest try not constructing the barrier and see how it works without one.		C. It was agreed at the 90% PRM to not include the log barrier. A discussion regarding floating debris will be included in Section 10.5.	
8.	Plate 10	Suggest providing a plan to determine the location of the orifice closure in relation to the fishway channel.		C – A plan view is included on Plate 10.	
9.					
10.					
11.					

REVIEW COMMENTS

Page [ ] of [ ]

DESIGN DOCUMENT TYPE ☒ DESIGN MEMO ☐ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY ☐ %	PROJECT Bonneville Second Powerhouse Aux. Water Supply Backup System, DDR	LOCATION Bonneville Second Powerhouse	DATE 8-31-01

REVIEWER

☒ CENWP-EC-DM
☐ AIR FORCE
☐ ARMY
☐

NAME Dwayne Weston

PHONE NUMBER
503-808-4928

☐ ARCHITECT
☐ LAND ARCHITECT
☐ CIVIL
☐ SANITARY

☒ MECHANICAL
☐ ELECTRICAL
☐ STRUCTURAL
☐

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number where correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1.	6.3-a	Please describe in the text a range of design head for slide gates.		The design head is reported in the criteria section. The gates are floating. The head remains constant throughout the design tailwater range.	
2.	6.4 b	Last sentence in paragraph b makes reference to "proposed portable actuator for B diffuser", I do not see the proposed actuator listed in the section discussing B gates (section a)		C	
3.	6.7 General	Both alternatives show a log barrier. Describe in text how will this be cleaned?		It was decided at the 90% PRM to delete the log barrier.	
4.	6.7 General	Describe in text types of debris common to this intake.		C	
5.	6.7-a and b	Please state range of estimated time between cleaning cycles.		C – discussion will be added.	
6.	6.7-b(5)	Depth of new trash rack is not specified for this system.		C – This will be added. Note it is stated in Section 5 (–9fmsl)	
7.	6.7 General	Please discuss some of the operational advantages and disadvantages to each system. Please make a recommendation of best type of system.		It was decided at the 90% PRM to move forward with the gripper type trash rake.	
8.					
9.					

To: "Dennis Dorratcague (E-mail)" <dennis.dorratcague@mw.com>, "Peter Barton (E-mail)" <Peter.T.Barton@us.mw.com>
cc:

Subject: FW: 90% Comments

fyi

-----Original Message-----
From: **Dasso, Joseph M NWP**
Sent: Wednesday, August 29, 2001 11:24 AM
To: Maurseth, Jerome A NWP
Subject: 90% Comments

Jerry,
About the only comment I have is the following:

I don't see the need for a construction schedule in this DDR. I don't have any idea exactly how, in what order, when, and who will pay for, implementing each of the recommendations. So having a schedule is kind of silly. What I think will actually happen is we will present the finished report (recommendations) to FDDRWG and that body will help us establish priorities. Then you and I will budget and schedule accordingly.

Mark

Response:
Schedule will be deleted from report. Long lead time items will be identified.

11/07/01REVIEW COMMENTS

Page 1 of 1

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY

PROJECT **Bonneville 2 AWS Backup Alternatives Study**

60% DDR ITR Review

LOCATION

DATE **5/22/01**

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY

NAME **See Item No. 1**

PHONE NUMBER **425-453-5000 (Wiedemann)**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1	-----------------	The reviewers are indicated by their initials as follows: PFW – Pete Wiedemann Mechanical Review RR – Dick Regan Hydraulics Review TD – Tom Delaney Structural Review			-----------
2-PFW	General	Scope of study is confusing. The title on the cover implies only a backup (new?) system to the AWS is being studied. However, para 1.1.a states that a backup (emergency) system already exists. In addition, the first para. of the syllabus states the study covers O&M considerations with the existing system.		Para 1.1.a lists deficiencies with the existing backup system. The syllabus states that the design, construction and the O &M costs will considered for any alternative being evaluated.	
3-PFW	Cover	The Montgomery Watson name should be replaced with the CH2M HILL M-W joint venture name.		C	
4-PFW	Syllabus, page i	Next to the last bullet: At the end of the sentence add – "(Alternative 4 of the Trashrack Cleaning Systems)".		C	
5-PFW	Table of Contents, page v	Only Appendix D has been provided.		Did not reproduce all the appendicies for the mechanical reviewer.	
6-PFW	Para 1.3.a.(3)	The rest of the document mentions only 3 transducers.		C – There are three pairs of transducers. Two transducers are installed at three locations.	
7-PFW	Para 1.4	No "Agency Coordination" text has been provided.		Noted	
8-PFW	Paras 2.5.c.(1) & (2)	Reference in both paragraphs is to a "trailer mounted compressor, generator and tank." Shouldn't this be: "trailer mounted compressor, air receiver, and diesel engine drive"?		C	
9-PFW	Paras 6.1.a.(1)(b), (2)(b),&(3)(b)	The 0.2 friction factor for the UHMW seals seems low for design purposes. In addition, the seals will need a higher "break-out" force to initially get the gate moving. This needs to be factored into the sizing of the operators.		The gates are very low head (2-feet) without wedging devices, therefore 0.2 should be an appropriate coefficient of	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

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DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY	PROJECT **Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**	LOCATION	DATE **5/22/01**

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY

NAME **See Item No. 1**

PHONE NUMBER **425-453-5000 (Wiedemann)**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
				friction. The hydraulic load factor of 2.0 accounts for unseating.	
10-PFW	Paras 6.1.c.(1)(f) &(2)(f)	The stated max. debris <u>load</u> is different for the two rakes. Is this because the two rakes have different <u>rated capacities</u>? If the telescoping rake has a larger capacity shouldn't this be listed as an advantage in Chapter 12? Also, the "design log" at Bonn 2 powerhouse s 2' in diameter, 40 feet long, and weighs 8000 lbs. There's some chance this could become a "sinker" and have to be fished out from the bottom. Do we have a problem here with either trashrake, or will some other crane be used?		C: The stated debris load pertains to the rated capacity. Alt. 1 has a higher capacity and this will be included as an advantage. Extraordinary debris, such as logs, will need to be handled by the gantry crane. This will be clarified in the text.	
11-PFW	Para 6.5	Not clear what the Main Gates are. Should this be Main Entrance Gates?		C	
12-PFW	Paras 6.7(a)(4) & (b)(4)	Both paragraphs should state how much deeper the trash rack bars need to be.		C: The bar depth is 2-inches minimum and will be clarified in the text.	
13-PFW	Para 8.1.a	For consistency with the rest of the document, the heading should read: "Alternative 1 – Slide Gate Mounted to Floating Orifice (Upstream Side).		C	
14-PFW	Para 8.1.a.(1)	In the fifth sentence clarify what the "additional bulkheads" are.		C	
15-PFW	Para 8.1.b	For consistency with the rest of the document, the heading should read: "Alternative 2 – Slide Gate Mounted to Floating Orifice (Downstream Side).		C	
16-PFW	Para 9.1.e	In the first sentence, state the table numbers for the "previous tables."		C – Section is revised.	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE			PROJECT	LOCATION	DATE
☐ DESIGN MEMO	☒ CONCEPT	☐ FINAL	**Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**		**5/22/01**
☐ PLANS & SPECS	☐ PRELIMINARY				

REVIEWER

☒ CH2M/MW JV	NAME **See Item No. 1**	☐ ARCHITECT	☐ MECHANICAL
☐ AIR FORCE		☐ LAND ARCHITECT	☐ ELECTRICAL
☐ ARMY	PHONE NUMBER **425-453-5000 (Wiedemann)**	☐ CIVIL	☐ STRUCTURAL
		☐ SANITARY	☐ Technical Review Team

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17-PFW	Para 9.1.e	Since Table 9-2 doesn't state that these are additional spare parts to purchase, it is not clear whether these parts are on hand, are to be purchased, or a combination of both.		C – Section is revised, Table 9-2 is deleted.	
18-PFW	Para 10.1.(a)	For consistency with the rest of the document, the heading should read: "Alternative 1 – Slide Gate Mounted to Floating Orifice (Upstream Side).		C	
19-PFW	Para 10.1.(b)	For consistency with the rest of the document, the heading should read: "Alternative 2 – Slide Gate Mounted to Floating Orifice (Downstream Side).		C	
20-PFW	Para 12.2.a.(1)(c)	State why this alternative is more reliable than Alternative 2.		C	
21-PFW	Paras 12.4a.(2)(f) & (b)(2)(a)	Since debris has to be disposed of with either raking options, why is it a disadvantage to both?		This was included to highlight the disposal requirements. Currently the cleaning method does not remove debris from the flow-stream, rather debris passes through the Main Units.	
22-PFW	Plate 2	Too many superfluous callouts; the studied features do not stand out. A larger scale, just showing the dam, might also be helpful.		C – Callouts removed. Dam is shown in figures included in Appendix F.	
23-PFW	Plate 11	Is the UHMW seal assembly, in Section B, similar to what is required for Alternative 1? If so, so state.		The gate seal will depend on the manufacturer's standard for a low seating head / no unseating head fabricated gate. The frame and seals for these gates differ from the Section B detail. Note; clearance is not an issue on Alternative 1.	
24-PFW	Plate 12	Drawing is very difficult to follow. The text (para 2.5 c.(3)) states that this alternative consists only of a "stab plate" and "detachable lifting mechanism" However, different terminology is used on the drawing, and it is not clear from view-to-view what is the stab plate and what is the lifting mechanism. In		C	

11/07/01REVIEW COMMENTS

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DESIGN DOCUMENT TYPE
☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY

PROJECT **Bonneville 2 AWS Backup Alternatives Study**
60% DDR ITR Review

LOCATION

DATE **5/22/01**

REVIEWER
☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY

NAME **See Item No. 1**
PHONE NUMBER **425-453-5000 (Wiedemann)**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
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☐ SANITARY ☐ Technical Review Team

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		addition, if Section B/11 is the section shown on Plate 11, then Plate 11 should refer back to Plate 12.			
25-PFW	Plate 13	Alternate 2 Section: "Sheave" is misspelled and "STN STL" should be added to the abbreviation list.		C	
26-PFW	Plate 14	It might be helpful to call out the debris bin on the Detail Section.		C	
27-PFW	Plate 15	In the Detail Section: the clearance between the gripper and monorail knee brace may not be sufficient for the monorail to travel with gangly debris.		This may be a problem at the center support, but only with large limbs or logs, other debris will be broken or swept downward. This configuration has a minimum of 8-inches of clearance between the gripper and support column.	
1-RR	Page vii	Flow through orifices stated that flow varies with tailwater, this is not the case the flow varies with head difference across the orifice. Also states that there are 12 orifices whereas other portions of the report states that there are 20, which is correct?		C: Clarification made to text. There are 20 floating orifice openings, however, only 12 of those actually have operating floating orifices. The rest are closed with permanent bulkheads.	
2-RR	Numerous pages	The report discusses model studies to analyze conditions within the fishway system. The term model should be qualified throughout the report as a numerical computer model.		C	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY	PROJECT **Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**	LOCATION	DATE **5/22/01**

REVIEWER			
☒ CH2M/MW JV ☐ AIR FORCE ☐ ARMY	NAME **See Item No. 1** PHONE NUMBER **425-453-5000 (Wiedemann)**	☐ ARCHITECT ☐ LAND ARCHITECT ☐ CIVIL ☐ SANITARY	☐ MECHANICAL ☐ ELECTRICAL ☐ STRUCTURAL ☐ Technical Review Team

			ACTION TAKEN ON COMMENT		
ITEM NO.	**DRAWING SHEET SPEC PARA**	**COMMENTS**	**REVIEW CONFERENCE** (A = Comment accepted) (If not accepted explain)	**DESIGN OFFICE** (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	**BACK CHECK BY** (Initials)
3-RR	Sect. 2.4	Investigations should be accomplished to determine the source of the sediments, the % of material carried in suspension and as bed load, and the gradation of the material that is entering the AWS. If the majority of the material is suspended the design presented to keep material out of the AWS will not work. This material might be the remains of the upstream cofferdam and if so the remnants most likely are moving as bed load a dredging of this area in a manner that would provide a trap might stop the material transport into the units. However if as suspected the majority of the sediments are carried in suspension the only solution is a scheduled AWS sediment removal operation.		Further investigation may be worthwhile, however the proposed solution of blocking off the lower portion of the trashrack is at least a good first step. Given that the Fish Unit intakes have been buried at least twice it is likely that bedload movement is a significant contributor to the sediment build up within the AWS.	
4-RR	Sect 4.1 j (1)	Don't understand this statement. Needs to be clarified.		C- deleted	
5-RR	Figure 2.2 and 2.3	What is the basis for the data points shown on these two graphs? This basis should be explained in the text.		C	
6-RR	Sect 4.1 j (1)	What does this paragraph mean? Clarification is required.		C	
7-RR	Sect 4.2 b	Provide credit to NHC for this report		C	
8-RR	Sect 4.2 c (3)	Give credit to the author (Milo Bell) for this text.		C	
9-RR	Sect 4.3 b (2)	Is the entrance weir submergence 's' given value? here it states that it is computed. This should be checked and corrected as required.		C: Clarification made to text. The tailwater elevation is given; however, the weir elevation can be adjusted in the model.	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE

☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL
☐ PLANS & SPECS ☐ PRELIMINARY

PROJECT **Bonneville 2 AWS Backup Alternatives Study**

60% DDR ITR Review

LOCATION

DATE **5/22/01**

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY

NAME **See Item No. 1**

PHONE NUMBER **425-453-5000 (Wiedemann)**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☐ Technical Review Team

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
10-RR	Sect 4.3 c (2)	Should state in percent how much the AWS discharge is reduced with one turbine operation		C	
11-RR	Sect 4.3 c (3)	The words "lowest portion of the fish ladder" should be "lower portion of the fish ladder". ALSO this section discusses 20 floating orifices, this should be changed to 12. This same cmt. pertaining to orifices is applicable to the 6th bullet item in this Section.		C	
12-RR	Sect 4.3 c (3)	Third bullet item change the word "supplied" to "equipped"		C	
13-RR	Sect 4.3 c (3)	Fifth bullet item. The statement that not all diffusers have functioning gates is confusing. Does this mean that all diffusers have gates and some do not work or does it mean that some diffusers do not have gates. This should be clarified.		The condition of the powerhouse diffuser gates will be checked in June 2001. According to project staff, all gates are functioning and all openings have gates.	
14-RR	Sect 4.3 c (3)	Seventh bullet item. Why weren't operational changes to the Ladder diffusers considered. Should explain. By reducing discharge through these diffusers, it would provide water to areas that might need it more.		The ladder diffusers are controlled by weir valves. A structural modification would be required to change the operation of these diffusers. The amount of discharge through these diffusers is small compared to the B diffusers.	
15-RR	Sect 4.3 c (5)	Provide reference to the previous reports that you discuss		C	
16-RR	Sect 4.3 e	See comment 1F. This paragraph needs to be rewritten to qualify the expected accuracy of the model and not give the impression that the model that the model will provide adequate data to establish emergency operation.		Testing the operational changes at a low, medium, and high tailwater will be recommended in the 90% report.	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE			PROJECT **Bonneville 2 AWS Backup Alternatives Study**	LOCATION	DATE
☐ DESIGN MEMO	☒ CONCEPT	☐ FINAL	**60% DDR ITR Review**		**5/22/01**
☐ PLANS & SPECS	☐ PRELIMINARY				

REVIEWER				ACTION TAKEN ON COMMENT		
☒ CH2M/MW JV	NAME **See Item No. 1**	☐ ARCHITECT	☐ MECHANICAL	REVIEW CONFERENCE	DESIGN OFFICE	BACK CHECK BY
☐ AIR FORCE		☐ LAND ARCHITECT	☐ ELECTRICAL	(A = Comment accepted)	(C = Correction made. List drawing or paragraph number whwere correction made)	
☐ ARMY	PHONE NUMBER **425-453-5000 (Wiedemann)**	☐ CIVIL	☐ STRUCTURAL	(If not accepted explain)	(If not corrected, explain)	(Initials)
		☐ SANITARY	☐ Technical Review Team			

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	BACK CHECK
17-RR	Sect 4.3 j	This paragraph should provide more information pertaining to diffuser criteria not being met. Discussion on whether the criteria was exceeded the max or below the min., and how much is needed.		C	
1F-RR	Appendix F	The reconfigured model (no orifice flow and one turbine off) was somewhat verified for against the data taken for field test 1. The computed data did not compare to well with the observed, up to 0.4 ft off. Then this same model configuration is used to predict conditions with the tailwater 3 ft lower and 16.5 ft higher. A detail explanation must be presented in this appendix discussing expected accuracy at these extremes and the need for more field data especially at higher tailwater elevations.		Testing the fishway for a floating orifice condition requires a significant amount of project staff time and must be done during the winter maintenance period. As a result of some unforeseen complications during data collection for this particular test, the 0.4 ft difference was considered to be an outlier. Testing at other tailwater elevations will be recommended in the 90 percent report.	
1. TD	General	The floating orifices should be shown somewhere in the plates. I did not see them in the information I have.		Will add to Plate 2.	
2. TD	Section 5-1	There should be references in the text to each plate where an alternative is shown.		Will add reference.	
3. TD	Page 5-1	Add references to any Corps Engineering Manuals used.		Will add reference.	
4. TD	Page 5-4	Since there is nothing shown with respect to the structure of the trash rack or the diffuser rack, it is impossible to verify the information in paragraphs 5.4, 5.5, and 5.6. The structure for these racks should be shown somewhere.		Will add Plate 18 to show details.	
5. TD	Plates General	There are places where the existing structure is shown screened and some where it is not shown screened. The plates should be consistent when showing existing structure.		Will make consistent.	

11/07/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

DESIGN DOCUMENT TYPE			PROJECT **Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**	LOCATION	DATE **5/22/01**
☐ DESIGN MEMO	☒ CONCEPT	☐ FINAL			
☐ PLANS & SPECS	☐ PRELIMINARY				

REVIEWER				**ACTION TAKEN ON COMMENT**
☒ CH2M/MW JV ☐ AIR FORCE ☐ ARMY	NAME **See Item No. 1** PHONE NUMBER **425-453-5000 (Wiedemann)**	☐ ARCHITECT ☐ LAND ARCHITECT ☐ CIVIL ☐ SANITARY	☐ MECHANICAL ☐ ELECTRICAL ☐ STRUCTURAL ☐ Technical Review Team	

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6. TD	Plate14	In the Erection Bay Section-The callout for the proposed solid plate should be coordinated with the text. The text calls this plate a blank plate.		C	

07/30/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 1 of 3

DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY ☐	PROJECT **Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**	LOCATION	DATE **5/9/01**

REVIEWER

☒ CH2M/MW JV
☐ AIR FORCE
☐ ARMY
☐

NAME **Al Giorgi**

PHONE NUMBER **425-883-8295**

☐ ARCHITECT ☐ MECHANICAL
☐ LAND ARCHITECT ☐ ELECTRICAL
☐ CIVIL ☐ STRUCTURAL
☐ SANITARY ☒ BIOLOGICAL

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
1	1.1.b	I suggest two additional biological objectives be considered for inclusion: 1. Develop a strategy that prevents juvenile or adult salmonids from entering and being entrained within the auxiliary water system channel below the diffuser grates. 2. Be able to maintain NMFS criteria within the fishway, in the event of a fish turbine failure.		C. Text added.	-----
2	Section 3	Somewhere in this section it would be instructive to discuss the effects or risks to the adult salmonids that is associated with either the permanent or temporary closure of the orifices along the face of the dam. Investigators at the University of Idaho have evaluated effects of orifice closure at Bonneville. But to my knowledge the results have not yet been published. That information should be considered in the decision making process.		Requests for the results of the Uof I study on the effects of closing the floating orifices have been made on several occasions. The decision to permanently close the floating orifices can not be made without the results of the U of I study. Text will be added that states that there is a risk to the upstream migrants caused by reducing the number of entry points to the B2 fishway, however, this risk is unquantified. It may be that the orifice closure is a benefit to fish passage by reducing adult fallback along the powerhouse collection channel.	
3	Table 3-1	Consider adding shad to this table, since they are such a dominant using the fishway and certain operating conditions are maintained to accommodate shad.		Will consult with COE biologists.	
4	3.5.a	It may be helpful to state those adult criteria that are important in dictating strategies considered in the DDR For example the 1.5-4.0 fps water velocity criteria that the modeling effort focused on.		C. Text added. The charts in Appendix F provide a graphical method to visualize the extent that the channel velocities would be out of criteria. Entrance velocity, entrance gate submergence, channel velocity and diffuser velocity were all tracked and reported in the numerical modeling effort. Using the	

07/30/01REVIEW COMMENTS

(For use of this form, see NPD Suppl 1, ER 1110-1-12.)

Page 2 of 3

DESIGN DOCUMENT TYPE ☐ DESIGN MEMO ☒ CONCEPT ☐ FINAL ☐ PLANS & SPECS ☐ PRELIMINARY	PROJECT **Bonneville 2 AWS Backup Alternatives Study** **60% DDR ITR Review**	LOCATION
DATE	**5/9/01**	

REVIEWER

☒ CH2M/MW JV ☐ AIR FORCE ☐ ARMY ☐	NAME **Al Giorgi** PHONE NUMBER **425-883-8295**	☐ ARCHITECT ☐ LAND ARCHITECT ☐ CIVIL ☐ SANITARY	☐ MECHANICAL ☐ ELECTRICAL ☐ STRUCTURAL ☒ BIOLOGICAL

ACTION TAKEN ON COMMENT

ITEM NO.	DRAWING SHEET SPEC PARA	COMMENTS	REVIEW CONFERENCE (A = Comment accepted) (If not accepted explain)	DESIGN OFFICE (C = Correction made. List drawing or paragraph number whwere correction made) (If not corrected, explain)	BACK CHECK BY (Initials)
				hierarchy of criteria as stated by the agencies, all attempts were made to maintain the entrance velocity and submergence (at the expense of channel velocity and diffuser velocity). Channel velocity was difficult to maintain, and diffuser velocity criteria were sacrificed to help meet them.	
5	3.4	The subheading for this section does not appear appropriate, since the juvenile passage period is never described in this subsection.		C. Text changed	
6	4.1.j	Is the 2-h changeover requirement still in effect? I was under the impression this was relaxed.		C. deleted.	
7	4.1.e	Is the first sentence accurate? The latest version of the fish passage plan for Bonneville indicates that powerhouse priority varies from 1 March – 30 November (Table Bon-5 in the FPP). That table suggests that initially B2 has priority, and then it switches to B1 21 June – 31 August, then back to B2 priority.		C. Text added.	
8	4.1.c	Is this an accurate characterization? If the previous comment is correct, then this one may need recasting.		C. Text deleted.	
9	13.2.a	It may be appropriate to describe the risks associated with the recommended alternative at this point in the report. Refer to comment 2 above		C. Text added.	
10	Appendix F	Figures in this section have legends for 1.5 and 4.0 fps, but the significance of these values is not indicated anywhere. Perhaps a global caption that identifies these as the range bounding acceptable water velocity within the fishway (@ NMFS criteria).		C	

Comments on B2 AWS DDR 60% submittal: Response to comments are in *italics.*

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

From: Dasso, Joseph M NWP

Sent: Friday, April 13, 2001 1:45 PM

To: Maurseth, Jerome A NWP

Subject: B2 AWS Meeting

Jerry,

I won't be able to make the meeting. I have another one scheduled at the same time for the Bradford Island Landfill. It looks like MW is on track anyway. The only comments I have are:

Does it make sense to go on designing motorized gates for the orifice openings. Perhaps, as we talked the other day, they could verify whether the openings can be blocked at all tailwater elevations. If so, we could cost that option out instead of proceeding with the motors, etc.

> *No decision has been made concerning permanent blockage of the orifice gates. At the 60% PRM, it was decided to develop a non-motorized solution. This solution would lower a bulkhead (stab plate) from above.*

On page 2-3, they have a forebay sediment table. It shows infill and scour from '97 to '98 and from '98 to 2000. I would like to know where they got their data. I don't believe it is correct.

> *Montgomery Watson received three data sets from CENWP as hard copies and as electronic copies. Rex O. Duus NWP supplied the electronic data. These data sets are:*
>
> - *1997 Soundings. Point data referencing depths from elevation 70 <cl-144-145.dgn>.*
> - *1998 Bathemetry. Measured direct elevations. <part of bonneville base file supplied by CENWP>*
> - *March 2000 Soundings. Point data referencing depths from elevation 70 <cl-144-mark.dgn>.*
>
> *The process used to interpret the data was as follows: The data were converted to elevation points. An evaluation area was defined as a space 100 feet from the face of the powerhouse and 120 feet from the face of the retaining wall, into the forebay (as denoted on Plates 3, 4, 5, and 6). Contours were generated in Intergraph from the points within the evaluation area. The contours were refined by hand and some extrapolation of the data was required immediately adjacent to the face of the powerhouse on the March 2000 survey data. (these contours are designated as dashed lines shown on Plate 6 in the DDR). The infill and scour quantities were calculated using "inroads" add-on software with Intergraph. Quantities were also checked by hand using the average end area method.*
>
> *Discrepancies between our conclusions and other reports or data should be clarified in order to proceed with the 90% submittal.*

Can't think of anything else. If everyone accepts the idea of blocking the lower section of the intakes, then I could presumable get Dwayne started on a trashrake/trashrack contract.

Mark

Pat Hunter Comments to Bonneville Powerhouse Auxiliary Water Supply Backup System 60% Report:

Page i. Should some discussion of the FU/AWS Debris Problem be included in this explanation of the report?

> *Detailed explanations are available in the body of the report. It is our intent to keep the syllabus brief.*

Page 2-5 Alt 2. Will this type of gate drop if debris gets in the guide? (Since this is not a recommended alternative, it should not become a problem).

> *We agree that debris could be a problem, though at this location, the water flowing from the orifices has passed through a trashrack and diffuser gratings. We are unaware of eddy patterns that would collect debris on the tailrace side and overwhelm the orifice flow. But a stick hanging up in the guide slot could stop the gate.*

General. Should some type of collection channel velocity measurement system be included to verify the water velocities are within criteria during operation?

> *Velocity is an important parameter however, providing velocity measuring devices are not in the scope of this contract.*

Section 9, The Project will try to have information on the spare parts in stock and a recommendation on what spare parts would be stocked by May 7, 2001.

> *Noted.*

APPENDIX C

AGENCY COORDINATION

APPENDIX D

COST ESTIMATE

BONNEVILLE SECOND POWERHOUSE

AWS BACKUP DESIGN DOCUMENT REPT
CONSTRUCTION COST ESTIMATE
100%

Designed By: MWH
Estimated By: J LOUCKS

Prepared By: J LOUCKS

Preparation Date: 09/13/01
Effective Date of Pricing: 09/13/01

Sales Tax: 0.00%

MCACES GOLD EDITION
Composer GOLD Software Copyright (c) 1985-1994
by Building Systems Design, Inc.
Release 5.30

LABOR ID: WASH99 EQUIP ID: NAT97B

Currency in DOLLARS

CREW ID: NAT97A UPB ID: UP99EA

U.S. Army Corps of Engineers
PROJECT BN3AWS: BONNEVILLE SECOND POWERHOUSE
BONNEVILLE POWER HOUSE #2 - AUXILARY WATER SYS.
** PROJECT OWNER SUMMARY - Feature **

	QUANTY UOM	CONTRACT	CONTINGN	ESCALATN	OWN FURN	SIOH	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES								
B-10 FLOATING ORIFICE CLOSURE		140,135	28,027	13,810	0	0	181,972	
B-20 STOCKPILE CRUCIAL SPARE PARTS		100,070	20,014	9,861	0	0	129,945	
B-25 OPERATIONS ALTERNATIVE		36,849	7,370	3,631	0	0	47,850	
B-27 PORTABLE POWER OPERATOR		7,397	1,479	729	0	0	9,605	
B-30 TRASHRACK CLEANING SYSTEM		1,476,598	295,320	145,513	0	0	1,917,430	
B-40 MONITOR DIFFUSER RACK CLOGGING		66,757	13,351	6,579	0	0	86,688	
TOTAL B2 AWS BACKUP FACILITIES		1,827,806	365,561	180,123	0	0	2,373,490	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,827,806	365,561	180,123	0	0	2,373,490	

	QUANTY UOM	CONTRACT	CONTINGN	ESCALATN	OWN FURN	SIOH	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES								
B-10 FLOATING ORIFICE CLOSURE								
B-1003 MANUAL DOWNSTREAM SLIDE GATE		140,135	28,027	13,810	0	0	181,972	
TOTAL FLOATING ORIFICE CLOSURE		140,135	28,027	13,810	0	0	181,972	
B-20 STOCKPILE CRUCIAL SPARE PARTS								
B-2001 FISH UNIT SPARE PARTS LIST		100,070	20,014	9,861	0	0	129,945	
TOTAL STOCKPILE CRUCIAL SPARE PARTS		100,070	20,014	9,861	0	0	129,945	
B-25 OPERATIONS ALTERNATIVE								
B-2520 TESTING PROGRAM		36,849	7,370	3,631	0	0	47,850	
TOTAL OPERATIONS ALTERNATIVE		36,849	7,370	3,631	0	0	47,850	
B-27 PORTABLE POWER OPERATOR								
B-2710 PROVIDE PORTABLE POWER OPERATOR		7,397	1,479	729	0	0	9,605	
TOTAL PORTABLE POWER OPERATOR		7,397	1,479	729	0	0	9,605	
B-30 TRASHRACK CLEANING SYSTEM								
B-3002 AUTOMATIC TRAVEL GRIP RAKE		1,374,753	274,951	135,477	0	0	1,785,180	
B-3003 BLKG OFF LOWER PNL		101,845	20,369	10,036	0	0	132,250	
TOTAL TRASHRACK CLEANING SYSTEM		1,476,598	295,320	145,513	0	0	1,917,430	
B-40 MONITOR DIFFUSER RACK CLOGGING								
B-4001 INSTALL LEVEL TRANSDUCERS		66,757	13,351	6,579	0	0	86,688	
TOTAL MONITOR DIFFUSER RACK CLOGGING		66,757	13,351	6,579	0	0	86,688	
TOTAL B2 AWS BACKUP FACILITIES		1,827,806	365,561	180,123	0	0	2,373,490	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,827,806	365,561	180,123	0	0	2,373,490	

** PROJECT INDIRECT SUMMARY - CONTRACT **

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
CONTINGENCY - 20%							365,561	
SUBTOTAL							2,193,367	
ESCALATION - 8%							180,123	
TOTAL INCL OWNER COSTS							2,373,490	

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES								
B-10 FLOATING ORIFICE CLOSURE		108,669	10,867	5,977	12,551	2,071	140,135	
B-20 STOCKPILE CRUCIAL SPARE PARTS		77,600	7,760	4,268	8,963	1,479	100,070	
B-25 OPERATIONS ALTERNATIVE		28,575	2,858	1,572	3,300	545	36,849	
B-27 PORTABLE POWER OPERATOR		5,736	574	315	663	109	7,397	
B-30 TRASHRACK CLEANING SYSTEM		1,145,042	114,504	62,977	132,252	21,822	1,476,598	
B-40 MONITOR DIFFUSER RACK CLOGGING		51,768	5,177	2,847	5,979	987	66,757	
TOTAL B2 AWS BACKUP FACILITIES		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
CONTINGENCY - 20%							365,561	
SUBTOTAL							2,193,367	
ESCALATION - 8%							180,123	
TOTAL INCL OWNER COSTS							2,373,490	

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES								
B-10 FLOATING ORIFICE CLOSURE								
B-1003 MANUAL DOWNSTREAM SLIDE GATE		108,669	10,867	5,977	12,551	2,071	140,135	
TOTAL FLOATING ORIFICE CLOSURE		108,669	10,867	5,977	12,551	2,071	140,135	
B-20 STOCKPILE CRUCIAL SPARE PARTS								
B-2001 FISH UNIT SPARE PARTS LIST		77,600	7,760	4,268	8,963	1,479	100,070	
TOTAL STOCKPILE CRUCIAL SPARE PARTS		77,600	7,760	4,268	8,963	1,479	100,070	
B-25 OPERATIONS ALTERNATIVE								
B-2520 TESTING PROGRAM		28,575	2,858	1,572	3,300	545	36,849	
TOTAL OPERATIONS ALTERNATIVE		28,575	2,858	1,572	3,300	545	36,849	
B-27 PORTABLE POWER OPERATOR								
B-2710 PROVIDE PORTABLE POWER OPERATOR		5,736	574	315	663	109	7,397	
TOTAL PORTABLE POWER OPERATOR		5,736	574	315	663	109	7,397	
B-30 TRASHRACK CLEANING SYSTEM								
B-3002 AUTOMATIC TRAVEL GRIP RAKE		1,066,066	106,607	58,634	123,131	20,317	1,374,753	
B-3003 BLKG OFF LOWER PNL		78,976	7,898	4,344	9,122	1,505	101,845	
TOTAL TRASHRACK CLEANING SYSTEM		1,145,042	114,504	62,977	132,252	21,822	1,476,598	
B-40 MONITOR DIFFUSER RACK CLOGGING								
B-4001 INSTALL LEVEL TRANSDUCERS		51,768	5,177	2,847	5,979	987	66,757	
TOTAL MONITOR DIFFUSER RACK CLOGGING		51,768	5,177	2,847	5,979	987	66,757	
TOTAL B2 AWS BACKUP FACILITIES		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,417,390	141,739	77,956	163,709	27,012	1,827,806	
CONTINGENCY - 20%							365,561	

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
SUBTOTAL							2,193,367	
ESCALATION - 8%							180,123	
TOTAL INCL OWNER COSTS							2,373,490	

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                                                                      QUANTY UOM  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST       UNIT
------------------------------------------------------------------------------------------------------------------------------------------

                                        B  B2 AWS BACKUP FACILITIES                2,422   128,416    40,805 1,035,359   212,811   1,417,390
                                                                                 -------  --------  --------  --------  --------  ----------
                                      TOTAL BONNEVILLE SECOND POWERHOUSE           2,422   128,416    40,805 1,035,359   212,811   1,417,390

                                          FIELD  OVERHEADS - 10%                                                                    141,739
                                                                                                                                 ----------
                                            SUBTOTAL                                                                              1,559,129
                                          PRIME'S HOME OFFICE RECOVERY - 7.5%                                                        77,956
                                                                                                                                 ----------
                                            SUBTOTAL                                                                              1,637,086
                                          PRIME CONTRACTOR'S PROFIT - 10%                                                           163,709
                                                                                                                                 ----------
                                            SUBTOTAL                                                                              1,800,794
                                          PRIME CONTRACTOR'S BOND - 1.5%                                                             27,012
                                                                                                                                 ----------
                                            TOTAL INCL INDIRECTS                                                                  1,827,806
                                          CONTINGENCY - 20%                                                                         365,561
                                                                                                                                 ----------
                                            SUBTOTAL                                                                              2,193,367
                                          ESCALATION - 8%                                                                           180,123
                                                                                                                                 ----------
                                            TOTAL INCL OWNER COSTS                                                                2,373,490
```

	QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES									
B-10 FLOATING ORIFICE CLOSURE			572	30,881	6,988	48,200	22,600	108,669	
B-20 STOCKPILE CRUCIAL SPARE PARTS			0	0	0	77,600	0	77,600	
B-25 OPERATIONS ALTERNATIVE			0	0	0	0	28,575	28,575	
B-27 PORTABLE POWER OPERATOR			0	100	100	5,200	336	5,736	
B-30 TRASHRACK CLEANING SYSTEM			1,500	78,834	26,800	881,109	158,300	1,145,042	
B-40 MONITOR DIFFUSER RACK CLOGGING			350	18,601	6,917	23,250	3,000	51,768	
TOTAL B2 AWS BACKUP FACILITIES			2,422	128,416	40,805	1,035,359	212,811	1,417,390	
TOTAL BONNEVILLE SECOND POWERHOUSE			2,422	128,416	40,805	1,035,359	212,811	1,417,390	
FIELD OVERHEADS - 10%								141,739	
SUBTOTAL								1,559,129	
PRIME'S HOME OFFICE RECOVERY - 7.5%								77,956	
SUBTOTAL								1,637,086	
PRIME CONTRACTOR'S PROFIT - 10%								163,709	
SUBTOTAL								1,800,794	
PRIME CONTRACTOR'S BOND - 1.5%								27,012	
TOTAL INCL INDIRECTS								1,827,806	
CONTINGENCY - 20%								365,561	
SUBTOTAL								2,193,367	
ESCALATION - 8%								180,123	
TOTAL INCL OWNER COSTS								2,373,490	

	QUANTY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES									
B-10 FLOATING ORIFICE CLOSURE									
B-1003 MANUAL DOWNSTREAM SLIDE GATE			572	30,881	6,988	48,200	22,600	108,669	
TOTAL FLOATING ORIFICE CLOSURE			572	30,881	6,988	48,200	22,600	108,669	
B-20 STOCKPILE CRUCIAL SPARE PARTS									
B-2001 FISH UNIT SPARE PARTS LIST			0	0	0	77,600	0	77,600	
TOTAL STOCKPILE CRUCIAL SPARE PARTS			0	0	0	77,600	0	77,600	
B-25 OPERATIONS ALTERNATIVE									
B-2520 TESTING PROGRAM			0	0	0	0	28,575	28,575	
TOTAL OPERATIONS ALTERNATIVE			0	0	0	0	28,575	28,575	
B-27 PORTABLE POWER OPERATOR									
B-2710 PROVIDE PORTABLE POWER OPERATOR			0	100	100	5,200	336	5,736	
TOTAL PORTABLE POWER OPERATOR			0	100	100	5,200	336	5,736	
B-30 TRASHRACK CLEANING SYSTEM									
B-3002 AUTOMATIC TRAVEL GRIP RAKE			1,140	60,496	22,020	842,250	141,300	1,066,066	
B-3003 BLKG OFF LOWER PNL			360	18,338	4,780	38,859	17,000	78,976	
TOTAL TRASHRACK CLEANING SYSTEM			1,500	78,834	26,800	881,109	158,300	1,145,042	
B-40 MONITOR DIFFUSER RACK CLOGGING									
B-4001 INSTALL LEVEL TRANSDUCERS			350	18,601	6,917	23,250	3,000	51,768	
TOTAL MONITOR DIFFUSER RACK CLOGGING			350	18,601	6,917	23,250	3,000	51,768	
TOTAL B2 AWS BACKUP FACILITIES			2,422	128,416	40,805	1,035,359	212,811	1,417,390	
TOTAL BONNEVILLE SECOND POWERHOUSE			2,422	128,416	40,805	1,035,359	212,811	1,417,390	
FIELD OVERHEADS - 10%								141,739	

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                                                                            QUANTY UOM  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST    UNIT
---------------------------------------------------------------------------------------------------------------------------------------------

                                                                                                                                 -----------
                                             SUBTOTAL                                                                              1,559,129
                                            PRIME'S HOME OFFICE RECOVERY - 7.5%                                                       77,956
                                                                                                                                 -----------
                                             SUBTOTAL                                                                              1,637,086
                                            PRIME CONTRACTOR'S PROFIT - 10%                                                          163,709
                                                                                                                                 -----------
                                             SUBTOTAL                                                                              1,800,794
                                            PRIME CONTRACTOR'S BOND - 1.5%                                                            27,012
                                                                                                                                 -----------
                                             TOTAL INCL INDIRECTS                                                                  1,827,806
                                            CONTINGENCY - 20%                                                                        365,561
                                                                                                                                 -----------
                                             SUBTOTAL                                                                              2,193,367
                                            ESCALATION - 8%                                                                          180,123
                                                                                                                                 -----------
                                             TOTAL INCL OWNER COSTS                                                                2,373,490
```

											**** TOTAL ****	
SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	DEFAULT	HOURS
MIL	X-ELECTRN	Outside Electrician	27.30	0.0%	46.5%	10.47	0.00	50.46	HR	09/17/99	22.78	240
MIL	X-EQOPRLT	Outside Equip. Oper Light	23.27	0.0%	46.5%	8.20	0.00	42.29	HR	09/17/99	17.05	350
MIL	X-LABORER	Outside Laborer (Semi-Skilled)	22.10	0.0%	46.5%	6.36	0.00	38.74	HR	09/22/99	11.84	772
MIL	X-PLUMBER	Outside Plumber	27.80	0.0%	46.5%	9.60	0.00	50.33	HR	09/22/99	18.66	350
MIL	X-STRSTEEL	Outside Steel Worker	24.22	0.0%	46.5%	10.35	0.00	45.83	HR	09/17/99	18.82	660

** EQUIPMENT BACKUP **

SRC	ID.NO.	EQUIPMENT DESCRIPTION	DEPR	FCCM	FUEL	FOG	TR WR	TR REP	EQ REP	TOTAL RATE	** TOTAL ** HOURS
MAP	C75GV011	CRANE,HYD,S/P,RT,4WD,30T/80'BOOM	18.15	4.84	6.46	2.42	3.44	0.61	21.88	57.80 HR	105
GEN	T40Z6950	FLATBED, 8' (2.4 M) X 9' (2.7 M)	0.26	0.04					0.24	0.54 HR	440
MIL	T45XX011	TRLR,LOWBOY, 25T, 2 AXLE	1.61	0.46		0.40	0.58	0.10	1.51	4.67 HR	440
GEN	T50Z7320	TRUCK, PICKUP, 8,800 (3992 KG)	2.08	0.35	2.67	0.94	0.23	0.04	2.39	8.69 HR	750
MAP	W30MG099	WATER TANK, PORTABLE, 500 GAL	0.23	0.06			0.07	0.01	0.24	0.61 HR	520
MIL	W35XX003	WELDER, 300 AMP, W/1 AXLE TRLR	0.76	0.16	1.70	0.51	0.04	0.01	1.04	4.21 HR	560
GEN	XMEZ8760	COMPRESSOR, 115 V, AIR, PORTABLE	0.19	0.02	0.04	0.27	0.02		0.21	0.75 HR	400
GEN	XMEZ9180	TOOL VAN	2.90	0.93	9.89	3.06	0.48	0.07	2.63	19.96 HR	480
GEN	XMEZ9200	POWERLINE, CABLE REEL-CARRIER	1.38	0.30		1.00	0.10	0.02	1.50	4.30 HR	360
GEN	XMEZ9480	TORCH, OXYGEN/ACETYLENE	0.23	0.02		1.50			0.25	2.00 HR	360

No errors detected...

* * * END OF ERROR REPORT * * *

SUMMARY REPORTS — SUMMARY PAGE

DETAILED ESTIMATE — DETAIL PAGE

B. B2 AWS BACKUP FACILITIES
  10. FLOATING ORIFICE CLOSURE
    03. MANUAL DOWNSTREAM SLIDE GATE

  20. STOCKPILE CRUCIAL SPARE PARTS

  25. OPERATIONS ALTERNATIVE

  27. PORTABLE POWER OPERATOR

  30. TRASHRACK CLEANING SYSTEM
    02. AUTOMATIC TRAVEL GRIP RAKE

    03. BLKG OFF LOWER PNL

  40. MONITOR DIFFUSER RACK CLOGGING
    01. INSTALL LEVEL TRANSDUCERS

BACKUP REPORTS — BACKUP PAGE

* * * END TABLE OF CONTENTS * * *

B. B2 AWS BACKUP FACILITIES

B-10. FLOATING ORIFICE CLOSURE

B-1003. MANUAL DOWNSTREAM SLIDE GATE

Note: This alternative consists of 8-24"x169" low-head plates and 4-48"x172" low-head (2-foot) plates, which will slide over the downstream (tailrace side) of the floating orifice. Each plate will be placed by lowering it onto the floating orifice from above. When not in use, plates will be kept in a specially fabricated rack for storage and transport.

Prod: 3-4 weeks or 500 hrs.

B-100301. GENL CONDITIONS/OVERHEADS

Note: Item provides an allowance for misc. costs including permitting, mobilization, and special equipment fabrication etc..

B-10. FLOATING ORIFICE CLOSURE		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
USR AA <I	> ALLOWANCE					0.00	3000.00	1500.00	1500.00	1500.00	7500.00	
		1.00	LS		0.00	0	3,000	1,500	1,500	1,500	7,500	7500.00
	TOTAL GENL CONDITIONS/OVERHEADS					0	3,000	1,500	1,500	1,500	7,500	

B-100302. FABRICATE/INSTALL SLIDE GATES

Note: Item includes the following activities:

a) Fabricate or pruchase the slide plate holder assembly, the floatation chamber extensions, the slide plate and guides, cable retrival system and rack fabrication other misc. parts.
b) Exchange the floating orifice with the bulkhead.
c) Disassemble the upper and lower orifice panels.
d) Weld a new floatation chamber extension onto the existing upper orifice panel.
e) Weld the threaded slide gate guides onto the upper orifice panel.
f) Pressure test panels for air-tightness and epoxy coat.
g) Re-install modified floating orifice gate assembly.
h) Test slide gate actuation.

Labor: 3 Men @ 3 weeks x 10 hrs/day = 450 hrs; Say 500 hrs..

B-10. FLOATING ORIFICE CLOSURE		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
MIL AA <	> OUTSIDE EQUIP. OPER LIGHT					1.00	42.29	0.00	0.00	0.00	42.29	
		100.00	HR	X-EQOPRLT	1.00	100	4,229	0	0	0	4,229	42.29
MIL AA <	> OUTSIDE LABORER (SEMI-SKILLED)					1.00	38.74	0.00	0.00	0.00	38.74	
		272.00	HR	X-LABORER	1.00	272	10,536	0	0	0	10,536	38.74
MIL AA <	> OUTSIDE PLUMBER					1.00	50.33	0.00	0.00	0.00	50.33	
		100.00	HR	X-PLUMBER	1.00	100	5,033	0	0	0	5,033	50.33

	B-10. FLOATING ORIFICE CLOSURE	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
MIL AA <	> OUTSIDE STEEL WORKER	100.00	HR	X-STRSTEEL	1.00	1.00 100	45.83 4,583	0.00 0	0.00 0	0.00 0	45.83 4,583	45.83
L GEN AA <	> FLATBED, 8' (2.4 M) X 9' (2.7 M) (ADD 20,000 - 25,000 GVW TRK)	120.00	HR	T40Z6950	1.00	0.00 0	0.00 0	0.54 65	0.00 0	0.00 0	0.54 65	0.54
MIL AA <	> TRLR,LOWBOY, 25T, 2 AXLE (ADD TOWING TRUCK)	120.00	HR	T45XX011	1.00	0.00 0	0.00 0	4.67 560	0.00 0	0.00 0	4.67 560	4.67
GEN AA <	> TRUCK, PICKUP, 8,800 (3992 KG) GVW 4X4, 3/4 TON	120.00	HR	T50Z7320	1.00	0.00 0	0.00 0	8.69 1,043	0.00 0	0.00 0	8.69 1,043	8.69
GEN AA <	> TORCH, OXYGEN/ACETYLENE (W/ TANKS & HOSES)	120.00	HR	XMEZ9480	1.00	0.00 0	0.00 0	2.00 240	0.00 0	0.00 0	2.00 240	2.00
GEN AA <	> POWERLINE, CABLE REEL-CARRIER (W/ DBL AXLE TRAILER)	120.00	HR	XMEZ9200	1.00	0.00 0	0.00 0	4.30 516	0.00 0	0.00 0	4.30 516	4.30
L GEN AA <	> TOOL VAN (ADD 20,000 - 25,000 GVW TRK)	120.00	HR	XMEZ9180	1.00	0.00 0	0.00 0	19.96 2,395	0.00 0	0.00 0	19.96 2,395	19.96
GEN AA <	> COMPRESSOR, 115 V, AIR, PORTABLE	120.00	HR	XMEZ8760	1.00	0.00 0	0.00 0	0.75 90	0.00 0	0.00 0	0.75 90	0.75
MIL AA <	> WELDER, 300 AMP, W/1 AXLE TRLR	120.00	HR	W35XX003	1.00	0.00 0	0.00 0	4.21 506	0.00 0	0.00 0	4.21 506	4.21
MAP AA <	> WATER TANK, PORTABLE, 500 GAL POLYETHYLENE, W/14' UTILITY TRLR	120.00	HR	W30MG099	1.00	0.00 0	0.00 0	0.61 73	0.00 0	0.00 0	0.61 73	0.61
USR AA <I	> FAB/PURCHASE 48"X84" LH SLD GAT	4.00	EA		0.00	0.00 0	0.00 0	0.00 0	3600.00 14,400	0.00 0	3600.00 14,400	3600.00
USR AA <I	> FAB/PURCHASE 24"X84" LH SLD GAT	8.00	EA		0.00	0.00 0	0.00 0	0.00 0	2250.00 18,000	0.00 0	2250.00 18,000	2250.00
USR AA <I	> RIGGERS & CRANE	2.00	WKS		0.00	0.00 0	0.00 0	0.00 0	0.00 0	2000.00 4,000	2000.00 4,000	2000.00
USR AA <I	> PROTECTIVE COATINGS	12.00	EA		0.00	0.00 0	0.00 0	0.00 0	0.00 0	300.00 3,600	300.00 3,600	300.00
USR AA <I	> CUSTOM GATE GUIDES W/ UHMW SEATS	12.00	EA		0.00	0.00 0	0.00 0	0.00 0	900.00 10,800	0.00 0	900.00 10,800	900.00
USR AA <I	> FIELD WELDING (SUB)	12.00	EA		0.00	0.00 0	0.00 0	0.00 0	0.00 0	200.00 2,400	200.00 2,400	200.00
USR AA <I	> J SEAL/GASKETT ALLOWANCE (Approx. 300-400 LF)	1.00	LS		0.00	0.00 0	3500.00 3,500	0.00 0	3500.00 3,500	0.00 0	7000.00 7,000	7000.00

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B-10. FLOATING ORIFICE CLOSURE                                QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST     UNIT
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                USR AA <I         > STORAGE/TRANSPORT RACK                                    0.00      0.00      0.00      0.00      3.00        3.00
                                                             1300.00 LB                0.00      0         0         0         0     3,900       3,900     3.00

                USR AA <I         > RETRIVAL CABLE SYSTEM                                     0.00      0.00      0.00      0.00    600.00      600.00
                                                               12.00 EA                0.00      0         0         0         0     7,200       7,200   600.00
                                                                                            ------- --------- --------- --------- --------- -----------
                            TOTAL FABRICATE/INSTALL SLIDE GATES                                572    27,881     5,488    46,700    21,100     101,169

                                                                                            ------- --------- --------- --------- --------- -----------
                            TOTAL MANUAL DOWNSTREAM SLIDE GATE                                 572    30,881     6,988    48,200    22,600     108,669
                                                                                            ------- --------- --------- --------- --------- -----------
                            TOTAL FLOATING ORIFICE CLOSURE                                     572    30,881     6,988    48,200    22,600     108,669
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B-20. STOCKPILE CRUCIAL SPARE PARTS                               QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST     UNIT
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      B-20. STOCKPILE CRUCIAL SPARE PARTS

         B-2001. FISH UNIT SPARE PARTS LIST

               Note: This scheme consists of buying spare turbine and generator parts for
                     use immediately after a fish unit goes off-line. Project personnel
                     have been reviewing inventory and accessing the likelihood pf parts
                     failures. A preliminary list of parts with a cost of approximately
                     $77,000 has been assembled to date. These do not include the
                     suggested manufactures spare parts list, or the cost of spare parts
                     for the 3-D CAM. These costs were assembled during the Bonneville
                     Secon Powerhouse Auxiliary Water System Backup Alternative Study,
                     Sept. 2000.

               USR AA <I          > ALLOWANCE                                                0.00      0.00      0.00  77600.00      0.00    77600.00
                                    (See attached speadsheet)           1.00 LS              0.00        0         0         0    77,600         0      77,600    77600
                                                                                         ------- --------- --------- --------- --------- -----------
                                  TOTAL FISH UNIT SPARE PARTS LIST                           0         0         0    77,600         0      77,600

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                                  TOTAL STOCKPILE CRUCIAL SPARE PARTS                        0         0         0    77,600         0      77,600
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B-25. OPERATIONS ALTERNATIVE                                               QUANTY UOM CREW ID    OUTPUT   MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST    UNIT
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        B-25. OPERATIONS ALTERNATIVE

              Note: This alternative provides support for the operational aspects of the
                    system after structural modifications have been completed. This scope
                    includes a three step testing process to document design changes. In
                    addition, costs for a powered actuator are detailed to facilitate
                    operating manual sluice gates.

            B-2520. TESTING PROGRAM

                    USR AA <I         > NORTHWEST HYDROLOGY/TEST                                          0.00      0.00      0.00      0.00   9525.00     9525.00
                                                                             3.00 EA               0.00       0         0         0         0    28,575      28,575 9525.00
                                                                                                        ------- --------- --------- --------- --------- -----------
                                   TOTAL TESTING PROGRAM                                                      0         0         0         0    28,575      28,575

                                                                                                        ------- --------- --------- --------- --------- -----------
                                   TOTAL OPERATIONS ALTERNATIVE                                               0         0         0         0    28,575      28,575
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B-27. PORTABLE POWER OPERATOR                              QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST     UNIT
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      B-27. PORTABLE POWER OPERATOR

         B-2710. PROVIDE PORTABLE POWER OPERATOR

               USR AA <I          > WACHS P/2 POW-R-DRIVE OPERATOR                    0.00      0.00      0.00   4800.00    336.00     5136.00
                                                             1.00 LS             0.00      0       0         0     4,800       336       5,136 5136.00

               USR AA <I          > OPERATING NUT - MODIFY HAND WHL                   0.00     50.00     50.00    200.00      0.00      300.00
                                                             2.00 EA             0.00      0       100       100       400         0         600  300.00
                                                                                     ------- --------- --------- --------- --------- -----------
                              TOTAL PROVIDE PORTABLE POWER OPERATOR                      0       100       100     5,200       336       5,736

                                                                                     ------- --------- --------- --------- --------- -----------
                              TOTAL PORTABLE POWER OPERATOR                              0       100       100     5,200       336       5,736
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B-30. TRASHRACK CLEANING SYSTEM

B-3002. AUTOMATIC TRAVEL GRIP RAKE

Note: This alternative consists of replacing the existing trashracks and trash rake with a monorail traveling gripper rake equal to system manufactured by Brackett Green. Dredging will be required upstream of the intake. The existing trashracks will be removed. The new trashrack and monorail type cleaner will be installed. Power will be extended to a junction box at the north end of the Fish Unit intake.

B-300201. GENL CONDITIONS/OVERHEADS

Note: Item provides an allowance for misc. costs including permitting, mobilization, and special equipment fabrication etc..

B-30. TRASHRACK CLEANING SYSTEM	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
USR AA <I > ALLOWANCE					0.00	10000.00	5000.00	5000.00	5000.00	25000.00	
	1.00	LS		0.00	0	10,000	5,000	5,000	5,000	25,000	25000
TOTAL GENL CONDITIONS/OVERHEADS					0	10,000	5,000	5,000	5,000	25,000	

B-300202. INSTALL AUTOMATIC TRVL GRIP RAKE

Note: Item includes the following activities:

a) Fabricate the automatic gripper rake and new trash rack.
b) Extend the new power service from the paneloard in the bldg on the Fish Evaluation Facility to a new junction box.
c) Cut Slots into the Erection bay forebay to extend the existing "forebay side" gantry rail and add a new middle gantry rail along the length or the Erection bay.
d) Mount trash rake support monorail on the Erection Bay deck.
e) After sediment accumulation improvements are in place, install the new trashracks with the existing service crane.
f) Starting at elevation 44-fmsl, install UHMW plastic panels on the forebay side face of the Erection Bay.
g) Mount the automatic gripper rake on the monorail and connect electrical power cable.

Labor: 4 Men @ 5 weeks x 10 hrs/day = 1000 hrs

B-30. TRASHRACK CLEANING SYSTEM	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT
MIL AA < > OUTSIDE EQUIP. OPER LIGHT					1.00	42.29	0.00	0.00	0.00	42.29	
	200.00	HR	X-EQOPRLT	1.00	200	8,458	0	0	0	8,458	42.29
MIL AA < > OUTSIDE LABORER (SEMI-SKILLED)					1.00	38.74	0.00	0.00	0.00	38.74	
	300.00	HR	X-LABORER	1.00	300	11,621	0	0	0	11,621	38.74
MIL AA < > OUTSIDE PLUMBER					1.00	50.33	0.00	0.00	0.00	50.33	
	200.00	HR	X-PLUMBER	1.00	200	10,065	0	0	0	10,065	50.33

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B-30. TRASHRACK CLEANING SYSTEM                                   QUANTY UOM CREW ID      OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL      OTHER  TOTAL COST      UNIT
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                MIL AA <          > OUTSIDE STEEL WORKER                                             1.00     45.83      0.00      0.00       0.00       45.83
                                                                   400.00 HR  X-STRSTEEL    1.00       400    18,333         0         0          0      18,333     45.83

                MIL AA <          > OUTSIDE ELECTRICIAN                                              1.00     50.46      0.00      0.00       0.00       50.46
                                                                    40.00 HR  X-ELECTRN     1.00        40     2,019         0         0          0       2,019     50.46

              L GEN AA <          > FLATBED, 8' (2.4 M) X 9' (2.7 M)                                 0.00      0.00      0.54      0.00       0.00        0.54
                                    (ADD 20,000 - 25,000 GVW TRK)  240.00 HR  T40Z6950      1.00         0         0       130         0          0         130      0.54

                MIL AA <          > TRLR,LOWBOY, 25T, 2 AXLE                                         0.00      0.00      4.67      0.00       0.00        4.67
                                    (ADD TOWING TRUCK)             240.00 HR  T45XX011      1.00         0         0     1,121         0          0       1,121      4.67

                GEN AA <          > TRUCK, PICKUP, 8,800 (3992 KG)                                   0.00      0.00      8.69      0.00       0.00        8.69
                                    GVW 4X4, 3/4 TON               240.00 HR  T50Z7320      1.00         0         0     2,086         0          0       2,086      8.69

                MAP AA <          > WATER TANK, PORTABLE, 500 GAL                                    0.00      0.00      0.61      0.00       0.00        0.61
                                    POLYETHYLENE, W/14' UTILITY TRLR 240.00 HR  W30MG099    1.00         0         0       146         0          0         146      0.61

                MIL AA <          > WELDER, 300 AMP, W/1 AXLE TRLR                                   0.00      0.00      4.21      0.00       0.00        4.21
                                                                   240.00 HR  W35XX003      1.00         0         0     1,012         0          0       1,012      4.21

                GEN AA <          > COMPRESSOR, 115 V, AIR, PORTABLE                                 0.00      0.00      0.75      0.00       0.00        0.75
                                                                   200.00 HR  XMEZ8760      1.00         0         0       150         0          0         150      0.75

              L GEN AA <          > TOOL VAN                                                         0.00      0.00     19.96      0.00       0.00       19.96
                                    (ADD 20,000 - 25,000 GVW TRK)  200.00 HR  XMEZ9180      1.00         0         0     3,992         0          0       3,992     19.96

                GEN AA <          > POWERLINE, CABLE REEL-CARRIER                                    0.00      0.00      4.30      0.00       0.00        4.30
                                    (W/ DBL AXLE TRAILER)          200.00 HR  XMEZ9200      1.00         0         0       860         0          0         860      4.30

                GEN AA <          > TORCH, OXYGEN/ACETYLENE                                          0.00      0.00      2.00      0.00       0.00        2.00
                                    (W/ TANKS & HOSES)             200.00 HR  XMEZ9480      1.00         0         0       400         0          0         400      2.00

                MAP AA <          > CRANE,HYD,S/P,RT,4WD,30T/80'BOOM                                 0.00      0.00     57.80      0.00       0.00       57.80
                                                                    80.00 HR  C75GV011      1.00         0         0     4,624         0          0       4,624     57.80

                USR AA <I         > FAB/PURCHASE NEW TRASHRACK B2 FU                                 0.00      0.00      0.00      2.00       0.00        2.00
                                                                   274000 LB                0.00         0         0         0   548,000          0     548,000      2.00

                USR AA <I         > PAINTING/COATING TRASHRACKS                                      0.00      0.00      0.00      0.00       3.00        3.00
                                                                    30000 SF                0.00         0         0         0         0     90,000      90,000      3.00

                USR AA <I         > UNIT SHUTDOWN                                                    0.00      0.00    500.00    250.00     250.00     1000.00
                                                                     1.00 LS                0.00         0         0       500       250        250       1,000   1000.00

                USR AA <I         > REMOVE EXIST TRASHRACK                                           0.00      0.00    500.00    500.00       0.00     1000.00
                                                                     1.00 LS                0.00         0         0       500       500          0       1,000   1000.00

                USR AA <I         > PURCHASE NEW MONORAIL AUTO TR                                    0.00      0.00      0.00 280000.00      50.00   280050.00
                                                                     1.00 LS                0.00         0         0         0   280,000         50     280,050    280050
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B-30. TRASHRACK CLEANING SYSTEM                                QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL      OTHER  TOTAL COST     UNIT
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               USR AA <I         > CONCRETE SIDEWALL DEMO (4 EA)                             0.00      0.00   1000.00   1000.00       0.00     2000.00
                                                                 1.00 LS              0.00      0         0     1,000     1,000          0       2,000  2000.00

               USR AA <I         > CONCRETE REPAIR (4 EA)                                    0.00      0.00    500.00   2500.00       0.00     3000.00
                                                                 1.00 LS              0.00      0         0       500     2,500          0       3,000  3000.00

               USR AA <I         > ELECTRICAL CONDUIT/MATLS                                  0.00      0.00      0.00   2000.00       0.00     2000.00
                                                                 1.00 LS              0.00      0         0         0     2,000          0       2,000  2000.00

               USR AA <I         > DREDGING AT UPSTREAM SECTION                              0.00      0.00      0.00      0.00      34.00       34.00
                                                              1000.00 CY              0.00      0         0         0         0     34,000      34,000    34.00

               USR AA <I         > MONORAIL INSTALLTION W/ FASTNERS                          0.00      0.00      0.00   3000.00       0.00     3000.00
                                                                 1.00 LS              0.00      0         0         0     3,000          0       3,000  3000.00

               USR AA <I         > PNUMATIC ACTUATOR ADDER                                   0.00      0.00      0.00      0.00   12000.00    12000.00
                                                                 1.00 LS              0.00      0         0         0         0     12,000      12,000    12000
                                                                                      ------- --------- --------- --------- ---------- -----------
                              TOTAL INSTALL AUTOMATIC TRVL GRIP RAKE                         1,140    50,496    17,020   837,250    136,300   1,041,066

                                                                                      ------- --------- --------- --------- ---------- -----------
                              TOTAL AUTOMATIC TRAVEL GRIP RAKE                               1,140    60,496    22,020   842,250    141,300   1,066,066

          B-3003. BLKG OFF LOWER PNL

               Note: This alternative is a cost adjustment to the Trashrack. This involves
                     welding a blank panel onto the face of the bottom existing trashrack
                     and shortening the total trashrack length of each trashrack section.
                     This variation applies to both alternatives trash rakes.

            B-300301. GENL CONDITIONS/OVERHEADS

                  Note: Item provides an allowance for misc. costs including
                        permitting, mobilization, and special equipment fabrication etc..

               USR AA <I         > ALLOWANCE                                                 0.00   2500.00   1000.00   1000.00    1000.00     5500.00
                                                                 1.00 LS              0.00      0     2,500     1,000     1,000      1,000       5,500  5500.00
                                                                                      ------- --------- --------- --------- ---------- -----------
                              TOTAL GENL CONDITIONS/OVERHEADS                                    0     2,500     1,000     1,000      1,000       5,500

            B-300302. ADJUST TRASHRACK PANEL

                  Note: Item includes the following activities:

                        a) Weld new blank panel onto the face of the bottom of the existing
                           trashrack.

                        Labor: 4 Men @ 1 weeks x 10 hrs/day = 200 hrs
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B-30. TRASHRACK CLEANING SYSTEM                                  QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST     UNIT
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               MIL AA <         > OUTSIDE EQUIP. OPER LIGHT                                   1.00     42.29      0.00      0.00      0.00       42.29
                                                                   50.00 HR  X-EQOPRLT    1.00      50     2,115         0         0         0       2,115    42.29

               MIL AA <         > OUTSIDE LABORER (SEMI-SKILLED)                              1.00     38.74      0.00      0.00      0.00       38.74
                                                                  100.00 HR  X-LABORER    1.00     100     3,874         0         0         0       3,874    38.74

               MIL AA <         > OUTSIDE PLUMBER                                             1.00     50.33      0.00      0.00      0.00       50.33
                                                                   50.00 HR  X-PLUMBER    1.00      50     2,516         0         0         0       2,516    50.33

               MIL AA <         > OUTSIDE STEEL WORKER                                        1.00     45.83      0.00      0.00      0.00       45.83
                                                                  160.00 HR  X-STRSTEEL   1.00     160     7,333         0         0         0       7,333    45.83

               GEN AA <         > FLATBED, 8' (2.4 M) X 9' (2.7 M)                            0.00      0.00      0.54      0.00      0.00        0.54
                                  (ADD 20,000 - 25,000 GVW TRK)    40.00 HR  T40Z6950     1.00       0         0        22         0         0          22     0.54

               MIL AA <         > TRLR,LOWBOY, 25T, 2 AXLE                                    0.00      0.00      4.67      0.00      0.00        4.67
                                  (ADD TOWING TRUCK)               40.00 HR  T45XX011     1.00       0         0       187         0         0         187     4.67

               GEN AA <         > TRUCK, PICKUP, 8,800 (3992 KG)                              0.00      0.00      8.69      0.00      0.00        8.69
                                  GVW 4X4, 3/4 TON                 40.00 HR  T50Z7320     1.00       0         0       348         0         0         348     8.69

               MAP AA <         > WATER TANK, PORTABLE, 500 GAL                               0.00      0.00      0.61      0.00      0.00        0.61
                                  POLYETHYLENE, W/14' UTILITY TRLR 40.00 HR  W30MG099     1.00       0         0        24         0         0          24     0.61

               MIL AA <         > WELDER, 300 AMP, W/1 AXLE TRLR                              0.00      0.00      4.21      0.00      0.00        4.21
                                                                  160.00 HR  W35XX003     1.00       0         0       674         0         0         674     4.21

               GEN AA <         > COMPRESSOR, 115 V, AIR, PORTABLE                            0.00      0.00      0.75      0.00      0.00        0.75
                                                                   40.00 HR  XMEZ8760     1.00       0         0        30         0         0          30     0.75

             L GEN AA <         > TOOL VAN                                                    0.00      0.00     19.96      0.00      0.00       19.96
                                  (ADD 20,000 - 25,000 GVW TRK)    40.00 HR  XMEZ9180     1.00       0         0       798         0         0         798    19.96

               GEN AA <         > POWERLINE, CABLE REEL-CARRIER                               0.00      0.00      4.30      0.00      0.00        4.30
                                  (W/ DBL AXLE TRAILER)            40.00 HR  XMEZ9200     1.00       0         0       172         0         0         172     4.30

               GEN AA <         > TORCH, OXYGEN/ACETYLENE                                     0.00      0.00      2.00      0.00      0.00        2.00
                                  (W/ TANKS & HOSES)               40.00 HR  XMEZ9480     1.00       0         0        80         0         0          80     2.00

               MAP AA <         > CRANE,HYD,S/P,RT,4WD,30T/80'BOOM                            0.00      0.00     57.80      0.00      0.00       57.80
                                                                   25.00 HR  C75GV011     1.00       0         0     1,445         0         0       1,445    57.80

               USR AA <I        > 0.38"X13.5H X 19.5W STEEL PLATS                             0.00      0.00      0.00      2.35      0.00        2.35
                                                                   16110 LB               0.00       0         0         0    37,859         0      37,859     2.35

               USR AA <I        > COATING (BLASTING 3 COAT EXPOXY)                            0.00      0.00      0.00      0.00      5.00        5.00
                                                                 3200.00 SF               0.00       0         0         0         0    16,000      16,000     5.00
                                                                                           ------- --------- --------- --------- --------- -----------
                       TOTAL ADJUST TRASHRACK PANEL                                            360    15,838     3,780    37,859    16,000      73,476
```

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B-30. TRASHRACK CLEANING SYSTEM                      QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST    UNIT

                                                                                   ------- --------- --------- --------- --------- -----------
                  TOTAL BLKG OFF LOWER PNL                                             360    18,338     4,780    38,859    17,000      78,976
                                                                                   ------- --------- --------- --------- --------- -----------
                  TOTAL TRASHRACK CLEANING SYSTEM                                    1,500    78,834    26,800   881,109   158,300   1,145,042
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B-40. MONITOR DIFFUSER RACK CLOGGING                              QUANTY UOM CREW ID     OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST      UNIT
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      B-40. MONITOR DIFFUSER RACK CLOGGING

         B-4001. INSTALL LEVEL TRANSDUCERS

               Note: This item provides level tansducers at three locations just upstream
                     and downstream of the diffuser grating. These locations include the
                     North Junction Pool and Diffuser Gate B@ adjacent to the North
                     Upstream entrance. Two transducers are included at each location
                     with a digital transmitter communicating over a pair of communication
                     wires back to a central control panel.

            B-400101. GENL CONDITIONS/OVERHEADS

                    Note: Item provides an allowance for misc. costs including
                          permitting, mobilization, and special equipment fabrication etc..

               USR AA <I         > ALLOWANCE                                           0.00   2500.00   1000.00   1000.00   1000.00     5500.00
                                                                  1.00 LS        0.00      0     2,500     1,000     1,000     1,000       5,500  5500.00
                                                                                        -------  --------- --------- --------- ---------  ----------
                                 TOTAL GENL CONDITIONS/OVERHEADS                           0     2,500     1,000     1,000     1,000       5,500

            B-400102. REPROGRAM PLC/INSTALL TRANSDUCER

                    Note: Item includes the following activities:

                         a) Acquire the conduit, wire, level transmitters, transmitter panels,
                            GE Funac, PLC modules and other materials.
                         b) Re-program PLC to include logic for level transmitter
                            communications; analog level outputs to digital displays, and
                            digital outputs for high diffuser grating alarm lights.
                         c) Install the level transmitter panels and associated conduit to the
                            existing power house control wire cable trays.
                         d) Install power and control wiring form the Fish Unit control panel
                            SA4 to each of the transmitter panels at the North Junction Pool
                            and at Diffuser Gate B2.
                         e) During the water work period, install the two upper and lower
                            level transmitters conduits.
                         f) Upgrade the existing GE Funac PLC in control panel SA4 with a new
                            10 slot module rack, a new CPU, a communication modulem and an
                            alalog output module, and a digital output module. Install the
                            diffuser grating alarm lights. Complete panel SA4 wiring of
                            improvements.
                         g) Install the level transmitters and complete wiring.
                         h) Test and calibarate diffuser grating monitoring system.

                          Labor: 3 Men @ 2.5 weeks x 10 hrs/day = 350 hrs

               USR AA <          > OUTSIDE EQUIP. OPER LIGHT                           1.00     42.69      0.00      0.00      0.00       42.69
                                                                 50.00 HR        0.00     50     2,135         0         0         0       2,135    42.69
```

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----------------------------------------------------------------------------------------------------------------------------------------------
B-40. MONITOR DIFFUSER RACK CLOGGING                                    QUANTY UOM CREW ID    OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER TOTAL COST    UNIT
----------------------------------------------------------------------------------------------------------------------------------------------

          MIL AA <          > OUTSIDE LABORER (SEMI-SKILLED)                                          1.00     38.74      0.00      0.00      0.00      38.74
                                                                        100.00 HR  X-LABORER    1.00     100     3,874         0         0         0      3,874   38.74

          MIL AA <          > OUTSIDE ELECTRICIAN                                                     1.00     50.46      0.00      0.00      0.00      50.46
                                                                        200.00 HR  X-ELECTRN    1.00     200    10,093         0         0         0     10,093   50.46

        L GEN AA <          > FLATBED, 8' (2.4 M) X 9' (2.7 M)                                        0.00      0.00      0.54      0.00      0.00       0.54
                              (ADD 20,000 - 25,000 GVW TRK)              40.00 HR  T40Z6950     1.00       0         0        22         0         0         22    0.54

          MIL AA <          > TRLR,LOWBOY, 25T, 2 AXLE                                                0.00      0.00      4.67      0.00      0.00       4.67
                              (ADD TOWING TRUCK)                         40.00 HR  T45XX011     1.00       0         0       187         0         0        187    4.67

          GEN AA <          > TRUCK, PICKUP, 8,800 (3992 KG)                                          0.00      0.00      8.69      0.00      0.00       8.69
                              GVW 4X4, 3/4 TON                          350.00 HR  T50Z7320     1.00       0         0     3,041         0         0      3,041    8.69

        L MAP AA <          > WATER TANK, PORTABLE, 500 GAL                                           0.00      0.00      0.61      0.00      0.00       0.61
                              POLYETHYLENE, W/14' UTILITY TRLR          120.00 HR  W30MG099     1.00       0         0        73         0         0         73    0.61

        L MIL AA <          > WELDER, 300 AMP, W/1 AXLE TRLR                                          0.00      0.00      4.21      0.00      0.00       4.21
                                                                         40.00 HR  W35XX003     1.00       0         0       169         0         0        169    4.21

        L GEN AA <          > COMPRESSOR, 115 V, AIR, PORTABLE                                        0.00      0.00      0.75      0.00      0.00       0.75
                                                                         40.00 HR  XMEZ8760     1.00       0         0        30         0         0         30    0.75

        L GEN AA <          > TOOL VAN                                                                0.00      0.00     19.96      0.00      0.00      19.96
                              (ADD 20,000 - 25,000 GVW TRK)             120.00 HR  XMEZ9180     1.00       0         0     2,395         0         0      2,395   19.96

          USR AA <I         > MISC MATLS (GROUT/PVC/ANCHORS)                                          0.00      0.00      0.00   1500.00      0.00    1500.00
                                                                          1.00 LS               0.00       0         0         0     1,500         0      1,500 1500.00

          USR AA <I         > PURCHASE SUBMESIBLE LEVEL TRANS                                         0.00      0.00      0.00   1400.00      0.00    1400.00
                                                                          4.00 EA               0.00       0         0         0     5,600         0      5,600 1400.00

          USR AA <I         > LOCAL CONTROL PANELS                                                    0.00      0.00      0.00   2500.00      0.00    2500.00
                                                                          2.00 EA               0.00       0         0         0     5,000         0      5,000 2500.00

          USR AA <I         > MISC ELEC MATLS (CODUIT/WIRE)                                           0.00      0.00      0.00   1200.00      0.00    1200.00
                                                                          1.00 LS               0.00       0         0         0     1,200         0      1,200 1200.00

          USR AA <I         > MODIFY EXIST PANEL                                                      0.00      0.00      0.00   8000.00   2000.00   10000.00
                                                                          1.00 LS               0.00       0         0         0     8,000     2,000     10,000   10000

          USR AA <I         > 10" X 2'-0" CORE DRILLED HOLES                                          0.00      0.00      0.00    325.00      0.00     325.00
                                                                          2.00 EA               0.00       0         0         0       650         0        650  325.00

          USR AA <I         > 2" X 3'-0" CORE DRILLED HOLES                                           0.00      0.00      0.00    300.00      0.00     300.00
                                                                          1.00 EA               0.00       0         0         0       300         0        300  300.00
                                                                                              -------  --------  --------  --------  --------  ---------
                    TOTAL REPROGRAM PLC/INSTALL TRANSDUCER                                         350    16,101     5,917    22,250     2,000     46,268
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B-40. MONITOR DIFFUSER RACK CLOGGING                     QUANTY UOM CREW ID     OUTPUT  MANHRS     LABOR  EQUIPMNT  MATERIAL     OTHER  TOTAL COST    UNIT
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                                                                                       ------- --------- --------- --------- --------- -----------
                          TOTAL INSTALL LEVEL TRANSDUCERS                                  350    18,601     6,917    23,250     3,000      51,768
                                                                                       ------- --------- --------- --------- --------- -----------
                          TOTAL MONITOR DIFFUSER RACK CLOGGING                             350    18,601     6,917    23,250     3,000      51,768
                                                                                       ------- --------- --------- --------- --------- -----------
                          TOTAL B2 AWS BACKUP FACILITIES                                 2,422   128,416    40,805 1,035,359   212,811   1,417,390
                                                                                       ------- --------- --------- --------- --------- -----------
                          TOTAL BONNEVILLE SECOND POWERHOUSE                             2,422   128,416    40,805 1,035,359   212,811   1,417,390
```

U.S. Army Corps of Engineers
PROJECT BN3AWS: BONNEVILLE SECOND POWERHOUSE
BONNEVILLE POWER HOUSE #2 - AUXILARY WATER SYS.
** PROJECT OWNER SUMMARY - CONTRACT **

	QUANTY UOM	CONTRACT	CONTINGN	ESCALATN	OWN FURN	SIOH	TOTAL COST	UNIT
B B2 AWS BACKUP FACILITIES		1,827,806	365,561	180,123	0	0	2,373,490	
TOTAL BONNEVILLE SECOND POWERHOUSE		1,827,806	365,561	180,123	0	0	2,373,490	

Trent T Gathright <trent@bgusa.com> on 09/25/2001 04:00:14 PM

To: Frank Postlewaite <Frank.E.Postlewaite@us.mw.com>
cc:

Subject: Bonneville Dam, Brackett Bosker Questions, Our Ref. P00-115

Mr. Postlewaite,

Per our on going discussions regarding the Brackett Bosker and the questions relating to pneumatics vs. hydraulics, we are pleased to confirm the following:

1. Yes, pneumatics are a viable option that we can utilize in lieu of hydraulics. It will require 4 - 5 pneumatic cylinders to maintain the same gripper debris retaining capabilities.

2. We do not enough failure data on the life of the cylinder seals and/or the number of cycles/strokes to quantify a definitive life. While some applications have lasted for more than 20 years, some may developed a slight problem in 12 to 15 years but the failures are so far in between that we could say the cylinders have a better than 20 year life expectancy in fresh water. Since we have agreed to pursue pneumatics, this question is now essentially nullified.

3. As also discussed, we do not have enough failure data to quantify hydraulic fluid consumption as is with no. 2, this is now also nullified.

4. We trust you have reviewed the photos previously sent showing the perforated plate. if you require more, please advise and I will see what we can round up.

5. We are not that concerned with protection of the hoses considering they will be operating on new bar screens. Since we would design & build the new bar screens, and since they will be 7/8" bar openings, we will increase the number of supports, which will aid in preventing damage to the hose while deeply submerged. The only real flags of trouble for us are high velocity projects (above 4 ft/sec) combined with operating on existing bar screens with horizontal spacer supports that terminate from section to section. Since this projects includes neither of these, we are not concerned with hose damage.

6. We also confirm a budget price add on for the pneumatics of $ 12,000.00 USD.

Regarding the "open" competition of the specifications, as we discussed, we recommend including numerous qualification statements such as:

Only qualified manufacturers will be considered having a minimum of XXX installations in the US operating for a minimum of XXX years.

You can also include very definitive statements such as : Designs utilizing hydraulics or mechanical means to close and retain debris shall absolutely not be considered due to the sensitive of the project requirements.

If you read our the spec on our CD shown under "Municipal- for Raw Water Intakes", you will find a number of these already included.

PLEASE LET ME KNOW WHAT ELSE YOU REQUIRE BUT I WILL BE OUT ON WEDNESDAY (POSSIBLE THURSDAY AS WELL AS I HAVE JURY DUTY AND I HAVE THE DISTINCT HONOR OF FULFILLING MY CIVIC DUTY, ALBEIT BAD TIMING).

Brackett Green USA, Inc.
1335 Regents Park Dr., Suite 140
Houston, TX 77058

Trent T. Gathright
Marketing Manager

Tel: 281-480-7955
Fax: 281-480-8225
Mob: 832-489-7956

Email: trent@bgusa.com
Web: www.bgusa.com

URGENT

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TELEFAX COMMUNICATION

TO:	Montgomery Watson	DATE:	January 9, 2001
Attn:	Mr. Frank Postlewaite	FAX NO:	1-425-881-8937
CC:	Scott & Associates		
Attn:	Mr. Gary M. Scott	FAX NO:	1-510-536-1885
FROM:	Trent T. Gathright	NO. OF PAGES:	Twelve (12)

SUBJECT: BUDGET PROPOSAL REQUEST

EQUIPMENT RECOMMENDED:	Brackett Bosker® Raking Machine
BG-USA FILE REFERENCE NUMBER:	P00-115

Dear Mr. Postlewaite,

We, Brackett Green USA, Inc., are pleased to provide the following Budget Proposal based on the above customer reference information and the following conditions/considerations: (normally ex-works)

I. EQUIPMENT INCLUDED IN BUDGET PRICE BY (X)

X	Heavy Duty Brackett Bosker® Raking Machine; Option for Bar screens	X	Factory Coating
X	Controls	X	Factory Testing
X	Anchor Bolts	X	Shipment Loading
X	O & M Manuals		Freight to Site
X	Warranty		Field Service

II. ITEMS NORMALLY SUPPLIED BY OTHERS

Unloading at Site / Field Touch-up
Installation / Erection / Mounting
Civil Works / Grouting / Anchor Installation
Conduit / Wiring / Cables & Glands
Access Ladders / Handrails / Flooring
Site Protection / Storage
State, Federal, Local Taxes or Use Taxes

III. TYPICAL DELIVERY AND SHIPMENT

A. DELIVERY

The Equipment can be typical delivered in 28-30 weeks based on:

		WEEKS
A.	General Drawings for Review	8 - 10
B.	Review by Client/User	4 - 6
C.	Details, Fabrication Shipment	16 - 18
	TOTAL	28 - 30

B. OVERALL SIZE / WEIGHT

A.	Approximate Size	Bar screen: 19'-6" W x 67'-0" L Each Bosker – See attached Drawing
B.	Approximate Weight	Bar screen: 160,000# Bosker: 25,000 #

IV. VALIDITY AND PAYMENT

A. VALIDITY

This Budget Proposal should be considered as valid for approximately three (3) months based on normal industry circumstances. After such time, please check with us for changes such as material/labor rates continued validity.

B. NORMAL PAYMENT TERMS

The budget prices are based on our normal payment terms, which are as follows:

10% - Of the contract value on submission of equipment/foundation drawings.

30% - Of the contract value at a point 3/5ths of the contract period when major raw materials will have been received from our Suppliers.

60% - Of the contract value on deliver to agreed point or as made ready for delivery if delayed by Purchaser.

V. NORMAL TERMS AND CONDITIONS

The following budget price(s) are based on our standard general conditions of tender available on request.

VI. BUDGET PRICES

A. One (1) Heavy Duty Brackett Bosker® Raking Machine with Trolley & Gripper, Monorail, Support Columns, Automatic Control System, Ultrasonic Differential Level Controller, per the attached specifications and drawing.

Total Budget Price: $ 280, 000.00 USD

(Two Hundred Eighty Thousand Dollars)

Optional Pricing

B. Four (4) each, Bar screens, designed for Raking by a Heavy Duty Brackett Bosker® Raking Machine. Each Bar screen will be 19'-6" wide X 67'-0" High, per the attached specification.

Carbon Steel Option:

Total Budget Price: $ 662, 500.00 USD

(Six Hundred Sixty-Two Thousand Five Hundred Dollars)

Stainless Steel Option:

Total Budget Price: $ 1,150, 000.00 USD

(One Million One Hundred Fifty Thousand Dollars)

C. Field Service

Our Field Service Technicians are available for $900.00 USD/Day plus all travel, living and per diem at cost. (Please refer to table I to determine if Field Service has been included).

VII. INFORMATION ATTACHED

X	Typical Specification Reference	Brackett Bosker® Raking Machine; Automatic Controls with Differential Level Control; Bar screens
X	Outline Drawing Reference	General Arrangement Drawing
X	Brochure Reference	Brackett Bosker Raking Machine Under separate cover)

If you have any further questions, please contact your local sales representative, Mr. Gary Scott of Scott & Associates, at 1-510-536-1884, or the undersigned directly at 281-480-7955.

Best Regards,
Brackett Green USA, Inc.
Trent T. Gathright
Marketing Manager

CC: Brackett Green USA, Inc. – Mr. W. Ford Wall - Listed

REF: P00-115

SPECIFICATION
FOR
BRACKETT BOSKER®
RAKING MACHINE
HEAVY DUTY DESIGN FOR CURVED TRACK

I. GENERAL DESCRIPTION

A. CONCEPT

The Brackett Bosker® Raking Machine will be designed and arranged to remove debris from a Bar Screen, transport it to and discharge into the appropriate debris container (by others) or discharge area.

B. DESCRIPTION

The Brackett Bosker® Raking Machine will primarily consist of an overhead monorail type track, a traversing trolley and a gripper unit. The trolley will travel along the overhead track until the desired Bar Screen has been reached. The gripper unit may then be lowered to engage and penetrate the Bar Screen for debris removal to just above invert elevation. The gripper may then be closed, raised and debris transported to the appropriate dumping site.

The overhead track will be fabricated from two (2) channel sections continuously welded together with an intermediate top plate to protect the traversing motors and wheels from inclement weather. This provides the track for the traversing drives and support wheels fitted to the top of the trolley. The track will be supported at various points by support columns of hollow steel tubing flanged at the bottom for direct fastening to the civil work deck.

The trolley unit will contain the two (2) traversing gear motors, hoisting shaft and hydraulic power pack. The trolley will be traversed by gear motors mounted on top of the trolley and will include rubber-rimmed wheels, fitted directly to the gearbox output shaft to run inside the track. The hoisting gear will consist of two spirally grooved rope drums mounted on a common shaft within the trolley to raise and lower the gripper. The hoist shaft will be driven by a geared motor unit. The hydraulic power pack provides for the operation of the two hydraulic cylinders which open/close the gripper. Fluid power is transferred to cylinders through high strength hydraulic hoses which are wound on two (2) spring tensioned drums operating in sequence with hoisting drums. Electrical power to the trolley unit is supplied by a trailing cable which contains both power and control leads supported on cable wagons inside the track.

The gripper head will be supported by the hoist shaft via wire ropes and will consist of a series of special teeth designed to engage with the Bar Screen and are opened/closed by two (2) hydraulic cylinders. The gripper head will be prevented from swaying by specially designed swing restrictors.

C. SITE DATA

Site	Bonneville PH2 – Fish Turbine
Liquid Being Screened	Columbia River Water
Number of Screens Serviced	Four (4)
Deck Level	90.0'
Top of Barscreen Level	44.0'

C. SITE DATA - Continued

Invert Level	-21.92'
Channel Width	19.5'
Channel Depth	111.92'
Screen Inclination	10°

D. TECHNICAL DATA

Number of Cleaners	One (1)
Gripper Width	7'-2"
Maximum Debris Load	1,100 Lbs
Weight of Trolley	2,200 Lbs
Weight of Gripper	Max. 2,750 Lbs
Length of Straight Track	140.5'
Curve Track Radius	12'.
Raking Speed (up/down)	60 Fpm
Traversing Speed (left/right)	100 Fpm
Gripper open/close time	6 Sec
Hoist Motor Size	5.5 Hp
Traversing Motor Size (Two Each)	1/2 Hp x 2
Hydraulic Motor Size	2 Hp
Motor Speeds	1800 Rpm
Motor Enclosure	TEFC/IP55
Hydraulic Operating Pressure	1300 Psi

II. SPECIFICATION

A. MATERIALS OF CONSTRUCTION

Gripper	Galvanized Steel
Hoist Cables	Stainless Steel, Gr. 316
Trolley/Hoist Parts	Mild Carbon Steel
Trolley Enclosure	Carbon Steel w/ Stainless Steel Doors
Track	Mild Carbon Steel
Columns	Mild Carbon Steel
Track/Columns Fasteners	Zinc Plated
Foundation Fasteners	By Others

B. ACCESSORIES

The following items will be supplied:

- First Filling of Lubricants.

C. PROTECTION

All equipment not manufactured in corrosion resistant materials, or otherwise protected, will be protected as follows:

- All mild steel structural parts will be hot dip galvanized in accordance with ASTM A-123.
- Bought in items such as motors, gearboxes, etc... will be supplied in the manufactures' standard finish, suitable for the application.

D. CONTROLS

See separate specification.

Options for manual controlled, automatic/timed controlled and differential level controlled.

REF: P00-115

BRACKETT BOSKER® RAKING MACHINE

SPECIFICATION

FOR AUTOMATIC CONTROLS

A. STANDARD

Enclosure: NEMA 4

Enclosure Mounted Components

Pushbuttons: NEMA Type 4/4x Non-illuminated

1. Lamp Test
2. Reset For
3. Start Auto Sequence
4. Emergency Stop (Twist to reset)

Pilot Lights: NEMA Type 4/4x

1. Emergency Stop Activated
2. Trolley Motor Fault/Overload
3. Hoist Motor Fault/Overload
4. Hydraulic Pump Motor Fault/Overload
5. Low Hydraulic Fluid Level
6. Running

Switches

1. Manual/Off/Automatic: 3 Position NEMA Type 4/4x
2. Flange Mounted Disconnect

Elapsed Time Meters: NEMA 4

1. Trolley Motor
2. Hoist Motor

Internal Control Components

Programmable Logic Controller:

1. Chassis
2. Power Supply
3. Digital Input Modules
4. Digital Output Modules
5. Processor

Periodic Time Clock: Fifteen (15) minute multiple intervals

Control Power Transformer with mounted fuse block.

Motor Starters with overload protection.

1. Trolley Motor
2. Hydraulic Pump Motor
3. Hoist Motor

B. OPTIONS

1. Separately fused thermostatically controlled anti-condensation heater.
2. Differential Level Detectors for automatic start.
3. Multiple cleaning zone selection switches.
4. Output signals of customers request.
5. Remote plug-in pendant station and receptacle for local manual controls. NEMA Type environmental ratings 1, 2, 3, 4, 4x or 13.
6. Trolley mounted floodlights for night operation.
7. Programming for multiple well widths and inverts.
8. Processor Programming Software Kit

C. SAFETY FEATURES

1. Solid State Motor Overload Relays with Automatic/Manual Resets. These relays have field selectable trip class 10, 15, 20 or 30 and provide jam and ground fault protection.
2. Secondary fail-safe, limit switch to prevent trolley overtravel as a back up to the primary proximity switch.
3. Secondary fail safe, limit switch in addition to the primary proximity switch, to detect a slack rope condition which indicates an obstruction in the grippers path.
4. Trolley Mounted Visual and Audible Alarms activated by the start signal, to warn personnel near by of automatic equipment.

The Brackett Bosker® removes debris form a bar screen, section by section. Each section width is equal to the width of the gripper. The removal of debris will be automatically controlled.

The automatic cleaning cycle is initiated in one of the three ways:

1. An operator depresses the AUTO START pushbutton located on the front of the control panel.

or

2. The periodic time clock located in the control panel.

or

3. The differential level controls.

One the start signal is given, a time delay is begun and an audible and a visible alarm is activated.

After the time delay, the trolley, with gripper is the open position, moves along the monorail toward the first section of the cleaning zone. When the trolley reaches the first section, a proximity sensor sends a signal for the trolley to stop. As soon as the trolley stops, a time delay is initiated, then the gripper is lowered to engage the bar screen. As the gripper lowered, the debris is forced to the bottom of the bar screen.

Once the gripper has made its complete descent to the bottom limit, the hydraulic cylinders will close the gripper jaws, securing the debris for removal. Now the hoist motor rewinds the wire rope, lifting the gripper and load safely toward the trolley as the gripper enters the swing restrictor plates on the trolley, the upper hoist proximity switch is actuated and the hoist motor is stopped. Next the trolley motor is started and the trolley is moved to the designated dump area.

When the loaded Brackett Bosker® reaches the dumpsite a proximity sensor sends a signal for the trolley to stop. Once stationary, the cylinders release the jaws of the gripper allowing the debris to fall into the dump area.

The Bosker® will repeat this cycle until each section of the cleaning zone is cleared. Finally the trolley will return to the designated park position.

REF: P00-115

SPECIFICATION

FOR

BAR SCREENS

I. GENERAL DESCRIPTION

The bar screen (Trash Rack) will be designed to be a raked by a Raking Machine. The trash racks will extend from bottom of the channel to an elevation of 44.0'.

The bar screen will be of all welded and bolted construction, manufactured with rectangular section bars attached to built-in steel section supports beams spanning the width of the channel.

II. SPECIFICATIONS

A. SITE DATA

Site	Bonneville PH2 – Fish Turbine
Liquid Being Screened	Columbia River Water
Deck Level	90.0'
Top of Barscreen	44.0'
Channel Base Level	-21.92'
Channel Depth	111.92'
Channel Width	19.5'

B. SCREEN DATA

Number of Screens	Four (4)
Screen Width	19.5'
Screen Height	67.0'
Number of Screen Sections	Nine (9) sections per Screen
Bar Size	3/8" x 1-1/2"
Bar Spacing	7/8"
Angle of Installation	10°

D. MATERIAL OF CONSTRUCTION

	Carbon Steel Option	Stainless Option
Screen Bars	Carbon Steel, A-36	Stainless Steel, Gr 316
Support Beams	Carbon Steel, A-36	Stainless Steel, Gr 316
Transition Plate	Carbon Steel, A-36	Stainless Steel, Gr 316
Fasteners	Zinc Plated	Stainless Steel, Gr 316

E. PROTECTION

See protection specification for protection.

New B2 FU Trashrack Weights

	Quantity	Component Dim. in inches			Volume cubic inches	Weight lbs 0.2833	Surface Area, sf
		Thickness	Width	Length			
Trashrack Bars	181	0.375	2	161	21856	6192	961
Horizontal Supports	5	0.375	15	234	6581	1864	250
	10	2	4	234	18720	5303	195
Vertical Supports	5	0.375	15	161	4528	1283	172
	10	0.375	4	161	2415	684	98
Top Lifts	2	2.25	7.5	20	675	191	5
Side Plates	4	0.5	4	161	1288	365	40
	2	0.375	19	161	2294	650	87
	2	0.375	15	161	1811	513	69
	4	3.5	1.5	6	126	36	2
	2	0.5	4	36	144	41	5
Total Weight per Assembly, lbs						17,122	
Total Number of Assemblies						16	
Total Weight, lbs						273,956	
Total Surface Area, per Assembly							1883
Total Surface Area, sf							30,129
Fabrication Cost, $/lb					$2.00		
Total Fabrication Cost						$547,912	
Coating Cost, $/sf					$3.00		
Total Coating Cost						$90,387	
Total Cost						**$638,300**	

WACHS
THE WACHS COMPANIES
PIPE MACHINERY & SERVICE SINCE 1883

FACSIMILE

DATE: **July 12, 2001**

COMPANY: **Montgomery Watson**

ATTENTION: **Mr. Frank Postlewaite**

NUMBER OF PAGES: 4 (Includes this Page)

From: **WACHS COMPANIES**
100 Shepard Street
Wheeling, IL 60090

Bret O'Brien - Application Engineer
Direct Phone: 847-484-2651
Fax: 847-520-1147
Website: www.wachsco.com

Frank,

Please find attached the quotation that you requested.

Should you have any questions or need any additional information, please feel free to contact me directly at 847-484-2651.

Sincerely,

Bret O'Brien
Application Engineer

THE WACHS COMPANIES
PIPE MACHINERY & SERVICE SINCE 1883

QUOTATION

TO: Mr. Frank Postlewaite
Montgomery Watson
2375 130th Ave. North East
Suite 200
Bellevue, WA 98005

DATE: July 12, 2001
OUR QUOTATION NO.: BO0107121203
PAYMENT TERMS: Net 30 Days
SHIPPING TERMS: FOB Wheeling
VALID THROUGH: September 10, 2001

Shown below is the quotation you requested:

ITEM	QTY	PART NO	DESCRIPTION	PRICE	LINE TOTAL
1	1	11-000-02	Wachs 110 Volt Electric Powered P/2 Pow-R-Drive Portable Reversible Valve Operator, complete with 110 Volt Electric Drive, LCD Revolution Counter w/push button reset, Torque Arm Extension, Steel Storage Case and Manual.	$4,250.00	$4,250.00
2	1	05-402-00	Valve Key, 8 foot long with 2" Ductile Iron Socket and Stop Collar.	$186.84	$186.84
				Sub Total :	**$4,436.84**
				Shipping & Handling	**$275.00**
				Quote Total :	**$4,711.84**

We will pre-pay and add the shipping charges to your invoice or ship via collect using your preferred carrier.

Should you have any questions or would like to place an order, please feel free to contact me at 847-484-2651 or Gary Althide 916-719-6529.

Sincerely,

Bret O'Brien

By: Bret O'Brien
Application Engineer

WACHS

POW-R-DRIVE II

A VERSATILE, LOW COST, HAND HELD VALVE TURNING MACHINE...

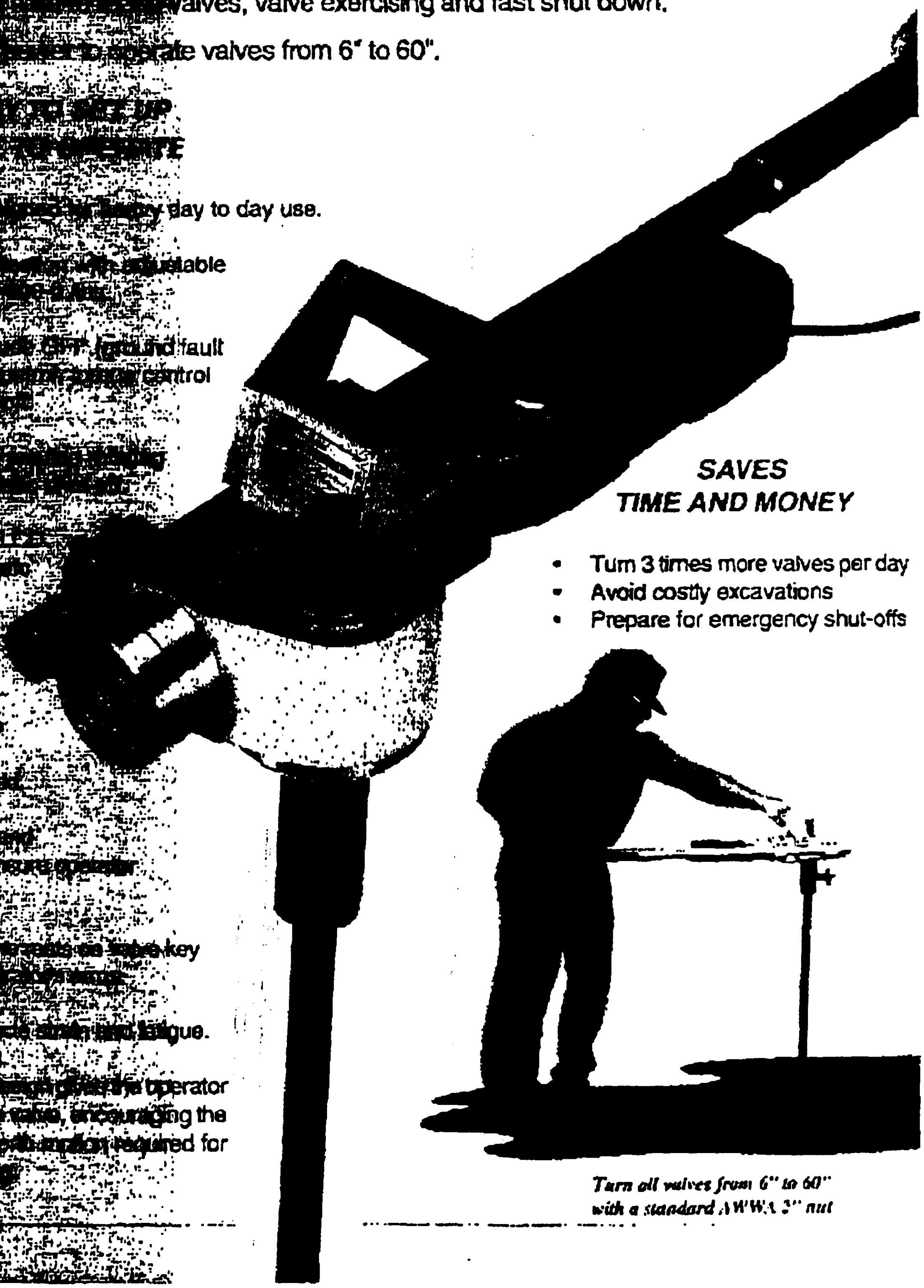
[illegible] increased productivity, operator safety and valve protection.

[illegible] valves, valve exercising and fast shut down.

[illegible] to operate valves from 6" to 60".

[illegible]

- [illegible] day to day use.
- [illegible] adjustable [illegible]
- Safety features include GFI (ground fault [illegible] control [illegible]
- [illegible]
- Built in [illegible] counter with automatic forward/reverse provides accurate rotation count to operator.
- Easy one man setup [illegible]
- [illegible] and operating handles ensure operator [illegible]
- [illegible] valve key [illegible]
- [illegible] reduces muscle strain and fatigue.
- The Pow-R-Drive II [illegible] the operator a sensitive feel of the valve, encouraging the [illegible] required for [illegible]

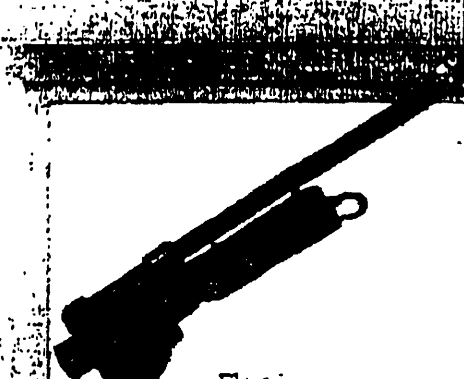


SAVES TIME AND MONEY

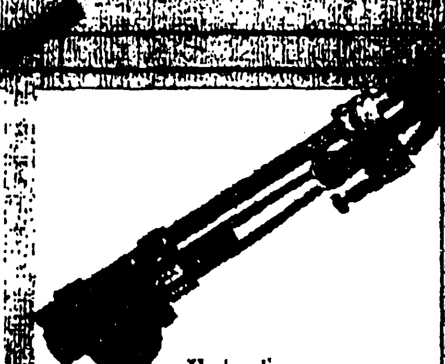
- Turn 3 times more valves per day
- Avoid costly excavations
- Prepare for emergency shut-offs

Turn all valves from 6" to 60" with a standard AWWA 2" nut

- [illegible]



Electric



Hydraulic

Pneumatic

SPECIFICATIONS

Capacity: Operates all gate valves 6" to 60" (15.3 to 152.4 cm) and other equipment requiring mechanized turning.

Drive:
- Sealed lightweight aluminum gearbox
- Two stage reduction
- Planetary primary
- Bronze/Steel secondary (120:1 reduction)

Power Requirements:

Electric	Hydraulic	Pneumatic
110 V AC/220 V AC (15 AMP OR 3300 WATT)	8 gpm @ 1800 psi	70 cfm @ 90 psi

Peak Torque: 800 ft./lbs. (1084 N-m)

Motor Controls:

Electric:
- 2 speed gearbox (Low RPM/High Torque) (High RPM/Low Torque).
- Overload Reset Button.
- On/off, forward/reverse and neutral.
- GFI (ground fault interrupter) with test and reset.

Hydraulic:
- Adjustable torque setting valve from 0 to 800 ft./lbs. with torque indicator gauge.
- Reversing valve, spring loaded self centering automatic stop after release.

Pneumatic:
- Reversible pneumatic motor with spring loaded on/off lever.
- Automatic stop after release.

Revolution Counter: Built in digital counter display. Push button reset counts in 1/10 revolution increments, forward and reverse automatically.

Torque Gauges: Hydraulic: 0 to 800 ft./lbs. Glycerine filled.
Pneumatic: 0 to 800 ft./lbs.

Finish: Enamel paint, Nickel plated handles and accessories.

Valve Key Size: 1" square solid (2.54 cm).

Socket: 2" square. AWWA standard (5 cm).

Dimensions:

	Length	Width	Height
Pow-R-Drive II	39-3/4" (101 cm)	7-3/4" (20 cm)	7" (18 cm)
Storage Case	40-1/2" (103 cm)	10-1/4" (26 cm)	8-1/2" (22 cm)

Weight:

Electric	Hydraulic	Pneumatic
32 lbs. (15 kg)	36 lbs. (16 kg.)	37 lbs. (17 kg.)

Torque Performance Charts

Electric 110 Volts

TORQUE FT./LBS.	RPM *High Speed Low Torque Setting	AMPS	RPM Low Speed High Torque Setting	AMPS
100	12.5	8.8		
* 175	9	10	5.5	8
300	4.3	15	4.7	9.5
375	4.0	20	4.2	11 **
500	2	25	3.5	13.2
600			2.5	15.5
700			1.5	17.8
800			.5	20

* Factory rated continuous load high speed/low torque
** Factory rated continuous load low speed/high torque

Electric 220 Volts

TORQUE FT./LBS.	RPM *High Speed Low Torque Setting	AMPS	RPM Low Speed High Torque Setting	AMPS
100	10.2	3.1		
* 175	9.9	4.4	5.2	3.2
300	7.4	6.1	4.8	3.5
375	5	7.6	4.6	4.5 **
500	2	10	3.8	5.5
600			2.8	6.2
700			1.5	7.5
800			.5	10

* Factory rated continuous load high speed/low torque
** Factory rated continuous load low speed/high torque

Hydraulic

Based on 8 gpm @ 1800 psi

FT/LBS	RPM
100	12
200	12
300	12
400	12
* 500	12
600	12
700	12
800	11

* Factory rated continuous use

Pneumatic

Based on 90 psi @ 70 cfm

FT/LBS	RPM
100	13
200	11
300	7
400	5
* 500	4
600	3
700	2
800	1

* Factory rated continuous use

Standard Accessories:
- Torque Arm Extension for two man operation.

Optional Accessories:
- 8' Valve Key (244 cm)
- 2" Square AWWA Socket
- 15/16 Drive Socket
- 4' Valve Key (122 cm)
- Stop Collar.

CE

[illegible] 12/97 5000

WACHS

[illegible]

FAX [illegible]-1147 • [illegible]

[illegible]

MONTGOMERY WATSON

Telephone Discussion Notes

Subject: B2 AWS Diffuser Grating Monitoring

Discussion:

Costs and availability of MTL Components

A/I Module for analog input (4-20 mA)	$1158 each	3 weeks
To Modbus (Protocol Converter)	$2120 each	6 weeks
Power Supply PS-01	$2085	3 weeks

- Power supply powers the communicators and the level transmitters
- A/I talks to the Modbus converter thru the PS-01

Montgomery Watson Party	Other Party
Project Name: BVO 23	Company Name: MTL
Project No. ____ Billable? Yes, No	Address:
Employee Name: Frank Postlewaite	Phone No. 603-926-0090/703-361-0111
Date: 7/17 Time: 11^{05} AM	Person Name: Sales & Tech Support

Call placed by: MW _____, Other Party _____

GO-60 (10/84)

IO95CAT3.pdf
7/18/01

MTL I/O95™
System Overview

The MTL I/O95 system consists of 3 key elements:

System Software

MTL I/O95 software provides the drivers to directly interface to your Windows application programming package. The system software utilizes a PC interface card with dual ported memory to manage TransNet communications. I/O data is automatically updated independent of the host computer and is readily accessible by the host PC. The interface card performs data validation and maintains system status information. The interface card also controls the transmission of data between the PC and the I/O modules.

I/O Modules and Termination bases

The I/O modules acquire and process I/O data from the field mounted sensors and actuators. The modules continually self-check for errors and faults. All field wiring connects directly to the module bases. The I/O modules plug into the termination bases, allowing the modules to be "hot swapped" without removing power or field wiring.

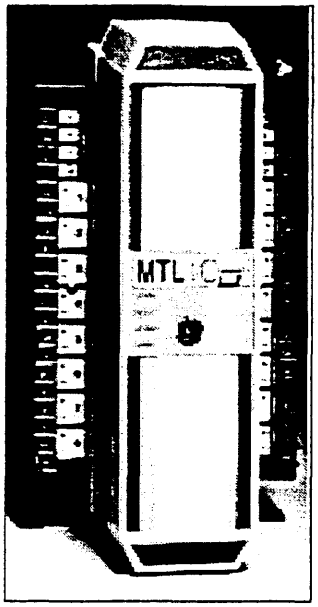
Module Power Supplies

The module power supplies provide power to the TransNet communications network over the same wires used for the communications network.

These elements define a cost-effective I/O solution, resulting in a measurement and control system that can be truly distributed throughout your plant.

Network Communications

The system network operates up to one mile from the host computer, allowing the modules to be placed right next to the process they are to monitor and control. The distributed architecture of MTL I/O95 eliminates the need to run sensor wires to a central host system, saving you significant time and money in the installation process.



I/O 95 [illegible]
[illegible]

Modules Built for the Plant Floor

The modules are designed to be installed directly in harsh industrial applications. The modules provide input to output isolation of 1500V rms, protecting the module and the system from transients. The modules operate over 0 to 60 degrees C and can withstand up to 95% relative humidity, assuring reliable performance in your application. The modules are calibrated at both 25 and 50 degrees C. Each analog module incorporates an internal sensor to measure ambient temperature and compensate for temperature effects during operation, resulting in accuracy of 0.1% over temperature.

Analog I/O Modules		
	Modularity	8 or 16 channels each
	Input Types	4-20mA, TCs, RTDs, strain gage, mV, V, LVDT
	Output Types	0-20mA, 4-20mA
	Isolation	1500 Vrms Input to Output, Input to Power, and Channel to Channel
	Accuracy	± 0.1%, ± 0.05% & ± 0.02% of span over temperature
	Common Mode Rejection	160dB Transient Protection Meets C37.90.1 Surge Withstand Test - 3000V peak
	Input Resistance	> 500 M Ohms
Discrete I/O Modules		
	Modularity	16 or 32 channels each
	Type	AC and DC Inputs and Outputs From 90 Vac to 260 Vac & 5 Vdc to 125 Vdc
	Isolation	1500 Vrms Input to Output, Input to Power
	Transient Protection	Meets C37.90.1 Surge Withstand Test - 3000V peak
	Counters	Up to 450 Hz, optional on Discrete Input Module
	High Speed Counter	Up to 200 Khz for Frequency, Up / Down Counting & Quadrature
Host Computer Interfaces Supported		IBM AT Computer Interface & VME Backplane Interface
	System CPU	Dual Processors manage host computer interface and control and check communications
	RAM	64K dual port RAM
	Required Card Slots for PC	1/2 size PC/AT slot (Upto to 10 Cards per PC)
	Required Card Slots for Backplane VME Computer	6U Style Card, Single Slots
I/O Capacity per interface card		1920 Analog I/O / 3840 Digital I/O
Communications		
	Throughput	320 analog in 30 msec, 640 digital in 12 msec
	Wire	Twinaxial cable
	Distance	Up to 1 mile from Host (without repeaters), Fiber Optic Extenders Available
	Error Checking	CRC-16 format verification, watch dog timer
	Redundant Communications	Optional Redundant Communications Interface Adapter
Software Interfaces		Compatible with many popular MMI / HMI software packages some listed below: Intellution FIX & FIX Dynamics NemaSoft Paragon Iconics Genesis Wonderware InTouch DDE & DDE32 Applications Lab View *OPC applications (Preliminary) Intellution Paradym Soft PLC Steeplechase Software VLC Citect C Tool Kit with DLL's (for Win 3.1, 95 & NT) GE Cimplicity
Environmental		
	Temperature, Rated Performance	0 to +60 Deg C
	Temperature, Operating	-20 to +60 Deg C
	Temperature, Storage	-40 to +85 Deg C
	Humidity	0 to 95% RH noncondensing
Power Requirements		18 to 35 Vdc
	Analog Modules Consumption	12.5 W for input modules, 20.0 W for output modules
	Discrete Modules	3 W for input modules, 4 W for output modules
Standards	FM	FM Class I, Div II, Groups A,B,C & D hazardous locations
	CE	CE Marked, EMC Directive (1995), LVD
Physical	Module Weight	2.2 lbs. (1.0 kg)
	Module Bases	(Refer to selection table on page 10 for appropriate base)
	Base Dimensions	8.6 in. (218mm) L x 5.1 in. (129.5mm) W x 1.6 in (40.6mm) H
	Assembly Dimensions	9.5 in. (241mm) L x 5.1 in. (129.5mm) W x 4.25 in (108mm) H

Selection and Configuration

MTL I/O95 is designed specifically for PC based monitoring and control applications in harsh industrial environments. For those applications that may be exposed to hazardous gases. MTL I/O95 is approved for use in Class 1, Division 2, Groups A, B, C, and D environments.

One of the first things to consider is where you are going to install your I/O. With MTL I/O95 , you can install the modules as close to the process as you desire. The industrially hardened modules are built to withstand harsh plant floor environments. This distributed mounting of the I/O modules can save you considerable money in wiring when installing your system. since all field wiring is terminated at the module and you will only need to bring the communications wiring back to your computer.

Analog Input Modules

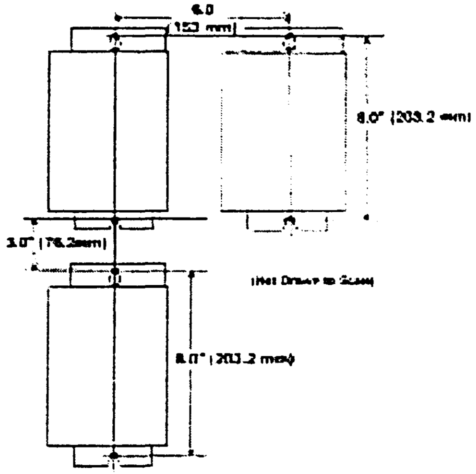
There are some options in the selection of analog input modules, that give you the ability to optimize the modules for your requirements. MTL I/O95 input modules are available with full 3 port isolation as well as with input to output isolation only. Refer to the Selection Table on pages 10 - 11 for specific model numbers.

Input to Output Isolation

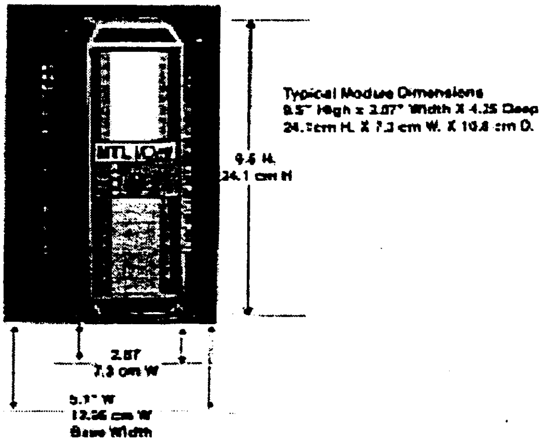
Only You can consider the modules with input to output isolation only if your environment is not electrically noisy and will not be susceptible to ground loops caused by noise and interference. These products will provide good, cost-effective performance in those environments that are not electrically harsh and will not experience channel to channel interference.

Full 3 Port Isolation

If you have electrically noisy environments or are not sure about the environment, you should choose the 3 port isolated products. These products provide isolation from input to output, input to power and channel to channel, and will eliminate the effects of ground loops and provide superior performance in the harshest of industrial environments.



Module Dimensions



Analog Output Modules

Analog output modules are available to provide a 4-20 mA current output. These products are 3 port isolated and provide isolation from input to output, input to power and channel to channel.MTL I/O95 is a good choice for your data acquisition and control applications. The system's integrated nature assures a quick system startup.

MTL I/O95 offers a simple approach to the selection and configuration of your system. The system's open architecture and clear definition of module and base options allow the first time user to quickly and simply become familiar with the product

Discrete Input Modules

Discrete Inputs are available to address AC or DC Inputs. Counters are optionally available for the discrete inputs. These products are 3 port isolated and provide isolation from input to output, input to power and channel to channel.

Discrete Output Modules

Discrete Outputs are available to address AC or DC Output requirements. A monitoring option is available to provide system feedback on all discrete outputs. These products are 3 port isolated and provide isolation from input to output, input to power and channel to channel.

A Sample MTL I/O95 Application

The following steps should be followed as you prepare to purchase and/or configure the MTL I/O95 system components for your particular application:

Determine the types and quantity of I/O modules required at each location.

Select the interface and software to be used.

Choose the driver package which is appropriate for your computer hardware and software.

Calculate power supply requirements.

Now, we will apply these steps in the selection and configuration of a sample I/O application. Let's assume that this is a two location field application with the following conditions:

The first remote location contains fifteen thermocouples. The second remote field location contains thirteen 4 - 20mA inputs, six analog outputs, forty 24 Vdc digital inputs, and twelve 24 Vdc digital outputs.

The host computer is a PC, running Intellution's *FIX 32 for Windows NT.*

Determining I/O Types and Quantities

Our first step is to determine the types and quantity of I/O that are necessary.

At the first field location, one AIU-16 module and its TE07-M base will fully accommodate the thirteen thermocouples.

At the second location, an AIH-16 and TE08-M will collect the 13 high level analog inputs, and an AOC-08 and TE03-M will provide the six analog outputs.

The forty digital inputs will be collected by a DI24D-32 and TE01-M, and a DI24D-16 with a TE02-M, and a DO24D-16 and TEF09-5M will provide the 12 digital outputs.

Choosing an Interface and Software

Next, we will select the interface and software. The FIX-HOSTWIN 32 package includes both the PC master card and driver software for use with *Intellution FIX 32.*

Defining I/O Power Requirements

Finally, we should determine power requirements.

Based on the power supply chart on page eleven, our application would require a total of 64 watts. With this requirement, we would then order one PS-170 power supply and the PSC-24 power adapter.

Sample System - Final Configuration

We now have a complete distributed I/O system, with the following products in its configuration:

Model	Qty.	Description
AIU-16	1	Universal Input Module
TE07-M	1	Universal Input Base
AIH-16	1	High Level Input Module
TE08-M	1	High Level Input Base
AOC-08	1	Isolated Current Output Module
TE03-M	1	Isolated Current Output Base
DI24D-32	1	Discrete 24 Vdc Input Module
TE02-M	1	Discrete Input Base
DO24D	1	Discrete Output Module
TEF09-5M	1	Discrete Output Base
FIX-HOSTWIN32	1	FIX Driver with PC card
PS-170	1	170 Watt Power Supply
PSC-24	1	24 Volt, 170 Watt Power Adapter

MTL I/O95 Selection Table

Analog Inputs	Input Type	Channels	Module	Base	Page #:
Universal	Type J,K,T,E,R,S,B,C,N	16	AIU-16	TE07-M	10
	mV, volts and 4-20mA	8	AIU-08	TE07-M	10
Universal High-	" "	16	AIU-16-EP & -EP2	TE07-M	10
Accuracy Models	" "	8	AIU-08-EP & -EP2	TE07-M	10
RTD	100 Ohm Pt, 120 Ohm Ni	16	AIR-16	TE06-M	12
"	" "	8	AIR-08	TE06-M	12
RTD High-	100 Ohm Pt, 120 Ohm Ni	16	AIR-16-EP2	TE06-M	12
Accuracy Models	" "	8	AIR-08-EP2	TE06-M	12
RTD	10 Ohm Copper	16	AICR-16	TE06-M	12
		8	AICR-08	TE06-M	12
High Level	4-20mA, +/-5V, 1-5 V	16	AIH-16	TE08-M	14
		8	AIH-08	TE08-M	14
Strain Gage	350-1000 Ohm bridge	16	AIS-16	TE12-M	16
		8	AIS-08	TE12-M	16

Analog Outputs	Input Type	Channels	Module	Base	Page #:
Current	0-20,4-20mAOutput	16	AOC-16	TE03-M	18
		8	AOC-08	TE03-M	18

Discrete Inputs	Input Type	Channels	Module	Base	Page #:
Standard Inputs	5VDC	32	DI05D-32	TE01-M	22
		16	DI05D-16	TE02-M	22
	24VDC	32	DI24D-32	TE01-M	22
		16	DI24D-16	TE02-M	22
	48VDC	32	DI48D-32	TE01-M	22
		16	DI48D-16	TE02-M	22
	125VDC	32	DI125D-32	TE01-M	22
		8	DI125D-16	TE02-M	22
	115VAC	32	DI115A-32	TE01-M	22
		16	DI115A-16	TE02-M	22
	230VAC	32	DI230A-32	TE01-M	22
		16	DI230A-16	TE02-M	22

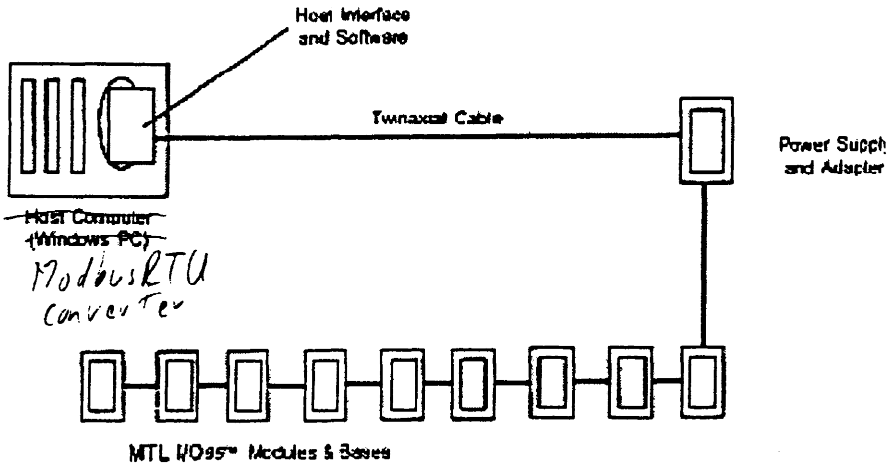
Discrete Inputs with Counters (first 4 channels up to 400 Hz)

Counters	5VDC	32	DI05D-32-C	TE01-M	22
		16	DI05D-16-C	TE02-M	22
(400Hz)	24VDC	32	DI24D-32-C	TE01-M	22
		16	DI24D-16-C	TE02-M	22
	48VDC	32	DI48D-32-C	TE01-M	22
		16	DI48D-16-C	TE02-M	22
	125VDC	32	DI125D-32-C	TE01-M	22
		16	DI125D-16-C	TE02-M	22

Discrete Inputs	Input Type	Channels	Module	Base	Page #:
High Speed Counters All Channels (200Khz)	24VDC	16	DI24D-16-HC	TE01-HC-M	20
		8	DI24D-08-HC	TE01-HC-M	20

Discrete Outputs	OutputType	Channels	Module	Base	Page #:
	2-50 Vdc, Pulsed Output	16	DO24D-16PO	TEF09-5M	24
	4-130 Vdc, Pulsed Output	16	DO125D-16PO	TEF09-5M	24
	20-230 Vac, Pulsed Output	16	DO230A-16PO	TEF09-5M	24
	48 Vdc, H Drive Output	16	DO48HD-16	TE11-M	24
	0-50 Vdc	16	DO24D-16	TEF09-5M	24
	0-50 Vdc, monitored	16	DO24D-16M	TEF09-5M	24
	0-125 Vdc	16	DO125D-16	TEF09-5M	24
	0-125 Vdc, monitored	16	DO125D-16M	TEF09-5M	24
	0-230 Vac	16	DO230A-16	TEF09-5M	24
	0-230 Vac, monitored	16	DO230A-16M	TEF09-5M	24

Sample MTL I/O95 System Layout



Power Supply Requirements

Module Type	Channels	Watts
Analog Inputs	8	10
Analog Inputs	16	17
Analog Outputs	8	17
Analog Outputs	16	25
Discrete Inputs	All Models	4
Discrete Outputs	All Models	5
High Speed Counters	All Models	7

Analog Inputs: High Level Modules

For applications that interface to +/- 5V dc, 1 - 5V and/or 4 - 20 mA in harsh industrial environments, select the High Level Input Modules, AIH-08 and AIH-16. For -10 to +10 volt VDC select the AIH-08-10V or AIH-16-10V.

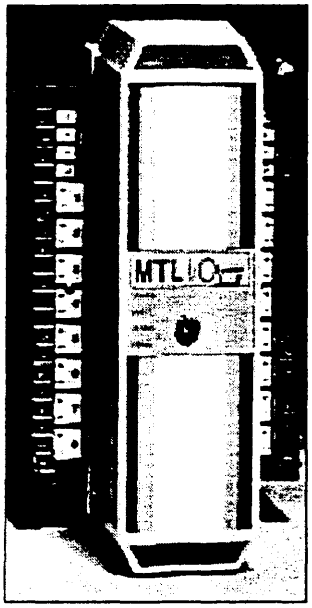
Module Description

These flexible modules are configurable on a channel by channel basis, allowing the user to select unique input types and ranges for each channel. The modules are designed to be installed directly in harsh industrial applications. The modules feature 3 port isolation of 1500 V rms, protecting the module and the system from transients and eliminating the errors caused by ground loops in the system. The modules are calibrated at both 25 and 50 deg C. Each module incorporates an internal sensor to measure ambient temperature and compensate for temperature effects during operation, resulting in accuracy of 0.1% over temperature.

Each module continuously transmits the present value of the input channels. They can be configured to maintain and report the peak (highest value) and valley (lowest value) of any channel since the last reset. The user can also configure a software filter for each input channel. The modules feature internal diagnostics that are presented via status lights on the module front. These lights indicate detection of an open circuit, communications status or module diagnostics status. Modules are offered in 16 and 8 channel versions to allow you to choose the right size for your needs.

Termination Bases

Each module requires a model TE08-M Termination Base. Remember to order one base for each module. The termination bases can be either DIN-Rail mounted or can be surface mounted directly on a wall or in a cabinet. All system wiring connects directly to the TE08- M base, which can be wired separately before the modules are installed to speed system installation. The universal modules plug directly into the TE08-M and can be easily removed without disturbing field wiring to allow easy access to the field screw terminals. Since the modules incorporate a low power design, they can also be "hot swapped" allowing units to be switched while the entire system is still under power, assuring ongoing system operation during simple maintenance activities.



External Power Connections

For applications where several high level inputs are powered from a common user power supply, the TE08-AM Termination Base is available to allow you to jumper (selectable) power to adjacent channels, simplifying the overall wiring installation. If the inputs are sharing a common power supply in this configuration, they are not isolated channel to channel.

Selecting a High Level Analog Module

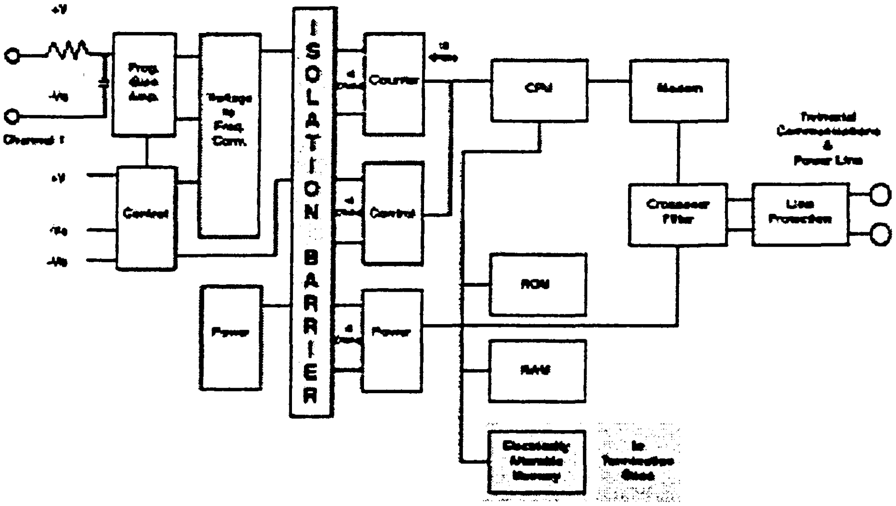
For 8 channel applications, choose the AIH-08, and for 16 channel applications, choose the AIH-16. Both modules are capable of interfacing with the following input types and ranges:

Input Type	Range
Voltage	+/- 5V, 1 - 5 V
Current	0 - 20 mA
~~AIH-08-10V~~	-10 to +10 VDC
~~AIH-16-10V~~	0-20 mA
Module Base (requires 250 Ohm external shunt resistors for 4-20 mA inputs Order our part number RS-250-8)	TE08-M
Module Base, with External Power Connections (Also includes internal 250 Ohm 4-20 ma shunt resistors)	TE08-AM

High Level Input Module Specifications

		AIH-08 AIH-16	~~AIH-08-10V~~ ~~AIH-16-10V~~
Modularity	8 or 16 channels each	8 or 16 channels each	
Input Types	4-20mA,1-5V, +/-5V	0-10V dc	
Isolation	1500 V rms Input to Output, Input to Power & Channel to Channel		
Accuracy	+/- 0.1% of span over temperature		
Conversion Rate		16 readings every 21.8 msec	
Common Mode		Rejection 160dB	
Transient Protection		Meets C37.90.1 Surge Withstand Test - 3000V peak	
Input Resistance		> 500 M Ohms	
User Configurable Parameters		Module address	
Host computer configuration		Input filter per channel	
available on a single channel basis		High and low value per channel	
Module Diagnostics			
Power Up Diagnostics		Internal voltage within range, CPU diagnostics All RAM Memory, ROM and EAROM checksum	
Run Time Diagnostics		Watchdog timer, Auto zero, Temperature Compensation	
System Throughput		320 analog in 30 msec, 640 digital in 12 msec	
Distance		Up to 1 mile from Host (without repeaters)	
Environmental			
Temperature, Rated Performance		0 to 60 Deg C	
Temperature, Operating		-20 to 60 Deg C	
Temperature, Storage		-40 Deg C to 85 Deg C	
Humidity		0 to 95% RH noncondensing	
Power Requirements		18 to 35 VDC; 12.5 W for AIH-16, 7W for AIH-08	
Standards			
FM		FM Class I, Div II, Groups A, B, C and D hazardous locations	
CE		CE Marked, EMC Directive (1995), LVD	
Module Base		TE08-M	
Module Base, with external power connections		TE08-AM	

Analog Input Signal Conditioning Block Diagram



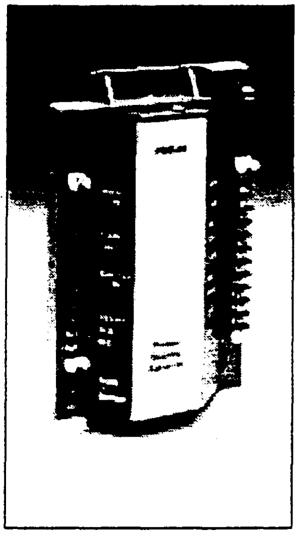
Power Supply for MTL I/O95

MTL I/O95 requires 18 to 35 Vdc of power to operate. The product line uniquely provides power over the same two wires used for communications, which reduces the number of wires which have to be connected to the system and run back to the host computer. The result is an efficient installation of remotely mounted I/O modules, significantly reducing the time and cost of starting up your system.

PS-01 Description Two power options are provided. For smaller applications, the PS-01 power supply can be used to convert 115 Vac 60 Hz or 230 Vac 50Hz power to provide 20W of DC power for the I/O modules, which regulate and isolate the power within the modules. The PS-01 is used with a TE04-M Termination Base, which is used to provide both power and communications on the two wire TransNet communications network. Refer to the power supply requirements table on page 11 to determine the power needed for your application.

PSC-24 & PSC-24-3 Description For larger applications, the PSC-24 Central Power Supply Adapters allows the use of any commercial power supply that delivers between 18 and 35Vdc to supply power to the modules. The PSC-24 places the power on the TransNet communications system, which provides both power and communications to the MTL I/O95 modules. The PSC-24 will deliver up to 6 Amps at the appropriate voltages. For special saftey requirements a PSC-24-3 can be ordered. This will deliver up to 3 Amps at the appropriate voltages.
When using larger quantities of modules, the PSC-24 can reduce the number of power supplies needed to deliver DC power to the system.The PSC-24 also has provisions for backup power supply connections. This power supply will activate when the main supply input is 1.5 Vdc less than the backup supply voltage. The backup power supply is activated instantly and is glitch-free so that power is not lost and remains constantly supplied to the network.

PS-170 Description The model PS-170 power supply is offered to provide up to 170 W of system power. It can be used in conjunction with the PSC-24 Central Power Adapter to provide power to the MTL I/O95 system.



In applications above 170 W, two PS-170's can be used with two PSC-24 Adapters to distribute power to the network. Refer to the power requirements table on page 11 to determine the power necessary for your application.

Note: Models PS01, PSC-24, PSC-24-3 and PS170 are FM approved for use in Class I, DIV 2, Groups A, B, C and D hazardous locations.

Power Supply Specifications

Feature	PS-01	PS-170
Input Power	100-130 Vac, 60 Hz 180-260 Vac, 50 Hz	100-130 Vac, 60 Hz 180-260 Vac, 50 Hz
Output Volts	28Vdc	28Vdc
Operating Range	18 to 35 Vdc	19.6-30.8V
Maximum Output Ratings	20 W @ 60 C	173W @ 50 C 120W @ 60 C
Current Limit	NA	7.0-7.3A
Overvoltage Protection Range	NA	32-35V
Environmental		
Operating Temperature	0 to 60 Deg C	0 to 71 Deg C
Storage Temperature	-40 to +85 Deg C	-20 to +75 Deg C
Humidity	0 to 95% RH, noncondensing	up to 95% RH, noncondensing
Dimensions	9.5" x 5.1" x 4.25" (242 x 130 x 108 mm)	8.7" x 4.3" x 3.9" (220 x 110 x 100 mm)
Weight	3.2 lbs, 1.45 Kg	3.96 lbs, 1.8 Kg
Module Bases	TE04-M	N/A
Standards	FM C I, Div II, Groups A, B, C and D hazardous locations	Same as PS-01 CE Marked

PSC-24 & PSC-24-3 Power Supply Adapter Specifications

Main Power Supply Input	18-35 Vdc, unregulated
Backup Power Supply Input	18-35 Vdc, unregulated
Activation	Activates when main power is 1.5V below backup supply voltage Glitch free transfer maintains power on the network at all times
Current Capacity (PSC-24)	6 Amps
Fuse Rating	6 Amps Max. on either main or backup power supply
Current Capacity (PSC-24-3)	3 Amps
Fuse Rating	3 Amps Max. on either main or backup power supply
Relay Connections	Activates when main power supply fails
Noise	Less than 10mV rms noise in 1.0 to 2.5 MHz communications band
LED Indicators	Main LED - Voltage is present at main power input Backup LED - Voltage is present at backup power input "Fuse Blown" LED - PSC-24 Fuse has blown, no voltage power terminals
Standards	
FM	FM Class I, Div II, Groups A, B, C and D hazardous locations
CE	CE Marked, EMC Directive (1995), LVD

MTL I/O95™ Accessories

The MTL I/O95 system comes with a complete range of accessories and additional products for network redundancy,relays, fiber optic extension, base programming, and interface cabling.

Modbus Interface Converter The model MODBUS95 converts TransNet communications protocol to Modbus RTU protocol. Connections are made via RS232 or RS422/485. Communication Speeds supported up to 115.2Kbaud.

The MODBUS95 supports the following functions:

Read Output Status (01)	ReadInput Status (02)
Read Output Registers (03)	Read Input Registers (04)
Force Single Coil (05)	Preset Single Register (06)
Force Multiple Coils (15)	Preset Multiple Registers (16)

Other features include:

Status Information about the System & Modules. (Health)

Readback Information from Digital & Analog Outputs.

A mapping utility is included with the Interface to document system information & set Communication Speed and Node Address. For more detailed information contact MTL.

Redundant Network Selector The RNS-01 is a useful accessory in TransNet communications. It has three common uses including use as a Power Supply Adapter.

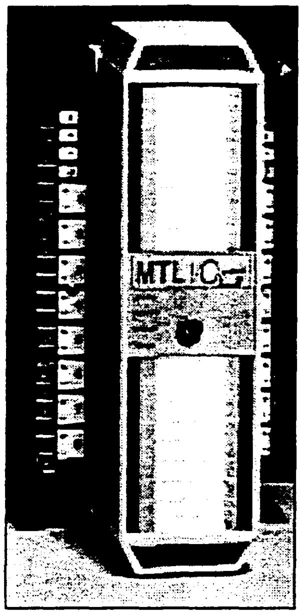
In the first, the RNS-01 has two inputs to a single TransNet connection and can be used to provide redundancy in some applications. Contact MTL applications engineering for further information.

In the second, the RNS-01 is used as a network splitter, allowing the user to tap (T) into the network at that point.

In the third, the RNS-01 is used as a repeater for applications where the TransNet communication length is beyond one mile.

Bus Switching Device The BSD-01 is a relay that can be used to switch between two communications networks. It can be used with redundant host computers to select the desired communications link.

Fiber Optic Converter The CI-FIBER is a fiber optic converter that may be used to extend the TransNet communications network beyond one mile, or can provide noise immunity in very noisy environments. Two specific CI-FIBER converters are needed to insert a fiber optic link within the TransNet network.



Base Programmers The BP-01 base programmer is an optional product which most commonly used to address a network of system bases before the modules are installed and the system is online.

The BP-03 base programmer is an optional product which is used to clear the base earom and reset the address to default.

Interface Cables and Options

CAI-01	150 Ohm Interface cable, 10 ft. length.
CAI-01-T	150 Ohm Interface cable with integral 150 Ohm terminating resistor, 10 ft. length.
CAI-02	Interface cable with phone jack on one end and DB9 on the other end, used with External Configuration option.
CA150-XXX*	150 Ohm Twinax TransNet cable available in 100,250,500,1000 foot lengths
CA100P-1000	100 Ohm Plenum Rated TransNet cable in 1000 foot legnths (200 Deg. C Rated)
RS-50-2	50 Ohm Termination Resistors (Pack of 2)
RS-75-2	75 Ohm Termination Resistors (Pack of 2)
RS-100-2	100 Ohm Termination Resistors (Pack of 2)
RS-125-2	125 Ohm Termination Resistors (Pack of 2)
RS-150-2	150 Ohm Termination Resistors (Pack of 2)
CRS-XX*	DB9M to DB9F termination adapter available in 50,75,100,125,150 Ohm versions
* note:	Substitute the XX for the value

APPENDIX E

HYDRAULIC MODEL DESCRIPTION

Appendix E
Description of Bonneville Second Powerhouse Fish Ladder Model

1.0 PURPOSE

This work was undertaken to develop a numerical computer model of Bonneville Dam Second Powerhouse, Adult Fish Facility. This model provides a tool by which the hydraulic characteristics resulting from the present mode, and any reasonably expected future mode of operation can be determined over a wide range of tailwater elevations, and these characteristics compared to present-day fishway hydraulic criteria. The numerical model also provides a means to identify measures that could be taken to maximize compliance with these criteria.

2.0 BACKGROUND INFORMATION

This work has been accomplished by Northwest Hydraulic Consultants (**nhc**) under contract to the Corps of Engineers, Portland District, as part of the Hydraulic Evaluation of Lower Columbia River Adult Bypass Systems program and was authorized by contract number DACW 57-96-D-0016, Task Order Number 0002. The bypass of adult anadromous fish from the tailrace of a dam to the forebay with a minimum of delay is critical in order that they continue their migration to the spawning channels. Well-defined criteria have been established for operating these bypass facilities (fishways) in the most efficient manner. Compliance with the criteria is essential for optimal operation of the fishways. The goal of this program is to identify measures that will maximize compliance with the hydraulic criteria. Accomplishing this goal requires the development of computer operated numerical simulation models which will provide accurate information concerning the flow characteristics throughout the fishway facility. The flow characteristics of particular concern are: ladder weir and orifice head, discharge and velocity; transportation channel average velocity, discharge and depth; fishway entrance head, depth, velocity, and discharge; diffuser velocity and discharge; and orifice entrance characteristics.

3.0 INTRODUCTION

The second powerhouse fishway was constructed to facilitate the bypass of adult anadromous fish. The design of these facilities was based on the best fishway hydraulic criteria that existed at the time of design and construction. Fishway Design criteria have been developed over the years based on continued experience with upstream fish passage facilities. Compliance with current fishway hydraulic criteria is essential to optimal operation of the fishway. The evaluation of the fishway system described in this appendix was undertaken to determine the hydraulic characteristics resulting from the present mode of operation, compare these characteristics to present-day fishway hydraulic criteria, and identify measures that could be taken to maximize compliance with these criteria.

The second powerhouse fishway facility includes two entrances on the south side of the powerhouse, a fish collection channel along the downstream face of the powerhouse, two entrances on the north side of the powerhouse, and a ladder extending from the north end of the powerhouse to the forebay. Water supplied to the fishway facility originates from two sources: the fishladder exit on the upstream face of the dam and from two turbines that are connected to conduits and diffusers referred to as the Auxiliary Water Supply System (AWS). A computer model of the second powerhouse fishway facility was developed based on a detailed analysis of the AWS routing, the fishway entrances, powerhouse collection channel, and the fishladder. The model does not include the control or exit section features located at the upstream end of the fishladder.

Measured prototype data obtained during five site visits were required to calibrate and verify the model. These prototype data were collected in a manner that provided information for steady state flow conditions at a variety of tailwater elevations. The fishway facility was cleaned of accumulated debris between the third and fourth site visit. A site visit was made during the cleaning operation, and it was apparent that a substantial amount of sediment and debris had accumulated in the AWS and fish ladder. This debris and sediment was suspected to be in sufficient quantities as to affect the hydraulic performance of the fishway. Therefore, the fourth and fifth site visits were taken to obtain data after the sediment was removed. The first and fifth site visits were taken during low tailwater elevations. The second and fourth site visits were taken during high tailwater elevations. The third site visit represents a mid tailwater elevation.

The fishway computer model presented in this appendix incorporates user-friendly interactive screens that enables a user who is familiar with the fish facility operation to run a simulation with only a few input parameters. Thus, the day-to-day operation can be monitored and a more complete operation guide can be developed. The computer model output provides a detailed description of the hydraulic characteristics of the operation of the fishway facility by calculating the discharge, average velocity, depth, and water surface elevations at defined ungaged locations, many of which are inaccessible for direct prototype measurements. The model also provides the hydraulic characteristics of the flow conditions at the fishway entrances, at diffusers, and within the AWS itself.

4.0 REFERENCES

The following references were used:

1. Army Corps of Engineers, Fisheries Handbook of Engineering Requirements and Biological Criteria, 1991.

2. Miller, D.S., Internal Flow Systems, BHRA, 1978.

3. Army Corps of Engineers, Hydraulic Design Criteria, Waterways Experiment Station.

4. Army Corps of Engineers, “Fishladders for John Day Dam Columbia River, Oregon and Washington.” TR No. 103-1, Dec 1968.

5. Army Corps of Engineers, Fish Passage Plan for 1992, Corps of Engineers Projects, March 1992.

6. Rossman, Lewis, Hydraulic and Water Quality Simulator for Water Distribution Networks “EPANET”, U.S. Environmental Protection Agency, RREL.

7. Army Corps of Engineers, Fish Ladders for Lower Monumental Dam Snake River, Washington, Technical Report 109-1 Corps of Engineers, Division Hydraulic Laboratory, Bonneville OR, Dec. 1973.

8. Army Corps of Engineers, As-built drawings of the Bonneville Second Powerhouse fishway facility.

9. Handbook of Hydraulics, Seventh Edition, King and Brater, et al, McGraw-Hill, 1963.

10. Army Corps of Engineers, “Hydraulic Data for Adult Bypass Fishways, Bonneville Second Powerhouse - December 1995,” Summit Technology Inc.

11. Engineering Hydraulics, Rouse, 1950

5.0 SITE VISITS

Five site visits were made to collect real-time data for use in the development of the computer model (see Reference 10).

The first site visit occurred on 31 August 1994. The tailwater elevation was relatively low; elevation 8.36 ft MSL. The data was collected from 1440 to 1540 hrs every 10 minutes and averaged to provide a steady state description of the flow in the fishway. In addition to the data recorded for the active components of the fishway facility, the static components were provided by Corps of Engineers personnel. These included the number of operating pumps, diffuser gate settings and gage calibration data.

Analysis of the first site visit data indicated that less time and more frequent readings would result in a similar description of the hydraulic characteristics. A time of 30 minutes and 15 minutes with readings every 5 minutes was selected for the second and third data collections, respectively.

The second site visit was delayed until a high tailwater elevation was available. This visit was made on 20 June 1995 when the tailwater was 22.71 ft MSL. The data was collected from 1345 to 1415 hrs every 5 minutes and averaged.

The third site visit was made on 22 Aug 1995 at a tailwater elevation of 13.67 ft MSL. The data was collected from 1535 to 1555 hrs every 5 minutes and averaged.

The first three visits provided the range of tailwater elevations necessary for computer model calibration; however, the fishway was cleaned in December 1997 and significant amounts of sediment were removed from the AWS and other sections of the fishway. Therefore, two more site visits were made to obtain data that would represent the conditions after the AWS was cleaned.

Site visit 4 was made on 30 June 1998 at a tailwater elevation of 20.9 ft MSL. Site visit 5 was made on 3 September 1998 at a tailwater elevation of 12.5 ft MSL. During site visit 4, data was taken from 14:00 to 14:15 every 5 minutes and averaged. During site visit 5, data was taken from 14:35 to 14:45 every 5 minutes and averaged.

Model calibration was completed based on site visits 2 and 5 data, which represent a low and high tailwater elevation, respectively. Model verification was completed based on site visit 3 representing a mid-range tailwater elevation. The model was also verified using site visits 1 and 2.

6.0 NUMERICAL MODEL DEVELOPMENT

6.1 General

Two separate computer programs were developed for hydraulic analysis of the Bonneville Second Powerhouse fishway facilities. These computer programs are linked to run as one program called **BONNE2**. The program simulates:

a) The pumps and the AWS system closed conduit flow, and

b) The open channel flow portion of the fish ladder downstream from the control section, the transportation channel, and the fishway entrances.

The model does not simulate the control and exit section of the upstream end of the fish ladder.

The hydraulic characteristics of the AWS system are simulated using the pipe network simulation program (**nhcnet**) which is based on the EPA program EPANET and modified by **nhc** to allow rectangular conduits and internal weirs. The open channel flow characteristics of the fish ladder, transportation channels, and fishway entrances are simulated using a **nhc** developed site-specific fishway analysis program (**nhcbonn2**). Hydraulic analysis of the fishway system involves a trial and error solution using both **nhcnet** and **nhcbonn2** to achieve a solution. To facilitate the computer application, the two programs have been linked by a third computer program (**fishstep**) which enables sequential operation of these two programs. The linking program converts the output from **nhcnet** to input to **nhcbonn2**, runs **fishnet**, checks the results against the input to **nhcnet** to determine if a solution has been achieved and, if a solution has not been achieved resets input to **nhcnet**, then reruns both **nhcnet** and **nhcbonn2**. This procedure is repeated until a solution is achieved. See Figure 1 for the flow chart of the Program Logic that details the procedure that this numerical model incorporates.

Three user interface screens are provided by the program **fishinp.** These screens include a menu to allow easy point and click modification to and input of the variable parameters used to run the programs. The four combined programs that analyze Bonneville Second Powerhouse fishway facility are run via a DOS Batch file termed **BONNE2.BAT**. These four programs compute a steady flow simulation of the hydraulic characteristics of the fishway facility.

6.2 AWS System Numerical Model

The FISHWAY sub-program **nhcnet** input describes the AWS system by a series of nodes representing specific conduit sizes, branches, gates, internal weirs, and inflow (turbines) and outflow locations (diffusers). Between successive nodes the conduit is described by height, width (or diameter), actual roughness, length, and the summation of shape loss coefficients associated with that portion of the conduit. The shape loss coefficient, k, defines the hydraulic head loss, h_L, of features such as bends, expansions, contractions, valves, branches of dividing and combining flow, etc. as function of the velocity head, $h_L=k(V^2/2g)$. The completed Bonneville Second Powerhouse Fish Facility **nhcnet** model involves 270 conduits, 55 fixed grade nodes (FGNS), 280 junctions, 2 turbines feeding water to the system, and 16 valves that control flow to the diffusers. The FGNS are located at the water surface elevation at the gatewells of the turbine draft tubes and at the water surface directly above the fishway floor-diffuser locations. Figure 2 depicts a schematic of the AWS system that defines all the interior nodes, pipes, and FGNS used in the **nhcnet** input. The friction loss within the AWS is computed based on an actual roughness height of e = 0.004 ft by the Darcy Weisbach Equation:

$$H_{Lf} := f \cdot \frac{L}{D} \cdot \frac{V^2}{2 \cdot g}$$

Where:

$$f := 0.25 \cdot \left(\log \left(\frac{e}{3.7 \cdot D} + \frac{5.74}{{R_N}^{0.9}} \right) \right)^{-2}$$

Where: f = friction factor
R_N = Reynolds Number
e = actual roughness height (ft)
D = hydraulic diameter
L = conduit length
H_{Lf} = head loss from friction
V = velocity

The shape loss coefficients were allocated based on data presented in References 2, 3, and 9. Modifications to the specific coefficients were required at various locations in order to represent the unusual geometric conditions involved in the AWS system. These modifications were based on engineering judgment. The **nhcnet** program input includes: FGNS water surface elevations at each diffuser, and FGNS water surface elevation at the gatewells of the turbine draft tubes. The **nhcnet** program computes the total discharge into the system, the discharge in each pipe, and the discharge from each diffuser. The outflow discharge at each diffuser FGNS is transferred to **nhcbonn2**, the fishway analysis program, by **fishstep**, for computing the open channel hydraulic characteristics of the fishway system, including the water surface elevations at each diffuser. **Fishstep** then compares the water surface elevation at each diffuser to that used by **nhcnet** to compute the diffuser discharge.

If the assumed and computed elevations balance is within 0.02 ft or the discharge does not change by more the 0.1 cfs, the simulation is completed; if not, iterations continue until a solution is obtained within these limits.

6.3 BONNE2 Numerical Model

The BONNE2 sub-program **nhcbonne2** computes the discharge, water surface elevations, average velocities and head differentials that occur in the fish ladder, transportation and collection channels, and at the fishway entrances. The computations of the hydraulic characteristics are based on the geometric shape and associated hydraulic head losses that occur throughout the open channel portion of the fishway. The input to **nhcbonne2** is the outflow discharge from each operating diffuser (computed by **nhcnet**), the tailwater elevation at the two main entrances, the entrance gate settings, and the depth of flow over the most upstream fish ladder weir.

The **nhcbonne2** describes the open channel portions of the fish facility by continuity, energy, and Manning's friction loss equations. The hydraulic characteristics of the transportation channel are computed at selected intervals by standard step backwater methods using loss coefficient values selected as a result of the model calibration.

The open channel portion of the fishway facility is described in **nhcbonn2** by the following equations:

continuity equation:

$$Q := V \cdot A$$

energy equation:

$$Z_1 + d_1 + \frac{\alpha \cdot V_1^2}{2 \cdot g} := Z_2 + d_2 + \frac{\alpha \cdot V_2^2}{2 \cdot g} + H_L$$

Manning's equation:

$$H_{Lf} := \left(\frac{Q \cdot n}{1.49 \cdot A \cdot R^{\frac{2}{3}}} \right)^2 \cdot L$$

The variables in the equations described above are defined as:

Q = channel discharge (cfs)
V = average channel velocity (fps)
A = area of water in channel section (ft^2)
H_{Lf} = head loss resulting from friction (ft)
Z = elevation above datum (ft)

g = gravitational constant (ft/s^2)
d = depth of water in channel section (ft)
L = Length of conduit (ft)
R = hydraulic radius (ft)
n = transportation channel loss coefficient (not necessarily equivalent to the expected Manning's friction coefficient)
H_L = Total headloss, friction and shape loss

The weirs and orifices involved in the fishladder portion of the facility are described by the following equations:

unsubmerged weir (6.3.1)

$$Q_w := C_w \cdot L \cdot h_1 \cdot (2 \cdot g \cdot h_w)^{0.5}$$

submerged weir (6.3.2)

$$Q_w := C_w \cdot C_V \cdot L \cdot h_1 \cdot (2 \cdot g \cdot h_w)^{0.5}$$

orifice: (6.3.3)

$$Q_o := C_o \cdot A \cdot (2 \cdot g \cdot h_o)^{0.5}$$

The main entrance weirs to the fishway facility are described by the following equation:

$$Q_e := 5.35 \cdot C_V \cdot C_R \cdot \left(h_1^{1.5}\right) \cdot L \cdot (1 - C_L) \tag{6.3.4}$$

The discharge coefficient C_R, for the main entrance submerged weirs was empirically derived based on Rehbock's weir equation, (Reference 11):

$$K_r := \frac{h_1}{P}$$

when K_r is equal to or less than 2.5: (6.3.5)

$$C_R := 0.611 + 0.08 \cdot K_r$$

when K_r is greater than 2.5: (6.3.6)

$$C_R := 0.6 + \frac{0.5275}{K_r}$$

The discharge correction coefficient for weir submergence C_v was computed based on Villamonte's equation (Reference 9).

$$C_V := \left[1 - \left(\frac{h_2}{h_1}\right)^{1.5}\right]^{0.385} \qquad (6.3.7)$$

The variables in the equations described in Section 6.3 are defined below:

Q_w = Ladder weir discharge
Q_o = Ladder orifice discharge
Q_e = Main entrance weir discharge
C_w = Discharge coefficient for weir.
C_v = Villamonte's correction coefficient for weir submergence
C_L = Contraction coefficient
C_o = Discharge coefficient for orifice
C_R = Rehbock's discharge coefficient for unsubmerged weir
L = Weir length
P = Depth of channel below weir crest
h_1 = Depth from upstream water surface to weir crest
h_2 = Depth from downstream water surface to weir crest
h_o = Head on orifice = $h_1 - h_2$
h_w = Head on weir = $h_1 - h_2$
A = Area of orifice

7.0 MODEL CALIBRATION AND VERIFICATION

7.1 General

The calibration of the model consisted of adjustments to the following properties until agreement with observed data is achieved:

- Head loss coefficients for the various geometric shapes within the AWS,
- Contraction coefficients at the fishway entrances,
- Friction and turbulence loss coefficients within the AWS conduits and the entrance channel.

The credibility of the model must be judged by the ability to accurately compute or verify the observed head differential at the fishway entrances, collection channel, and transportation channel elevations based on a reasonably calibrated model. The data collection from Site Visits 2 and 5 were used to calibrate the **FISHWAY** model, while the data collection from Site Visits 1, 3, and 4 were used to verify the **FISHWAY** model.

7.2 Calibration

The data used for step one calibration included:

Picketed lead upstream staff gauge
Tailwater staff gauge elevations at each entrance

Transportation channel staff gauge elevations at each entrance
Entrance Weir Elevations NU-E, ND-E, SU-E, SD-E
Diffuser gates – open or closed status
Turbine Megawatts
Turbine Head

Step 1 consisted of setting appropriate values for the minor losses in **nhcnet**, the losses within the transportation channel, and the weir coefficients for the fishladder weirs in **nhcbonn2**.

The transportation channel loss coefficient (n_t) was empirically derived using the water surface data obtained during the five site visits. This loss coefficient includes both friction, and turbulence resulting from diffuser inflow. The coefficient was varied along the channel to reflect the differences in channel configuration etc. As shown below, the coefficient also varies with tailwater elevation.

Transportation Channel Loss Coefficients			
	Tailwater Elevation (ft)		
Location:	Low TW	Mid TW	High TW
Ladder portion of fishway	0.013	0.013	0.013
Powerhouse collection channel	0.013	0.013	0.013
North upstream entrance channel	0.015	0.018	0.025
North downstream entrance channel	0.015	0.018	0.025
South entrance channel	0.013	0.013	0.013

The weir coefficient for the fishladder is an average value derived empirically from physical model data of the existing 1 vertical to 10 horizontal slope fishladder (see Reference 4). The orifice coefficient is an average theoretical value (see Reference 9). A vertical boundary contraction coefficient was added to the weir calculations at the south upstream entrance. Inspection of this entrance showed that there is a lateral contraction at this entrance. This entrance is located nearly parallel to the flow direction in the fish transportation channel.

Unsubmerged weir coefficient in the fishladder $C_w = 3.80$
Orifice coefficient in the fishladder $C_0 = 0.70$
Contraction coefficient – south upstream entrance $C_c = 0.07$

The comparison of the recorded and computed transportation channel elevations, and associated differences are shown on Table 7.1.

TABLE 7.1
Step 1 Calibration

	Site Visit 5	**Site Visit 2**

Fishladder Discharge cfs	76.0	94.0
AWS (Turbine) Discharge cfs	5597	6249
Computed Total Discharge cfs	5673	6343
NU-E Tailwater Elevation ft	12.60	22.96
ND-E Tailwater Elevation ft	12.60	22.91
SU-E Tailwater Elevation ft	12.50	22.70
SD-E Tailwater Elevation ft	12.50	22.71
Turbine Head	58.7	46.10
Turbine Megawatts (Turbine 1, Turbine 2)	12.10, 12.50	9.93, 11.30
North Junction Pool:		
Observed Elevation ft	14.31	24.50
Computed Elevation ft	14.31	24.57
Difference ft	+0.0	+0.07
ND-E Ladder Entrance:		
Observed Elevation ft	14.10	24.50
Computed Elevation ft	14.15	24.47
Difference ft	+0.05	-0.03
SU-E Ladder Entrance:		
Observed Elevation ft	13.77	24.29
Computed Elevation ft	13.87	24.29
Difference ft	+0.10	0.00
SD-E Ladder Entrance:		
Observed Elevation ft	13.70	24.20
Computed Elevation ft	13.74	24.26
Difference ft	+0.04	+0.06

The calibration errors ranged from -0.03 to +0.10. Readings from the staff gages are only accurate to ±0.10 ft. Thus the calibration is within the accuracy of the observed staff gage data.

The first model calibration was made for Site Visit 5 data, which is a relatively low tailwater elevation. All parameters were developed to adjust the model to fit this data set. The second model calibration was done for Site Visit 2, which is a reasonably high tailwater elevation.

7.3 Verification

Verification of the model was accomplished using Site Visit 1, 3, and 4. Verifying the model with the data from these site visits provided verification over a wide range of tailwater elevations. The comparison of the recorded and computed entrance channel elevations, discharge pool elevations, and associated differences are shown on Table 7.3.

TABLE 7.3
Verification

	Computed	Observed	Difference
Site Visit 3: Tailwater Elev. = 13.6 ft			
SD-E	15.06	15.00	+0.06
SU-E	15.17	15.20	-0.03
ND-E	15.60	15.50	+0.10
Junction Pool	15.82	15.83	-0.01
Site Visit 4: Tailwater Elev. = 20.9 ft			
SD-E	22.39	22.45	-0.06
SU-E	22.45	22.50	-0.05
ND-E	22.64	22.68	-0.04
Junction Pool	22.76	22.95	-0.19
Site Visit 1: Tailwater Elev. = 8.4			
SD-E	9.67	9.44	0.23
SU-E	9.67	9.90	-0.23
ND-E	10.06	10.16	-0.10
Junction Pool	10.19	10.46	-0.27

The verification differences for Site Visit 3 are similar to the calibration differences. The verification differences for Site Visit 4 are also acceptable. The Site Visit 4 computed values are within 0.10 of the measured values with the exception of the junction pool with is within 0.19. Since reading the staff gauges to the nearest hundredth of a foot is impractical and there is some fluctuation of the water surface levels, a difference of 0.19 is considered within acceptable limits. Although Site Visit 1 was used for a verification run, the measured data from that site visit is suspect. After studying the Site Visit 1 measurements, it was apparent that the measurements at the upstream and downstream entrances on both sides of the powerhouse may have been transposed. The correction was made for the verification run; however, the quality of the data remains questionable. The maximum differential between the measured and computed values is 0.27 for Site Visit 1.

8.0 FISH PASSAGE CRITERIA AND CONSTRAINTS

8.1 Criteria

The following adult fish passage hydraulic criteria were used for the fish facility evaluation:

1. Water surface difference at entrances:
   1.0 ft to 2.0 ft, 1.5 ft preferred
2. Unsubmerged water depth on fish ladder weir:
   1.2 to 1.4 ft, 1.3 ft preferred
3. Submerged fishladder weir and transportation channel velocity:
   1.5 to 4.0 fps, 2.0 fps preferred
4. Diffuser inflow to fish ladder, average velocity:
   0.25 to 0.5 fps
5. Entrance weir depth below tailwater elevation:
   $\geq$ 8.0 ft

8.2 Project Constraints

A project constraint typical of most fish ladders is the limited amount of supply water. At Bonneville Second Powerhouse, this water is supplied from the fishladder and the turbines that discharge into the AWS. The fishladder flow is typically around 100 cfs to maintain the required head on the ladder weirs. The two turbines supply the majority of the discharge required to operate the fishway (approximately 3,200 to 7,200 cfs depending on the turbine head and megawatts).

There are some problems associated with the flow distribution in the diffuser chambers along the powerhouse collection channel. Figure 2 shows the pipe network associated with Bays 11,12,17 and 18. This figure shows that there are two gates that feed four diffusers at each of these bays, and the diffuser chambers feeding the four diffusers are interconnected. The result of this configuration is that some of the diffuser discharges are very small, and reversed flow may occur at some of the diffusers (flow entering the AWS through the diffuser from the collection channel). Another constraint involves the control of flow from the AWS to the diffuser chambers in the ladder section. The diffusers in the ladder section have internal weirs that control the flow to the diffusers; however, there are no gates to shut off specific internal weirs. This results in small amounts of flow discharging through several diffusers along the ladder section, resulting in very low diffuser velocities.

9.0 FISHWAY OPERATION

9.1 Operational Characteristics During Site Visits

The operation of the fishway facility was assessed with respect to the criteria in section 6.2 using the numerical model. A comparison of the criteria range and computed values are shown on Table 9.1. Values shown in bold print indicate that the criteria are not met for that feature.

TABLE 9.1

Comparison of Criteria to Computed Conditions

	Criteria		**Computed**		
Location	**Range**	**Preferred**	**Site Visit 5**	**Site Visit 2**	**Site Visit 3**
Tailwater Elev. (ft)			12.5	22.7	13.6
Head Drop at Entrances (ft)	1.0 to 2.0	1.5			
Entrance SD-E			1.08	1.46	1.43
Entrance SU-E			1.37	1.59	1.27
Entrance ND-E			1.45	1.51	1.92
Entrance NU-E			1.46	1.48	1.74
Water Depth on Ladder Weirs (ft)	1.2 to 1.4	1.3	1.12	1.37	1.34
Channel Velocity (fps)	1.5 to 4.0	2.0			
South Channel			**0.72** to 3.53	**1.15** to 2.64	**1.19 to 4.15**
Across Powerhouse			**1.04** to 3.01	1.68 to 2.74	1.73 to 3.53
North Channels			3.90 to **4.14**	2.76 to 2.93	**4.5 to 4.65**
Diffuser Inflow (fps)	0.25 to 0.5				
South Channel			**0.71 to 0.97**	**0.70 to 1.03**	**0.84 to 1.13**
Powerhouse			**-0.24** to 0.46	**0 to** 0.31	**-0.23** to 0.50
Junction Pool			**0.82 to 1.25**	**0.85 to 1.29**	**0.92 to 1.41**
Ladder			**0.08 to 0.16**	**0.11** to 0.26	**0.08 to 0.24**
Entrance Submergence (ft)	>=8.0				
SD-E			10.6	12.7	12.4
SU-E			11.5	13.4	12.9
ND-E			10.5	13.1	12.5
NU-E			11.4	13.9	12.8

10.0 SUMMARY

The numeric simulations of the Bonneville Second Powerhouse Fishway appear to provide accurate information on the hydraulic characteristics of the system. The fact that the verification runs show errors that are approximately the same as the calibration runs indicates the model is suspected to simulate accurately over the calibrated range and to some degree outside of the calibration range. The conclusions can be summarized as:

A. The numerical model algorithm is functioning as intended, and will produce sufficient information to understand the operation of the fishway facility from the tailwater to the ladder control section.

B. The calibration of the model is accurate over the range of the calibration data, and this accuracy is expected to extend at least a half a foot of tailwater elevation on either side of the tailwater elevations used for the calibration data. Beyond these limits the accuracy of the model is expected to diminish.

The analysis of the fishway operation discussed in Section 9.0 shows that due to the complexity of this ladder only part of the fishway hydraulic criteria can be met for the range of tailwater elevations

FIGURES

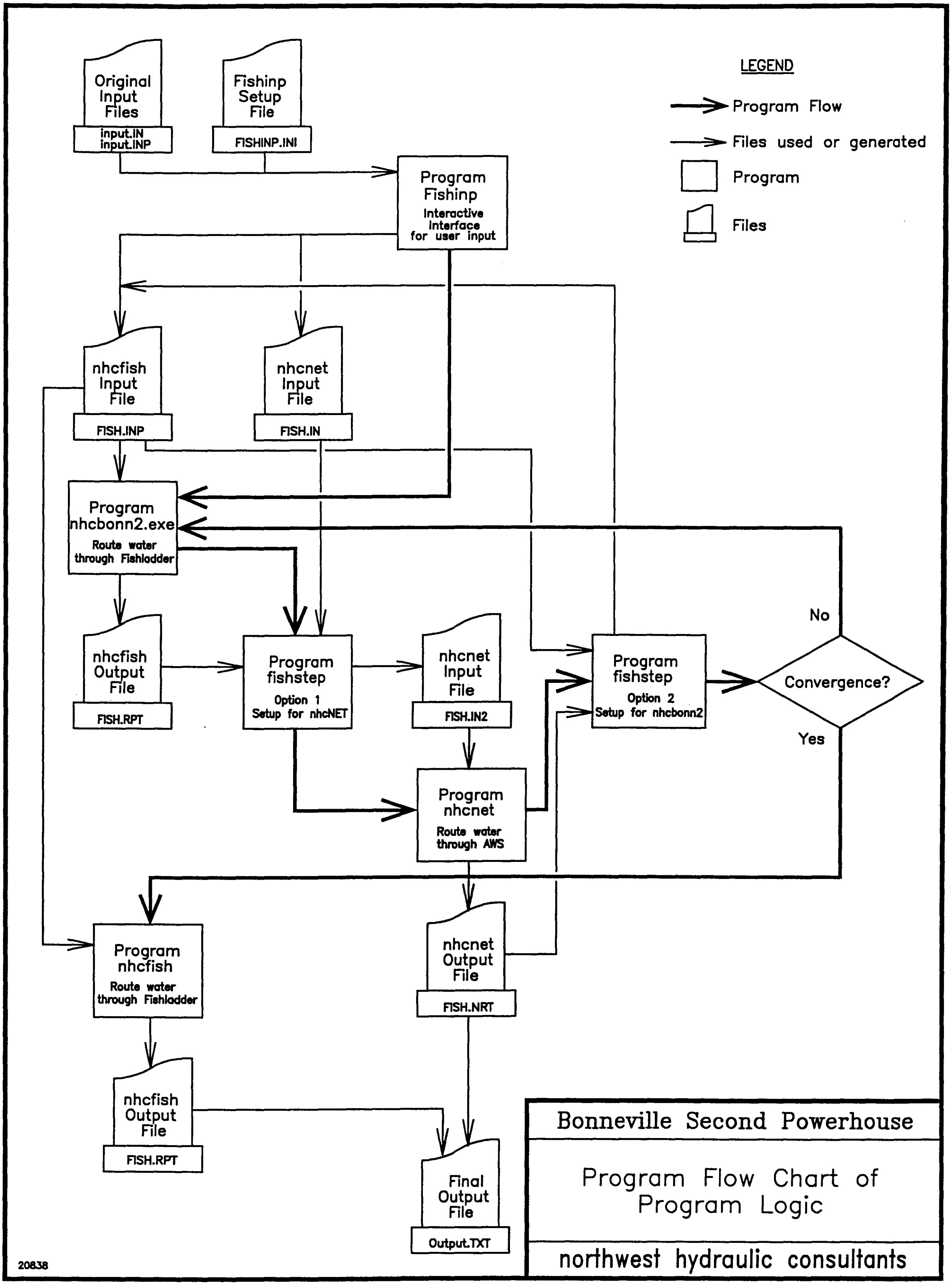

LEGEND
Program Flow
Files used or generated
Program
Files
Original Input Files
input.IN
input.INP
Fishinp Setup File
FISHINP.INI
Program Fishinp
Interactive Interface for user input
nhcfish Input File
FISH.INP
nhcnet Input File
FISH.IN
Program nhcbonn2.exe
Route water through Fishladder
nhcfish Output File
FISH.RPT
Program fishstep
Option 1
Setup for nhcNET
nhcnet Input File
FISH.IN2
Program fishstep
Option 2
Setup for nhcbonn2
Convergence?
No
Yes
Program nhcnet
Route water through AWS
Program nhcfish
Route water through Fishladder
nhcnet Output File
FISH.NRT
nhcfish Output File
FISH.RPT
Final Output File
Output.TXT
Bonneville Second Powerhouse
Program Flow Chart of Program Logic
northwest hydraulic consultants
20838

Figure 1

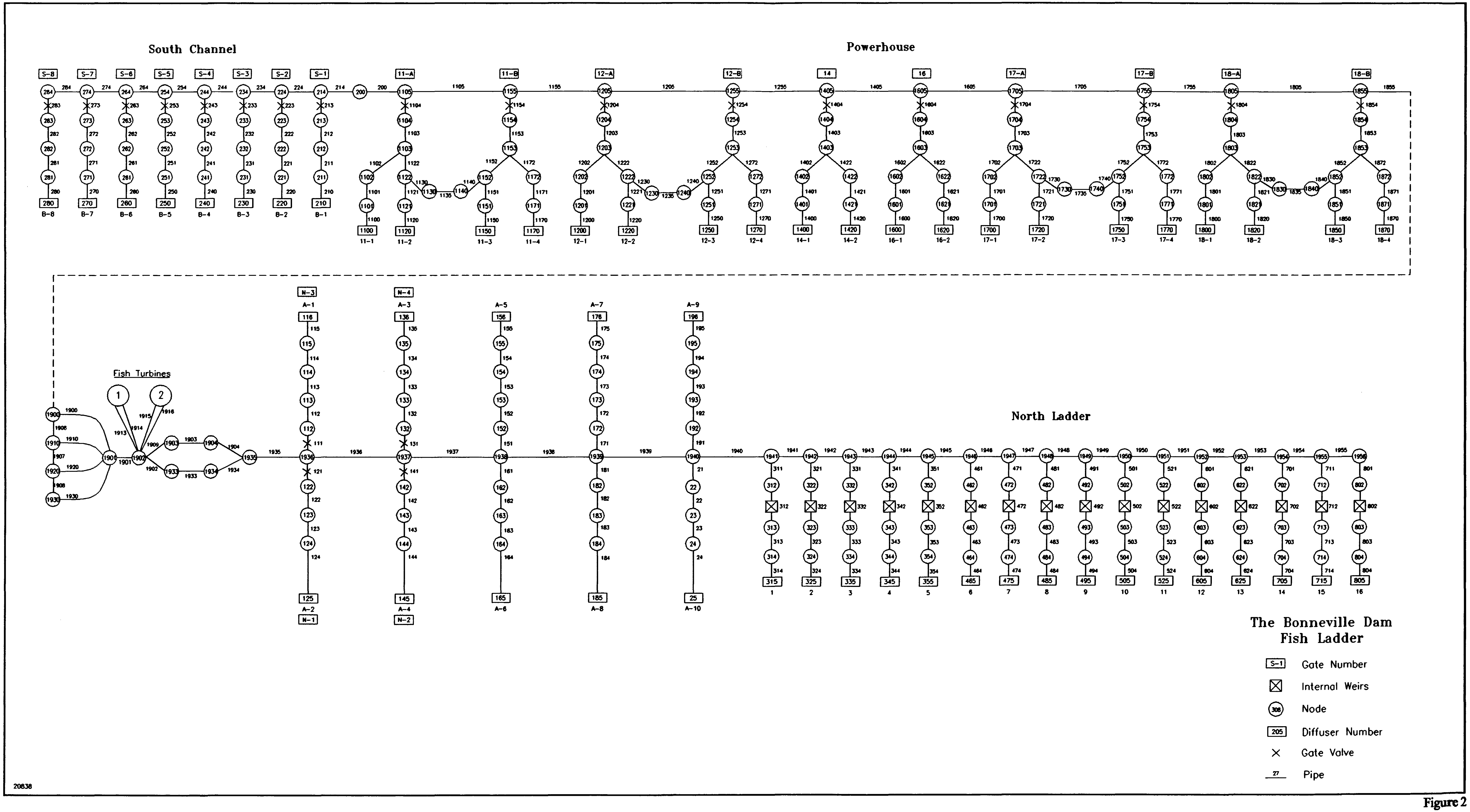

South Channel
Powerhouse
S-8
S-7
S-6
S-5
S-4
S-3
S-2
S-1
B-8
B-7
B-6
B-5
B-4
B-3
B-2
B-1
11-A
11-B
12-A
12-B
14
16
17-A
17-B
18-A
18-B
11-1
11-2
11-3
11-4
12-1
12-2
12-3
12-4
14-1
14-2
16-1
16-2
17-1
17-2
17-3
17-4
18-1
18-2
18-3
18-4
Fish Turbines
1
2
N-3
N-4
A-1
A-3
A-5
A-7
A-9
A-2
A-4
A-6
A-8
A-10
N-1
N-2
North Ladder
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
The Bonneville Dam Fish Ladder
S-1 Gate Number
Internal Weirs
306 Node
205 Diffuser Number
Gate Valve
27 Pipe
20838

Figure 2

APPENDIX F

HYDRAULIC MODEL RESULTS

Appendix F

Hydraulic Model Results

Model Verification:

The fishway numerical model described in Section 4 and Appendix E was used to predict an emergency operating condition with one turbine shut down and all of the floating orifices closed. The computed values were compared to data collected at the project under the same conditions. Field Test 1 consisted of closure of all floating orifices, adjustment of diffuser gates according to the previously recommended schedule, and keeping all four of the main entrance weirs open . Project personnel welded steel plates over the floating orifices for the field test.

Table 1.0 - Field Test 1
TW - 11.5 ft
Field Data Collection Settings for
Floating Orifices, Entrances, and Diffuser Gates

	TW 12
Model Run	TW12osv
SD-E Weir Elevation (ft msl)	3.00
SU-E Weir Elevation (ft msl)	2.50
ND-E Weir Elevation (ft msl)	2.00
NU-E Weir Elevation (ft msl)	2.00
Closed Floating Orifices	All
Closed Entrance Gates	None
Closed Diffusers	B-2 thru B-8
Number of Turbines Operating	One
Turbine Setting (MW)	15.5

The second field test (Field Test 2) was similar to the first test, except the north entrance gate was closed (NU-E), and the other gates were adjusted as shown in Table 2.0 below.

Table 2.0 - Field Test 2
TW – 11.5 ft
Field Data Collection Settings for
Floating Orifices, Entrances, and Diffuser Gates

	TW 12
Model Run	TW12ksv
SD-E Weir Elevation (ftmsl)	1.0
SU-E Weir Elevation (ftmsl)	1.0
ND-E Weir Elevation (ftmsl)	1.0
NU-E Weir Elevation ()	Closed Position
Closed Floating Orifices	All
Closed Entrance Gates	NU-E
Closed Diffusers	B-7 thru B-8
Number of Turbines Operating	One
Turbine Setting (MW)	14.0

The following data readings were taken every five minutes during a 15 minute time period.

Gauge and Gate Dial Readings:

- NU-E, ND-E, SU-E, SD-E Tailwater Staff Gauge Readings
  Note: Tailwater staff gauges could not be read at all locations.
- NU-E, ND-E, SU-E, SD-E Collection Channel Gauge Readings (water surface elevations)
- NU-E, ND-E, SU-E, SD-E Gate Dial Gauge Readings (Entrance weir elevation)
- Picketed Lead Staff Gauge Reading

Fishway Control Panel Readings (only one turbine was operating):

- Fish Turbine Head, Gate % open, Blade Position, Fish Turbine MW
- Entrance Gate Readings for all four entrances (also taken in control room in addition to reading the gauges at the entrances)
- Forebay Elevation (one reading)
- Tailrace Elevation (one reading)

Due to time constraints during the site visit, there were some difficulties with the data collection. The data collection began at about 2:00 p.m on February 28th ,2001. Some of the staff gauges were not readable at all of the weir gate entrances because the gauges do not extend below elevation 13.0 ft msl. Therefore, the tailwater elevation from the fishway control panel was used instead of the local readings in some cases, which introduced some error in the data. There is only one tailwater reading on the fishway control panel. From previous data taken at the second powerhouse, we note that there is some variation in the tailwater elevation between the entrances. A tailrace water surface elevation variation of 0.25 to 0.50 ft from the north to the south end of the powerhouse would not be unusual with the actual variation depending on the powerhouse operating conditions. During a normal data collection set, the tailwater elevations would be measured with water level indicators if the staff gauges are not readable; however, time constraints prevented measuring water surface elevations with water level indicators. Time constraints also prevented taking velocity measurements for Field Test 2.

The model was verified by comparing the computer predicted water surface elevations in the channel with the data collected during the field tests. The values predicted by the computer model were considered to be acceptable when compared to the data collected during the field tests. The most attention was focused on data collected for Field Test 1 for the model verification because that set of data was more complete. The differences between the computed and measured water surface elevations in the channel were less than 0.40 ft. Given the fluctuation and oscillating nature of the observed tailwater elevations about the mean (±0.20 ft) and the difficulty reading staff gauges, the maximum difference of 0.40 ft at one of the data collection locations was considered to be acceptable. The maximum difference of 0.40 ft only occurred at one location, and the maximum difference at other locations was less than or equal to 0.30 ft.

The velocity measurements for Test 1 were taken between Bays 14 and 15 in the collection channel. The measured velocities for Test 1 showed that the collection channel velocity ranged from 1.7 fps (closer to walls) to 2.4 fps (middle of channel), which is within criteria at the location of the measurement. The numerical model computed an average velocity of 2.5 fps at the same location. Velocity measurements could not be taken for Test 2 due to time constraints.

Based on the field data and model run results, the numerical model of the fishway was considered verified without having to modify any of the coefficients used to describe losses in the various water passages in the model. Some minor modifications to these coefficients could be made in the model to reduce the differences between the predicted and measured values; however, the model verification was considered to be within an acceptable range without making any modifications.

Collecting data to verify the model for a low, medium, and high tailwater is recommended. Further verification of the model could not be done because the plates covering the floating orifices were removed immediately after the test for the fish passage season. After the floating orifice closure scheme is implemented, additional testing is recommended. The data from the additional tests would be used to verify the numerical computer model and the operations plan at multiple tailwater elevations.

Table F-1
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 8.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.39.15.8	6.40.15.8	6.41.15.8
Computer Filename	TW8Kddr	TW8Pddr	TW8Oddr
		Selected	
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B5-B8 Closed	B3-B8 Closed	B2-B8 Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	2225	2950	2950
Total	2311	3036	3036
Weir Elevations: (ft)			
SD-E	1.00	1.00	1.00
SU-E	1.00	1.00	1.00
ND-E	1.75	1.00	1.00
NU-E	Closed	1.00	1.00
Entrance Head drop: (ft)			
SD-E	1.46	1.29	1.29
SU-E	1.64	1.46	1.46
ND-E	2.50	1.91	1.92
NU-E	Closed	1.94	1.94
Submergence: (ft)			
SD-E	7.00	7.00	7.00
SU-E	7.00	7.00	7.00
ND-E	6.75	7.00	7.00
NU-E	Closed	7.00	7.00
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	1.76 / 4.21	2.45 / 3.35	3.19 / 3.99
Powerhouse	0.46 / 2.58	1.97 / 3.60	1.48 / 4.78
North Channels	3.98 / 3.99	4.01 / 4.05	4.01 / 4.05
Junction Pool	0.45 / 1.36	0.18 / 2.92	0.85 / 2.77
Diffuser Velocities: (fps)			
B-1	0.60	0.85	0.84
B-2	0.65	0.82	0.00
B-3	0.72	0.00	0.00
B-4	0.64	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.39	0.14	0.44
Powerhouse C1 (11-2)	0.11	-0.37	0.22
Powerhouse C2 (11-3)	-0.32	0.44	-0.40
Powerhouse C2 (11-4)	0.18	-0.22	0.27
Powerhouse C3 (12-1)	0.33	0.14	0.39
Powerhouse C3 (12-2)	0.12	-0.37	0.17
Powerhouse C4 (12-3)	-0.30	0.44	-0.27
Powerhouse C4 (12-4)	0.16	-0.21	0.21
Powerhouse C5 (14-1)	0.23	0.16	0.27
Powerhouse C5 (14-2)	-0.09	-0.16	-0.03
Powerhouse C6 (16-1)	0.19	0.29	0.24
Powerhouse C6 (16-2)	-0.06	-0.04	-0.01
Powerhouse C7 (17-1)	0.21	0.28	0.24
Powerhouse C7 (17-2)	0.22	0.27	0.25
Powerhouse C8 (17-3)	-0.30	-0.24	-0.18
Powerhouse C8 (17-4)	0.11	0.17	0.14
Powerhouse C9 (18-1)	0.17	0.24	0.19
Powerhouse C9 (18-2)	0.26	0.26	0.24
Powerhouse C10 (18-3)	-0.30	-0.20	-0.12
Powerhouse C10 (18-4)	0.10	0.16	0.12
A-1	0.33	0.65	0.61
A-2	0.30	0.58	0.55
A-3	0.30	0.62	0.58
A-4	0.27	0.55	0.52
A-5	0.28	0.60	0.57
A-6	0.39	0.84	0.80
A-7	0.25	0.57	0.54
A-8	0.35	0.80	0.76
A-9	0.23	0.55	0.52
A-10	0.32	0.77	0.72

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-2
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 9.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.42.15.9	
Computer Filename		TW9Pddr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges: (cfs)			
Ladder		86.40	
Operating Turbine		3010	
Total		3096	
Weir Elevations: (ft)			
SD-E		1.00	
SU-E		1.00	
ND-E		1.00	
NU-E		1.00	
Entrance Head drop: (ft)			
SD-E		1.01	
SU-E		1.14	
ND-E		1.56	
NU-E		1.58	
Submergence: (ft)			
SD-E		8.00	
SU-E		8.00	
ND-E		8.00	
NU-E		8.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel		2.40 / 3.84	
Powerhouse		1.92 / 3.80	
North Channels		3.91 / 3.95	
Junction Pool		0.20 / 2.85	
Diffuser Velocities: (fps)			
B-1		0.83	
B-2		0.86	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.18	
Powerhouse C1 (11-2)		0.01	
Powerhouse C2 (11-3)		-0.37	
Powerhouse C2 (11-4)		0.19	
Powerhouse C3 (12-1)		0.13	
Powerhouse C3 (12-2)		-0.35	
Powerhouse C4 (12-3)		0.43	
Powerhouse C4 (12-4)		-0.21	
Powerhouse C5 (14-1)		0.16	
Powerhouse C5 (14-2)		-0.16	
Powerhouse C6 (16-1)		0.27	
Powerhouse C6 (16-2)		-0.01	
Powerhouse C7 (17-1)		0.26	
Powerhouse C7 (17-2)		0.28	
Powerhouse C8 (17-3)		-0.22	
Powerhouse C8 (17-4)		0.17	
Powerhouse C9 (18-1)		0.22	
Powerhouse C9 (18-2)		0.26	
Powerhouse C10 (18-3)		-0.16	
Powerhouse C10 (18-4)		0.14	
A-1		0.66	
A-2		0.58	
A-3		0.63	
A-4		0.56	
A-5		0.61	
A-6		0.85	
A-7		0.58	
A-8		0.82	
A-9		0.56	
A-10		0.79	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-3
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 10.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.43.15.10	
Computer Filename		TW10Pddr	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges: (cfs)			
Ladder		86.40	
Operating Turbine		3090	
Total		3176	
Weir Elevations: (ft)			
SD-E		2.00	
SU-E		2.00	
ND-E		2.00	
NU-E		2.00	
Entrance Head drop: (ft)			
SD-E		1.23	
SU-E		1.35	
ND-E		1.69	
NU-E		1.72	
Submergence: (ft)			
SD-E		8.00	
SU-E		8.00	
ND-E		8.00	
NU-E		8.00	
Collection Channel Velocities: (fps)	min / max	min / max	min / max
South Channel		2.43 / 3.75	
Powerhouse		2.10 / 3.80	
North Channels		3.62 / 3.66	
Junction Pool		0.22 / 2.74	
Diffuser Velocities: (fps)			
B-1		0.81	
B-2		0.83	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.14	
Powerhouse C1 (11-2)		-0.33	
Powerhouse C2 (11-3)		0.39	
Powerhouse C2 (11-4)		-0.20	
Powerhouse C3 (12-1)		0.14	
Powerhouse C3 (12-2)		-0.32	
Powerhouse C4 (12-3)		0.35	
Powerhouse C4 (12-4)		-0.17	
Powerhouse C5 (14-1)		0.14	
Powerhouse C5 (14-2)		-0.14	
Powerhouse C6 (16-1)		0.25	
Powerhouse C6 (16-2)		0.01	
Powerhouse C7 (17-1)		0.26	
Powerhouse C7 (17-2)		0.26	
Powerhouse C8 (17-3)		-0.17	
Powerhouse C8 (17-4)		0.14	
Powerhouse C9 (18-1)		0.22	
Powerhouse C9 (18-2)		0.25	
Powerhouse C10 (18-3)		-0.14	
Powerhouse C10 (18-4)		0.14	
A-1		0.67	
A-2		0.60	
A-3		0.64	
A-4		0.57	
A-5		0.62	
A-6		0.87	
A-7		0.60	
A-8		0.84	
A-9		0.58	
A-10		0.81	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-4
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 11.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.44.15.11	
Computer Filename		TW11Pddr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges: (cfs)			
Ladder		86.40	
Operating Turbine		3165	
Total		3251	
Weir Elevations: (ft)			
SD-E		2.50	
SU-E		2.50	
ND-E		2.50	
NU-E		2.50	
Entrance Head drop: (ft)			
SD-E		1.18	
SU-E		1.30	
ND-E		1.61	
NU-E		1.63	
Submergence: (ft)			
SD-E		8.50	
SU-E		8.50	
ND-E		8.50	
NU-E		8.50	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel		2.41 / 3.64	
Powerhouse		2.10 / 3.74	
North Channels		3.48 / 3.52	
Junction Pool		0.23 / 2.66	
Diffuser Velocities: (fps)			
B-1		0.81	
B-2		0.83	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.14	
Powerhouse C1 (11-2)		-0.26	
Powerhouse C2 (11-3)		0.26	
Powerhouse C2 (11-4)		-0.15	
Powerhouse C3 (12-1)		0.14	
Powerhouse C3 (12-2)		-0.33	
Powerhouse C4 (12-3)		0.37	
Powerhouse C4 (12-4)		-0.18	
Powerhouse C5 (14-1)		0.12	
Powerhouse C5 (14-2)		-0.12	
Powerhouse C6 (16-1)		0.21	
Powerhouse C6 (16-2)		0.05	
Powerhouse C7 (17-1)		0.24	
Powerhouse C7 (17-2)		0.28	
Powerhouse C8 (17-3)		-0.18	
Powerhouse C8 (17-4)		0.15	
Powerhouse C9 (18-1)		0.22	
Powerhouse C9 (18-2)		0.28	
Powerhouse C10 (18-3)		-0.15	
Powerhouse C10 (18-4)		0.13	
A-1		0.68	
A-2		0.60	
A-3		0.65	
A-4		0.58	
A-5		0.64	
A-6		0.89	
A-7		0.62	
A-8		0.86	
A-9		0.60	
A-10		0.84	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-5
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 12.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.45.15.12	6.46.15.12	6.47.15.12
Computer Filename	TW 12Kddr	TW12Pddr	TW12Oddr
		Selected	
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B5-B8 Closed	B2-B8 Closed	B2-B8 Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	3230	3230	3230
Total	3316	3316	3316
Weir Elevations: (ft)			
SD-E	1.00	3.40	3.50
SU-E	1.00	3.40	3.50
ND-E	3.50	3.40	3.50
NU-E	Closed	3.40	3.50
Entrance Head drop: (ft)			
SD-E	1.35	1.13	1.18
SU-E	1.58	1.22	1.28
ND-E	2.70	1.85	1.88
NU-E	Closed	1.88	1.90
Submergence: (ft)			
SD-E	11.00	8.60	8.50
SU-E	11.00	8.60	8.50
ND-E	8.50	8.60	8.50
NU-E	Closed	8.60	8.50
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.46 / 4.78	2.52 / 3.31	2.62 / 3.33
Powerhouse	1.45 / 3.61	2.01 / 3.69	1.07 / 3.84
North Channels	4.11 / 4.12	3.47 / 3.49	3.43 / 3.46
Junction Pool	0.61 / 1.67	0.82 / 2.64	0.74 / 2.30
Diffuser Velocities: (fps)			
B-1	0.78	1.11	1.00
B-2	0.82	0.00	0.00
B-3	0.88	0.00	0.00
B-4	0.76	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.45	0.26	0.51
Powerhouse C1 (11-2)	0.19	-0.04	0.23
Powerhouse C2 (11-3)	-0.37	-0.38	-0.35
Powerhouse C2 (11-4)	0.21	0.16	0.21
Powerhouse C3 (12-1)	0.40	0.25	0.44
Powerhouse C3 (12-2)	0.16	-0.38	0.22
Powerhouse C4 (12-3)	-0.31	0.40	-0.28
Powerhouse C4 (12-4)	0.18	-0.27	0.18
Powerhouse C5 (14-1)	0.28	0.20	0.28
Powerhouse C5 (14-2)	-0.08	-0.20	-0.02
Powerhouse C6 (16-1)	0.26	0.40	0.27
Powerhouse C6 (16-2)	-0.07	-0.09	-0.02
Powerhouse C7 (17-1)	0.27	0.38	0.27
Powerhouse C7 (17-2)	0.23	0.34	0.28
Powerhouse C8 (17-3)	-0.26	-0.33	-0.19
Powerhouse C8 (17-4)	0.13	0.18	0.13
Powerhouse C9 (18-1)	0.23	0.33	0.22
Powerhouse C9 (18-2)	0.24	0.32	0.27
Powerhouse C10 (18-3)	-0.25	-0.26	-0.15
Powerhouse C10 (18-4)	0.12	0.16	0.12
A-1	0.48	0.76	0.65
A-2	0.42	0.67	0.58
A-3	0.45	0.71	0.61
A-4	0.40	0.63	0.55
A-5	0.42	0.68	0.59
A-6	0.59	0.95	0.82
A-7	0.40	0.64	0.55
A-8	0.56	0.89	0.77
A-9	0.38	0.61	0.52
A-10	0.53	0.85	0.73

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-5a
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 12.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.48.15.12	
Computer Filename		TW12P2dr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges: (cfs)			
Ladder		86.40	
Operating Turbine		3230	
Total		3316	
Weir Elevations: (ft)			
SD-E		3.40	
SU-E		3.40	
ND-E		3.40	
NU-E		3.40	
Entrance Head drop: (ft)			
SD-E		1.18	
SU-E		1.27	
ND-E		1.80	
NU-E		1.82	
Submergence: (ft)			
SD-E		8.60	
SU-E		8.60	
ND-E		8.60	
NU-E		8.60	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel		2.00 / 3.37	
Powerhouse		1.46 / 3.04	
North Channels		3.41 / 3.44	
Junction Pool		0.26 / 2.44	
Diffuser Velocities: (fps)			
B-1		0.94	
B-2		0.99	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.22	
Powerhouse C1 (11-2)		0.00	
Powerhouse C2 (11-3)		-0.33	
Powerhouse C2 (11-4)		0.12	
Powerhouse C3 (12-1)		0.17	
Powerhouse C3 (12-2)		-0.17	
Powerhouse C4 (12-3)		0.15	
Powerhouse C4 (12-4)		-0.15	
Powerhouse C5 (14-1)		0.00	
Powerhouse C5 (14-2)		0.00	
Powerhouse C6 (16-1)		0.32	
Powerhouse C6 (16-2)		-0.04	
Powerhouse C7 (17-1)		0.32	
Powerhouse C7 (17-2)		0.31	
Powerhouse C8 (17-3)		-0.27	
Powerhouse C8 (17-4)		0.16	
Powerhouse C9 (18-1)		0.27	
Powerhouse C9 (18-2)		0.31	
Powerhouse C10 (18-3)		-0.22	
Powerhouse C10 (18-4)		0.13	
A-1		0.69	
A-2		0.62	
A-3		0.65	
A-4		0.58	
A-5		0.62	
A-6		0.87	
A-7		0.58	
A-8		0.81	
A-9		0.56	
A-10		0.77	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-6
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 13.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.49.15.13	
Computer Filename		TW13Pddr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges:			
Ladder		86.40	
Operating Turbine		3340	
Total		3426	
Weir Elevations: (ft)			
SD-E		4.00	
SU-E		4.00	
ND-E		4.00	
NU-E		4.00	
Entrance Head drop: (ft)			
SD-E		1.29	
SU-E		1.39	
ND-E		1.66	
NU-E		1.68	
Submergence: (ft)			
SD-E		9.00	
SU-E		9.00	
ND-E		9.00	
NU-E		9.00	
Collection Channel Velocities: (fps)	min / max	min / max	min / max
South Channel		2.34 / 3.44	
Powerhouse		2.14 / 3.50	
North Channels		3.21 / 3.24	
Junction Pool		0.26 / 2.51	
Diffuser Velocities:			
B-1		0.82	
B-2		0.84	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.15	
Powerhouse C1 (11-2)		-0.02	
Powerhouse C2 (11-3)		0.02	
Powerhouse C2 (11-4)		-0.15	
Powerhouse C3 (12-1)		0.13	
Powerhouse C3 (12-2)		-0.22	
Powerhouse C4 (12-3)		0.22	
Powerhouse C4 (12-4)		-0.14	
Powerhouse C5 (14-1)		0.00	
Powerhouse C5 (14-2)		0.00	
Powerhouse C6 (16-1)		0.20	
Powerhouse C6 (16-2)		0.07	
Powerhouse C7 (17-1)		0.23	
Powerhouse C7 (17-2)		0.30	
Powerhouse C8 (17-3)		-0.17	
Powerhouse C8 (17-4)		0.15	
Powerhouse C9 (18-1)		0.21	
Powerhouse C9 (18-2)		0.27	
Powerhouse C10 (18-3)		-0.13	
Powerhouse C10 (18-4)		0.14	
A-1		0.71	
A-2		0.63	
A-3		0.68	
A-4		0.61	
A-5		0.67	
A-6		0.94	
A-7		0.65	
A-8		0.91	
A-9		0.63	
A-10		0.88	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-7
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 14.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.50.15.14	
Computer Filename		TW14Pddr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges:			
Ladder		86.40	
Operating Turbine		3400	
Total		3486	
Weir Elevations: (ft)			
SD-E		4.50	
SU-E		4.50	
ND-E		4.50	
NU-E		4.50	
Entrance Head drop: (ft)			
SD-E		1.22	
SU-E		1.32	
ND-E		1.57	
NU-E		1.59	
Submergence: (ft)			
SD-E		9.50	
SU-E		9.50	
ND-E		9.50	
NU-E		9.50	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel		2.29 / 3.34	
Powerhouse		2.12 / 3.35	
North Channels		3.11 / 3.13	
Junction Pool		0.26 / 2.44	
Diffuser Velocities:			
B-1		0.83	
B-2		0.85	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.14	
Powerhouse C1 (11-2)		-0.14	
Powerhouse C2 (11-3)		0.15	
Powerhouse C2 (11-4)		-0.15	
Powerhouse C3 (12-1)		0.03	
Powerhouse C3 (12-2)		0.08	
Powerhouse C4 (12-3)		0.03	
Powerhouse C4 (12-4)		-0.14	
Powerhouse C5 (14-1)		0.00	
Powerhouse C5 (14-2)		0.00	
Powerhouse C6 (16-1)		0.21	
Powerhouse C6 (16-2)		0.06	
Powerhouse C7 (17-1)		0.23	
Powerhouse C7 (17-2)		0.28	
Powerhouse C8 (17-3)		-0.13	
Powerhouse C8 (17-4)		0.15	
Powerhouse C9 (18-1)		0.21	
Powerhouse C9 (18-2)		0.26	
Powerhouse C10 (18-3)		-0.10	
Powerhouse C10 (18-4)		0.14	
A-1		0.71	
A-2		0.64	
A-3		0.69	
A-4		0.62	
A-5		0.68	
A-6		0.95	
A-7		0.66	
A-8		0.93	
A-9		0.65	
A-10		0.90	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-8
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 15.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.74.15.15	6.51.15.15	
Computer Filename	TW15Kddr	TW15Pddr	
		Selected	
Operating Conditions:			
Floating Orifices	All Closed	All Closed	
North Diffusers	All Open	All Open	
Powerhouse Diffusers	All Open	C1-C5 Closed	
South Diffusers	B5-B8 Closed	B3-B8 Closed	
Input Discharges:			
Ladder	86.40	86.40	
Operating Turbine	3520	3520	
Total	3606	3606	
Weir Elevations: (ft)			
SD-E	2.50	5.00	
SU-E	2.50	5.00	
ND-E	2.50	5.00	
NU-E	Closed	5.00	
Entrance Head drop: (ft)			
SD-E	1.03	1.20	
SU-E	1.20	1.29	
ND-E	1.65	1.53	
NU-E	Closed	1.55	
Submergence: (ft)			
SD-E	12.50	10.00	
SU-E	12.50	10.00	
ND-E	12.50	10.00	
NU-E	Closed	10.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.71 / 4.36	2.27 / 3.30	
Powerhouse	2.07 / 3.72	2.11 / 3.43	
North Channels	4.35 / 4.36	3.05 / 3.08	
Junction Pool	0.27 / 1.89	0.27 / 2.41	
Diffuser Velocities:			
B-1	0.66	0.85	
B-2	0.68	0.88	
B-3	0.70	0.00	
B-4	0.60	0.00	
B-5	0.00	0.00	
B-6	0.00	0.00	
B-7	0.00	0.00	
B-8	0.00	0.00	
Powerhouse C1 (11-1)	0.29	0.00	
Powerhouse C1 (11-2)	0.19	0.00	
Powerhouse C2 (11-3)	-0.16	0.00	
Powerhouse C2 (11-4)	0.13	0.00	
Powerhouse C3 (12-1)	0.26	0.13	
Powerhouse C3 (12-2)	0.21	-0.25	
Powerhouse C4 (12-3)	-0.16	0.26	
Powerhouse C4 (12-4)	0.14	-0.14	
Powerhouse C5 (14-1)	0.18	0.00	
Powerhouse C5 (14-2)	0.03	0.00	
Powerhouse C6 (16-1)	0.18	0.21	
Powerhouse C6 (16-2)	0.04	0.07	
Powerhouse C7 (17-1)	0.19	0.21	
Powerhouse C7 (17-2)	0.21	0.32	
Powerhouse C8 (17-3)	-0.10	-0.14	
Powerhouse C8 (17-4)	0.11	0.14	
Powerhouse C9 (18-1)	0.17	0.19	
Powerhouse C9 (18-2)	0.23	0.29	
Powerhouse C10 (18-3)	-0.12	-0.08	
Powerhouse C10 (18-4)	0.11	0.12	
A-1	0.57	0.74	
A-2	0.51	0.66	
A-3	0.55	0.71	
A-4	0.49	0.64	
A-5	0.54	0.70	
A-6	0.76	0.98	
A-7	0.53	0.68	
A-8	0.74	0.96	
A-9	0.52	0.67	
A-10	0.72	0.93	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-9
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 16.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.52.15.16	6.53.15.16	6.54.15.16
Computer Filename	TW16Kddr	TW16Pddr	TW16Oddr
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B5-B8 Closed	B2-B8 Closed	B2-B8 Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	3515	3515	3515
Total	3601	3601	3601
Weir Elevations: (ft)			
SD-E	3.25	6.50	6.50
SU-E	3.25	6.50	6.50
ND-E	4.25	6.50	6.50
NU-E	Closed	6.50	6.50
Entrance Head drop: (ft)			
SD-E	1.07	1.44	1.42
SU-E	1.22	1.52	1.51
ND-E	1.99	1.73	1.74
NU-E	Closed	1.75	1.76
Submergence: (ft)			
SD-E	12.75	9.50	9.50
SU-E	12.75	9.50	9.50
ND-E	11.75	9.50	9.50
NU-E	Closed	9.50	9.50
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.35 / 4.18	2.52 / 3.14	2.51 / 3.13
Powerhouse	1.56 / 3.43	2.63 / 3.94	1.72 / 3.92
North Channels	3.99 / 4.01	2.84 / 2.87	2.85 / 2.88
Junction Pool	0.60 / 1.65	0.82 / 2.45	0.74 / 2.18
Diffuser Velocities: (fps)			
B-1	0.76	0.94	0.84
B-2	0.80	0.00	0.00
B-3	0.84	0.00	0.00
B-4	0.71	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.38	0.14	0.29
Powerhouse C1 (11-2)	0.19	-0.20	0.24
Powerhouse C2 (11-3)	-0.21	0.20	-0.13
Powerhouse C2 (11-4)	0.12	-0.14	0.15
Powerhouse C3 (12-1)	0.35	0.13	0.26
Powerhouse C3 (12-2)	0.19	-0.25	0.24
Powerhouse C4 (12-3)	-0.24	0.23	-0.13
Powerhouse C4 (12-4)	0.15	-0.11	0.15
Powerhouse C5 (14-1)	0.24	0.12	0.19
Powerhouse C5 (14-2)	-0.02	-0.12	0.07
Powerhouse C6 (16-1)	0.24	0.22	0.19
Powerhouse C6 (16-2)	-0.03	0.07	0.07
Powerhouse C7 (17-1)	0.24	0.24	0.20
Powerhouse C7 (17-2)	0.26	0.30	0.23
Powerhouse C8 (17-3)	-0.22	-0.10	-0.06
Powerhouse C8 (17-4)	0.12	0.13	0.12
Powerhouse C9 (18-1)	0.22	0.22	0.18
Powerhouse C9 (18-2)	0.25	0.30	0.24
Powerhouse C10 (18-3)	-0.19	-0.11	-0.04
Powerhouse C10 (18-4)	0.10	0.15	0.11
A-1	0.53	0.78	0.69
A-2	0.48	0.70	0.62
A-3	0.51	0.76	0.67
A-4	0.45	0.68	0.60
A-5	0.49	0.75	0.66
A-6	0.69	1.05	0.92
A-7	0.47	0.73	0.65
A-8	0.65	1.02	0.90
A-9	0.45	0.72	0.63
A-10	0.63	1.00	0.88

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-9a
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 16.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number		6.55.15.16	
Computer Filename		TW16P2dr	
		Selected	
Operating Conditions:			
Floating Orifices		All Closed	
North Diffusers		All Open	
Powerhouse Diffusers		C1-C5 Closed	
South Diffusers		B3-B8 Closed	
Input Discharges: (cfs)			
Ladder		86.40	
Operating Turbine		3515	
Total		3601	
Weir Elevations: (ft)			
SD-E		6.00	
SU-E		6.00	
ND-E		6.00	
NU-E		6.00	
Entrance Head drop: (ft)			
SD-E		1.26	
SU-E		1.35	
ND-E		1.55	
NU-E		1.57	
Submergence: (ft)			
SD-E		10.00	
SU-E		10.00	
ND-E		10.00	
NU-E		10.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel		2.19 / 3.16	
Powerhouse		2.07 / 3.21	
North Channels		2.88 / 2.90	
Junction Pool		0.27 / 2.30	
Diffuser Velocities: (fps)			
B-1		0.85	
B-2		0.86	
B-3		0.00	
B-4		0.00	
B-5		0.00	
B-6		0.00	
B-7		0.00	
B-8		0.00	
Powerhouse C1 (11-1)		0.00	
Powerhouse C1 (11-2)		0.00	
Powerhouse C2 (11-3)		0.00	
Powerhouse C2 (11-4)		0.00	
Powerhouse C3 (12-1)		0.13	
Powerhouse C3 (12-2)		-0.23	
Powerhouse C4 (12-3)		0.24	
Powerhouse C4 (12-4)		-0.14	
Powerhouse C5 (14-1)		0.00	
Powerhouse C5 (14-2)		0.00	
Powerhouse C6 (16-1)		0.19	
Powerhouse C6 (16-2)		0.08	
Powerhouse C7 (17-1)		0.22	
Powerhouse C7 (17-2)		0.28	
Powerhouse C8 (17-3)		-0.12	
Powerhouse C8 (17-4)		0.15	
Powerhouse C9 (18-1)		0.19	
Powerhouse C9 (18-2)		0.27	
Powerhouse C10 (18-3)		-0.05	
Powerhouse C10 (18-4)		0.11	
A-1		0.73	
A-2		0.65	
A-3		0.71	
A-4		0.63	
A-5		0.70	
A-6		0.98	
A-7		0.68	
A-8		0.95	
A-9		0.67	
A-10		0.93	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-10
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 17.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.75.15.17	6.56.15.17	
Computer Filename	TW17Kddr	TW17Pddr	
		Selected	
Operating Conditions:			
Floating Orifices	All Closed	All Closed	
North Diffusers	All Open	All Open	
Powerhouse Diffusers	All Open	C1-C5 Closed	
South Diffusers	B5-B8 Closed	B3-B8 Closed	
Input Discharges:			
Ladder	86.40	86.40	
Operating Turbine	3560	3560	
Total	3646	3646	
Weir Elevations: (ft)			
SD-E	4.00	7.00	
SU-E	4.00	7.00	
ND-E	4.00	7.00	
NU-E	Closed	7.00	
Entrance Head drop: (ft)			
SD-E	1.11	1.34	
SU-E	1.25	1.42	
ND-E	1.61	1.61	
NU-E	Closed	1.64	
Submergence: (ft)			
SD-E	13.00	10.00	
SU-E	13.00	10.00	
ND-E	13.00	10.00	
NU-E	13.00	10.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.57 / 4.05	2.13 / 3.05	
Powerhouse	2.09 / 3.60	2.04 / 3.16	
North Channels	3.91 / 3.93	2.76 / 2.79	
Junction Pool	0.27 / 1.77	0.28 / 2.22	
Diffuser Velocities:			
B-1	0.66	0.85	
B-2	0.67	0.87	
B-3	0.69	0.00	
B-4	0.58	0.00	
B-5	0.00	0.00	
B-6	0.00	0.00	
B-7	0.00	0.00	
B-8	0.00	0.00	
Powerhouse C1 (11-1)	0.26	0.14	
Powerhouse C1 (11-2)	0.25	-0.19	
Powerhouse C2 (11-3)	-0.20	0.19	
Powerhouse C2 (11-4)	0.15	-0.14	
Powerhouse C3 (12-1)	0.24	0.02	
Powerhouse C3 (12-2)	0.24	0.05	
Powerhouse C4 (12-3)	-0.17	0.07	
Powerhouse C4 (12-4)	0.13	-0.14	
Powerhouse C5 (14-1)	0.17	0.00	
Powerhouse C5 (14-2)	0.04	0.00	
Powerhouse C6 (16-1)	0.16	0.20	
Powerhouse C6 (16-2)	0.05	0.07	
Powerhouse C7 (17-1)	0.19	0.21	
Powerhouse C7 (17-2)	0.23	0.25	
Powerhouse C8 (17-3)	-0.11	-0.06	
Powerhouse C8 (17-4)	0.11	0.13	
Powerhouse C9 (18-1)	0.16	0.19	
Powerhouse C9 (18-2)	0.26	0.29	
Powerhouse C10 (18-3)	-0.12	-0.08	
Powerhouse C10 (18-4)	0.10	0.12	
A-1	0.57	0.73	
A-2	0.51	0.65	
A-3	0.56	0.71	
A-4	0.50	0.64	
A-5	0.55	0.70	
A-6	0.77	0.98	
A-7	0.54	0.69	
A-8	0.75	0.96	
A-9	0.53	0.68	
A-10	0.73	0.94	

Notes: 1. **Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.**

2. **Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.**

Table F-11
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 18.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.57.15.18	6.76.15.18	
Computer Filename	TW18Kddr	TW18Pddr	
	Selected		
Operating Conditions:			
Floating Orifices	All Closed	All Closed	
North Diffusers	All Open	All Open	
Powerhouse Diffusers	All Open	C1-C5 Closed	
South Diffusers	B5-B8 Closed	B3-B5 Closed	
Input Discharges:			
Ladder	86.40	86.40	
Operating Turbine	3575	3575	
Total	3661	3661	
Weir Elevations: (ft)			
SD-E	5.00	7.00	
SU-E	5.00	7.00	
ND-E	5.00	7.00	
NU-E	Closed	7.00	
Entrance Head drop: (ft)			
SD-E	1.21	1.09	
SU-E	1.34	1.16	
ND-E	1.67	1.34	
NU-E	Closed	1.36	
Submergence: (ft)			
SD-E	13.00	11.00	
SU-E	13.00	11.00	
ND-E	13.00	11.00	
NU-E	Closed	11.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.51 / 3.91	2.07 / 2.96	
Powerhouse	2.08 / 3.73	1.97 / 3.02	
North Channels	3.71 / 3.72	2.69 / 2.71	
Junction Pool	0.28 / 1.71	0.26 / 2.16	
Diffuser Velocities:			
B-1	0.65	0.85	
B-2	0.67	0.87	
B-3	0.68	0.00	
B-4	0.57	0.00	
B-5	0.00	0.00	
B-6	0.00	0.00	
B-7	0.00	0.00	
B-8	0.00	0.00	
Powerhouse C1 (11-1)	0.24	0.00	
Powerhouse C1 (11-2)	0.22	0.00	
Powerhouse C2 (11-3)	-0.14	0.00	
Powerhouse C2 (11-4)	0.13	0.00	
Powerhouse C3 (12-1)	0.23	0.00	
Powerhouse C3 (12-2)	0.23	0.00	
Powerhouse C4 (12-3)	-0.14	0.00	
Powerhouse C4 (12-4)	0.12	0.00	
Powerhouse C5 (14-1)	0.17	0.00	
Powerhouse C5 (14-2)	0.05	0.00	
Powerhouse C6 (16-1)	0.15	0.21	
Powerhouse C6 (16-2)	0.06	0.07	
Powerhouse C7 (17-1)	0.18	0.21	
Powerhouse C7 (17-2)	0.20	0.24	
Powerhouse C8 (17-3)	-0.06	-0.04	
Powerhouse C8 (17-4)	0.09	0.13	
Powerhouse C9 (18-1)	0.16	0.18	
Powerhouse C9 (18-2)	0.22	0.24	
Powerhouse C10 (18-3)	-0.08	-0.02	
Powerhouse C10 (18-4)	0.10	0.12	
A-1	0.57	0.74	
A-2	0.51	0.66	
A-3	0.56	0.72	
A-4	0.50	0.64	
A-5	0.55	0.71	
A-6	0.77	0.99	
A-7	0.54	0.70	
A-8	0.75	0.97	
A-9	0.53	0.68	
A-10	0.74	0.95	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-12
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 19.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.58.15.19	6.77.15.19	
Computer Filename	TW19Kddr	TW19Pddr	
	Selected		
Operating Conditions:			
Floating Orifices	All Closed	All Closed	
North Diffusers	All Open	All Open	
Powerhouse Diffusers	All Open	C1-C5 Closed	
South Diffusers	B5-B8 Closed	B3-B8 Closed	
Input Discharges:			
Ladder	86.40	86.40	
Operating Turbine	3535	3535	
Total	3621	3621	
Weir Elevations: (ft)			
SD-E	6.00	8.00	
SU-E	6.00	8.00	
ND-E	6.00	8.00	
NU-E	Closed	8.00	
Entrance Head drop: (ft)			
SD-E	1.26	1.11	
SU-E	1.37	1.17	
ND-E	1.67	1.33	
NU-E	Closed	1.35	
Submergence: (ft)			
SD-E	13.00	11.00	
SU-E	13.00	11.00	
ND-E	13.00	11.00	
NU-E	Closed	11.00	
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.40 / 3.72	1.98 / 2.82	
Powerhouse	2.03 / 3.58	1.90 / 2.89	
North Channels	3.49 / 3.50	2.53 / 2.56	
Junction Pool	0.28 / 1.63	0.25 / 2.05	
Diffuser Velocities:			
B-1	0.64	0.84	
B-2	0.65	0.85	
B-3	0.67	0.00	
B-4	0.55	0.00	
B-5	0.00	0.00	
B-6	0.00	0.00	
B-7	0.00	0.00	
B-8	0.00	0.00	
Powerhouse C1 (11-1)	0.24	0.00	
Powerhouse C1 (11-2)	0.21	0.00	
Powerhouse C2 (11-3)	-0.12	0.00	
Powerhouse C2 (11-4)	0.12	0.00	
Powerhouse C3 (12-1)	0.22	0.00	
Powerhouse C3 (12-2)	0.20	0.00	
Powerhouse C4 (12-3)	-0.13	0.00	
Powerhouse C4 (12-4)	0.13	0.00	
Powerhouse C5 (14-1)	0.15	0.00	
Powerhouse C5 (14-2)	0.06	0.00	
Powerhouse C6 (16-1)	0.15	0.17	
Powerhouse C6 (16-2)	0.06	0.10	
Powerhouse C7 (17-1)	0.16	0.19	
Powerhouse C7 (17-2)	0.21	0.28	
Powerhouse C8 (17-3)	-0.05	-0.08	
Powerhouse C8 (17-4)	0.09	0.14	
Powerhouse C9 (18-1)	0.16	0.18	
Powerhouse C9 (18-2)	0.21	0.23	
Powerhouse C10 (18-3)	-0.06	-0.01	
Powerhouse C10 (18-4)	0.09	0.12	
A-1	0.57	0.73	
A-2	0.50	0.65	
A-3	0.55	0.71	
A-4	0.49	0.63	
A-5	0.54	0.70	
A-6	0.76	0.98	
A-7	0.53	0.69	
A-8	0.74	0.96	
A-9	0.52	0.67	
A-10	0.73	0.94	

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-13
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 20.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.59.15.20	6.60.15.20	6.61.15.20
Computer Filename	TW20Kddr	TW20Pddr	Tw20Oddr
	Selected		
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B4-B8 Closed	B3-B8 Closed	All Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	3520	3520	3520
Total	3606	3606	3606
Weir Elevations: (ft)			
SD-E	8.20	9.50	10.00
SU-E	8.20	9.50	10.00
ND-E	7.50	9.50	9.50
NU-E	Closed	9.50	9.50
Entrance Head drop: (ft)			
SD-E	1.64	1.13	1.37
SU-E	1.74	1.20	1.42
ND-E	1.95	1.34	1.54
NU-E	Closed	1.36	1.57
Submergence: (ft)			
SD-E	11.80	11.00	10.00
SU-E	11.80	11.00	10.00
ND-E	12.50	11.00	10.50
NU-E	Closed	11.00	10.50
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.47 / 3.48	2.01 / 2.71	2.11 / 2.66
Powerhouse	2.16 / 3.69	1.86 / 2.79	1.93 / 3.88
North Channels	3.36 / 3.37	2.41 / 2.42	2.44 / 2.46
Junction Pool	0.62 / 1.64	0.26 / 1.97	0.70 / 2.00
Diffuser Velocities: (fps)			
B-1	0.67	0.84	0.00
B-2	0.68	0.83	0.00
B-3	0.70	0.00	0.00
B-4	0.00	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.24	0.00	0.27
Powerhouse C1 (11-2)	0.24	0.00	0.26
Powerhouse C2 (11-3)	-0.16	0.00	-0.12
Powerhouse C2 (11-4)	0.14	0.00	0.16
Powerhouse C3 (12-1)	0.22	0.00	0.24
Powerhouse C3 (12-2)	0.24	0.00	0.26
Powerhouse C4 (12-3)	-0.13	0.00	-0.07
Powerhouse C4 (12-4)	0.11	0.00	0.11
Powerhouse C5 (14-1)	0.16	0.00	0.18
Powerhouse C5 (14-2)	0.06	0.00	0.10
Powerhouse C6 (16-1)	0.15	0.17	0.18
Powerhouse C6 (16-2)	0.07	0.09	0.09
Powerhouse C7 (17-1)	0.17	0.19	0.20
Powerhouse C7 (17-2)	0.21	0.23	0.23
Powerhouse C8 (17-3)	-0.06	-0.01	-0.02
Powerhouse C8 (17-4)	0.10	0.11	0.11
Powerhouse C9 (18-1)	0.16	0.17	0.17
Powerhouse C9 (18-2)	0.23	0.23	0.26
Powerhouse C10 (18-3)	-0.08	-0.01	-0.03
Powerhouse C10 (18-4)	0.10	0.11	0.12
A-1	0.58	0.72	0.73
A-2	0.52	0.64	0.65
A-3	0.57	0.70	0.71
A-4	0.51	0.62	0.64
A-5	0.56	0.69	0.70
A-6	0.79	0.97	0.98
A-7	0.55	0.68	0.69
A-8	0.77	0.95	0.97
A-9	0.54	0.67	0.68
A-10	0.75	0.93	0.95

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-14
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 21.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.62.15.21		
Computer Filename	TW21Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3510		
Total	3596		
Weir Elevations: (ft)			
SD-E	8.20		
SU-E	8.20		
ND-E	8.20		
NU-E	Closed		
Entrance Head drop: (ft)			
SD-E	1.42		
SU-E	1.52		
ND-E	1.75		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.45 / 3.43		
Powerhouse	2.20 / 3.68		
North Channels	3.13 / 3.14		
Junction Pool	0.29 / 1.58		
Diffuser Velocities:			
B-1	0.67		
B-2	0.68		
B-3	0.70		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.21		
Powerhouse C1 (11-2)	0.25		
Powerhouse C2 (11-3)	-0.15		
Powerhouse C2 (11-4)	0.15		
Powerhouse C3 (12-1)	0.23		
Powerhouse C3 (12-2)	0.18		
Powerhouse C4 (12-3)	-0.06		
Powerhouse C4 (12-4)	0.09		
Powerhouse C5 (14-1)	0.16		
Powerhouse C5 (14-2)	0.06		
Powerhouse C6 (16-1)	0.15		
Powerhouse C6 (16-2)	0.06		
Powerhouse C7 (17-1)	0.17		
Powerhouse C7 (17-2)	0.21		
Powerhouse C8 (17-3)	-0.05		
Powerhouse C8 (17-4)	0.10		
Powerhouse C9 (18-1)	0.16		
Powerhouse C9 (18-2)	0.21		
Powerhouse C10 (18-3)	-0.06		
Powerhouse C10 (18-4)	0.10		
A-1	0.59		
A-2	0.52		
A-3	0.57		
A-4	0.51		
A-5	0.56		
A-6	0.79		
A-7	0.55		
A-8	0.77		
A-9	0.54		
A-10	0.76		

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-15
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 22.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.63.15.22		
Computer Filename	TW22Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3505		
Total	3591		
Weir Elevations: (ft)			
SD-E	9.20		
SU-E	9.20		
ND-E	9.20		
NU-E	Closed		
Entrance Head drop: (ft)			
SD-E	1.46		
SU-E	1.56		
ND-E	1.77		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.37 / 3.31		
Powerhouse	2.16 / 3.57		
North Channels	2.99 / 3.00		
Junction Pool	0.29 / 1.53		
Diffuser Velocities:			
B-1	0.66		
B-2	0.67		
B-3	0.68		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.20		
Powerhouse C1 (11-2)	0.25		
Powerhouse C2 (11-3)	-0.10		
Powerhouse C2 (11-4)	0.10		
Powerhouse C3 (12-1)	0.20		
Powerhouse C3 (12-2)	0.24		
Powerhouse C4 (12-3)	-0.15		
Powerhouse C4 (12-4)	0.14		
Powerhouse C5 (14-1)	0.15		
Powerhouse C5 (14-2)	0.07		
Powerhouse C6 (16-1)	0.15		
Powerhouse C6 (16-2)	0.06		
Powerhouse C7 (17-1)	0.15		
Powerhouse C7 (17-2)	0.26		
Powerhouse C8 (17-3)	-0.11		
Powerhouse C8 (17-4)	0.12		
Powerhouse C9 (18-1)	0.14		
Powerhouse C9 (18-2)	0.23		
Powerhouse C10 (18-3)	-0.08		
Powerhouse C10 (18-4)	0.12		
A-1	0.58		
A-2	0.52		
A-3	0.57		
A-4	0.50		
A-5	0.56		
A-6	0.79		
A-7	0.55		
A-8	0.77		
A-9	0.54		
A-10	0.75		

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-16
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 23.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.64.15.23		
Computer Filename	TW23Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3505		
Total	3591		
Weir Elevations: (ft)			
SD-E	10.20		
SU-E	10.20		
ND-E	10.20		
NU-E	Closed		
Entrance Head drop: (ft)			
SD-E	1.45		
SU-E	1.54		
ND-E	1.90		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.17 / 3.15		
Powerhouse	1.81 / 3.19		
North Channels	2.95 / 2.95		
Junction Pool	0.30 / 1.41		
Diffuser Velocities:			
B-1	0.74		
B-2	0.76		
B-3	0.79		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.30		
Powerhouse C1 (11-2)	0.23		
Powerhouse C2 (11-3)	-0.20		
Powerhouse C2 (11-4)	0.13		
Powerhouse C3 (12-1)	0.28		
Powerhouse C3 (12-2)	0.20		
Powerhouse C4 (12-3)	-0.15		
Powerhouse C4 (12-4)	0.11		
Powerhouse C5 (14-1)	0.19		
Powerhouse C5 (14-2)	0.03		
Powerhouse C6 (16-1)	0.18		
Powerhouse C6 (16-2)	0.03		
Powerhouse C7 (17-1)	0.19		
Powerhouse C7 (17-2)	0.25		
Powerhouse C8 (17-3)	-0.12		
Powerhouse C8 (17-4)	0.09		
Powerhouse C9 (18-1)	0.18		
Powerhouse C9 (18-2)	0.24		
Powerhouse C10 (18-3)	-0.13		
Powerhouse C10 (18-4)	0.10		
A-1	0.56		
A-2	0.50		
A-3	0.54		
A-4	0.48		
A-5	0.53		
A-6	0.74		
A-7	0.51		
A-8	0.71		
A-9	0.50		
A-10	0.70		

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-17
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 24.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.65.15.24	6.66.15.24	6.67.15.24
Computer Filename	TW24Kddr	TW24Pddr	TW24Oddr
	Selected		
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B4-B8 Closed	B2-B8 Closed	All Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	3535	3535	3535
Total	3621	3621	3621
Weir Elevations: (ft)			
SD-E	11.20	14.00	14.00
SU-E	11.20	14.00	14.00
ND-E	11.20	15.00	14.00
NU-E	Closed	15.00	14.00
Entrance Head drop: (ft)			
SD-E	1.52	1.74	1.49
SU-E	1.60	1.79	1.53
ND-E	1.94	1.87	1.77
NU-E	Closed	1.90	1.79
Submergence: (ft)			
SD-E	12.80	10.00	10.00
SU-E	12.80	10.00	10.00
ND-E	12.80	9.00	10.00
NU-E	Closed	9.00	10.00
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.13 / 3.07	1.99 / 2.47	1.84 / 2.32
Powerhouse	1.82 / 3.14	2.30 / 3.12	1.70 / 3.39
North Channels	2.85 / 3.82	1.91 / 1.92	2.07 / 2.09
Junction Pool	0.30 / 1.38	0.67 / 1.81	0.63 / 1.72
Diffuser Velocities: (fps)			
B-1	0.74	0.86	0.00
B-2	0.76	0.00	0.00
B-3	0.78	0.00	0.00
B-4	0.00	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.28	0.00	0.31
Powerhouse C1 (11-2)	0.24	0.00	0.31
Powerhouse C2 (11-3)	-0.18	0.00	-0.18
Powerhouse C2 (11-4)	0.13	0.00	0.15
Powerhouse C3 (12-1)	0.27	0.00	0.32
Powerhouse C3 (12-2)	0.21	0.00	0.25
Powerhouse C4 (12-3)	-0.14	0.00	-0.13
Powerhouse C4 (12-4)	0.11	0.00	0.13
Powerhouse C5 (14-1)	0.17	0.00	0.20
Powerhouse C5 (14-2)	0.04	0.00	0.08
Powerhouse C6 (16-1)	0.17	0.14	0.20
Powerhouse C6 (16-2)	0.05	0.13	0.07
Powerhouse C7 (17-1)	0.20	0.19	0.22
Powerhouse C7 (17-2)	0.23	0.28	0.29
Powerhouse C8 (17-3)	-0.12	-0.06	-0.11
Powerhouse C8 (17-4)	0.10	0.12	0.13
Powerhouse C9 (18-1)	0.17	0.18	0.21
Powerhouse C9 (18-2)	0.25	0.23	0.25
Powerhouse C10 (18-3)	-0.12	0.00	-0.07
Powerhouse C10 (18-4)	0.09	0.12	0.12
A-1	0.56	0.75	0.72
A-2	0.50	0.66	0.64
A-3	0.54	0.73	0.70
A-4	0.48	0.65	0.62
A-5	0.53	0.72	0.68
A-6	0.74	1.01	0.95
A-7	0.52	0.71	0.66
A-8	0.72	0.99	0.93
A-9	0.50	0.70	0.65
A-10	0.70	0.98	0.90

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-18
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 25.0 ft

	Configuration 1	**Configuration 2**	**Configuration 3**
Model Run Number	6.68.15.25		
Computer Filename	TW25Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3535		
Total	3621		
Weir Elevations: (ft)			
SD-E	12.20		
SU-E	12.20		
ND-E	12.20		
NU-E	Closed		
Entrance Head drop: (ft)			
SD-E	1.47		
SU-E	1.54		
ND-E	1.85		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	2.02 / 2.91		
Powerhouse	1.74 / 2.99		
North Channels	2.68 / 3.59		
Junction Pool	0.29 / 1.31		
Diffuser Velocities:			
B-1	0.71		
B-2	0.73		
B-3	0.75		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.25		
Powerhouse C1 (11-2)	0.23		
Powerhouse C2 (11-3)	-0.13		
Powerhouse C2 (11-4)	0.10		
Powerhouse C3 (12-1)	0.26		
Powerhouse C3 (12-2)	0.21		
Powerhouse C4 (12-3)	-0.13		
Powerhouse C4 (12-4)	0.10		
Powerhouse C5 (14-1)	0.17		
Powerhouse C5 (14-2)	0.04		
Powerhouse C6 (16-1)	0.15		
Powerhouse C6 (16-2)	0.06		
Powerhouse C7 (17-1)	0.18		
Powerhouse C7 (17-2)	0.23		
Powerhouse C8 (17-3)	-0.12		
Powerhouse C8 (17-4)	0.10		
Powerhouse C9 (18-1)	0.17		
Powerhouse C9 (18-2)	0.23		
Powerhouse C10 (18-3)	-0.11		
Powerhouse C10 (18-4)	0.09		
A-1	0.55		
A-2	0.49		
A-3	0.53		
A-4	0.47		
A-5	0.52		
A-6	0.72		
A-7	0.50		
A-8	0.70		
A-9	0.49		
A-10	0.68		

Notes:
1. **Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.**
2. **Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.**

Table F-19
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 26.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.69.15.26		
Computer Filename	TW26Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3365		
Total	3451		
Weir Elevations: (ft)			
SD-E	13.20		
SU-E	13.20		
ND-E	13.20		
NU-E	13.20		
Entrance Head drop: (ft)			
SD-E	1.44		
SU-E	1.51		
ND-E	1.78		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	1.94 / 2.77		
Powerhouse	1.71 / 2.87		
North Channels	2.53 / 3.39		
Junction Pool	0.27 / 1.26		
Diffuser Velocities:			
B-1	0.68		
B-2	0.71		
B-3	0.72		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.24		
Powerhouse C1 (11-2)	0.24		
Powerhouse C2 (11-3)	-0.14		
Powerhouse C2 (11-4)	0.10		
Powerhouse C3 (12-1)	0.24		
Powerhouse C3 (12-2)	0.21		
Powerhouse C4 (12-3)	-0.14		
Powerhouse C4 (12-4)	0.11		
Powerhouse C5 (14-1)	0.16		
Powerhouse C5 (14-2)	0.05		
Powerhouse C6 (16-1)	0.15		
Powerhouse C6 (16-2)	0.05		
Powerhouse C7 (17-1)	0.16		
Powerhouse C7 (17-2)	0.21		
Powerhouse C8 (17-3)	-0.07		
Powerhouse C8 (17-4)	0.09		
Powerhouse C9 (18-1)	0.16		
Powerhouse C9 (18-2)	0.21		
Powerhouse C10 (18-3)	-0.08		
Powerhouse C10 (18-4)	0.08		
A-1	0.54		
A-2	0.48		
A-3	0.52		
A-4	0.46		
A-5	0.51		
A-6	0.71		
A-7	0.50		
A-8	0.69		
A-9	0.49		
A-10	0.68		

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-20
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 27.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.70.15.27		
Computer Filename	TW27Kddr		
	Selected		
Operating Conditions:			
Floating Orifices	All Closed		
North Diffusers	All Open		
Powerhouse Diffusers	All Open		
South Diffusers	B4-B8 Closed		
Input Discharges:			
Ladder	86.40		
Operating Turbine	3285		
Total	3371		
Weir Elevations: (ft)			
SD-E	14.20		
SU-E	14.20		
ND-E	14.20		
NU-E	Closed		
Entrance Head drop: (ft)			
SD-E	1.40		
SU-E	1.46		
ND-E	1.70		
NU-E	Closed		
Submergence: (ft)			
SD-E	12.80		
SU-E	12.80		
ND-E	12.80		
NU-E	Closed		
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	1.88 / 2.63		
Powerhouse	1.64 / 2.75		
North Channels	2.38 / 3.19		
Junction Pool	0.26 / 1.20		
Diffuser Velocities:			
B-1	0.66		
B-2	0.68		
B-3	0.70		
B-4	0.00		
B-5	0.00		
B-6	0.00		
B-7	0.00		
B-8	0.00		
Powerhouse C1 (11-1)	0.23		
Powerhouse C1 (11-2)	0.21		
Powerhouse C2 (11-3)	-0.13		
Powerhouse C2 (11-4)	0.11		
Powerhouse C3 (12-1)	0.22		
Powerhouse C3 (12-2)	0.21		
Powerhouse C4 (12-3)	-0.11		
Powerhouse C4 (12-4)	0.09		
Powerhouse C5 (14-1)	0.16		
Powerhouse C5 (14-2)	0.04		
Powerhouse C6 (16-1)	0.15		
Powerhouse C6 (16-2)	0.05		
Powerhouse C7 (17-1)	0.16		
Powerhouse C7 (17-2)	0.22		
Powerhouse C8 (17-3)	-0.10		
Powerhouse C8 (17-4)	0.09		
Powerhouse C9 (18-1)	0.15		
Powerhouse C9 (18-2)	0.21		
Powerhouse C10 (18-3)	-0.07		
Powerhouse C10 (18-4)	0.07		
A-1	0.53		
A-2	0.47		
A-3	0.51		
A-4	0.46		
A-5	0.50		
A-6	0.70		
A-7	0.49		
A-8	0.68		
A-9	0.48		
A-10	0.66		

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

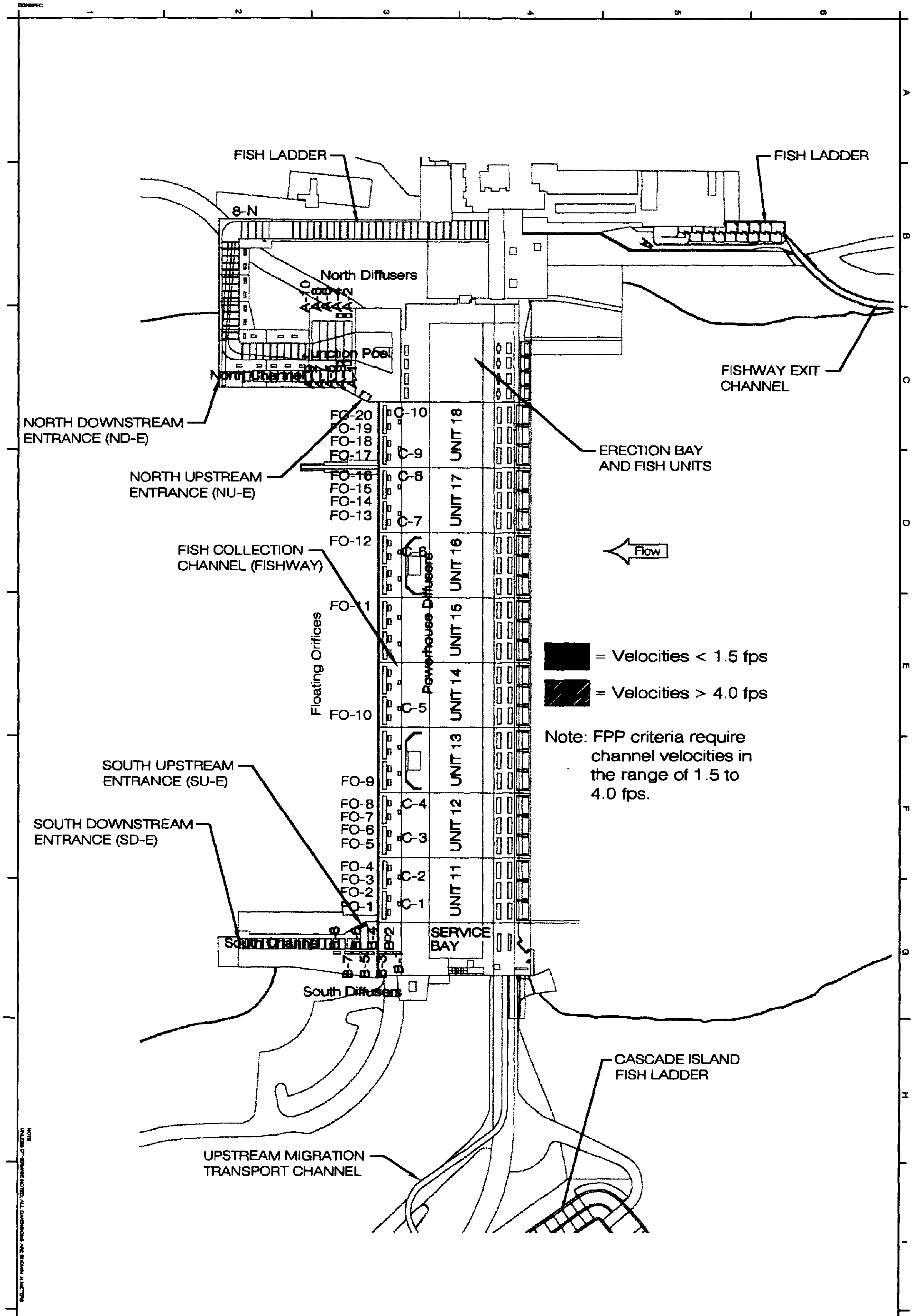
2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

Table F-21
Numerical Model Results
One Turbine Operating Scenario
Tailwater Elevation 28.0 ft

	Configuration 1	Configuration 2	Configuration 3
Model Run Number	6.71.15.28	6.72.15.28	6.73.15.28
Computer Filename	TW28Kddr	TW28Pddr	TW28Oddr
	Selected		
Operating Conditions:			
Floating Orifices	All Closed	All Closed	All Closed
North Diffusers	All Open	All Open	All Open
Powerhouse Diffusers	All Open	C1-C5 Closed	All Open
South Diffusers	B3-B8 Closed	B2-B8 Closed	All Closed
Input Discharges: (cfs)			
Ladder	86.40	86.40	86.40
Operating Turbine	3160	3160	3160
Total	3246	3246	3246
Weir Elevations: (ft)			
SD-E	15.20	18.00	17.00
SU-E	15.20	18.00	17.00
ND-E	15.20	19.00	17.80
NU-E	Closed	19.00	17.80
Entrance Head drop: (ft)			
SD-E	1.32	1.45	1.12
SU-E	1.38	1.48	1.15
ND-E	1.58	1.59	1.29
NU-E	Closed	1.61	1.31
Submergence: (ft)			
SD-E	12.80	10.00	11.00
SU-E	12.80	10.00	11.00
ND-E	12.80	9.00	10.20
NU-E	Closed	9.00	10.20
Collection Channel Velocities: (fps)	**min / max**	**min / max**	**min / max**
South Channel	1.94 / 2.47	1.57 / 1.96	1.55 / 1.95
Powerhouse	1.78 / 2.89	1.80 / 2.46	1.51 / 2.84
North Channels	2.22 / 2.23	1.52 / 1.53	1.57 / 1.59
Junction Pool	0.46 / 1.19	0.54 / 1.43	0.49 / 1.38
Diffuser Velocities: (fps)			
B-1	0.69	0.80	0.00
B-2	0.71	0.00	0.00
B-3	0.00	0.00	0.00
B-4	0.00	0.00	0.00
B-5	0.00	0.00	0.00
B-6	0.00	0.00	0.00
B-7	0.00	0.00	0.00
B-8	0.00	0.00	0.00
Powerhouse C1 (11-1)	0.23	0.00	0.26
Powerhouse C1 (11-2)	0.24	0.00	0.22
Powerhouse C2 (11-3)	-0.15	0.00	-0.06
Powerhouse C2 (11-4)	0.12	0.00	0.09
Powerhouse C3 (12-1)	0.23	0.14	0.24
Powerhouse C3 (12-2)	0.21	-0.07	0.23
Powerhouse C4 (12-3)	-0.11	-0.04	-0.07
Powerhouse C4 (12-4)	0.09	-0.03	0.10
Powerhouse C5 (14-1)	0.15	0.00	0.16
Powerhouse C5 (14-2)	0.06	0.00	0.08
Powerhouse C6 (16-1)	0.15	0.16	0.17
Powerhouse C6 (16-2)	0.05	0.09	0.07
Powerhouse C7 (17-1)	0.17	0.18	0.18
Powerhouse C7 (17-2)	0.22	0.27	0.25
Powerhouse C8 (17-3)	-0.09	-0.07	-0.06
Powerhouse C8 (17-4)	0.09	0.11	0.10
Powerhouse C9 (18-1)	0.16	0.20	0.17
Powerhouse C9 (18-2)	0.21	0.21	0.24
Powerhouse C10 (18-3)	-0.06	-0.04	-0.05
Powerhouse C10 (18-4)	0.08	0.11	0.10
A-1	0.54	0.66	0.65
A-2	0.48	0.59	0.58
A-3	0.53	0.65	0.63
A-4	0.47	0.58	0.56
A-5	0.52	0.63	0.62
A-6	0.72	0.89	0.87
A-7	0.50	0.62	0.61
A-8	0.70	0.86	0.84
A-9	0.49	0.61	0.60
A-10	0.69	0.85	0.83

Notes: 1. Powerhouse Diffuser configuration allows flow into the diffuser chamber via the collection channel even though the diffuser gate is closed in some cases.

2. Fish ladder diffuser velocities are not shown because velocities are always less than 0.5 fps.

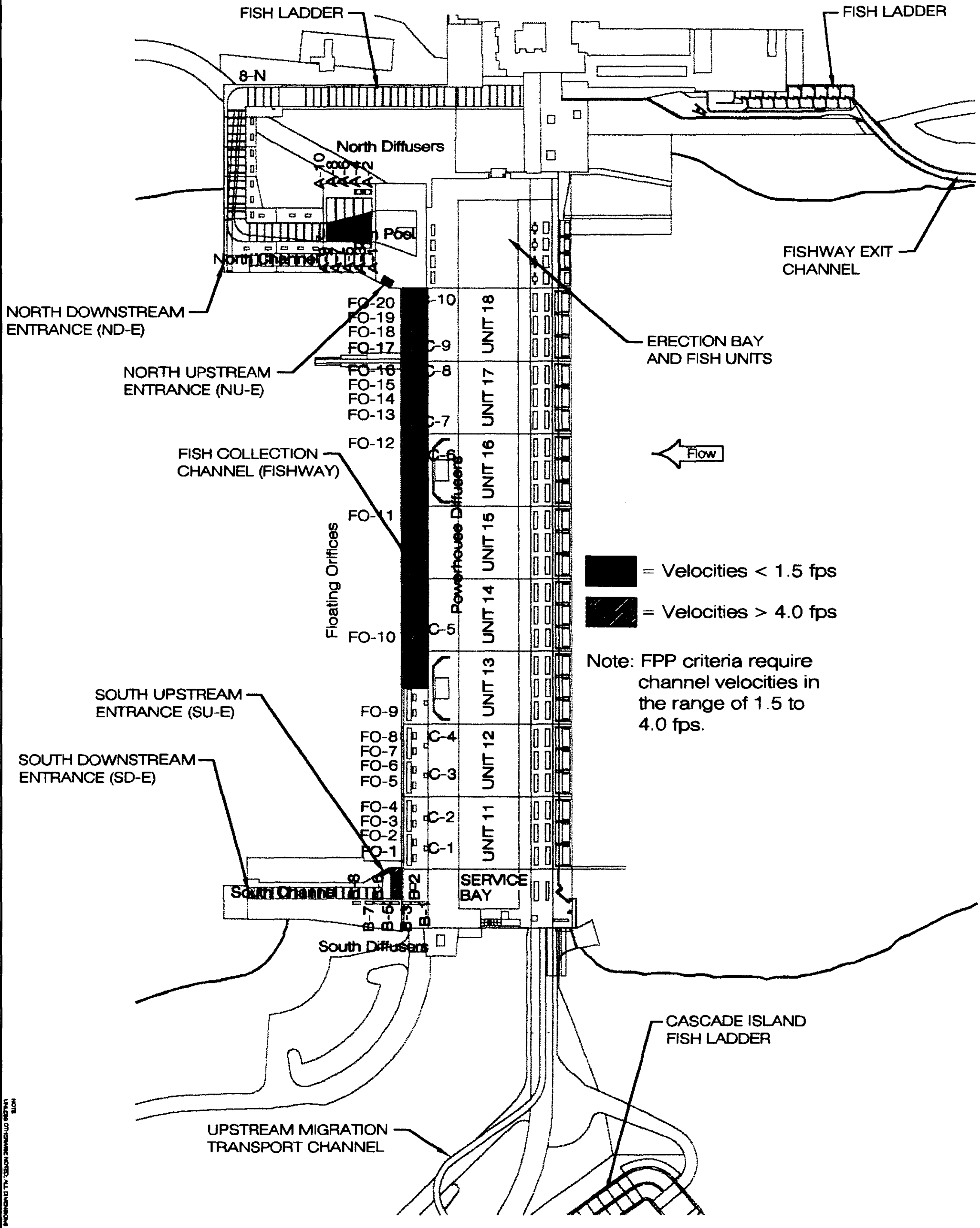


Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

NOTE
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

PLATE 2	DRAWING NO.	DRAWING STATUS:
COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY FEATURE LOCATION KEY	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	US Army Corps of Engineers Portland District
Designed by: D. PATRICK	Date: 27 SEPT 1999	
Drawn by: D. PATRICK	CADD File Name: BONPLATE02.DGN	
Checked by:	Technical Manager:	
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct & Arch Design		

Figure F-1



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-1]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 8
CONFIGURATION 1

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

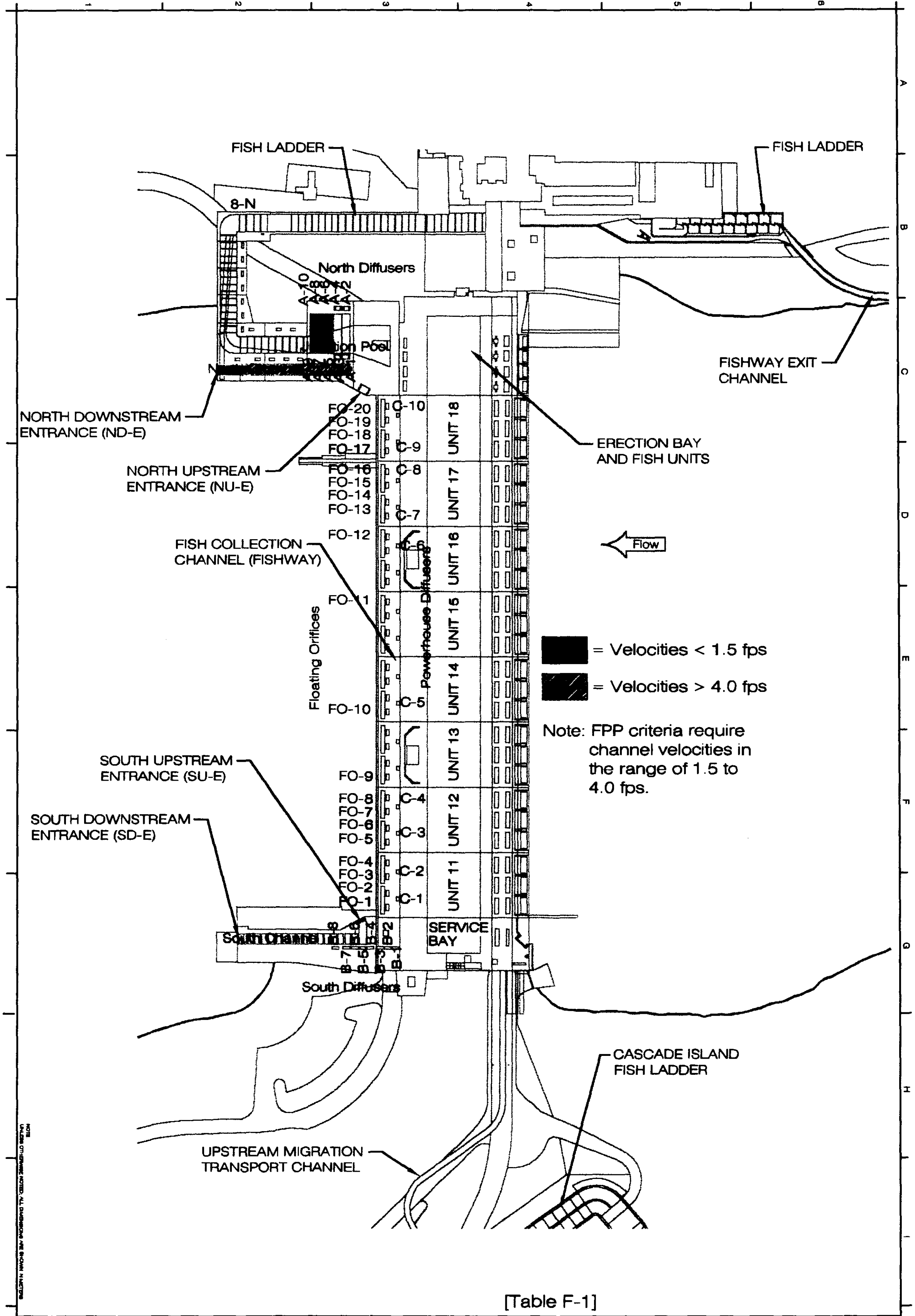
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

PLATE 2
DRAWING NO.
DRAWING STATUS

US Army Corps of Engineers Portland District

Figure F-2



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-1]

PLATE 2
DRAWING NO
DRAW NG STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 8
CONFIGURATION 2

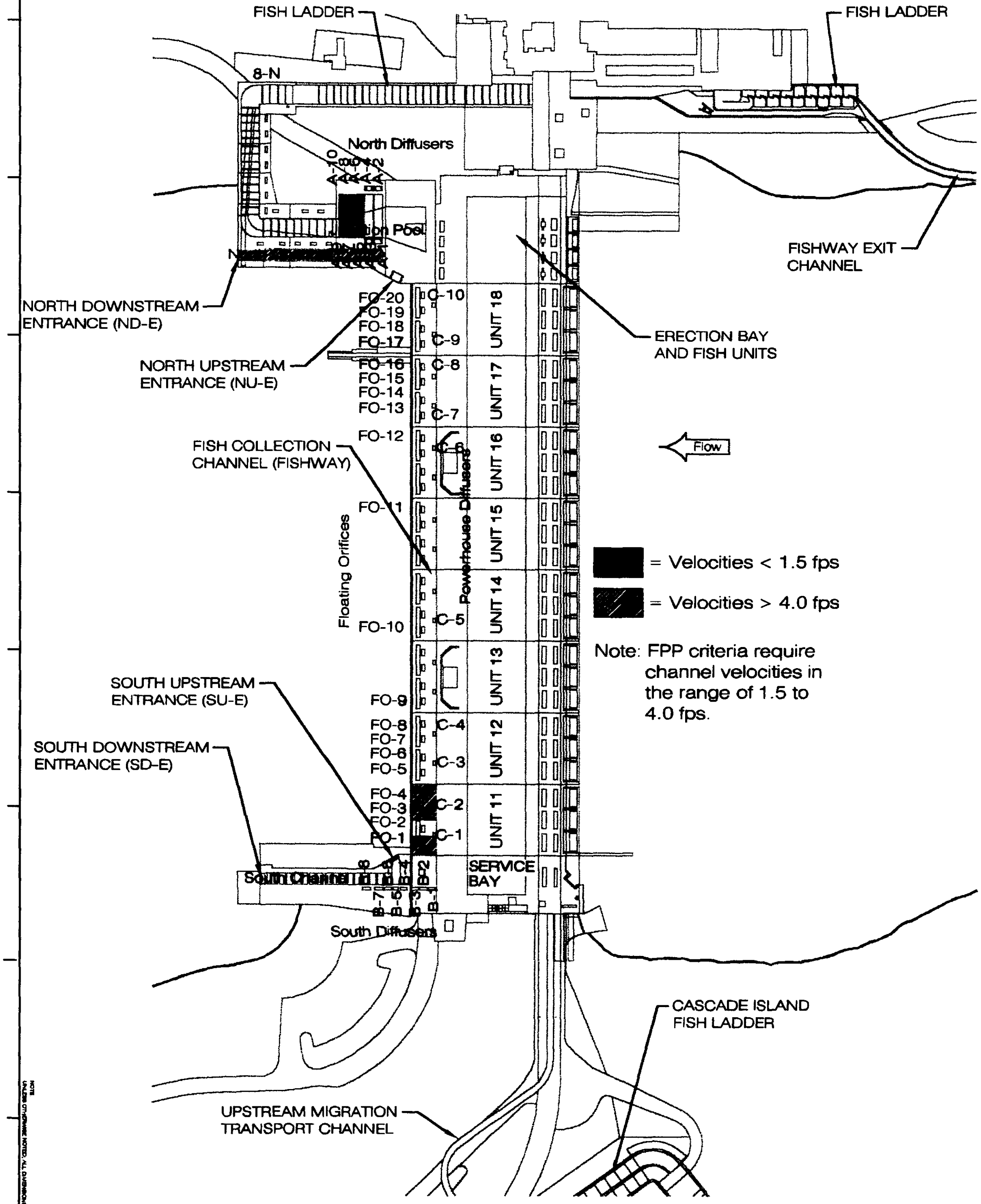
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief Struct.& Arch.Design

US Army Corps of Engineers Portland District

Figure F-3

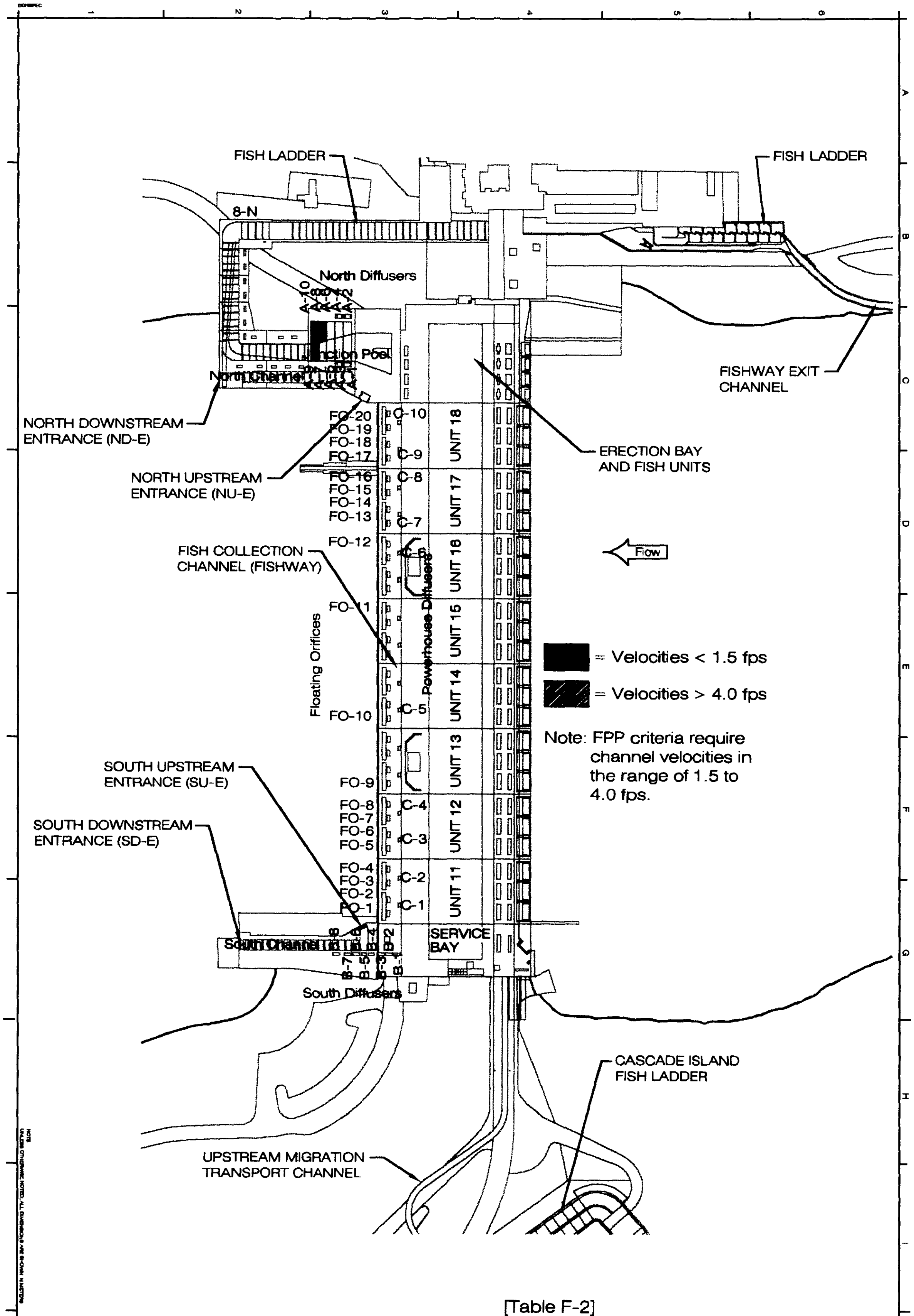


[Table F-1]

PLATE 2	DRAWING NO.	DRAWING STATUS	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 8 CONFIGURATION 3	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps of Engineers Portland District

Figure F-4



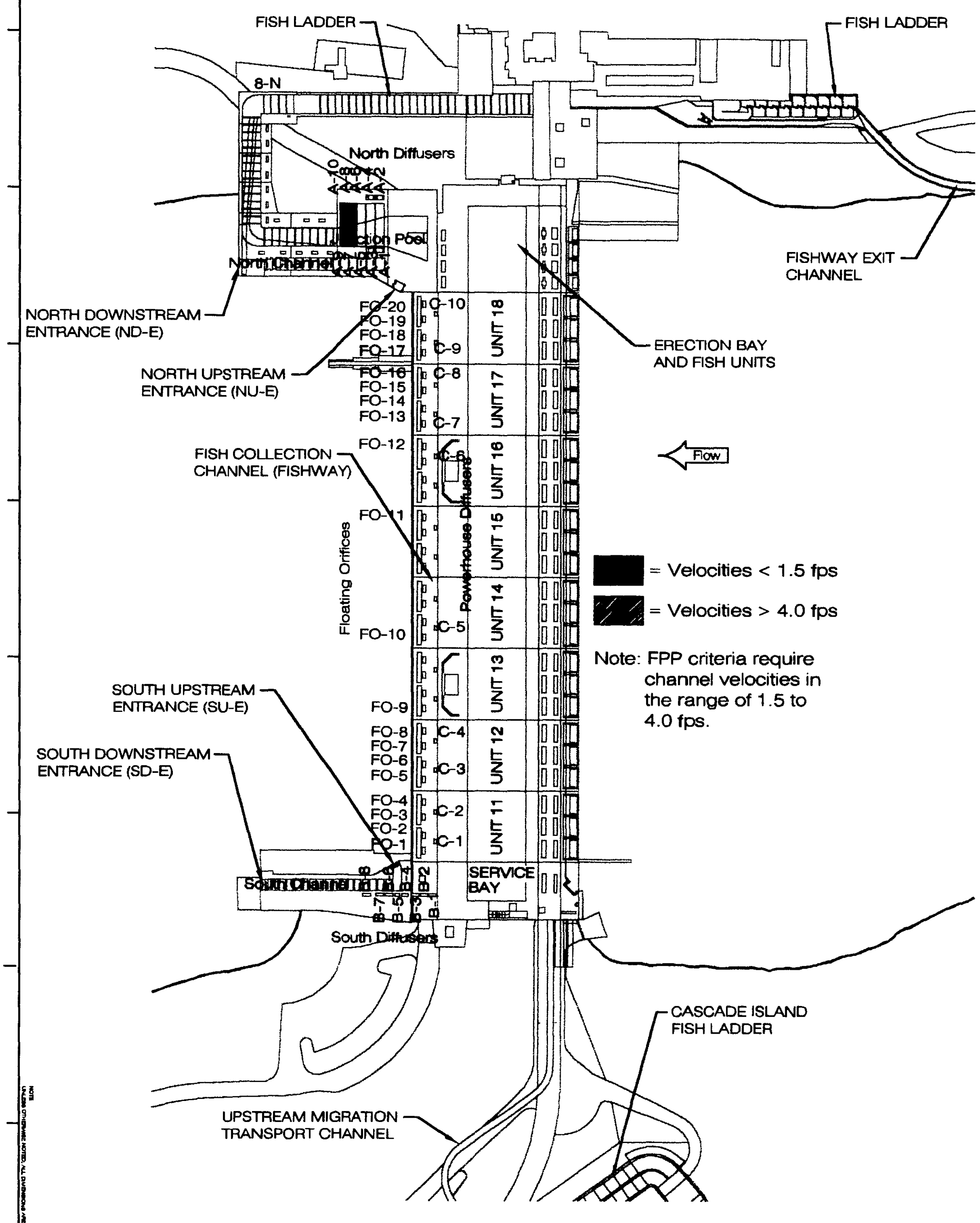
Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-2]

PLATE 2	DRAWING NO.	DRAWING STATUS	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 9 CONFIGURATION 3	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct & Arch Design
					Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps of Engineers Portland District

Figure F-5



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-3]

PLATE 2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 10
CONFIGURATION 3

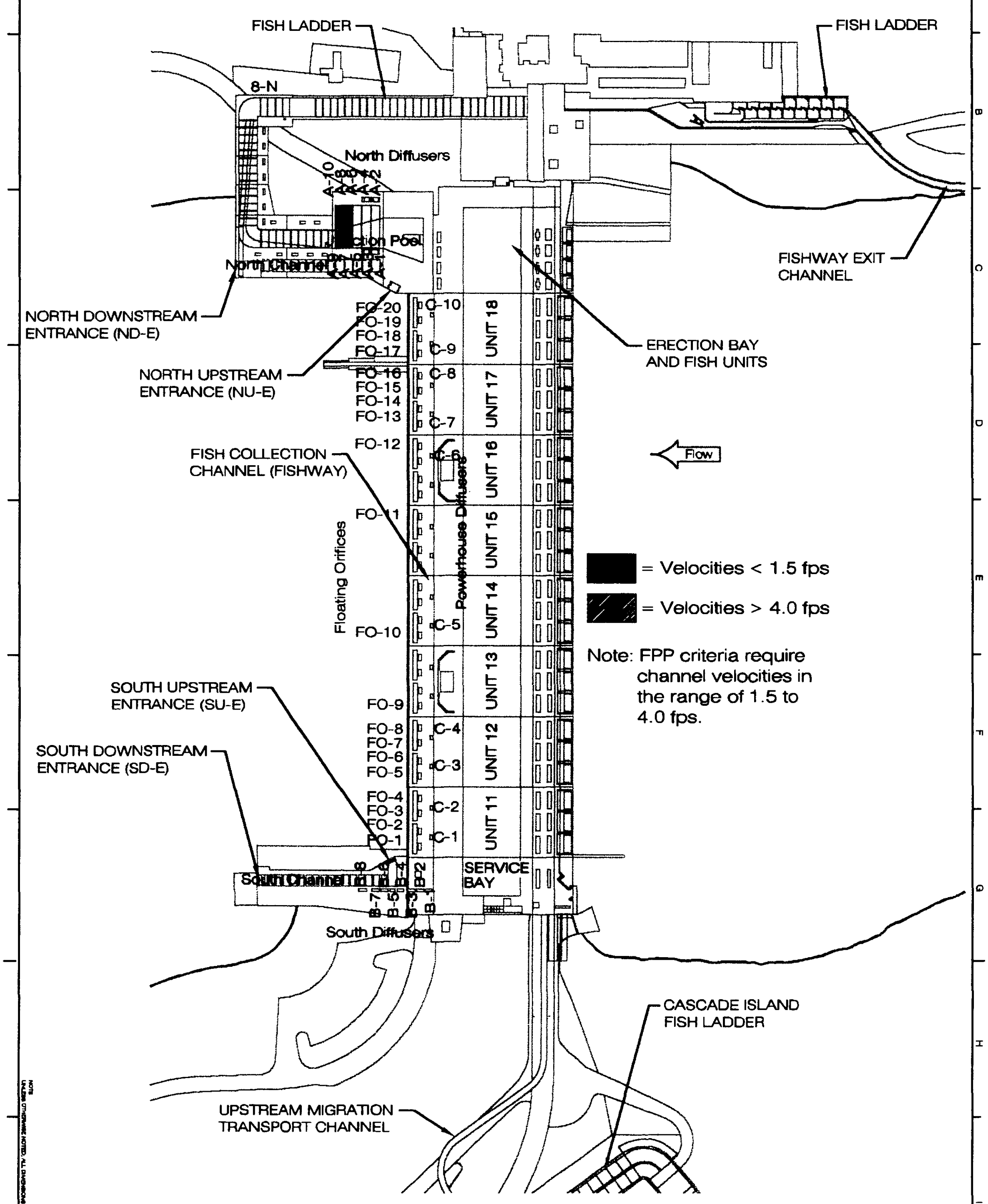
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design

US Army Corps of Engineers

Figure F-6



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-4]

PLATE 2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 11
CONFIGURATION 3

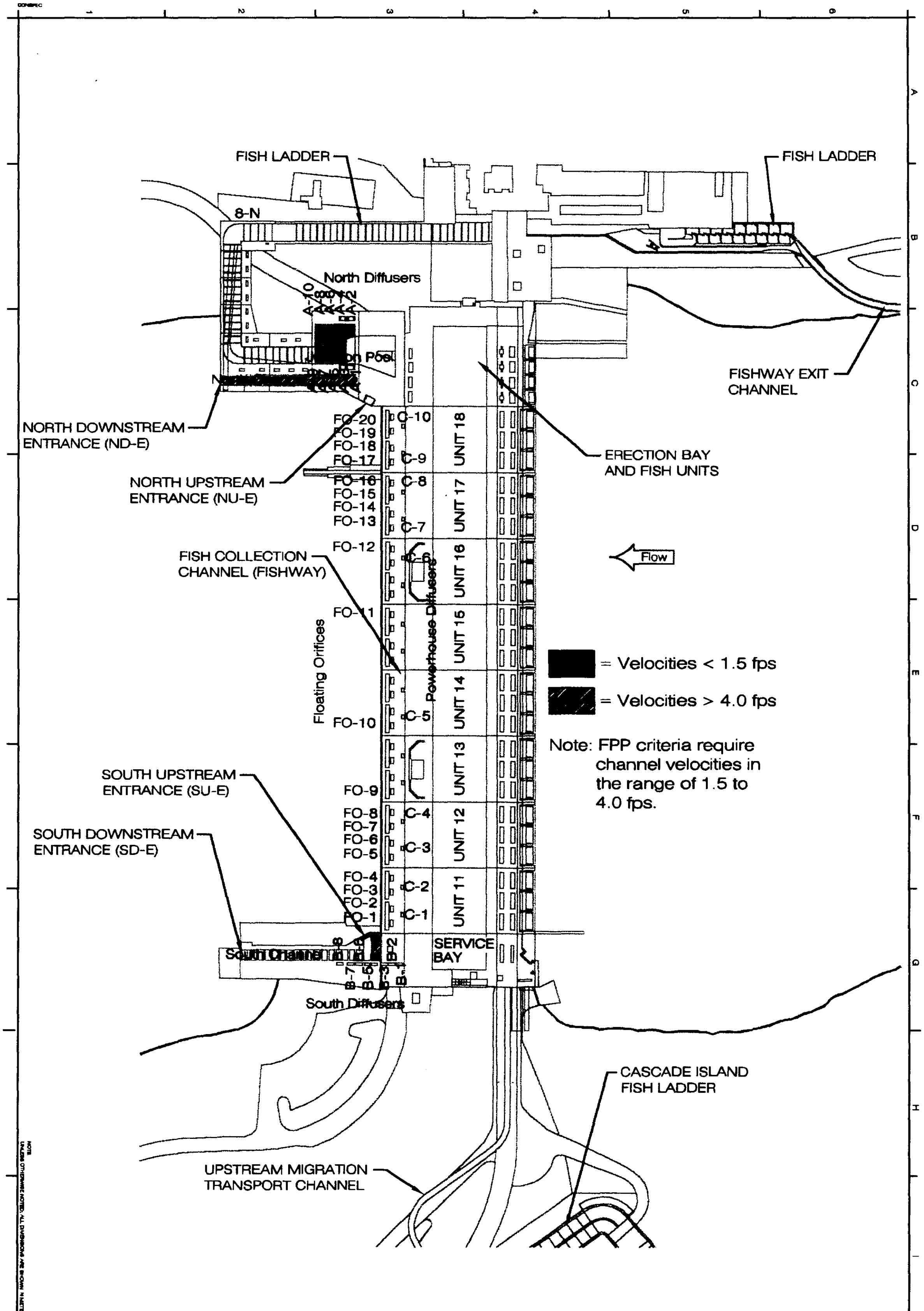
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct & Arch Design

US Army Corps of Engineers Portland District

Figure F-7



[Table F-5]

COLUMBIA RIVER — OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 12 CONFIGURATION 1	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Date: 27 SEPT 1999 Drawn by: D. PATRICK CADD File Name: BONPLATE02.DGN Checked by: Technica Manager: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

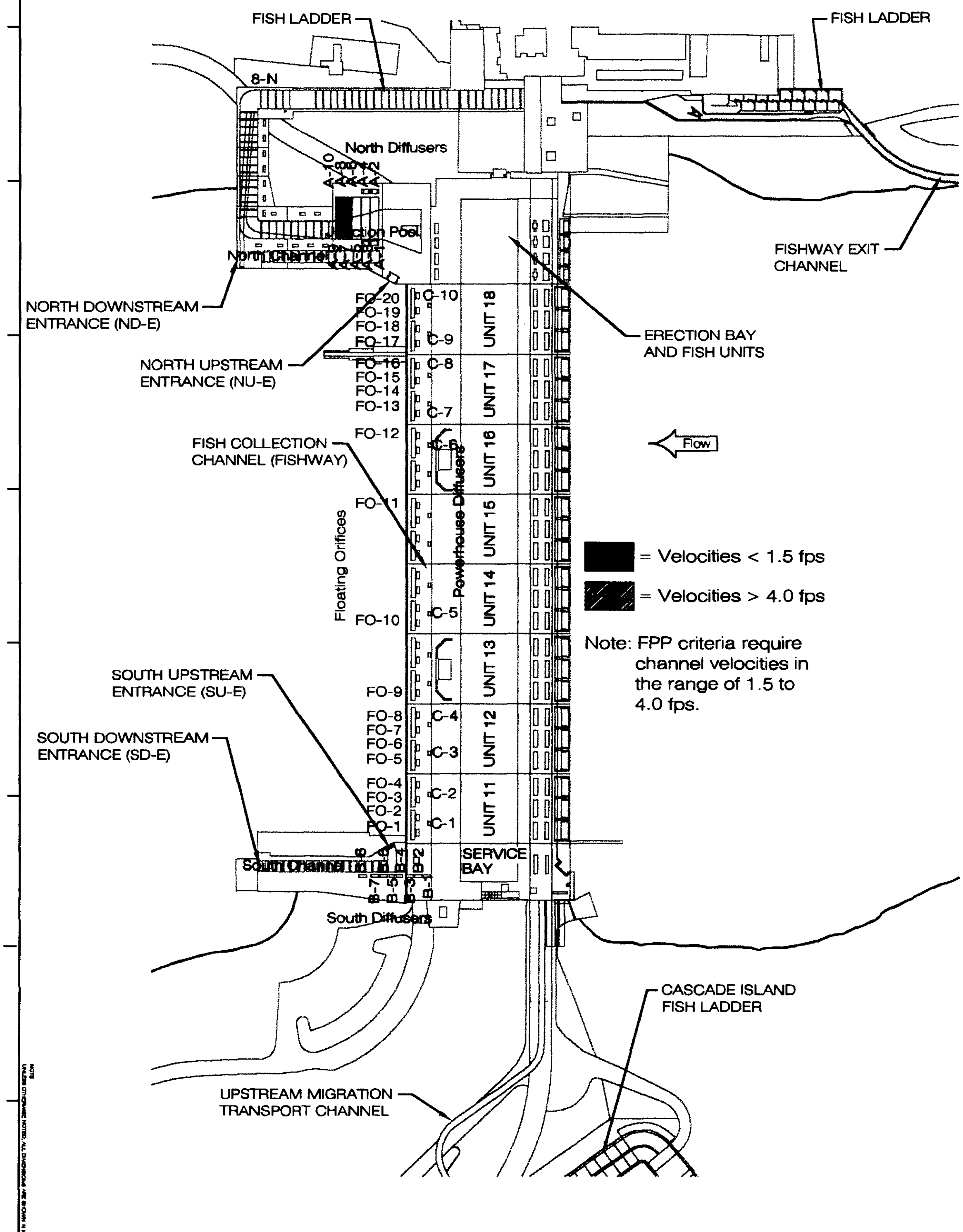
PLATE 2

DRAWING NO.

DRAWING STATUS

US Army Corps of Engineers Portland District

Figure F-8



[Table F-5]

PLATE 2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 12
CONFIGURATION 2

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

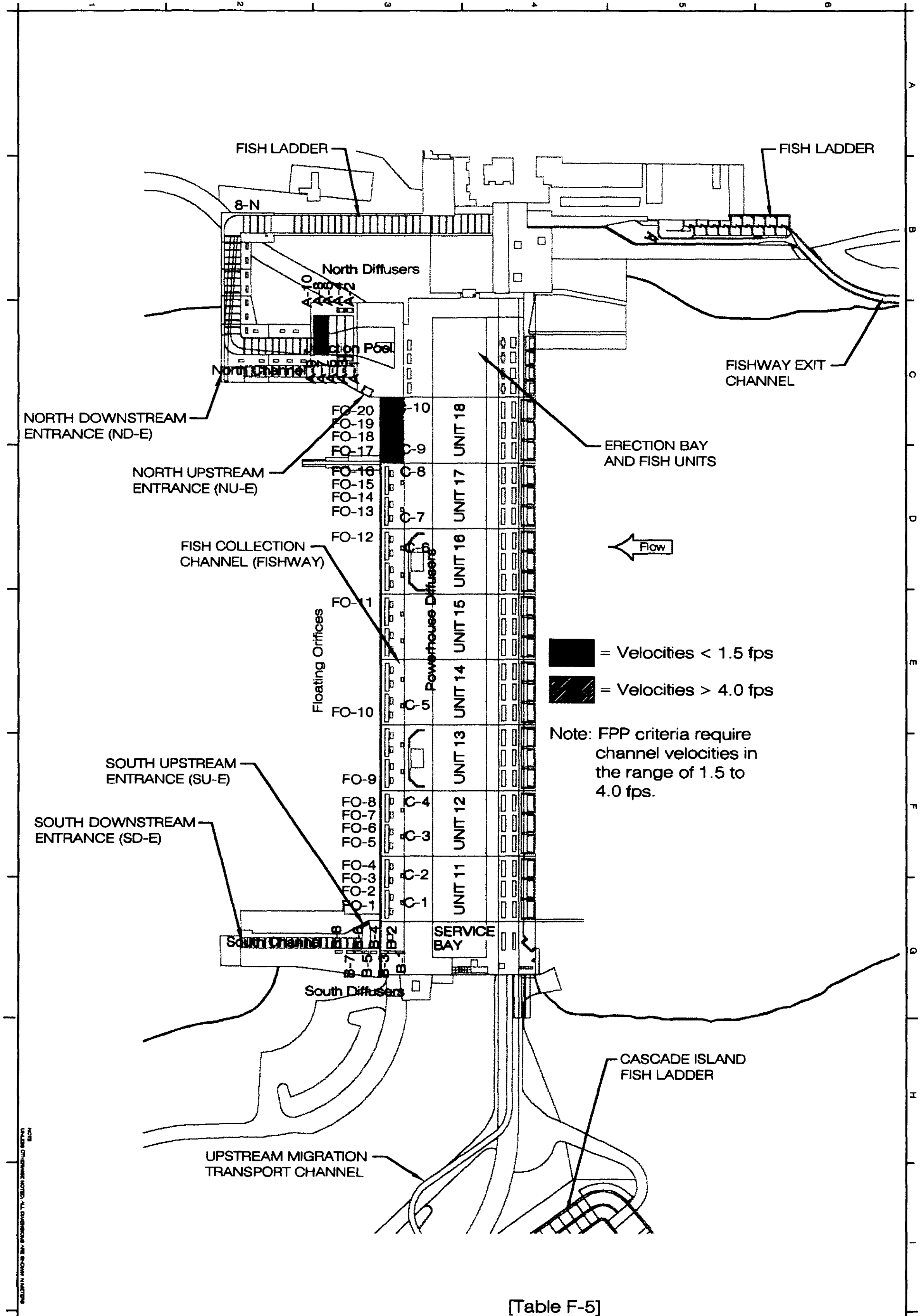
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief,Struct.& Arch.Design

Revision	Date	Description	By

US Army Corps of Engineers
Portland District

Figure F-9



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

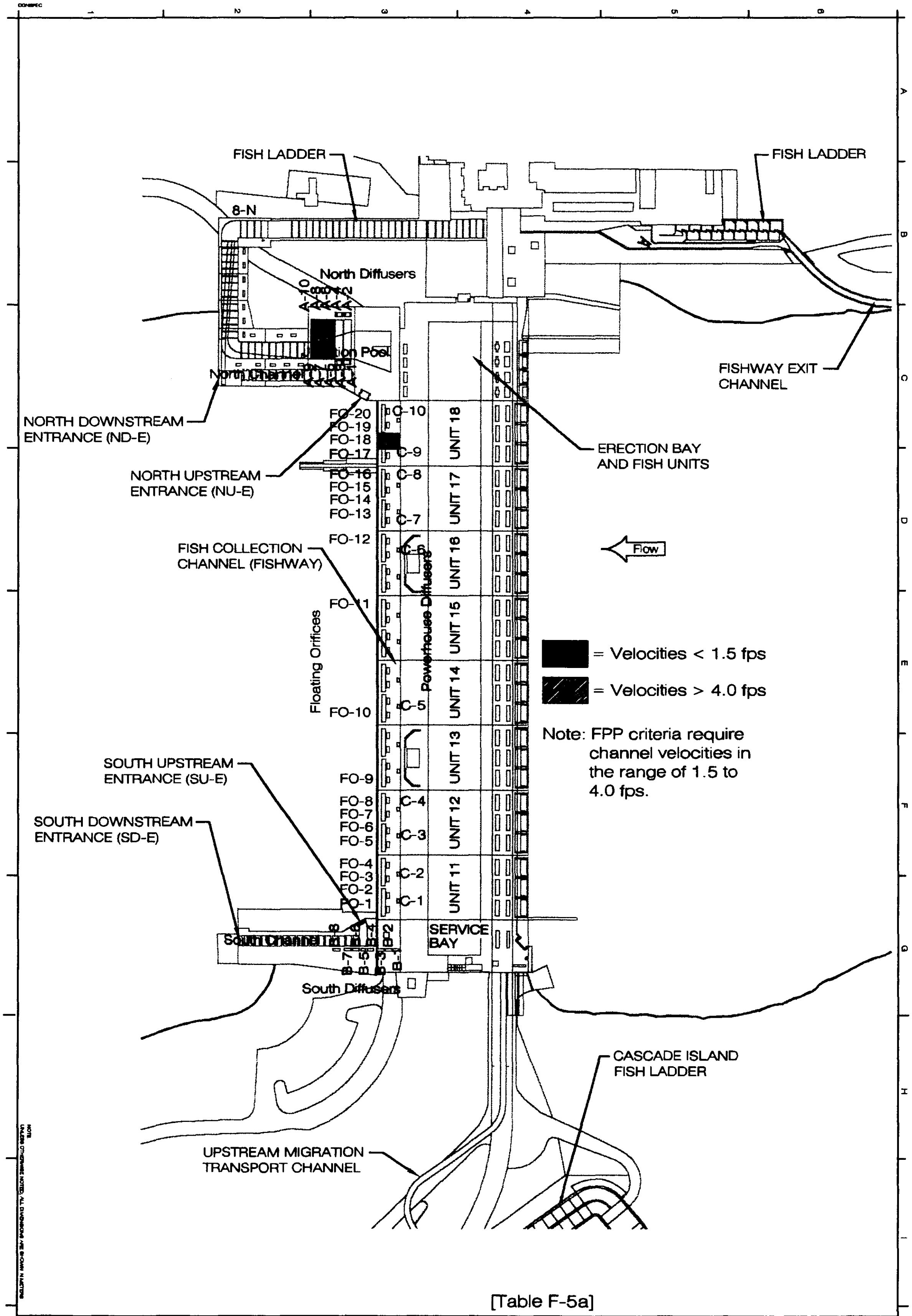
NOTE UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-5]

PLATE 2	DRAWING NO.	DRAWING STATUS:	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 12 CONFIGURATION 3	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps of Engineers Portland District

Figure F-10



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-5a]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 12
CONFIGURATION 2

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

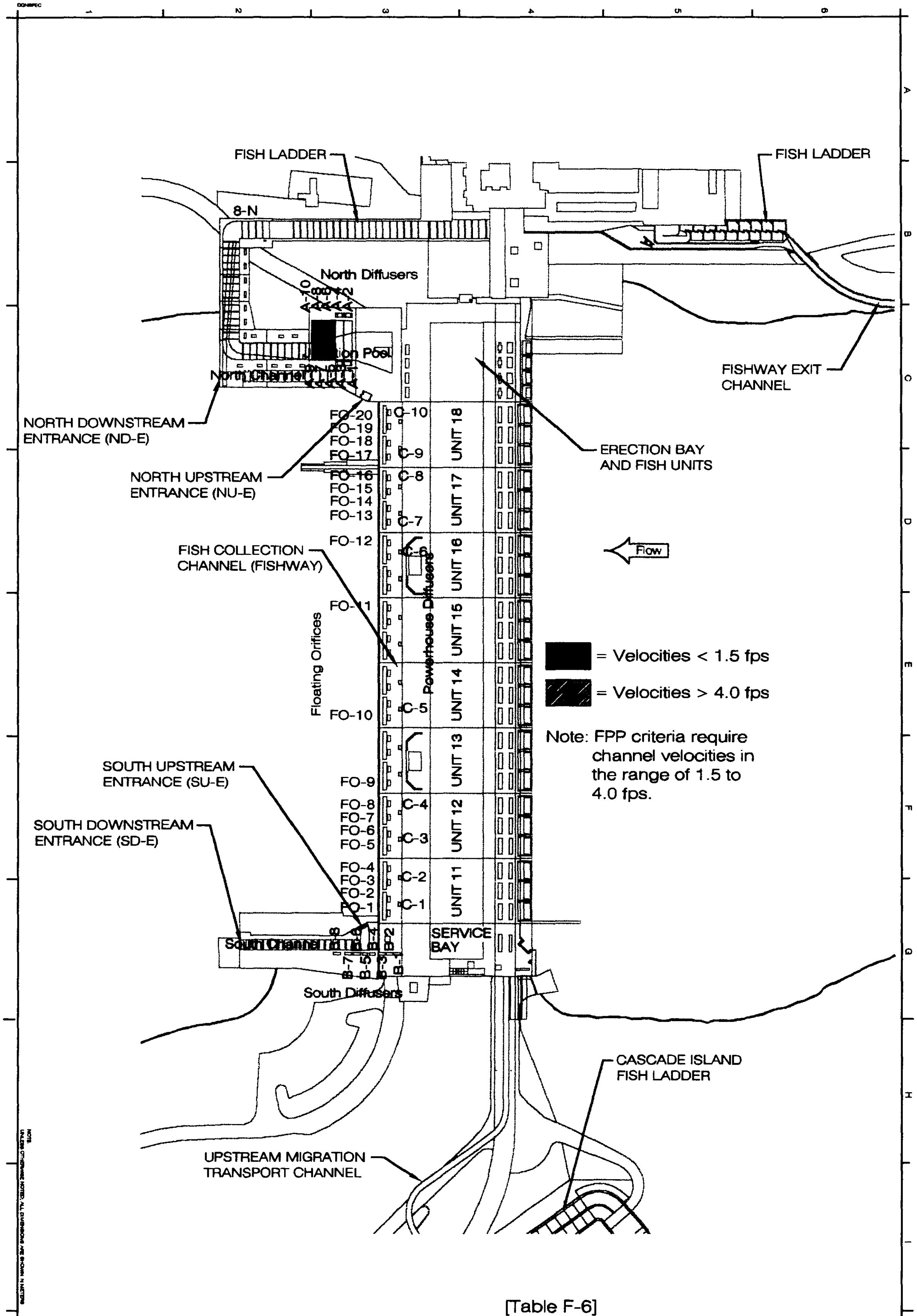
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

DRAWING STATUS:
DRAWING NO.
PLATE 2

US Army Corps of Engineers Portland District

Figure F-11

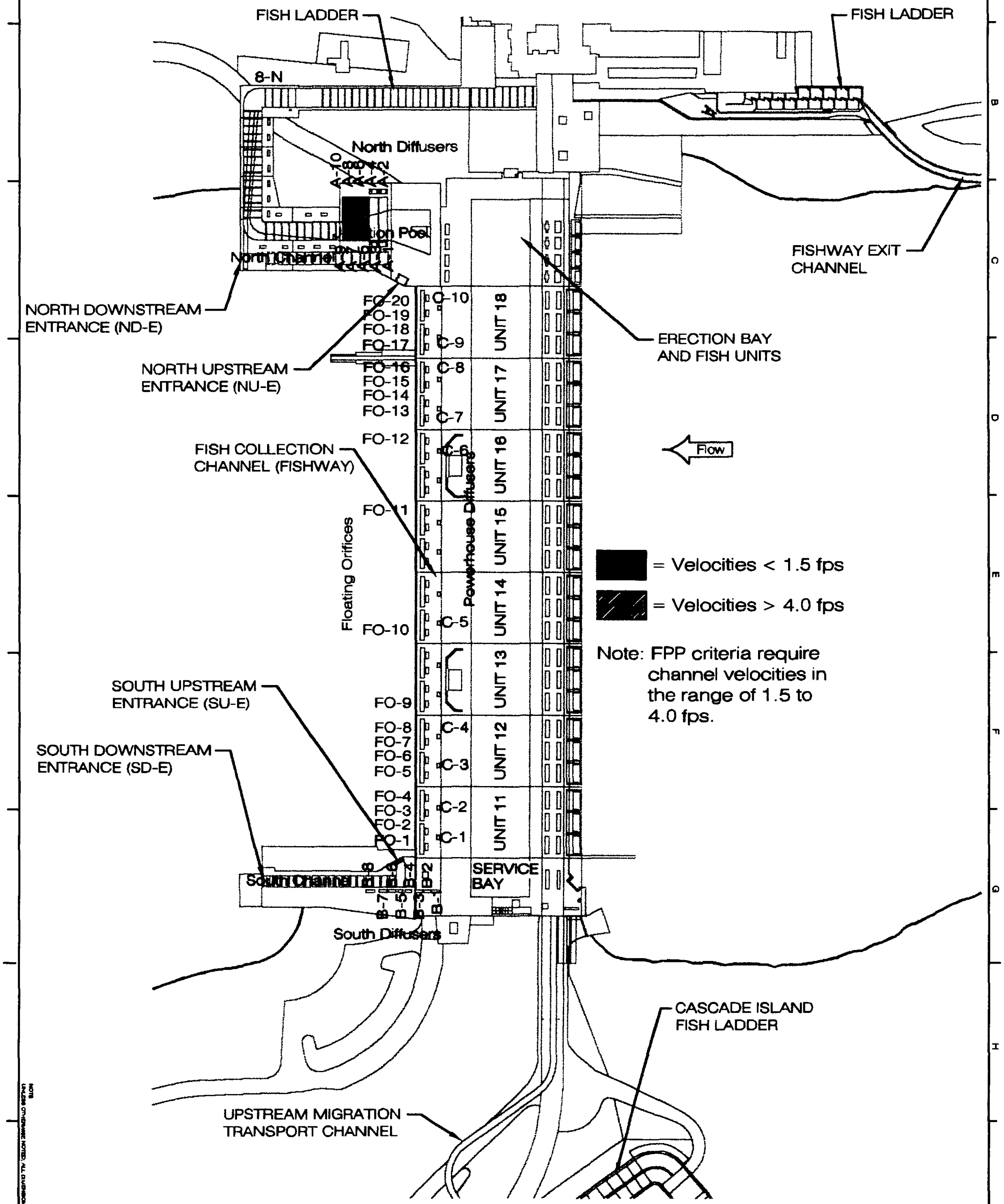


Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-6]

PLATE 2	DRAWING NO.	DRAWING STATUS:	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 13 CONFIGURATION 2	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:	US Army Corps of Engineers Portland District

Figure F-12



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-7]

COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 14 CONFIGURATION 2	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

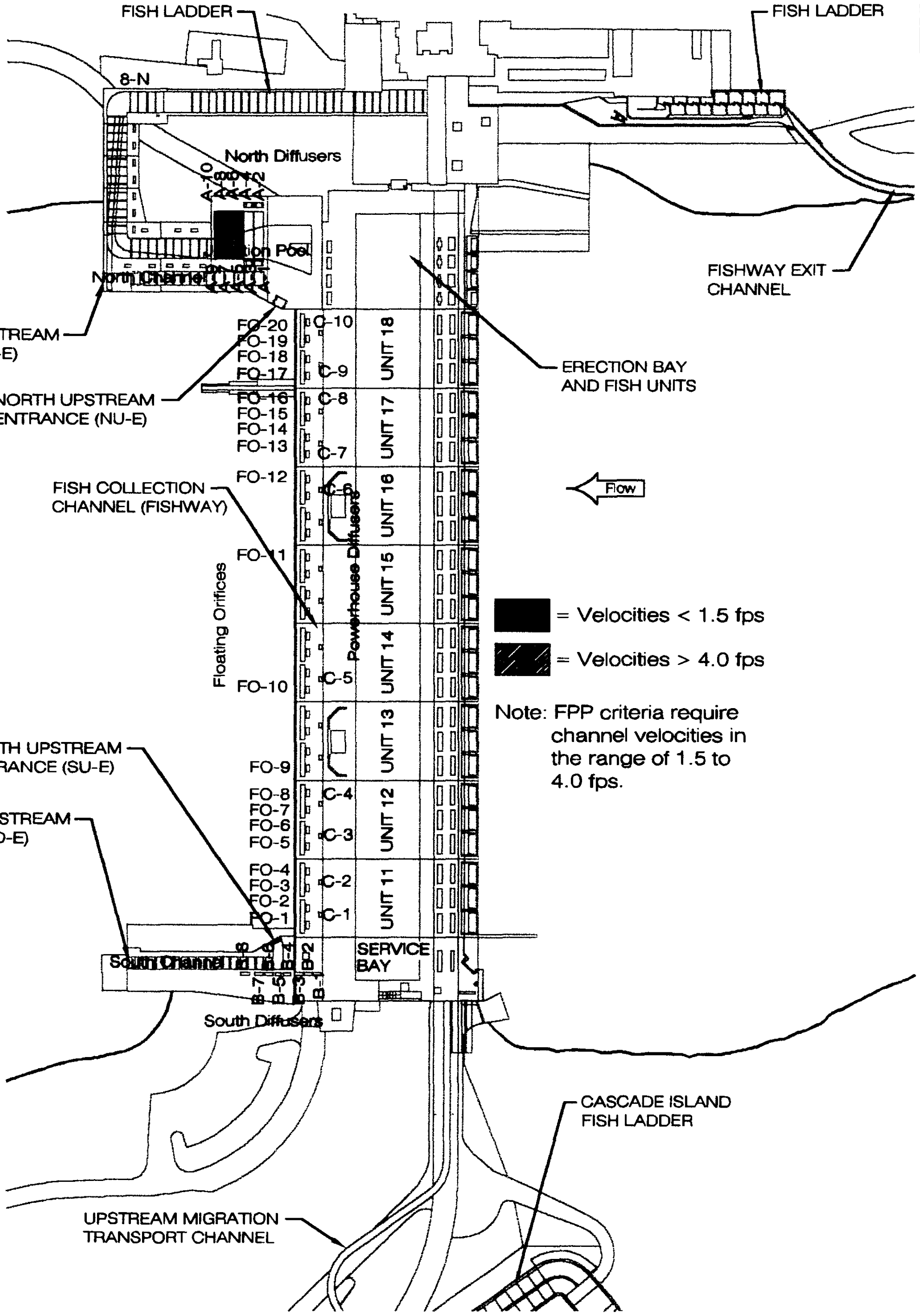
DRAWING STATUS:

DRAWING NO.

PLATE 2

US Army Corps of Engineers Portland District

Figure F-13



NOTE
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-8]

PLATE
2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 15
CONFIGURATION 2

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

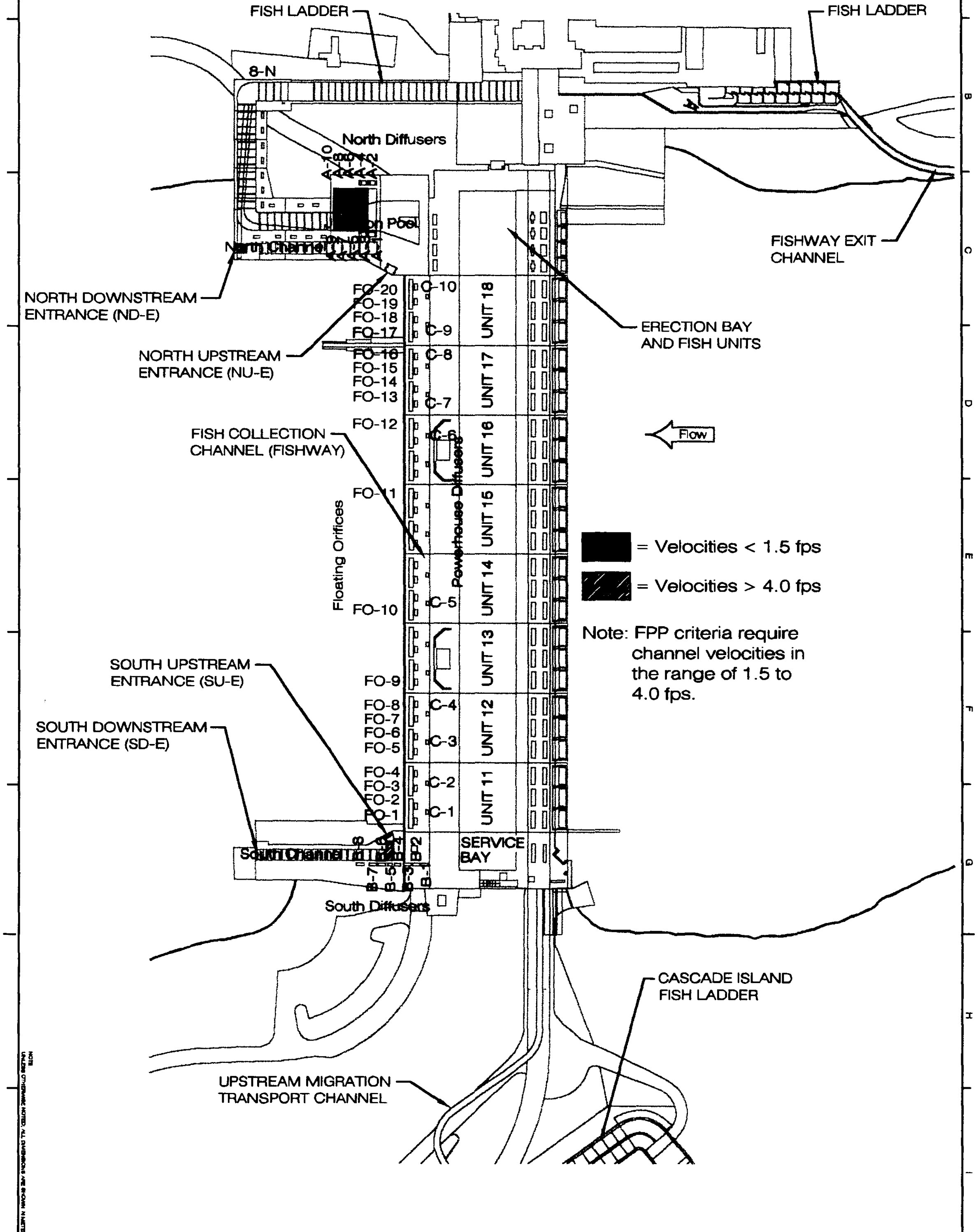
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief Struct & Arch.Design

Revision	Date	Description	By

US Army Corps
of Engineers
Portland District

Figure F-14



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

NOTE
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-9]

PLATE 2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 16
CONFIGURATION 1

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

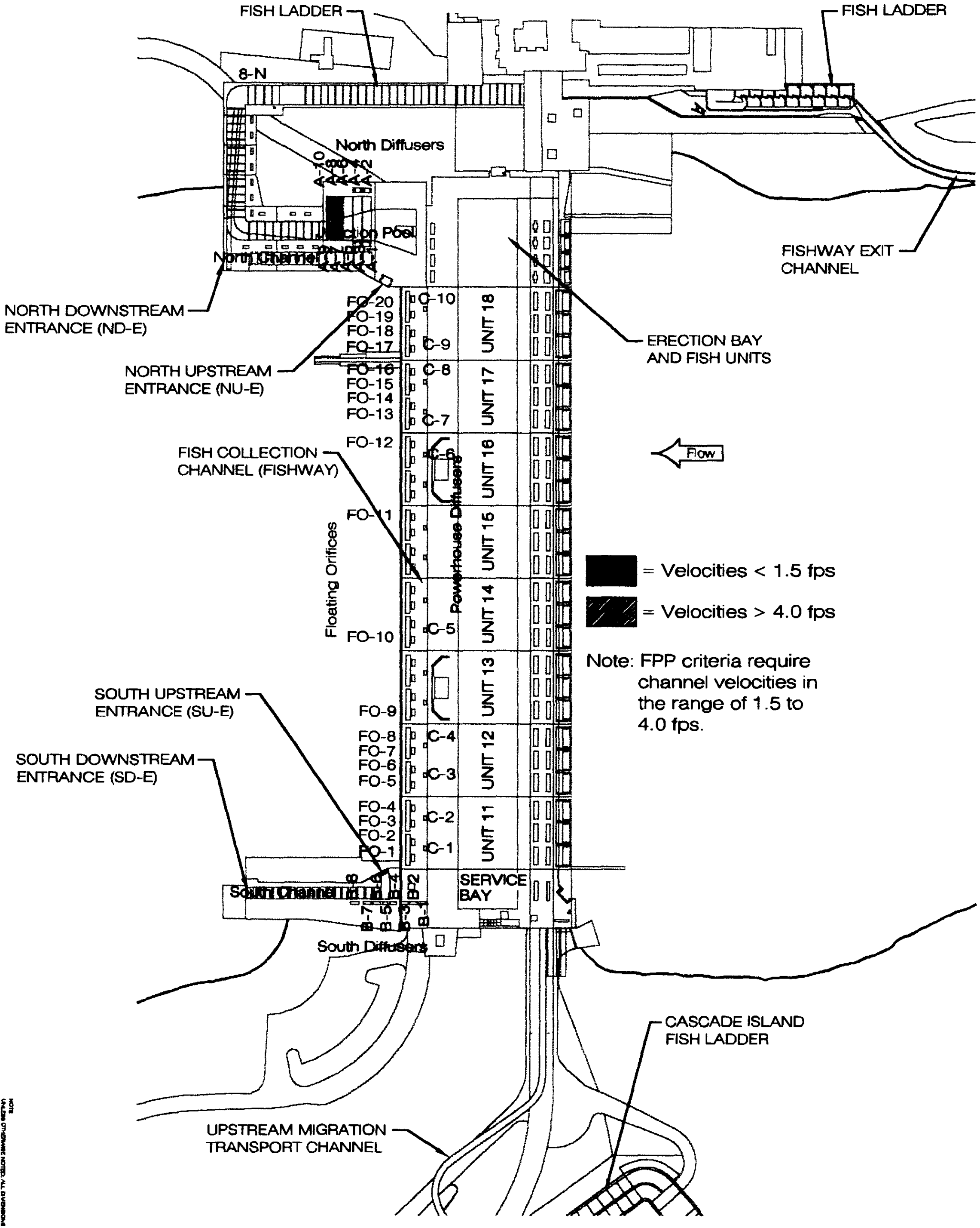
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct. & Arch. Design

Revision Date Description By

US Army Corps of Engineers Portland District

Figure F-15



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

NOTE: UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-9]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 16
CONFIGURATION 2

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

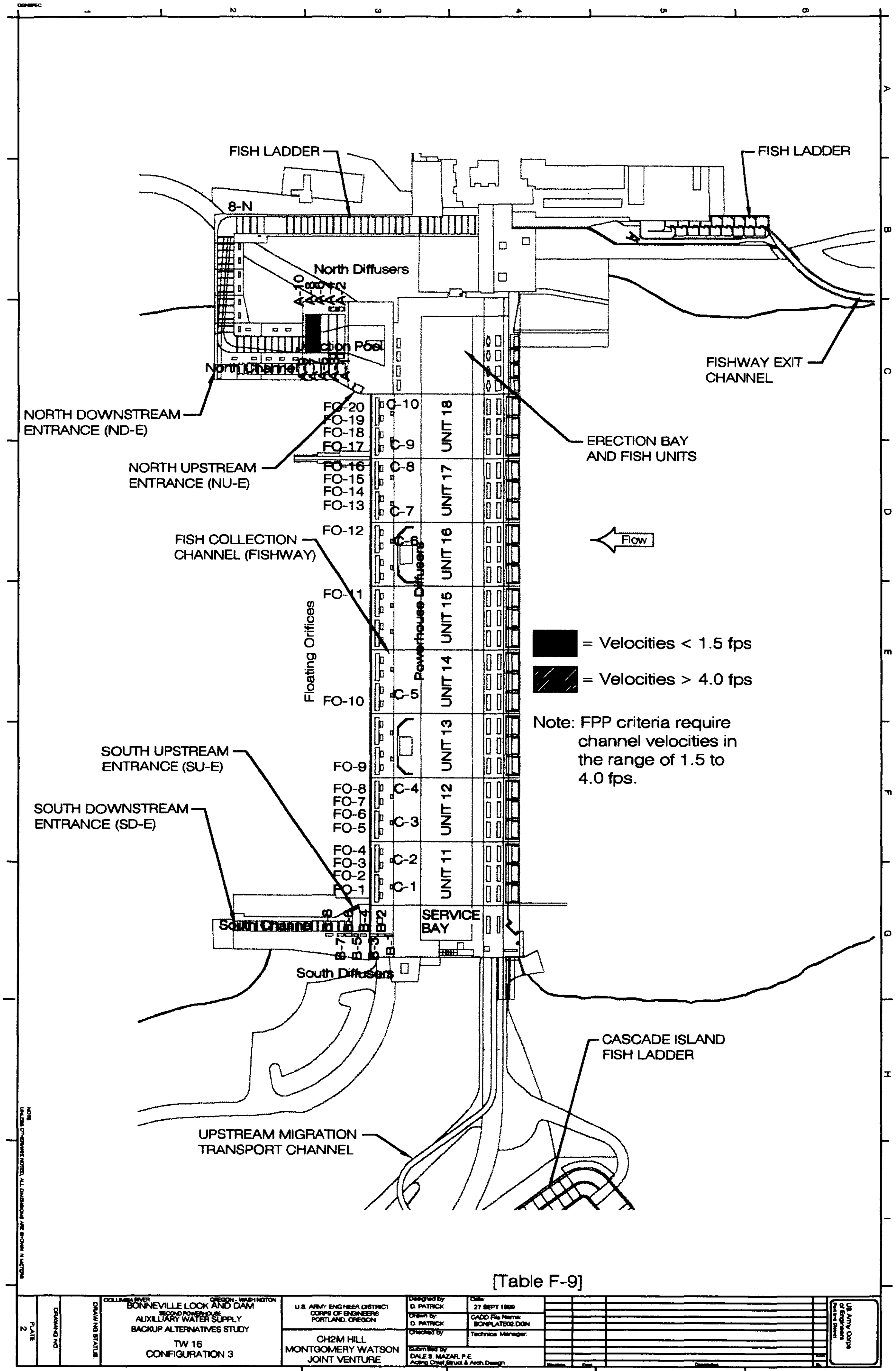
DRAWING STATUS

DRAWING NO

PLATE 2

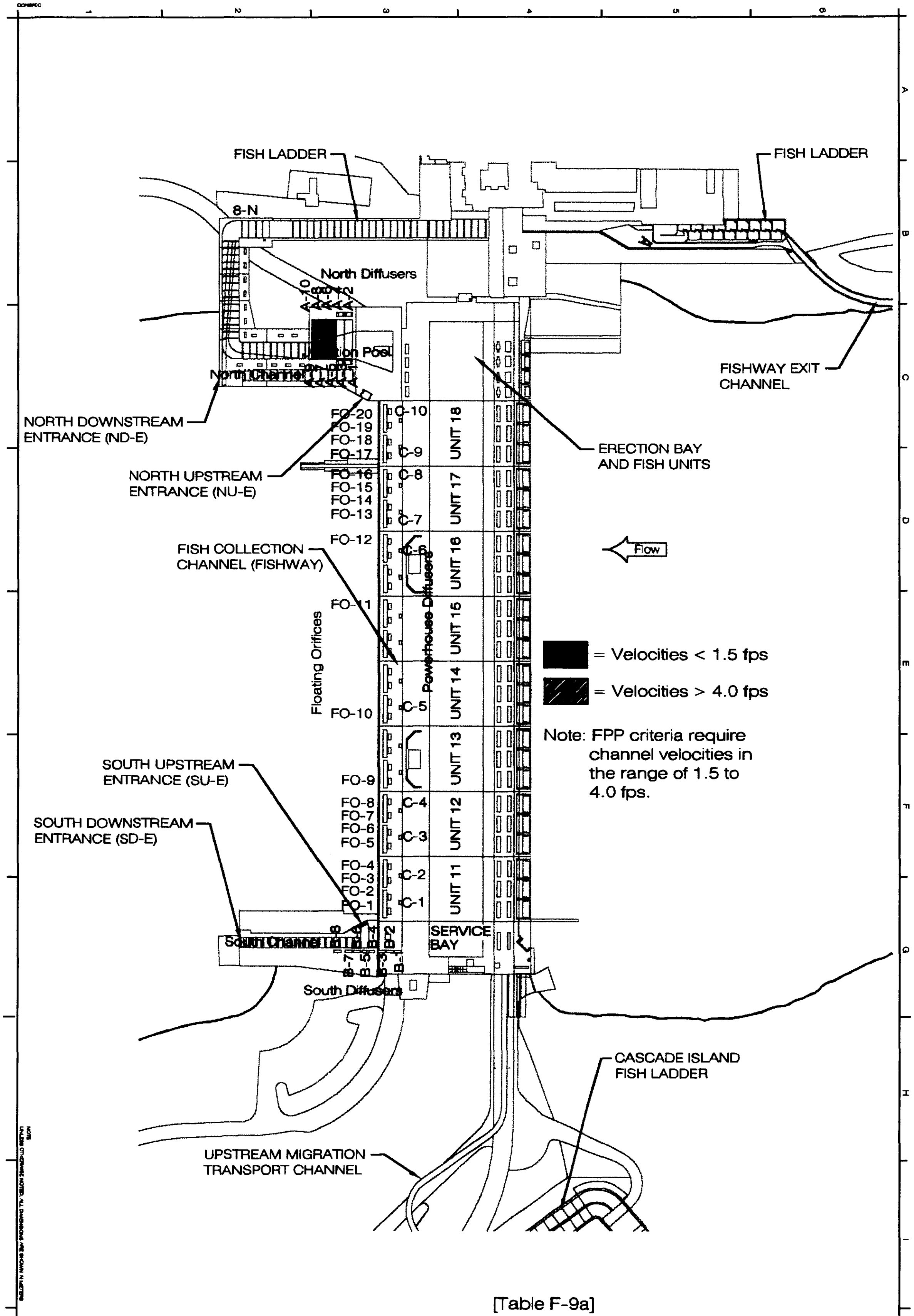
US Army Corps of Engineers Portland District

Figure F-16



[Table F-9]

Figure F-17



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-9a]

PLATE 2

DRAWING NO.

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 16
CONFIGURATION 2

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
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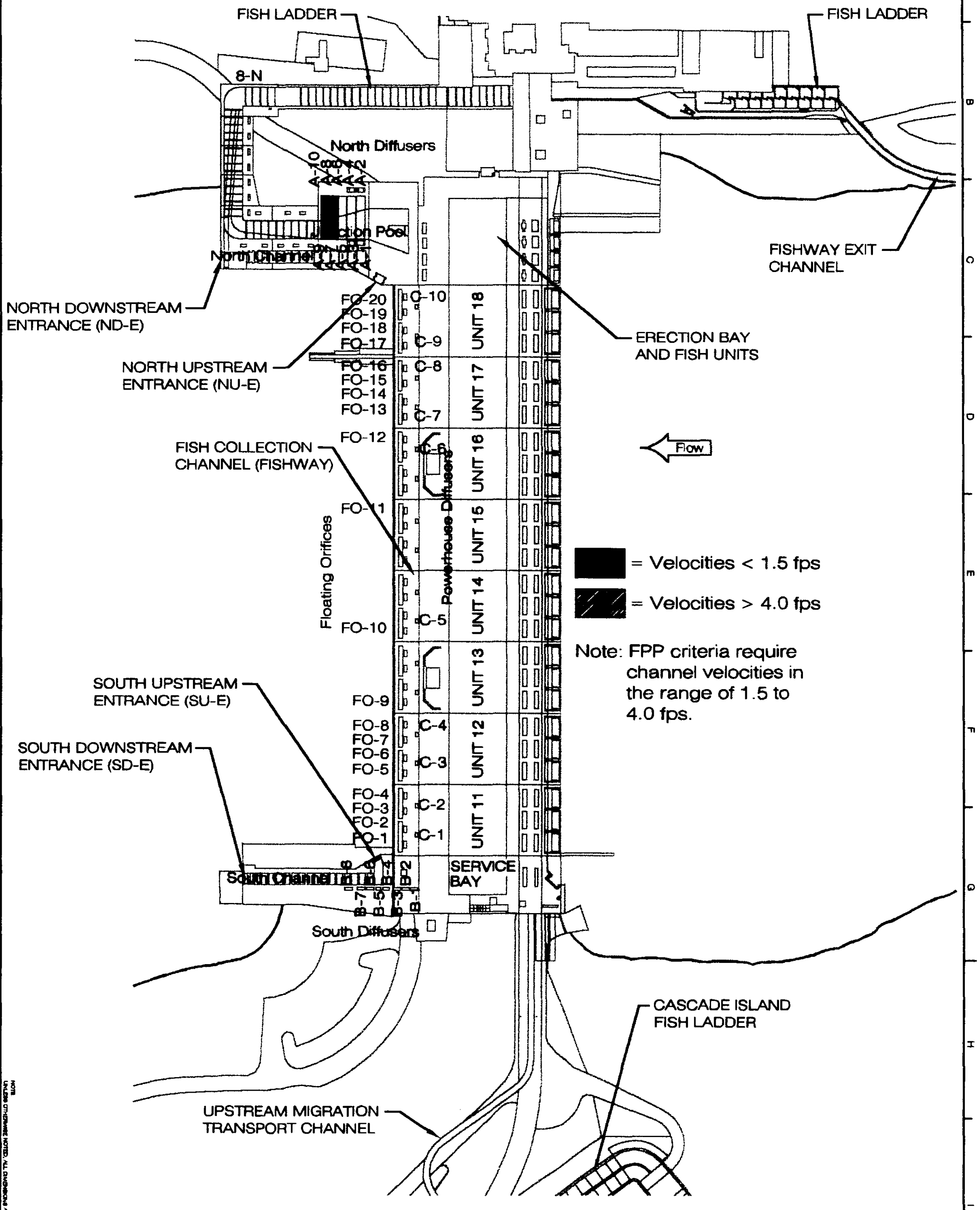
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct. & Arch. Design

US Army Corps of Engineers
Portland District

Figure F-18

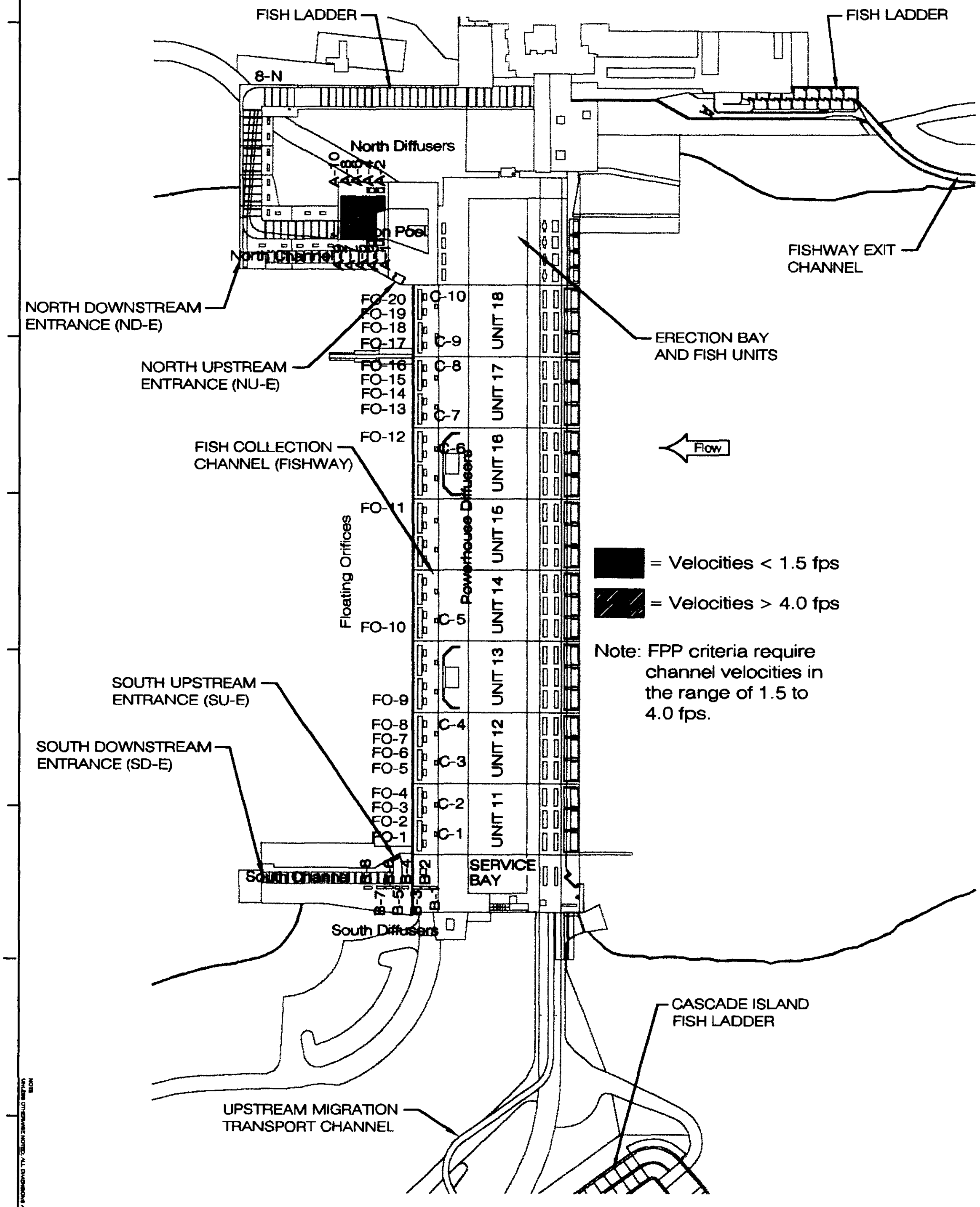


Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-10]

PLATE 2	DRAWING NO.	DRAWING STATUS:	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 17 CONFIGURATION 2	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

Figure F-19



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-11]

PLATE 2

DRAWING NO.

DRAWING STATUS:

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 18
CONFIGURATION 1

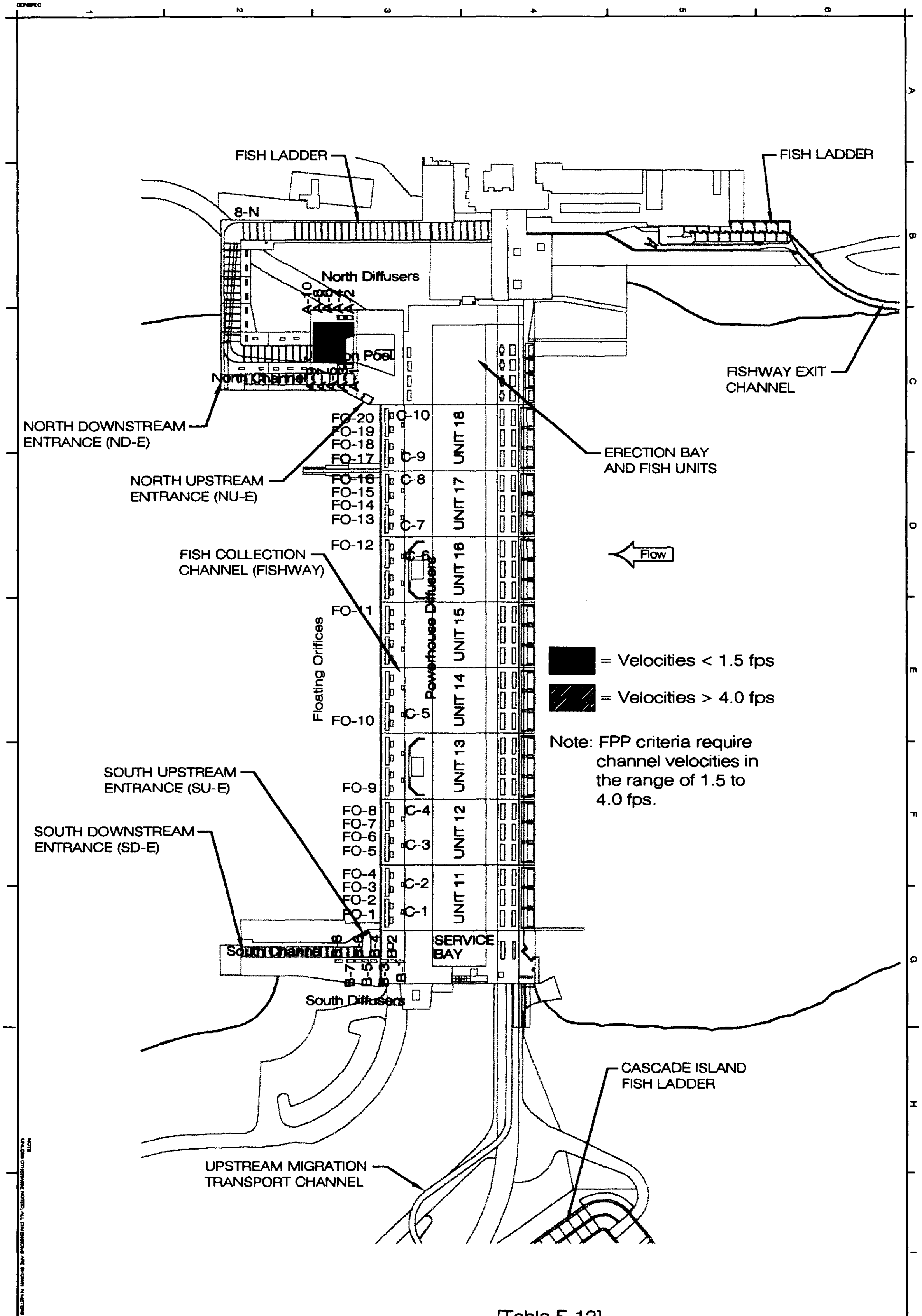
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct.& Arch.Design

US Army Corps
of Engineers
Portland District

Figure F-20



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-12]

PLATE 2

DRAWING NO

DRAWING STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 19
CONFIGURATION 1

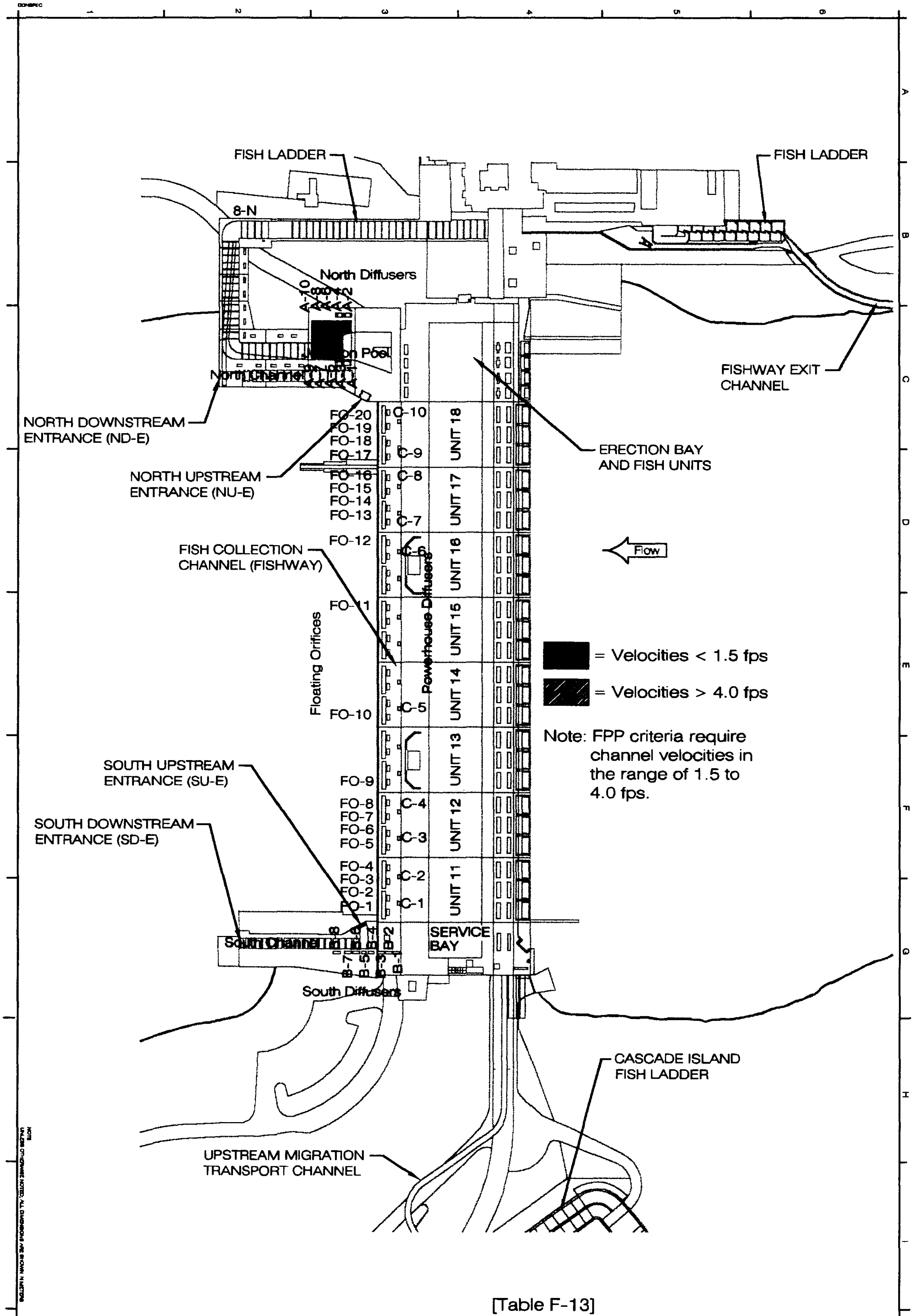
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design

US Army Corps of Engineers Portland District

Figure F-21



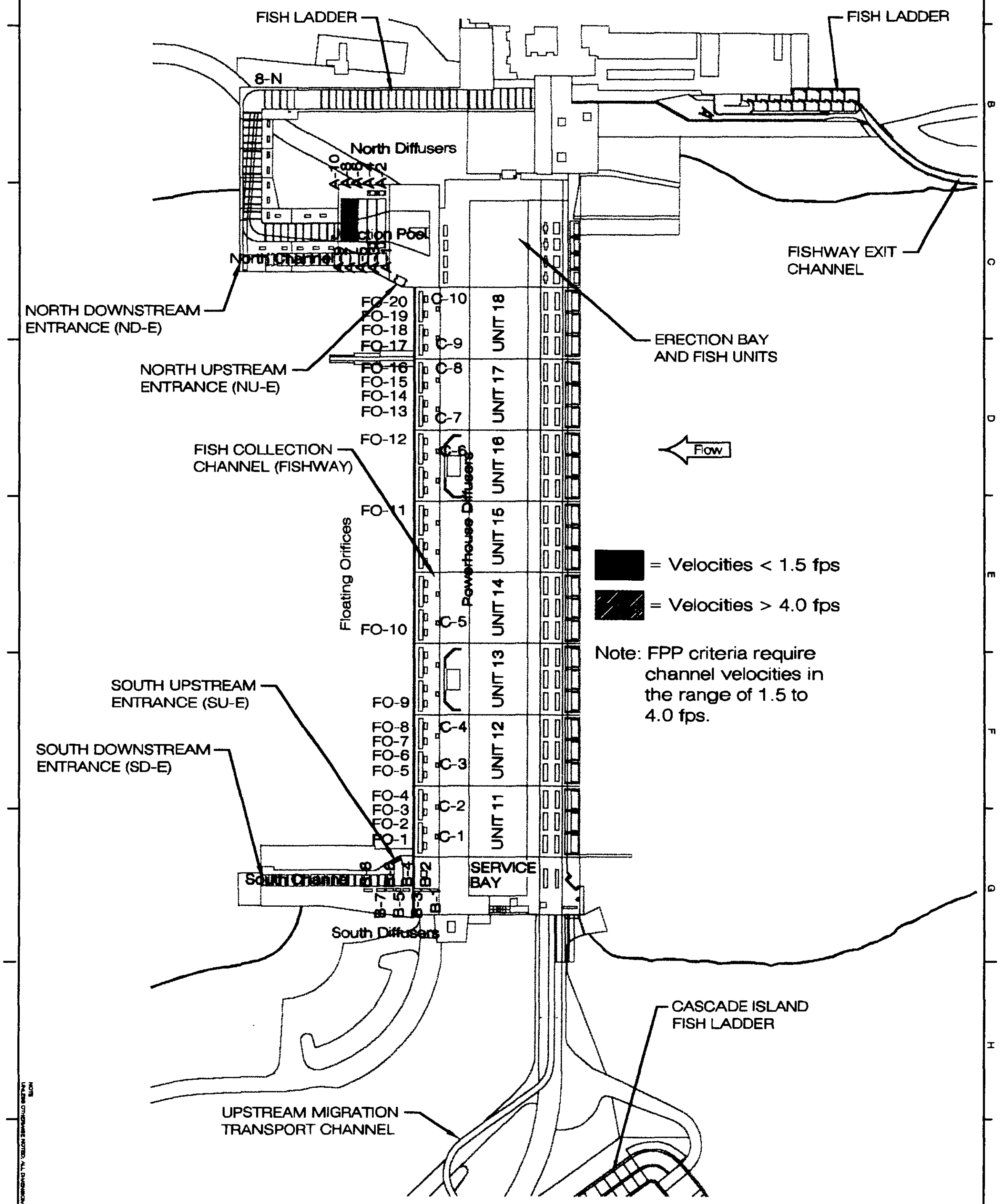
[Table F-13]

PLATE 2	DRAWING NO.	DRAWING STATUS:	COLUMBIA RIVER — OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 20 CONFIGURATION 1	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE

Designed by: D. PATRICK	Date: 27 SEPT 1999
Drawn by: D. PATRICK	CADD File Name: BONPLATE02.DGN
Checked by:	Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design	

US Army Corps of Engineers Portland District

Figure F-22

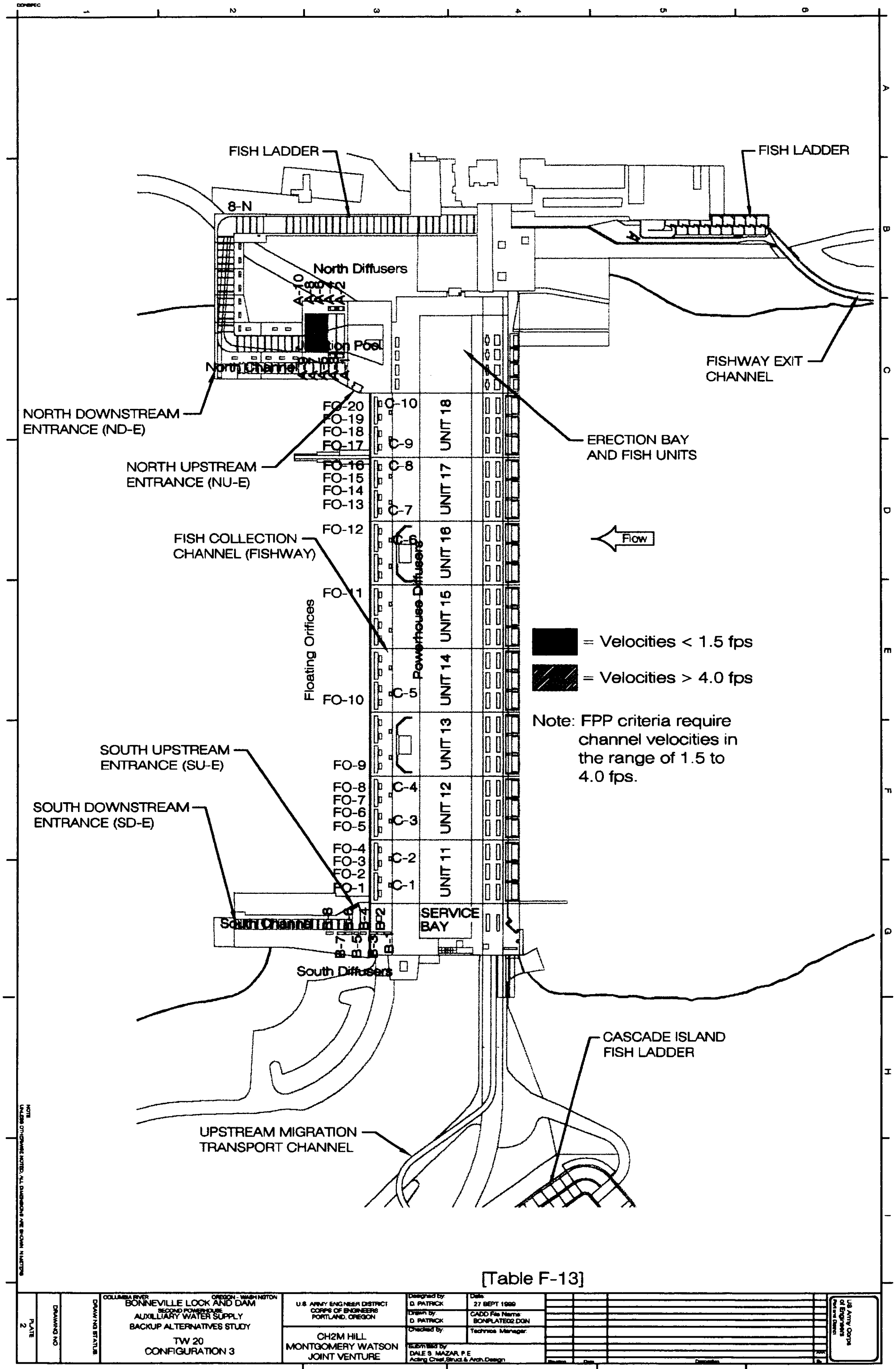


Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-13]

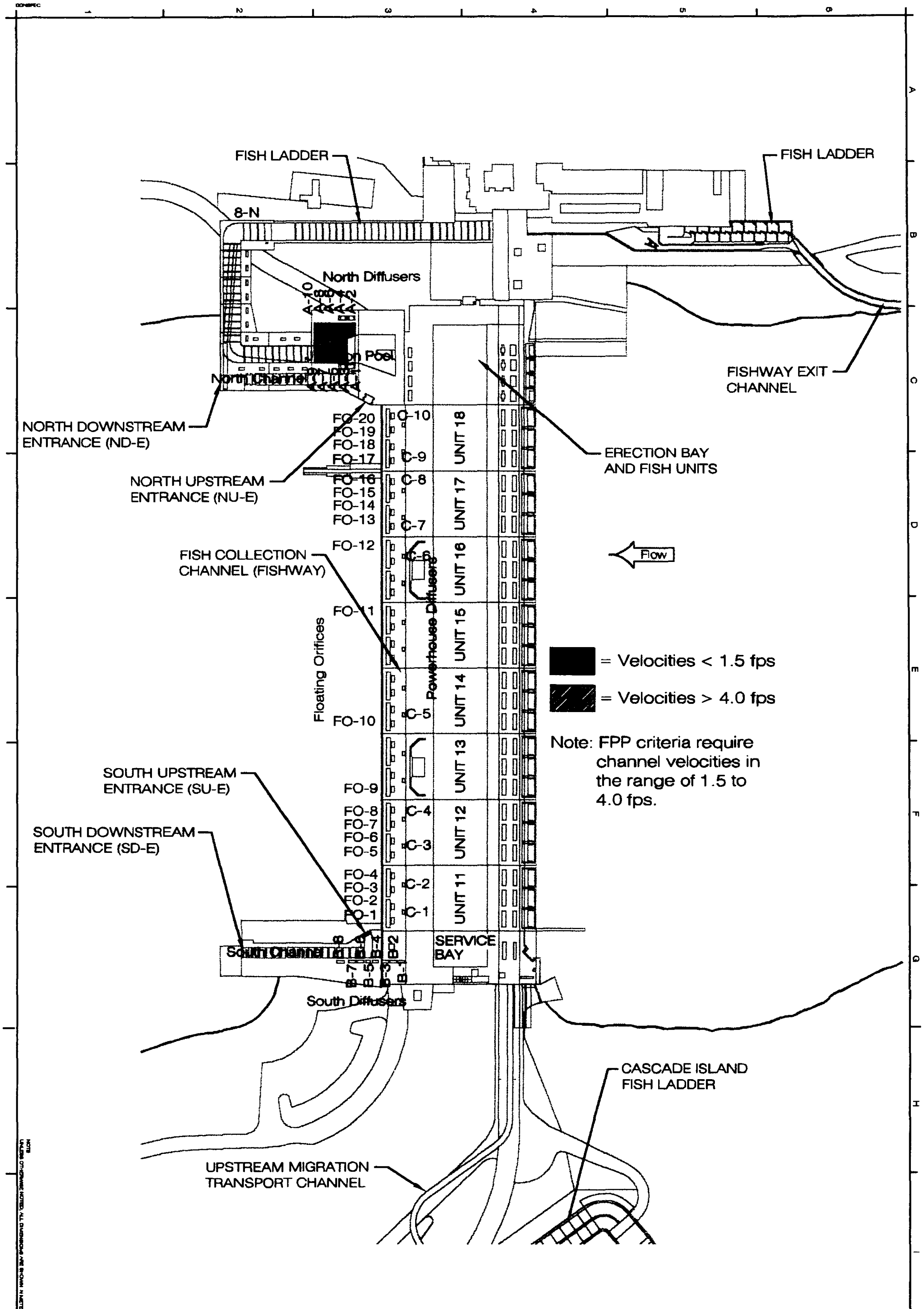
PLATE 2	DRAWING NO.	DRAWING STATUS	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 20 CONFIGURATION 2	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:	US Army Corps of Engineers Portland District

Figure F-23



[Table F-13]

Figure F-24



[Table F-14]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 21
CONFIGURATION 1

PLATE 2
DRAWING NO.
DRAWING STATUS

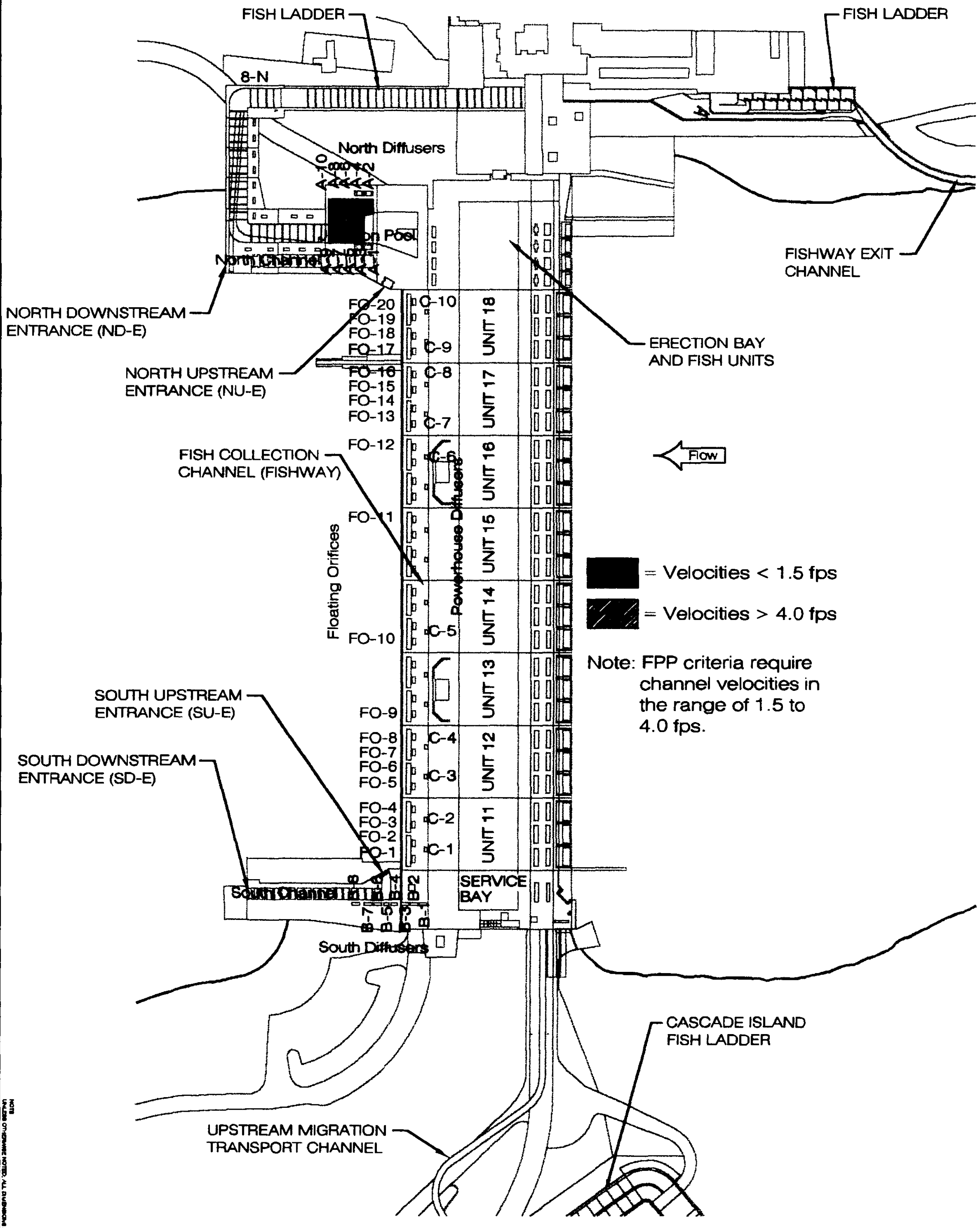
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct. & Arch. Design

US Army Corps of Engineers Portland District

Figure F-25

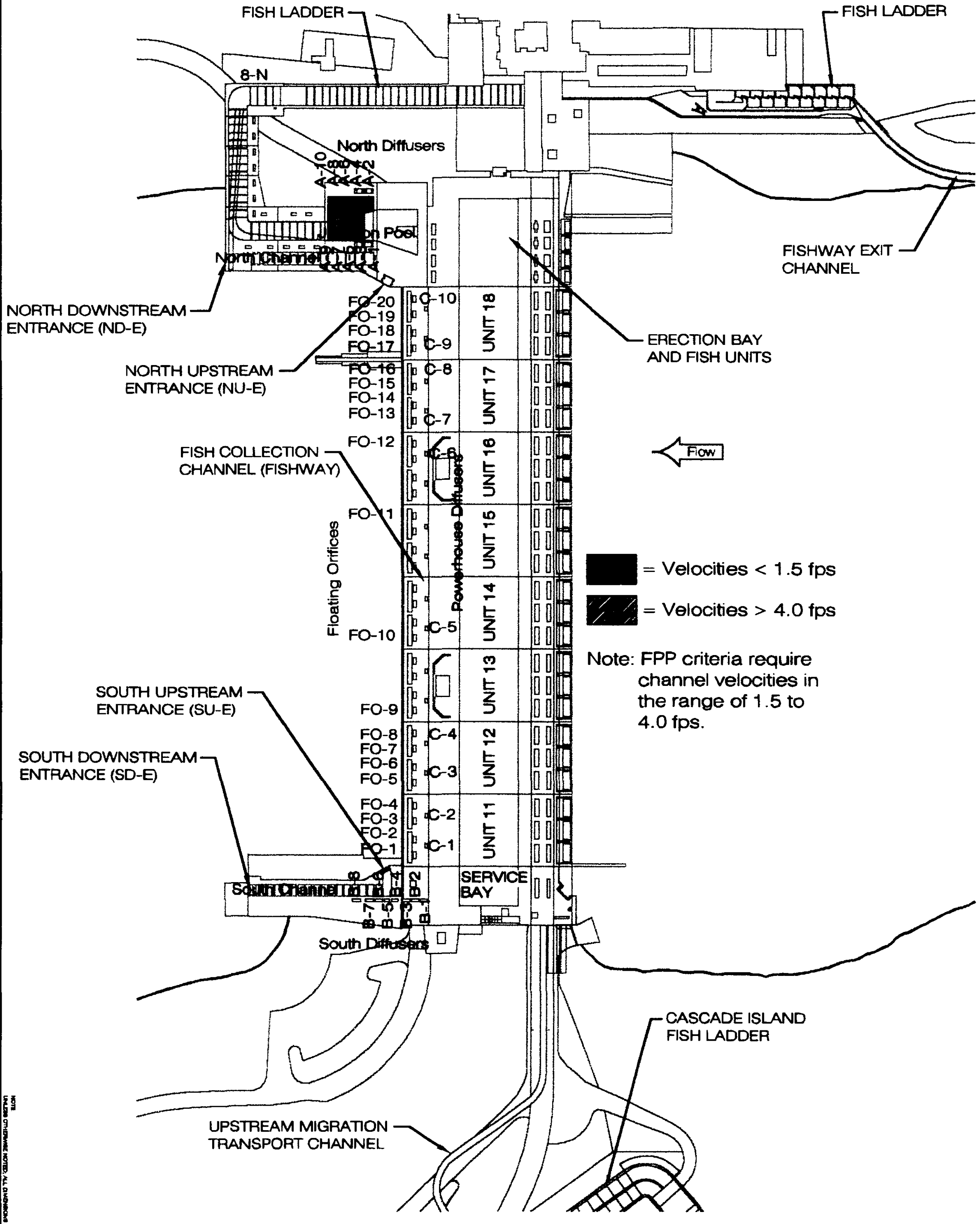


[Table F-15]

PLATE 2	DRAWING NO.	DRAWING STATUS	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 22 CONFIGURATION 1	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief Struct. & Arch. Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps of Engineers Portland District

Figure F-26



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-16]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 23
CONFIGURATION 1

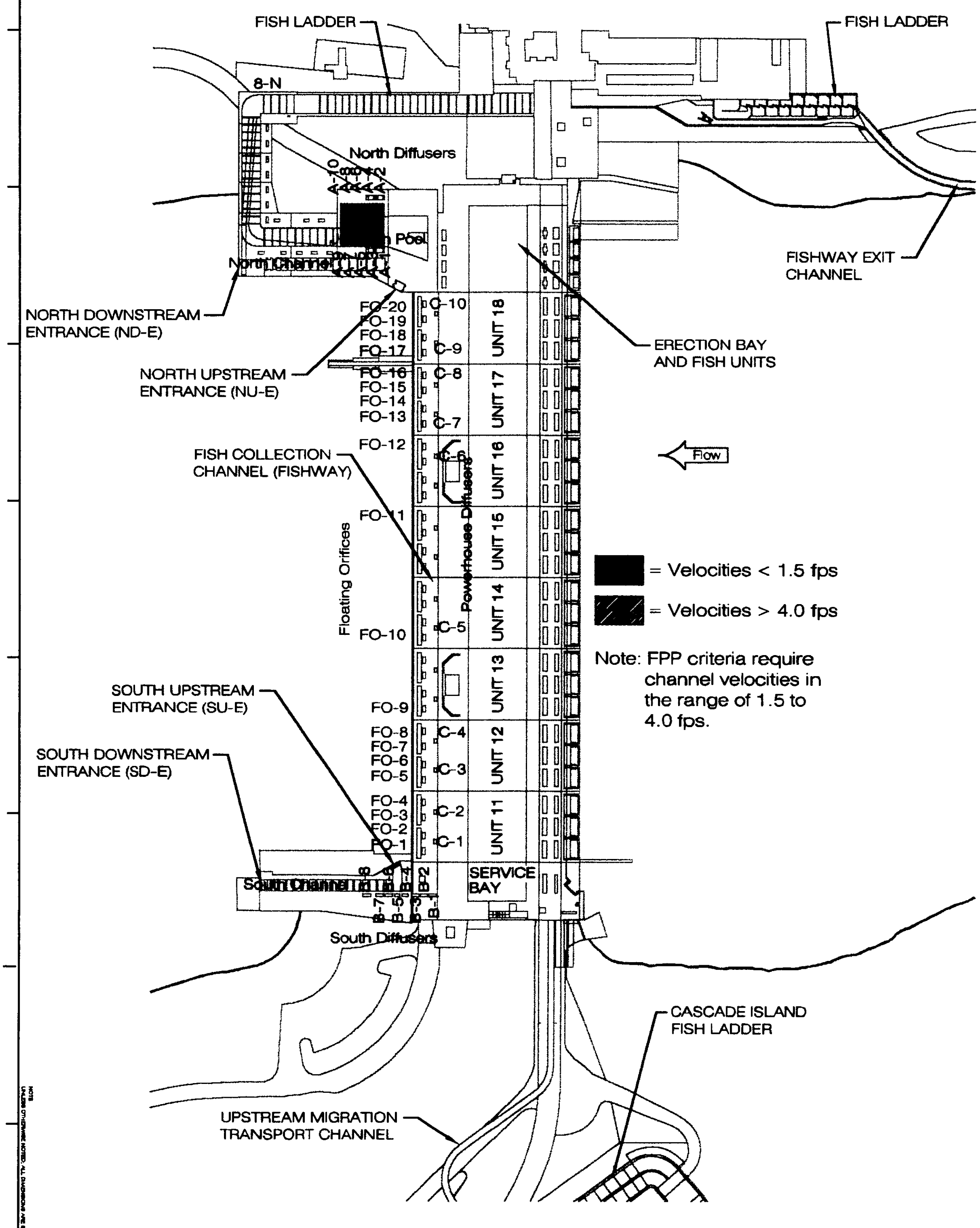
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design

PLATE 2

Figure F-27



[Table F-17]

PLATE 2

DRAWING NO.

DRAW NG STATUS

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 24
CONFIGURATION 1

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

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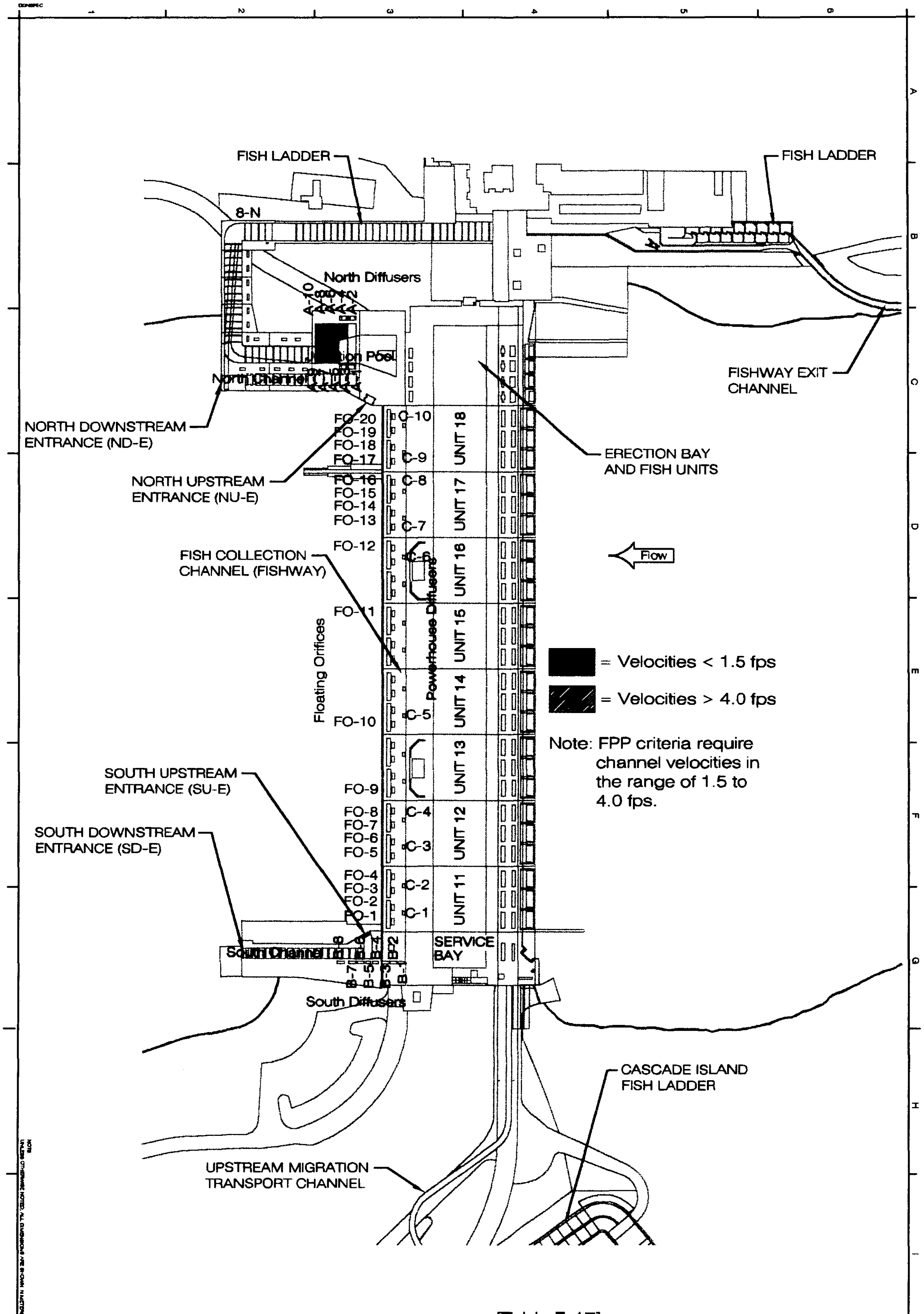
Date 27 SEPT 1999
Drawn by D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by
Technical Manager
Submitted by DALE S. MAZAR, P.E. Acting Chief Struct.& Arch.Design

US Army Corps of Engineers Portland District

Figure F-28



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-17]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 24
CONFIGURATION 2

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK	Date: 27 SEPT 1999
Drawn by: D. PATRICK	CADD File Name: BONPLATE02.DGN
Checked by:	Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct.& Arch.Design	

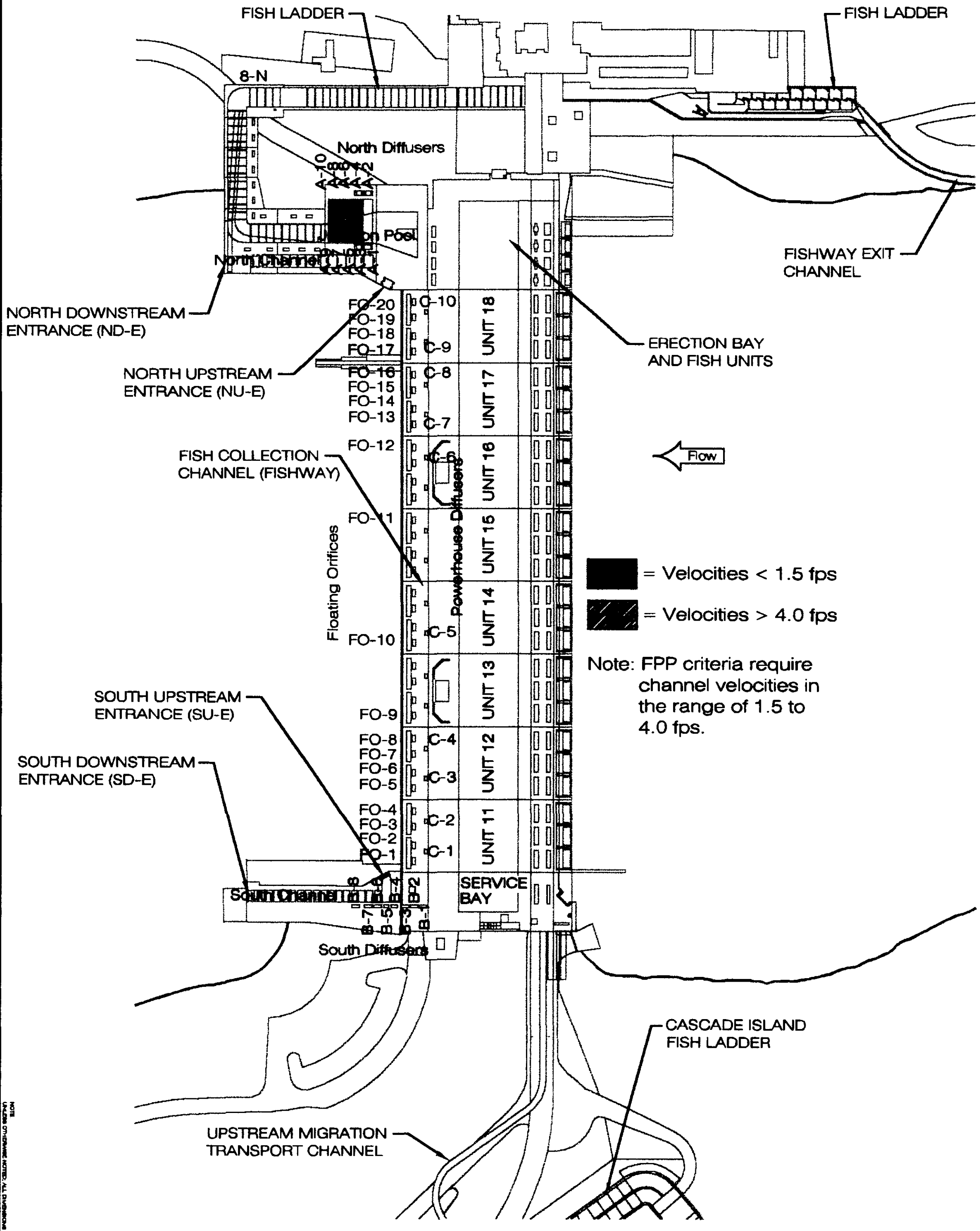
PLATE 2

DRAWING NO.

DRAWING STATUS

US Army Corps of Engineers Portland District

Figure F-29



■ = Velocities < 1.5 fps

▨ = Velocities > 4.0 fps

Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

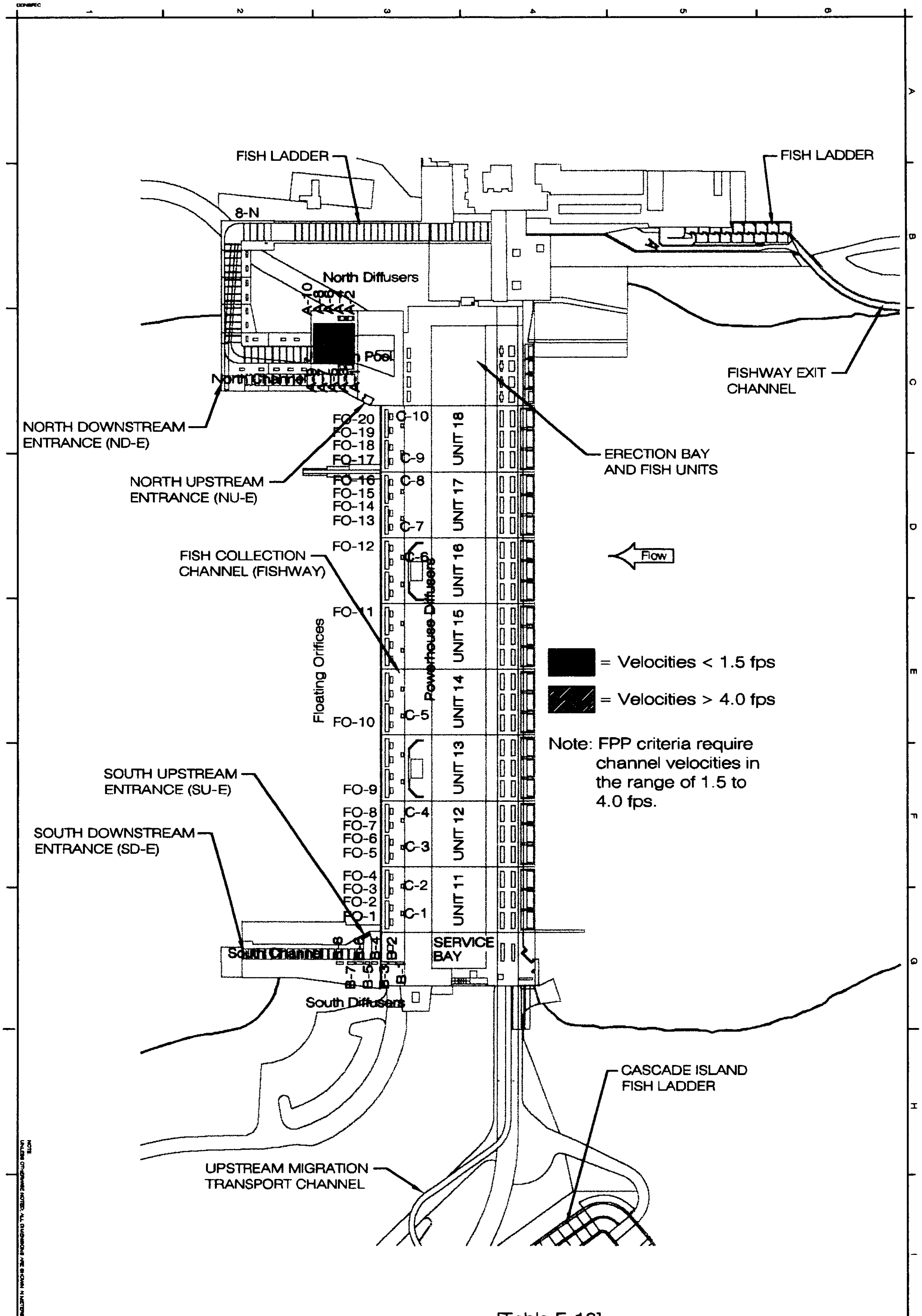
NOTE: UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-17]

PLATE 2	DRAWING NO.	DRAWING STATUS	COLUMBIA RIVER — OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 24 CONFIGURATION 3	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief Struct. & Arch. Design
					Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps of Engineers Portland District

Figure F-30

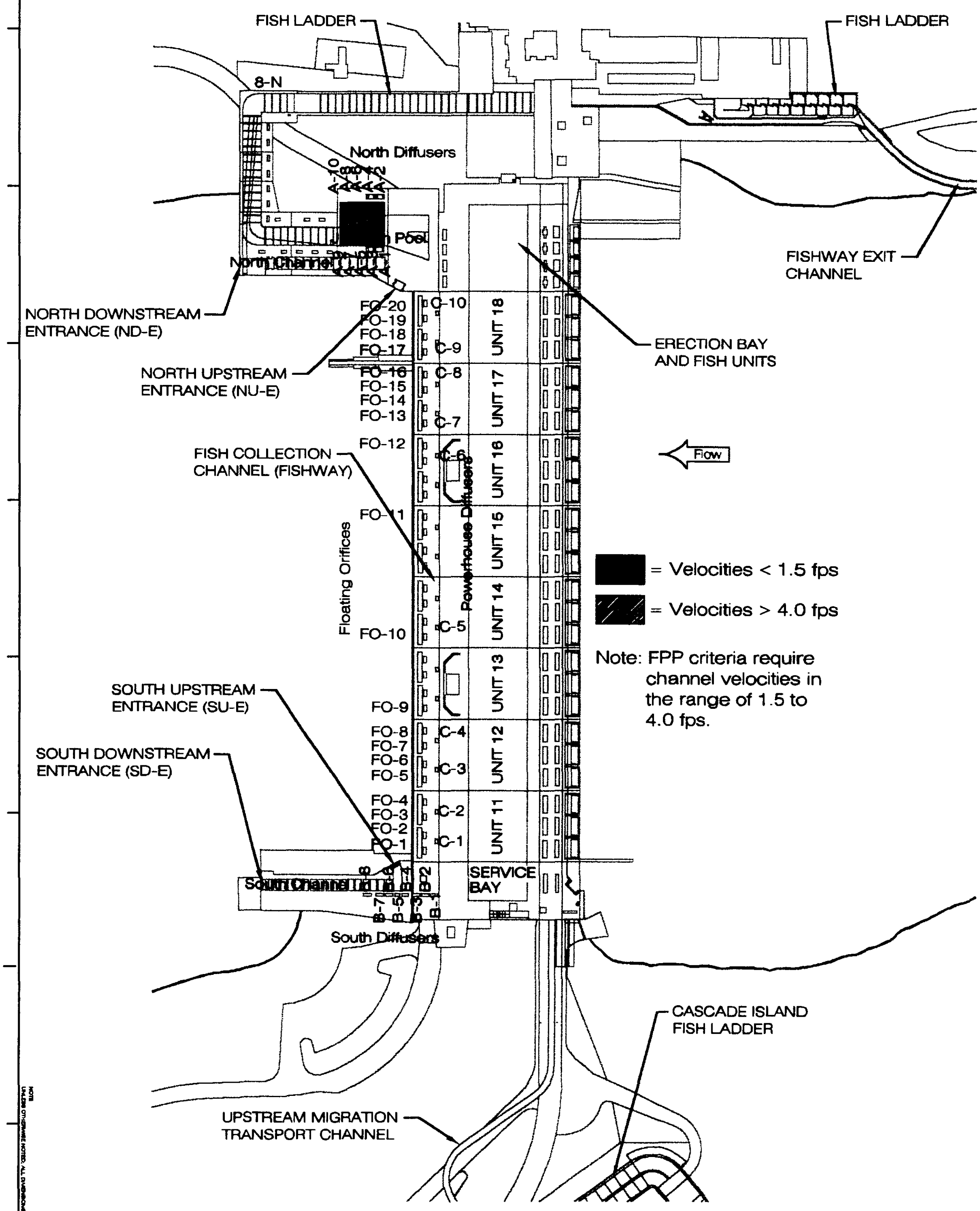


[Table F-18]

PLATE 2	DRAWING NO.	DRAWING STATUS:	COLUMBIA RIVER OREGON - WASHINGTON BONNEVILLE LOCK AND DAM SECOND POWERHOUSE AUXILLIARY WATER SUPPLY BACKUP ALTERNATIVES STUDY TW 25 CONFIGURATION 1	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS PORTLAND, OREGON CH2M HILL MONTGOMERY WATSON JOINT VENTURE	Designed by: D. PATRICK Drawn by: D. PATRICK Checked by: Submitted by: DALE S. MAZAR, P.E. Acting Chief Struct.& Arch.Design	Date: 27 SEPT 1999 CADD File Name: BONPLATE02.DGN Technical Manager:

US Army Corps
of Engineers
Portland District

Figure F-31



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

NOTE UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-19]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 26
CONFIGURATION 1

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

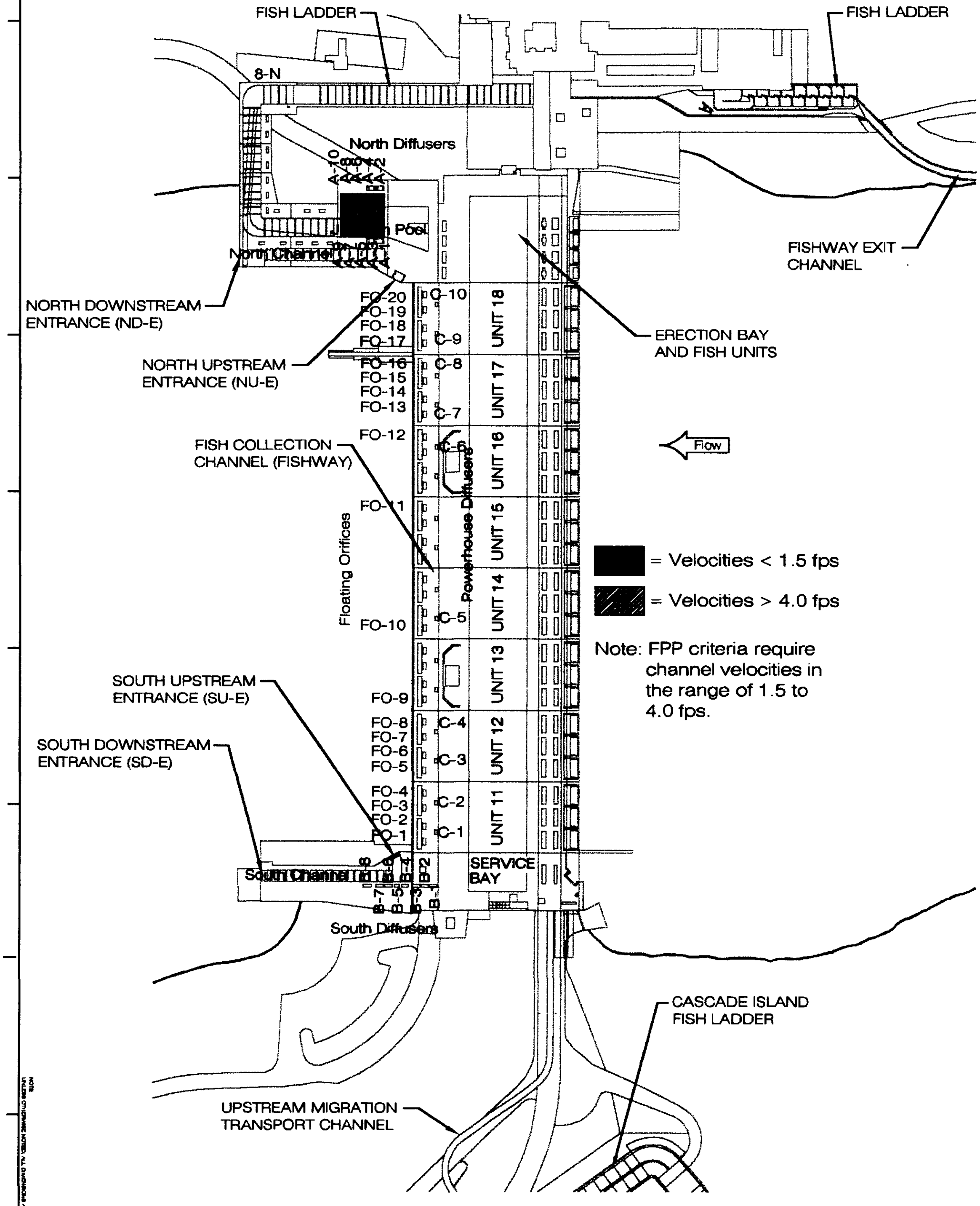
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

DRAWING STATUS:
DRAWING NO.
PLATE 2

US Army Corps of Engineers Portland District

Figure F-32



[Table F-20]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 27
CONFIGURATION 1

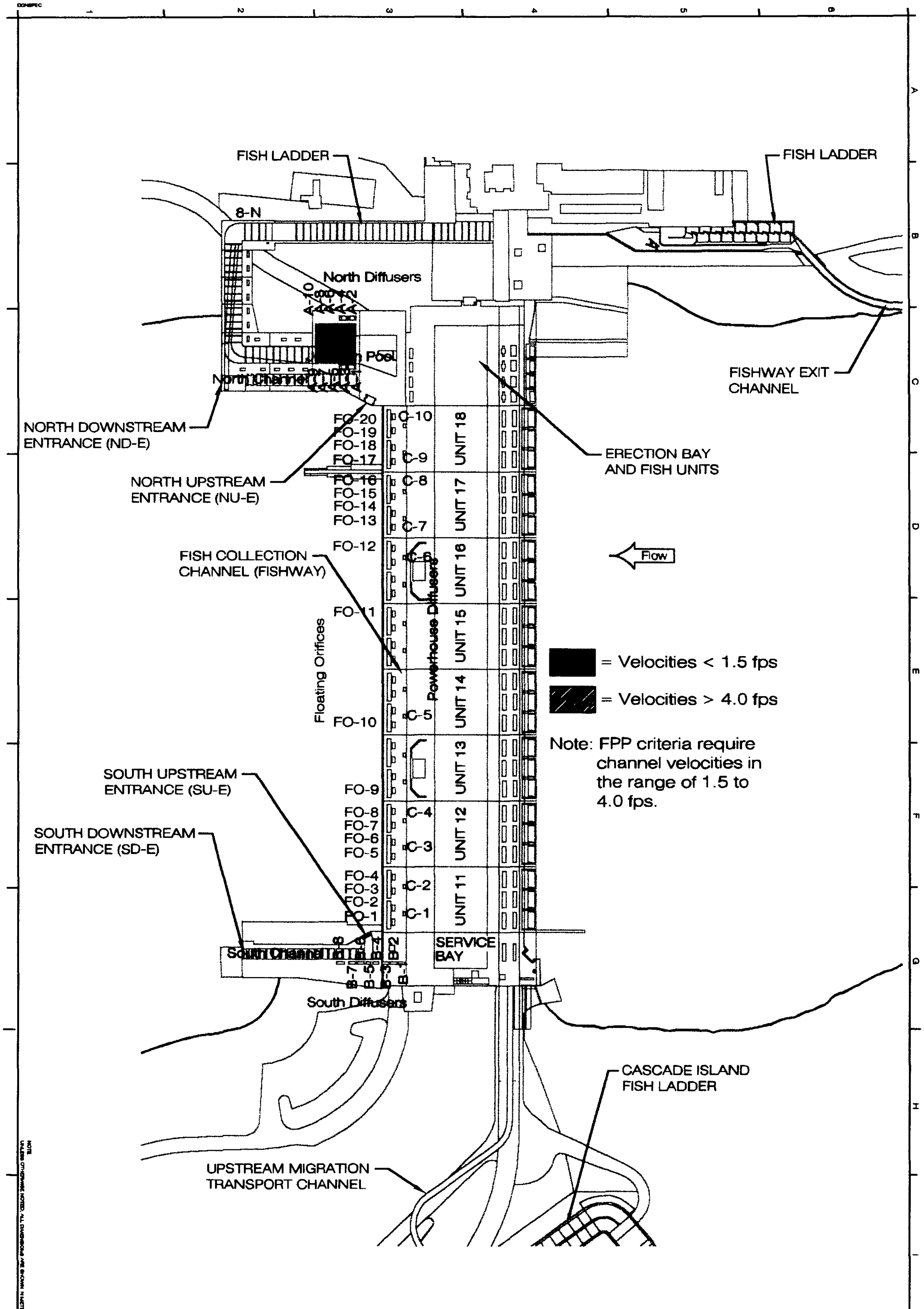
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

PLATE 2

Figure F-33



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-21]

PLATE 2

DRAWING NO.

DRAWING STATUS:

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 28
CONFIGURATION 1

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

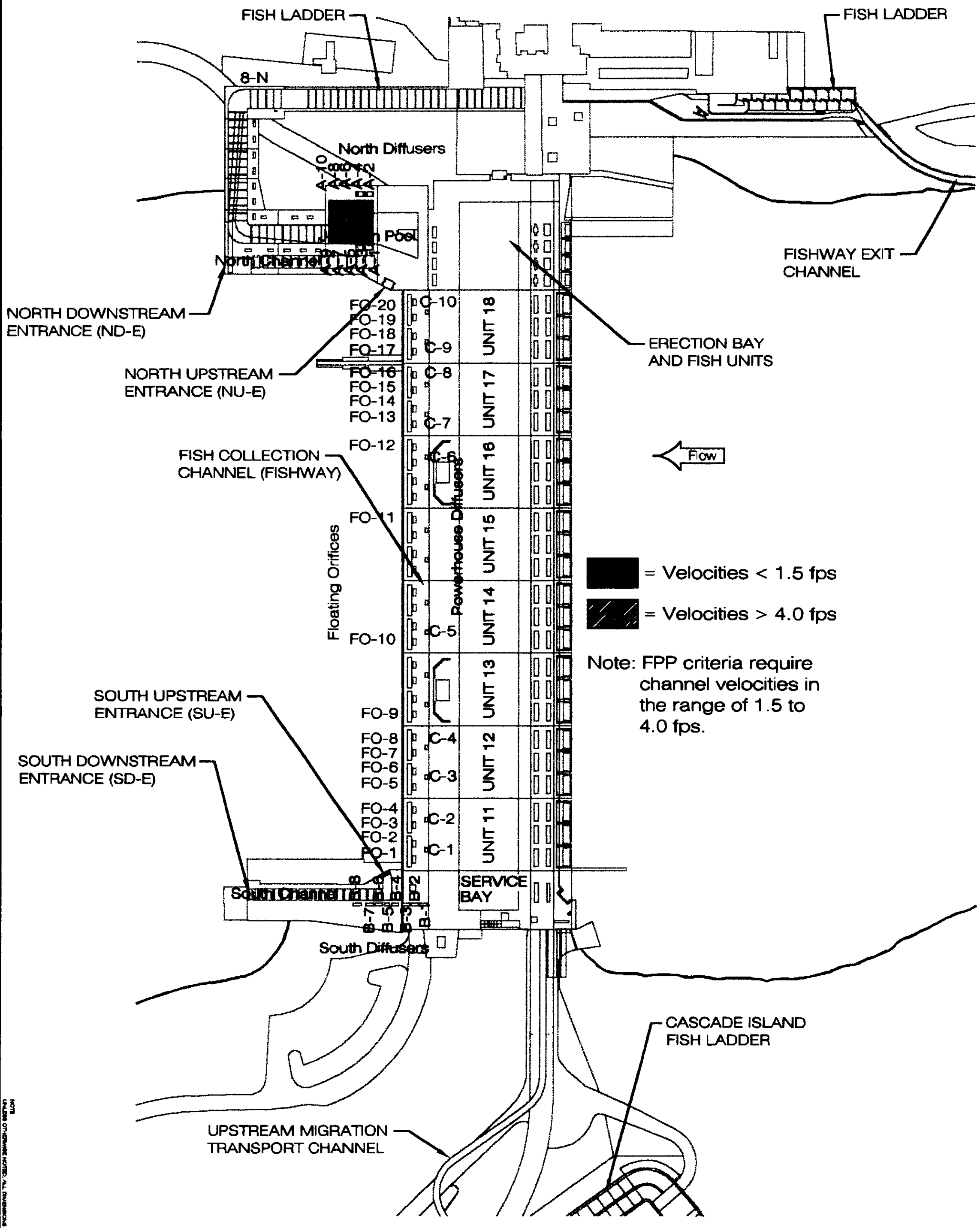
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct.& Arch. Design

Revision Date Description By

US Army Corps of Engineers
Portland District

Figure F-34



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

[Table F-21]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 28
CONFIGURATION 2

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

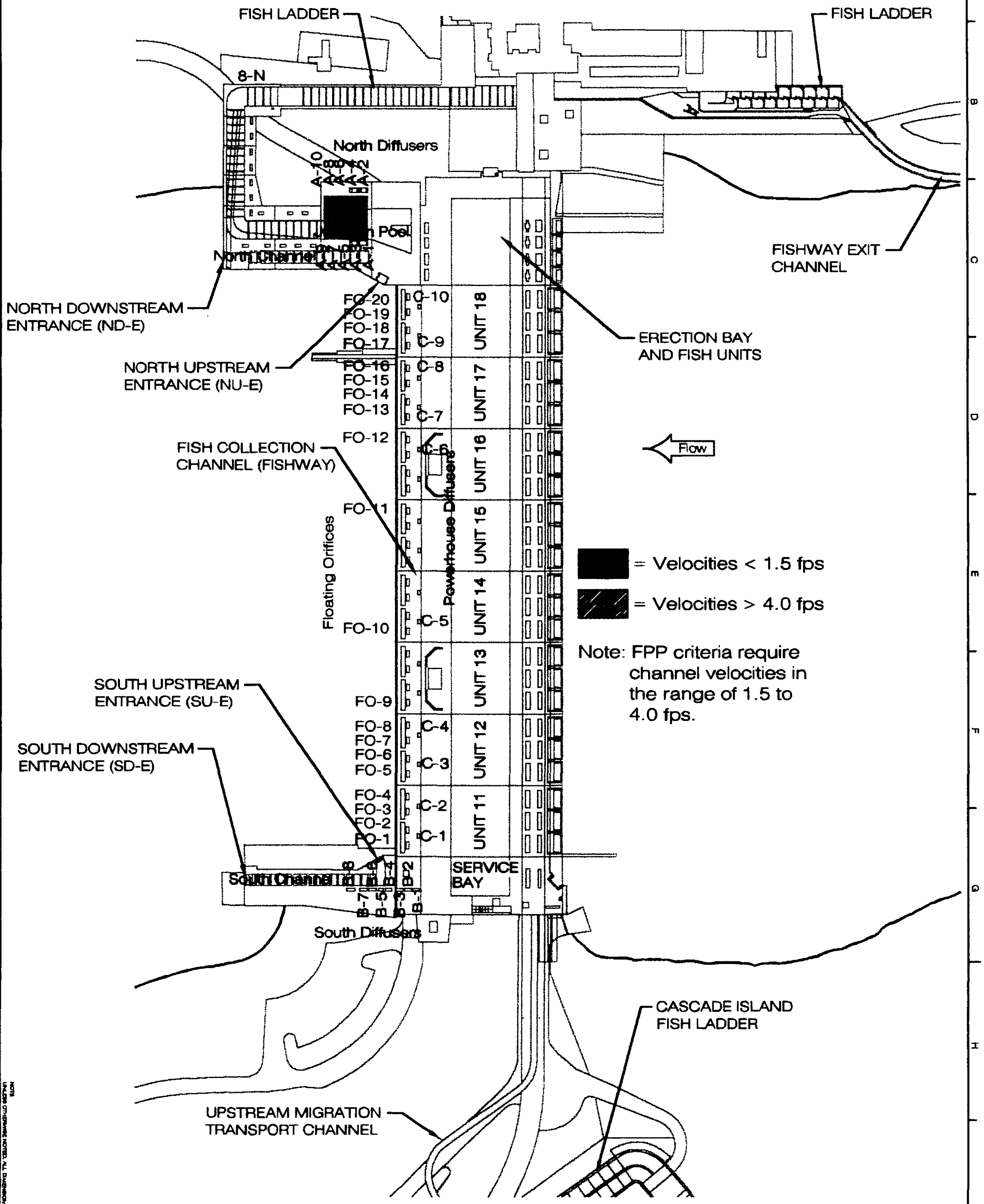
CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

DRAWING STATUS:
DRAWING NO.
PLATE 2

US Army Corps of Engineers Portland District

Figure F-35



Note: FPP criteria require channel velocities in the range of 1.5 to 4.0 fps.

NOTE
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

[Table F-21]

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE
AUXILLIARY WATER SUPPLY
BACKUP ALTERNATIVES STUDY
TW 28
CONFIGURATION 3

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design

US Army Corps of Engineers Portland District

DRAWING STATUS:
DRAWING NO.
PLATE 2

Figure F-36

APPENDIX G

OPERATIONS MANUAL

APPENDIX G

SECTION 1 -- BONNEVILLE SECOND POWERHOUSE EMERGENCY OPERATIONS MANUAL

1.1 INTRODUCTION

a. This manual was developed in the *Bonneville Second Powerhouse AWS Backup Design Documentation Report* (DDR), and is designed for inclusion in the *Fish Passage Plan* (FPP). The emergency operations manual provides a guide for configuring turbine flows, floating orifices, diffuser gates, and main gates during emergency situations when one of the Bonneville Second Powerhouse (B2) fish turbines has failed or been taken out of service. Many model runs using the *Bonneville Second Powerhouse Fishway Numerical Model* were analysed in order to determine the optimal operational configuration for the range of tailwater elevations experienced at the fishway entrances. Table 1 presents the recommended settings for each tailwater.

b. Emergency Operations Table.

TW (ft)	**Turbine MW**	**Turbine Q (cfs)**	**Floating Orifice Gates Closed**	**South "B" Diffuser Gates Closed**	**Power-House Diffuser Gates Closed**	**Main Entrance Gates Closed**
8	13.90	2950	all	B3-8	C1-5	None
9	13.95	3010	all	B3-8	C1-5	None
10	14.05	3090	all	B3-8	C1-5	None
11	14.15	3165	all	B3-8	C1-5	None
12	14.20	3230	all	B3-8	C1-5	None
13	14.40	3340	all	B3-8	C1-5	None
14	14.40	3400	all	B3-8	C1-5	None
15	14.60	3520	all	B3-8	C1-5	None
16	14.30	3515	all	B3-8	C1-5	None
17	14.20	3560	all	B3-8	C1-5	None
18	14.00	3575	all	B5-8	None	NU-E
19	13.60	3535	all	B5-8	None	NU-E
20	13.30	3520	all	B4-8	None	NU-E
21	13.00	3510	all	B4-8	None	NU-E
22	12.70	3505	all	B4-8	None	NU-E
23	12.40	3505	all	B4-8	None	NU-E
24	12.20	3535	all	B4-8	None	NU-E
25	11.60	3535	all	B4-8	None	NU-E
26	11.10	3365	All	B4-8	None	NU-E
27	10.60	3285	All	B4-8	None	NU-E
28	10.00	3160	All	B3-8	None	NU-E

c. Sensitivity Analysis Table.

(1) Since it may be difficult for project personnel to change from Configuration 1 to 2 between tailwater elevations 17.0 ft and 18.0 ft, a sensitivity analysis was done to determine the hydraulic conditions that would results if the configuration is not changed at the selected break point. Additional computer simulations were done to provide the hydraulic characteristics associated with both Configurations 1 and 2 for tailwater elevations between 15.0 ft and 20.0 ft. The following table provides the results associated with both Configuration 1 and 2 for this tailwater elevation range. The results of these additional computer simulations show that the powerhouse collection channel velocities would meet criteria with either configuration for this range of tailwater elevations. The only difference would be that the entrance head drops meet criteria more closely in the selected configuration for each tailwater elevation. As discussed previously, the entrance head criteria were given the highest priority when selecting the optimum configuration for each tailwater elevation. Outside of the 15.0 ft to 20.0 ft range, operating at configurations other than the selected configuration is not recommended because the optimum configuration does provide significantly better results at some tailwater elevations.

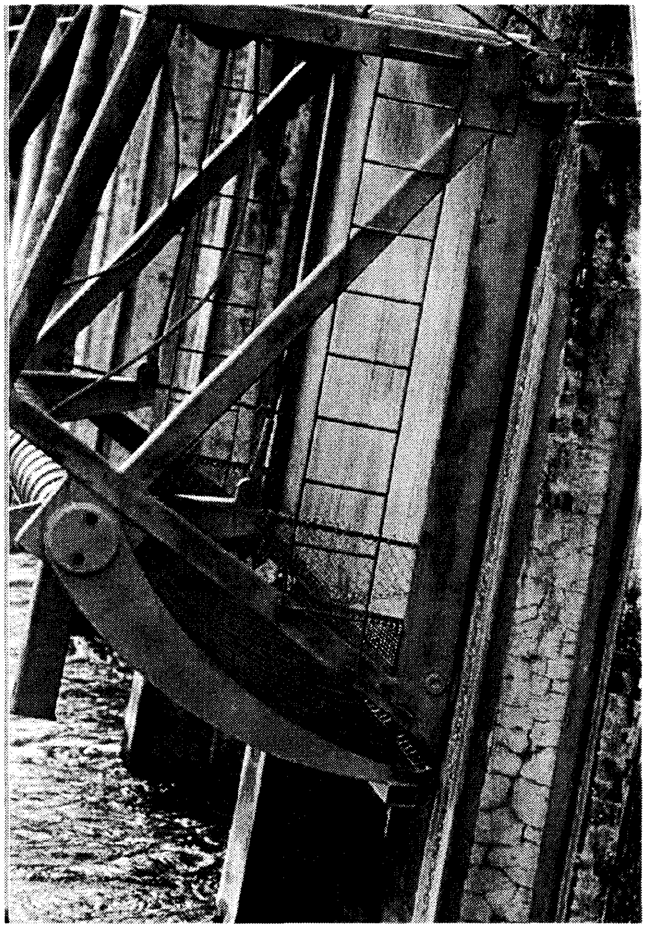
Sensitivity Analysis

	Configuration 1					Configuration 2				
Tailwater	Entrance Gate Head Difference	Entrance Gate Submergence	PH Collection Channel Velocity Range	% of PH Channel Out of Velocity Criteria	Diffuser Velocity Range (min/max)	Entrance Gate Head Difference	Entrance Gate Submergence	PH Collection Channel Velocity Range	% of PH Channel Out of Velocity Criteria	Diffuser Velocity Range
8	Configuration 2 not recommended in this range									
9										
10										
11										
12							Recommended break point.			
13										
14										
15	1.03 to 1.65	12.5	2.07 to 3.72	0	0.16 to 0.76	1.20 to 1.55	10	2.11 to 3.43	0	-0.25 to 0.98
16	1.07 to 1.99	11.75 to 12.75	1.56 to 3.43	0	-0.24 to 0.84	1.26 to 1.57	10	2.07 to 3.20	0	-0.23 to 0.98
17	1.11 to 1.61	13	2.08 to 3.60	0	-0.20 to 0.77	1.34 to 1.64	10	2.08 to 3.60	0	-0.19 to 0.96
18	1.21 to 1.67	13	2.08 to 3.73	0	-0.14 to 0.77	1.09 to 1.36	11	1.97 to 3.02	0	-0.04 to 0.97
19	1.26 to 1.67	13	2.03 to 3.58	0	-0.13 to 0.76	1.11 to 1.35	11	1.90 to 2.89	0	-0.08 to 0.98
20	1.64 to 1.95	11.8 to 12.5	2.16 to 3.69	0	-0.16 to 0.79	1.13 to 1.36	11	1.86 to 2.79	0	-0.01 to 0.97
21										
22										
23										
24						Configuration 1 not recommended in this range				
25										
26										
27										
28										

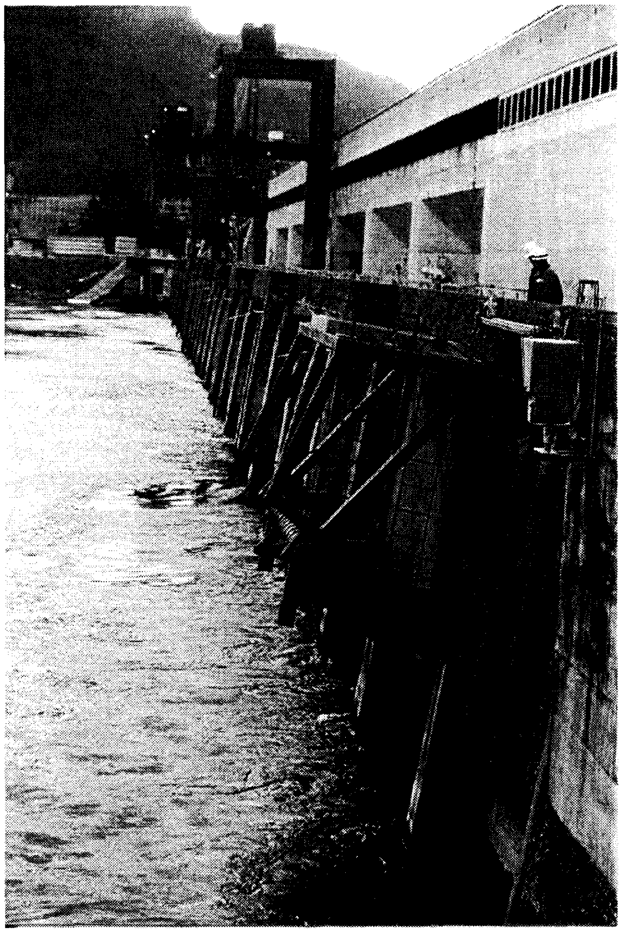
Sensitivity Analysis Table

APPENDIX H

PHOTOS

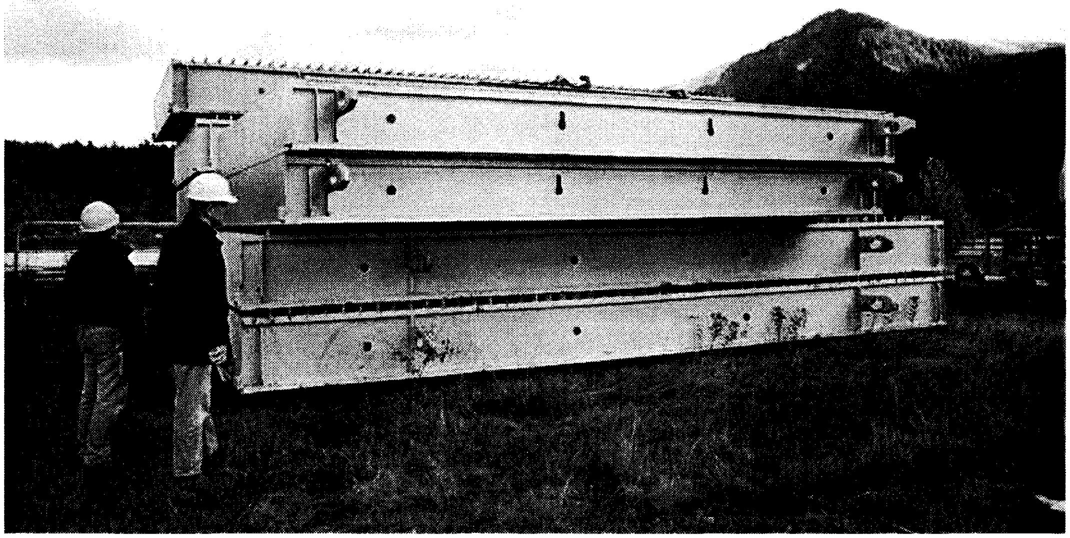


H1 Existing Rake



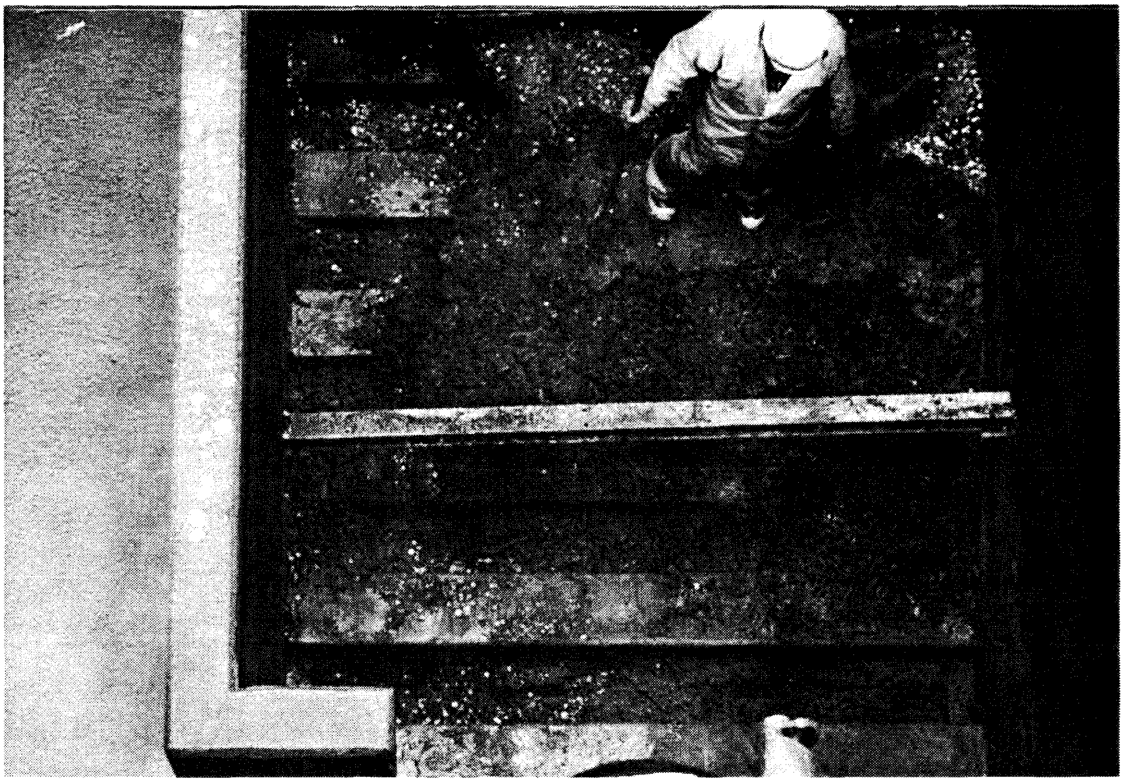
H2 Forebay and Rake

H3 Plugged Traskrack



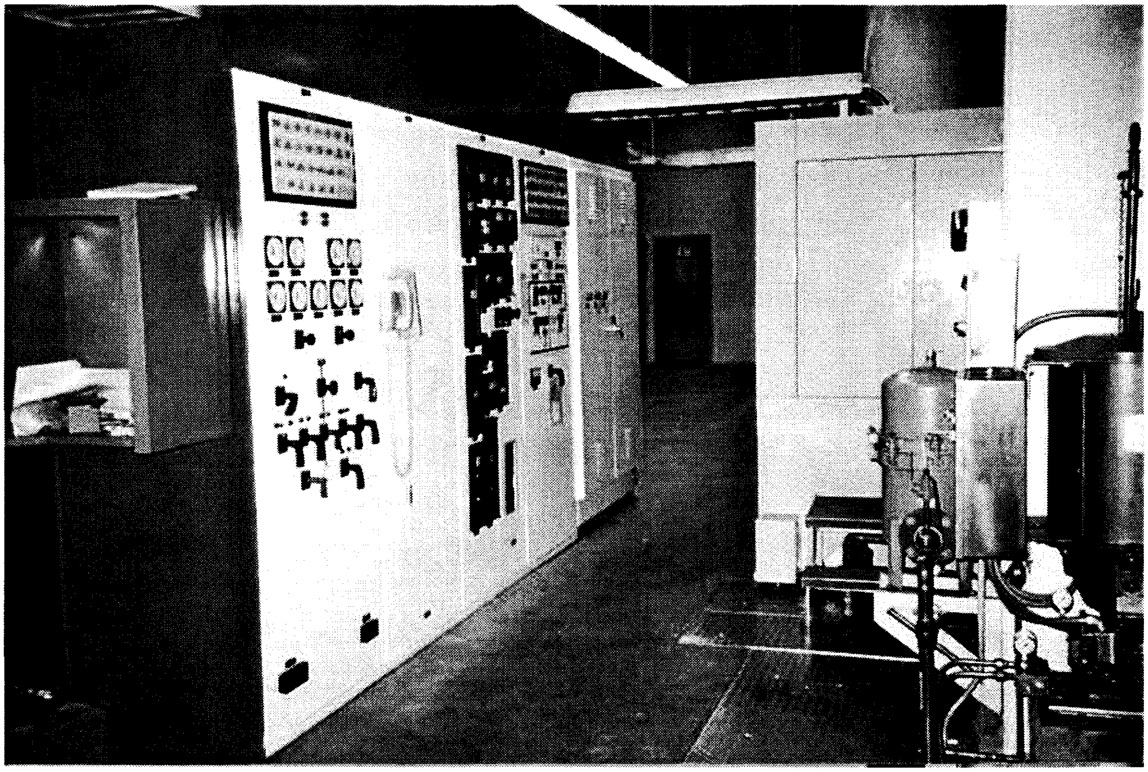
H4 Spare Trashrack

H5 Diffuser B Gate Actuator

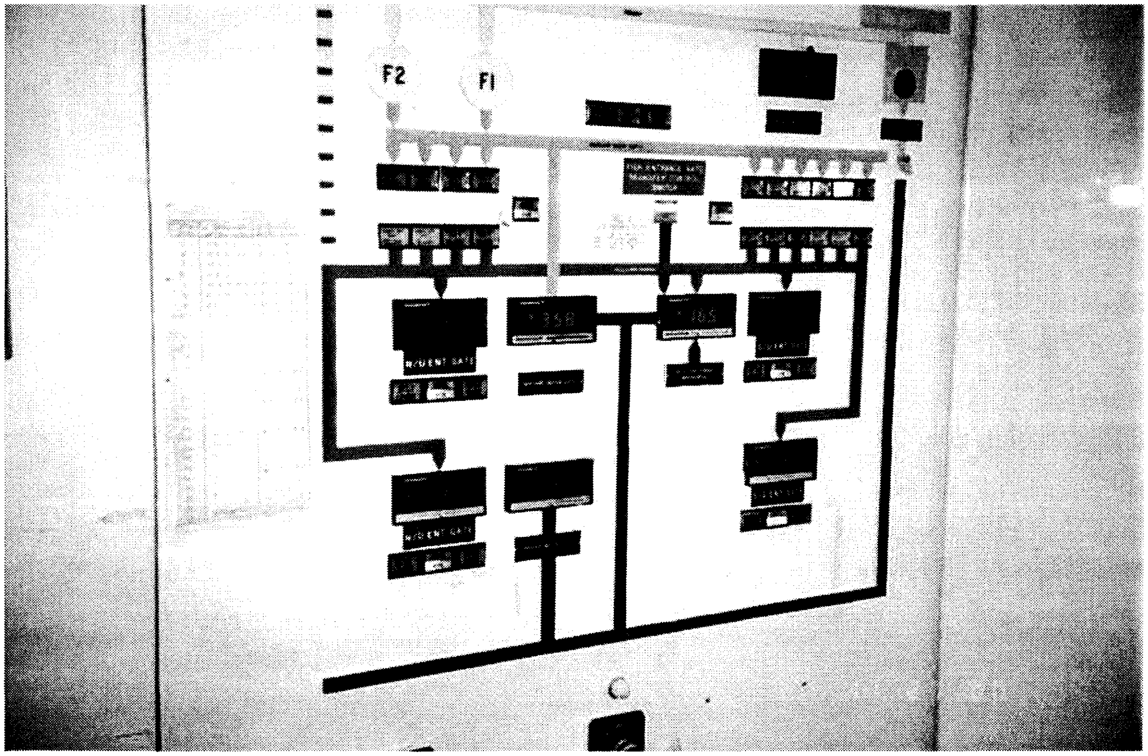


H6 Diffuser Sediment

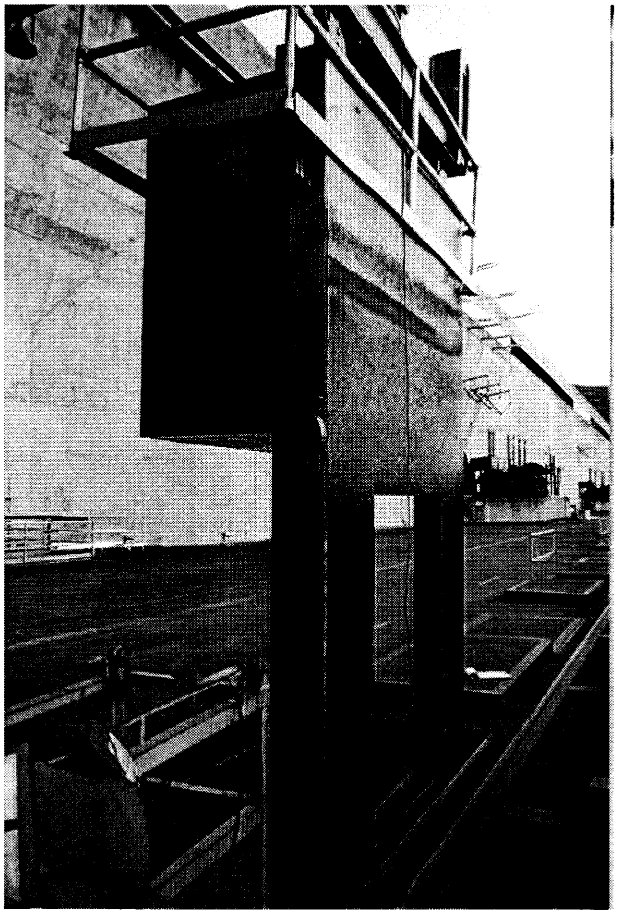
H7 Sediment in the AWS Conduit



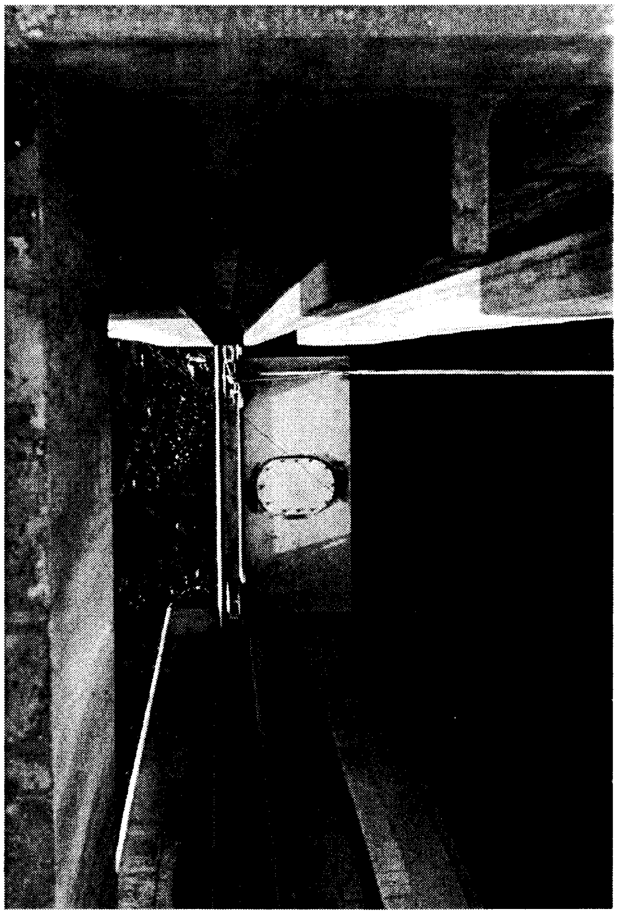
H8 SA24 Panel



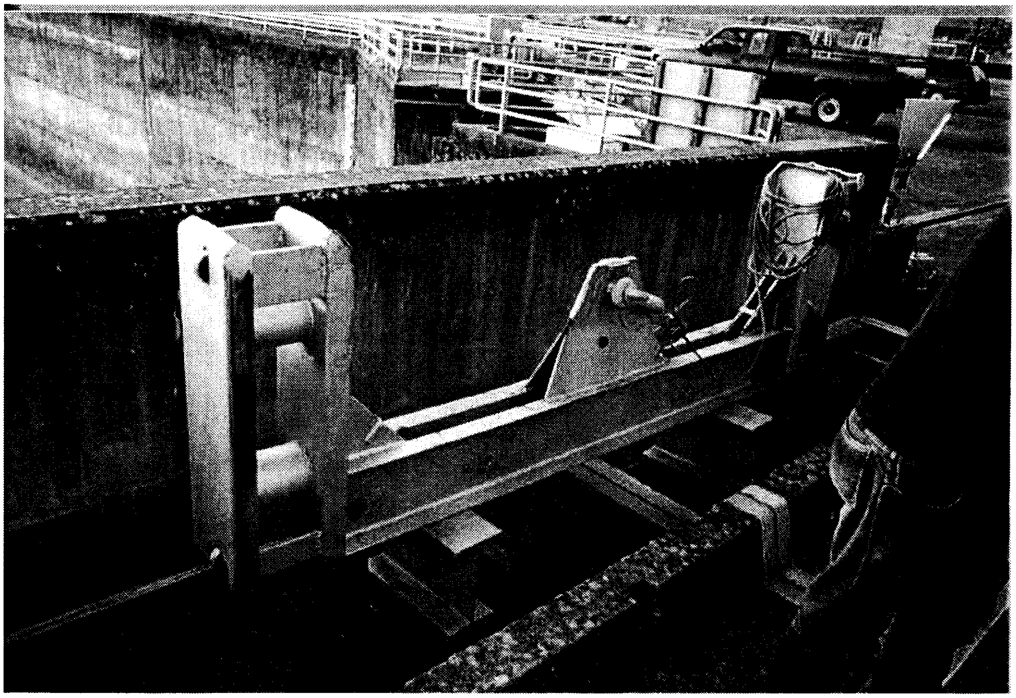
H9 SA24 Annunciator



H10 Floating Orifice Gate



H11 Floating Orifice Gate in slot Viewed from EL55 Deck



H12 Floating Orifice Gate Lifting Mechanism

APPENDIX I

MEETING REPORTS

DRAFT

MONTGOMERY WATSON

SITE VISIT AND KICKOFF MEETING REPORT

Project Name :	Bonneville 2 Auxiliary Water System (AWS) Backup Alternatives Study
Contract :	DACW57-97-D-0004, TASK ORDER NO. 23
Meeting Date :	November 27 & 28, 2000
Location :	Bonneville Project & Portland Office
Subject :	Site Visit and Kickoff Meeting

Attendees Site Meeting: Pat Hunter, CENWP-OP-B; Andy DeBriae, CENWP-OP-B; Dennis Schwartz, CENWP-EC-E, Jennifer Sturgill, CENWP-CO-B, Jerry Carroll, CENWP-CO-B; Dennis Dorratcague, Frank Postlewaite, and Chris Deerkop, Montgomery Watson; Lee Miesbauer, CivilTech; Lisa Larson and Eric Vandermeere, NHC.

Attendees Kickoff Meeting: Jerry Maurseth, CENWP-CE-DS; Randy Lee, CENWP-EC-HD; Dwayne Weston, CENWP-PE-DE, Mark Dasso, CENWP-CO-NWC, Corps of Engineers; Dennis Schwartz, CENWP-EC-E; Dennis Dorratcague, Montgomery Watson; Ed Zapel, NHC; Lee Miesbauer, CivilTech.

Action items are underlined in the meeting report below.

SITE VISIT

The site visit started with a meeting in the conference room of the operations building at the Bonneville Project. Gathering data for model calibration was discussed. Lisa Larsen said that obtaining velocity and water level data with a few of the orifices closed would help the model calibration. However, gathering data while all the orifices were closed would be the preferred and would provide the best model results. Andy DeBriae said that he could close all the orifices in two days. He would raise the orifices out of the water and weld a plate over the opening. He thought that it could be done without completely removing the orifices gates, thus keeping the fishway in operation. Andy said that he would need to have a budget for obtaining materials and doing the work.

Jennifer said that the The B2 fishway would be taken out of service on January 9 would be returned to service by January 23 when the Cascade Island fishway would be taken out of service. The fishway would be dewatered at the north end only at the north end only. When to cover the orifices and take the measurements were discussed. A resolution of the schedule was reached at the kickoff meeting the next day. See below. Dennis Schwartz said that it is imperative that the model be calibrated as fully as possible. Therefore, it was decided that the data should be collected with all orifice gates closed.

Dennis mentioned that Frank Postlewaite, the mechanical engineer, would like to inspect the diffuser gates to ascertain their condition. The gates to be inspected would be located at the south end of the collection channel and the south monolith. Since only the north part of the fishway is scheduled for dewatering it would not be possible to inspect the gates. Pat Hunter said that the gates underwent routine maintenance within the last two years. The gates are operated and tested during the fishway maintenance period, and many of these gates are operated during normal fishways operations. So, the gates should be in good condition. It was decided that Frank would coordinate with Pat Hunter and visit the site to witness the gate operation and testing. This would be done under normal operating conditions. Andy DeBriae said that the gates stuck and would not operate when they were trying to water up the AWS channel. However, this is not a usual operating mode. Prior to operating the gates Frank will check with a District mechanical engineer to make sure the gates would not be operated outside their design range.

The meeting ended at about 11:30. After lunch Chris Deerkop went with Carl Allen to inspect the electrical facilities. Frank Postlewaite, Dennis Dorratcague, and Lee Miesbauer went with Randy Price to look at the gates, collect a sample of the debris from the 1997 AWS cleaning, and inspect the spare fish unit trashracks. Lisa Larson and Eric went to B2 to obtain velocities and water surface elevations for model calibration purposes.

At about 3 PM Frank and Dennis returned to the Operations Building to obtain some drawings that had been requested earlier and look for more drawings.

The site visit ended at about 4 PM.

KICKOFF MEETING

The meeting started at 8:00 AM on November 28,2000 at the Corps offices in Duncan Plaza building. Dennis Dorratcague stated that the work on this DDR is a continuation of the feasibility study that was just completed. Since the feasibility study selected final alternatives, the first submittal would be the 60% submittal. The notice to proceed (NTP) was issued on October 31, but Montgomery did not receive it until 12 days later. So, it looked as if the schedule would have to be extended. Mark Dasso saw not problem with that since the money for final design and construction was not authorized.

Dennis described the site visit and conclusions reached at that meeting. Obtaining velocity and water elevation data with the orifices blocked was discussed. It was decided that the 60% submittal could be delayed until after the field data were obtained and the model calibrated. This means that model runs with a calibrated model would be available for the 60% submittal. Dennis said that this would delay the 60% submittal until the end of January. Dennis Dorratcague will prepare a new schedule and submit it to Jerry for review.

The schedule that was discussed included the following:

• January 2 – 4	Weld plates over the orifices in all twelve orifice gates
• January 5	NHC will collect velocity and water level data

DRAFT

• January 8	Begin taking the fishway out of service
• After January 8	Remove orifice cover plates, if necessary
• January 8 – 29	Calibrate model, make model runs, develop the 60% submittal

Dennis Schwartz will talk to the project about scheduling installing the orifice cover plates between January 2 and 4 and NHC taking data on January 5. Mark Dasso will arrange the budget for the project to obtain the steel plates and weld them over the orifice gate openings.

Mark Dasso mentioned that it would be advantageous to leave the orifice plates in place for about one year. This would allow for collecting not only velocity data but also biological data of fishway use by upstream migrants. Dennis Schwartz will contact NMFS and explore with them leaving the orifices covered for one year.

The meeting ended at 9:15 AM.

MONTGOMERY WATSON

PROGRESS REVIEW MEETING REPORT

Project Name :	Bonneville Second Powerhouse Auxiliary Water Supply Backup System Design Documentation Report
Contract :	DACW57-97-D-0004, TASK ORDER NO. 23
Meeting Date :	April 16, 2001
Location :	Summit Room, District Offices in Portland
Subject :	Progress Review Meeting 60% Report

Attendees : Jerry Maurseth, Randy Lee, Michael Moran, Dennis Schwartz, Dwayne Weston Portland District COE; Christine Mallette ODFW; Ed Myer, NMFS, Ed Zapel, Lisa Larson, Northwest Hydraulic Consultants; Lee Miesbauer, CivilTech; Dennis Dorratcague, Frank Postlewaite Peter Barton, Montgomery Watson.

The action items are underlined in the following meeting report.

Overview

The meeting began at 10:00 AM. Dennis Dorratacague gave a brief overview of the progress to date. The objective of the meeting was defined as achieving a consensus on which alternative(s) would be developed to the 90% level. The layout of the report was then described.

Alternatives Presentation

- **AWS Operations Alternative** – Lisa Larson provided an overview of the modeling effort to date. Three alternative fishway configurations are being modeled from which the best run for a tailwater is identified. The hierarchy of criteria established in the earlier study is used to guide model run evaluations along with operational considerations that take into account the frequency and location of diffuser gate closures. The following was decided: Because diffuser gates B1 and B2 do not have motorized actuators, other gate closure combinations will be investigated to see if not using these gates has a large impact on conditions in the fishway. If it necessary to operate these gates, modifications will be recommended that an actuator nut be added to the manual hand wheel and a hand actuator drive be acquired.

  Dennis Schwartz recommended that the operational plan being developed through the modeling effort be considered a guide, or a starting point, from which project operators can begin to optimize the fishway during an emergency. After setting the gates according the results of the modeling effort, the operators would then take measurements to verify that the fishway is behaving as predicted. Dennis doesn't want the operations plan to be adopted into the FPP before the verification effort.

Floating Orifice Gate Closure Schemes – Frank Postlewaite described the floating orifice closure schemes. Alternative 3 –Lower Bulkhead From Above was selected as the preferred alternative. There are two variations of this alternative – (1) place the stab closure plate in slots on the tailrace side of the orifice gate, and (2) place the stab plate on the collection channel side of the orifice. It was decided that variation (1) is preferred. This alternative will require that the operations staff verify the available horizontal clearance between the deck and the floating orifice as it is being removed through the deck. If the stab plates will not fit on the downstream face, variation No. 2 would be preferred, In this case the stab plates would be installed on the upstream face of the floating orifice gates. This would require rebuilding the floatation tanks to allow the stab plates to be withdrawn through them.

It was agreed that Dennis Schwartz would coordinate an effort to collect data at each gate slot to verify the horizontal clearance between the gates and the deck hatches. The data collection effort will occur in the summer lull in fish passage, which will probably occur during the second week of June. Precise measurements of existing freeboard will be taken. Montgomery Watson will prepare a memorandum describing the data to be collected and the methods to be used. Project staff at B2 will take the measurements. It was recognized that the schedule for the 90% submittal would be delayed by these activities.

A suggestion to bolt plates to the floating orifices was considered. However, because the fishway would be shut down to install the plates, for at least an 8-12 hour time period, with the potential for longer delays to pull the gates and install the plates, it was decided not to pursue this idea.

Ed Meyer thought that although the ability to close all the floating orifice gates within 2 hours would be beneficial, the cost associated with motorized actuation probably can't be justified. Ed thought that an alternative that could close the gates within one night (6 to 8 hours) would be accepted by the fisheries agencies.

Alternative 4 – Permanent Closure – This alternative can not be implemented without further biological testing of the effectiveness of the floating orifice gates. It was decided to keep it in the report.

Diffuser Gates – Frank described the field effort to evaluate the B diffuser gates. It was agreed that Montgomery would contact Andy Debrie at the project, in order to assess the C diffuser gates.

Stockpile Crucial Spare Parts – Work will continue to develop the spare parts list. Dennis Schwartz requested that he be able to review the list before the conclusion of the DDR.

Sediment Accumulation – Frank Postlewaite described the sediment accumulation problem, and it was agreed to block off the bottom portion of the trashracks in front of the fish units and to implement a yearly maintenance dredging program. Closing off the lower portion of the trashracks will allow yearly maintenance dredging to occur during the in-water work period. Jerry Maurseth will contact HDC in order explore the impacts on turbine efficiency due to closing off the bottom portion of the trashracks. It may be necessary to install a transition piece behind the blank panels in order to reduce turbulence.

Trashrack Debris Accumulation and Diffuser Rack Clogging – The most difficult question remaining is the choice between a telescoping rake, or an automatic traveling grip rake. Both rakes have advantages and disadvantages. This area of the forebay could be subject to high velocity cross currents (i. e. currents along the face of the powerhouse). Because the trash rack is over 100 feet below the surface of the EL 90 deck, alignment of either cleaning unit could be problematic. It was agreed that Jerry Maurseth would coordinate a conference call that would include Portland District COE staff, B2 operations staff, and MW in order to make a decision.

Randy Lee agreed to provide velocity data taken in the forebay in front of the powerhouse.

Cathodic protection and coatings for the new trashracks were discussed.

Install Pressure Gage in AWS Conduit – It was agreed to install pressure gages in locations where problems have occurred in the past. This would include the location selected in the B diffuser gallery, at the junction pool on the north end, and possibly a short distance up the ladder. It may be possible to use existing cable conduit to route the signal back to the generator switchboard, SA24 located near the fish units.

Concern was expressed about bolt fatigue induced by transients caused by starting the fish turbines. Pressure gages could measure the transients. If the debris is kept out of the AWS, headloss through the diffuser gratings would be very low.

Other Issues – It is assumed that AWS unwatering scheme would continue unchanged by the corner collector installation. Provisions should be made in the corner collector for a pipe to discharge from the "chimney" area into the sluiceway. The corner collector will discharge 5000 cfs. The amount of flow introduced by the unwatering pumps would be very small. Because the AWS would be unwatered during the in-water work period, it is unlikely that the AWS would be unwatered while the corner collector was in operation or juvenile fish are present.

Future Work – The schedule impacts of the floating orifice data collection effort will be assessed and communicated to Jerry Maurseth in order to establish dates for the 90% submittal and PRM.

Summary of Additional Data Collection:

- **MW** –
  - ➢ Montgomery will contact Andy Debrie at the project, in order to assess the C diffuser gates.
  - ➢ Prepare a memorandum describing the data to be collected and the methods to collect the data on gate clearances.
- **Dennis Schwartz** – Coordinate effort to measure gate clearance.
- **B2 Operations Staff** – Measure gate clearances and floating orifice freeboard.
- **Randy Lee** – Provide velocity data for area in front of the fish turbine intakes.
- **Jerry Maurseth** –
  - ➢ Contact HDC in order to explore the impacts on turbine efficiency due to closing off the bottom portion of the trashracks.
  - ➢ Coordinate a conference call that would include Portland District COE staff, B2 operations staff, and MW in order to make a decision on which trash rake alternative to select.

MONTGOMERY WATSON

PROGRESS REVIEW MEETING REPORT

Project Name : Bonneville Second Powerhouse Auxiliary Water Supply Backup System Design Documentation Report

Contract : DACW57-97-D-0004, TASK ORDER NO. 23

Meeting Date : September 4, 2001

Location : Cascade Room, District Offices in Portland

Subject : Progress Review Meeting 90% Report

Attendees : Jerry Maurseth, Randy Lee, Dennis Schwartz, Dwayne Weston, Duncan Kwong, Patrick Hunter, Mark Dasso, Dave Illias, Portland District COE; Gary Fredricks, Ed Myer, NMFS; Ed Zapel, Lisa Larson, Northwest Hydraulic Consultants; Lee Miesbauer, CivilTech; Dennis Dorratcague, Frank Postlewaite Peter Barton, Montgomery Watson Harza.

The action items are underlined in the following meeting report.

Overview

The meeting began at 10:00 AM. Dennis Dorratacague gave a brief overview of the progress to date. The objective of the meeting was defined as achieving a consensus on which trash rake would carried into the 100% report.

Alternatives Presentation

- **AWS Operations Alternative** – Lisa Larson provided an overview of the modeling effort to date. Three operating configurations were identified that produce optimum fishway conditions for low, medium, and high tailwaters. The 90% effort simulated the intermediate tailwaters, defining operating configurations in 1-foot increments from tailwater elevation 8 feet to 28 feet.

  The NMFS expressed some concern that the NUE would be closed under some operating configurations. The NMFS will examine their records and determine if closing the NUE would have too large an impact on the returning fish and if it would be better to close a different gate. It was explained that closing the NUE gate produced the largest beneficial effect on the hydraulic conditions in the powerhouse collection channel.

  The NMFS requested that a dead band be identified that would provide guidance to operators about the sensitivity of the fishway to the changes proposed in operations plan. Nhc will review their model runs and show the effects on the fishway hydraulics if it is operated in the alternative 1 configuration past the break point where it is recommended that the gates be reconfigured to the alternative 2 mode for tailwaters 1-foot, 2 feet, and three feet above and below the break points. Similarly, they will examine the break points between the alternative 2 and alternative 3 configurations. This information will be included in Appendix G.

A discussion followed that compared the effort required to close all the floating orifice gates and adjust the diffuser gates to the current method of closing the ice and trash sluiceway and spilling additional into the AWS over a weir. More man hours will be required when the operations plan is implemented.

It was agreed that the operations plan would be presented as a table for inclusion in the FPP. The language of the FPP will be modified by others.

Floating Orifice Gate Closure Schemes – Frank Postlewaite described the results from a field effort to measure the clearance between the floating orifice gates and deck openings on the EL 55 deck. He then described the evolution of the preferred gate closure scheme: an aluminum slide plate installed at deck level, and uninstalled by use of a tag line. Consensus was reached to proceed with this scheme. It was agreed that a rack to store the aluminum slide plates would be described in the text of the DDR. A sketch could be included.

Stockpile Crucial Spare Parts – The final list of spare parts was presented. It was noted that the list of parts no longer includes computer controller for the turbine cams. The B1 computer upgrades provide a source of compatible spare parts.

Sediment Accumulation – Frank Postlewaite described the sediment accumulation problem, and it was agreed to block off the bottom portion of the trashracks in front of the fish units and to implement a yearly maintenance dredging program. Closing off the lower portion of the trashracks will raise the invert of the fish unit intakes by 13.5 feet, thereby creating an adequate area for sediment to accumulate to allow yearly maintenance dredging to occur during the in-water work period. The HDC has stated that a blank panel will not produce a measurable effect on the efficiency of the fish unit turbines.

NMFS inquired about the structural alternatives modeled at WES (berms located upstream of trash racks). The COE replied the structural alternatives were too expensive so the option of installing a blank panel and maintaining a dredging program was chosen.

Trashrack Debris Accumulation and Diffuser Rack Clogging – It was agreed to move forward with the gripper type trash rake. Project staff feel it would be more difficult to maintain the Cross type rake because of its large size and more extensive hydraulics. The gripper type machine hangs over the water on a rail, leaving more deck space clear. The Cross type machine is powered by 50 HP motor. The gripper type trash rake is powered by a 5 HP motor to close the teeth and two 1.5 HP motors to lift it. The power requirements differ because the gripper descends by gravity, while the Cross type machine descends by means of an hydraulic boom. It would be simpler to supply the power to the gripper type machine. The Cross type machine needs much more hydraulic fluid than the gripper style machine. The hydraulics of the Cross type machine however are contained within the protection of the boom. The gripper style machine is powered by means a more exposed hydraulic line extending into the water. Both machines scrape the material from between the trash rack bars. However, both machines may have trouble containing the material scraped off. It was thought that the gripper style would be able to retain more material due to its opposing teeth. (the gripper has two jaws, while the Cross style machine has one).

NMFS expressed concern that the hydraulics from either rake will leak. It is not possible to actuate the gripper with cables. Frank Postlewaite will determine if the gripper could be reconfigured to operate pneumatically. If pneumatic operation is not possible, it was agreed that a preventive maintenance program would be developed that would systematically change the seals and hoses to the gripper hydraulics in order to stop leakage before it occurs.

Concern was expressed that the either rake would scrape debris off the rack only to suspend it briefly before it lodged on the screen again. Frank Postlewaite will investigate the possibility that the gripper could be modified to retain smaller debris.

A barrier was considered to prevent accumulations of logs in the path of the trash rake. This barrier would allow the trash rake to clean the trashrack without first removing the floating debris. However, the inclusion of the barrier could make it difficult to remove sunken or semi-buoyant logs with the gantry crane. A large submerged log could become wedged if either cleaner brought it to the top underneath the barrier. It was decided to not include the log barrier or a log boom as part of the design. It could be included at a later date if needed.

Install Pressure Gage in AWS Conduit – Conduit runs to the junction pool area at the north end of the powerhouse have been identified for the transducer installations. Powering the pressure transducers was discussed. Power will travel on the same wires as the digital signal returning to the control panel. This scheme will require 2-wire submersible level transmitters. It was pointed that these are not typically used at the Project.

Other Issues – The schedule will deleted. It was suggested to break the work into three parts and only describe the tasks in terms of critical durations. Lead times will be identified for key elements of the various tasks described in the DDR. This will enable various parts of the work to be appended to other work orders.

Future Work – The schedule the final submittal will be worked out with Jerry Maurseth.

Summary of Additional Data Collection:

- **MWH**–
  - Include a discussion of a storage rack for the aluminum slide plates.
  - Determine if the gripper trash rake can be actuated with air power.
  - Determine if the gripper trash rake can modified to retain material when closed.
  - Provide more detail on the gripper trashrake, including information on the tines and the hydraulic hose.
- **Gary Fredricks** – Will contact Jerry Maurseth if the NUE should not be closed.
- **Nhc**– Will provide dead band information for operations manual.

APPENDIX J

SITE VISIT REPORTS

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MONTGOMERY WATSON

DIFFUSER B GATE TESTING SITE VISIT REPORT

Project Name : Bonneville 2 Auxiliary Water System (AWS) Backup Alternatives Study

Contract : DACW57-97-D-0004, TASK ORDER NO. 23

Meeting Date : January 3, 2001

Location : Bonneville Project

Subject : Diffuser B Gates Testing

Attendees Site Meeting: Pat Hunter, Andy DeBriae, and Frank Postlewaite

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Action items are underlined in the meeting report below.

SITE VISIT

The purpose of this site visit was to test the B Diffuser Gate actuators. Emergency operation may require the gates to operate with a higher than normal hydraulic head across the gate. This test is intended to measure the gate performance while subjecting the gates to head conditions expected during emergency operation. The test requires measuring the hydraulic differential across the gate (between the chamber downstream of the gate and the Auxiliary Water System (AWS) Conduit) while measuring the electrical performance of the actuator motor.

The site visit started at the Bonneville Powerhouse south monolith. Pat Hunter, Andy DeBriae, and Frank Postlewaite discussed testing the B Diffuser Gates. Originally Frank Postlewaite had intended to measure the AWS water surface elevation through a shaft leading down to the AWS conduit from the Service Bay deck adjacent to the ice and trash chute. Unfortunately, one of the Fish Turbines was out of service and supplemental water was being discharged down this shaft from the ice and trash chute. This prevented direct measurements of the AWS conduit water surface elevation.

To work around this problem, the headloss through a given diffuser gate was estimated, while the water surface elevations of the collection channel and the chamber down stream of the diffuser gates was measured directly. Water surface elevations were measured with a well sounder, allowing measurements to within 0.25-inches. The differential across a fully open gate is estimated by calculating the flowrate based on the differential across the orifice between the chamber downstream of the diffuser gate and the collection channel. The gate differential is then calculated using this flowrate.

DRAFT

Pat Hunter, Operations Personal for operating the gates, an Electrician, and Frank Postlewaite sequentially opened and closed gates, measured motor current and voltage, and sounded the water surface levels. The results of this testing are summarized in the following table.

At about 1:30 PM Frank returned to the Operations Building to obtain some drawings.

The site visit ended at about 2 PM.

Field observations and estimated hydraulic differentials across the gates are summarized in the attached table titled “B Diffuser Gate Testing, 1/3/01”.

B Diffuser Gate Testing, 1/3/01

	Condition 1	Condition 2	Condition 3	Condition 4
Open Gates	B1, B2, B3, B4, B5	B1, B2, B3, B4	B1, B2, B3	B2
Closed Gates	B6, B7, B8	B5, B6, B7, B8	B4, B5, B6, B7, B8	B1, B3,B4, B5, B6, B7, B8
Collection Channel Location	B6	B5	B4	B3
Collection Channel Reading	33.25	33.25	33.18	33.33
Gate Reading	32.5	32.17	31.58	31.58
Collection Channel Elevation	12.75	12.75	12.82	12.67
Gate Chimney Elevation, fmsl	13.5	13.83	14.42	14.42
Differential, ft	0.75	1.08	1.6	1.75
Area of Outlet, sf	23.01	38.68	38.68	38.68
Flowrate, cfs	119.9	241.9	294.5	308.0
Area of Gate, sf	18.0	36.0	36.0	36.0
Gate to AWS Differential, ft	1.0	1.0	1.4	1.6
Total Differential with the Gate closed, ft	**1.7**	**2.1**	**3.0**	**3.3**
Note: Italized Parameters are Estimated				
Gate 3				
Start Closing			**5.40**	
50% Closed			**5.24**	
75% Closed			**5.30**	
90% Closed			**5.46**	
Start Opening			**7.10**	**7.60**
Gate 4				
Start Closing		**5.50**		
50% Closed		**4.98**		
75% Closed		**5.00**		
90% Closed		**4.95**		
Start Opening		**6.00**		**6.50**
Gate 5				
Start Closing	**3.50**			
50% Closed	**3.20**			
75% Closed	**3.30**			
90% Closed	**3.07**			
Start Opening	**3.40**			**3.70**
Gate 6				
Start Opening				**3.68**

Gate 7				
Start Opening				**4.00**
Gate 8				
Start Opening				**3.8**
Typical Voltage:	**205 to 208 VAC**			

Gates:	Size	Actuator	Actuator FLA	Maximum Reading
B1	72" x 72"	Manual	N.A.	N.A.
B2	72" x 72"	Manual	N.A.	N.A.
B3	72" x 72"	Electric	7.30	7.60
B4	72" x 72"	Electric	7.30	6.50
B5	36" x 72"	Electric	3.96	3.70
B6	36" x 72"	Electric	3.96	3.68
B7	36" x 72"	Electric	3.96	4.00
B8	36" x 72"	Electric	3.96	3.80

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MONTGOMERY WATSON

SITE VISIT REPORT - FLOATING ORIFICE MEASUREMENTS, C DIFFUSER GATES, AND RACEWAYS FOR LEVEL TRANSMITTERS IN THE TRANSPORTATION CHANNEL AT MONOLITH 1N.

Project Name :	Bonneville 2 Auxiliary Water System (AWS) Backup Alternatives Study
Contract :	DACW57-97-D-0004, TASK ORDER NO. 23
Meeting Date :	June 7, 2001
Location :	Bonneville Project
Subject :	Floating orifice measurements and information gathering on existing raceways, and C Diffuser gates.

Attendees Site Meeting: Pat Hunter and Frank Postlewaite

Action items are underlined in the meeting report below.

SITE VISIT

The purpose of this site visit was to measure the clearance between the floating orifices gates and the concrete deck (elevation 55) as the gates are withdrawn. The existing raceways to the AWS Diffuser Gates at monolith 1N were evaluated for use by level transmitters. Information was gathered on the C Diffuser gate actuators to determine a safe operating differential head across the gate.

The site visit started at the Bonneville Maintenance building. Pat Hunter and Frank Postlewaite discussed the necessary routing for future level transmitters in the junction pool at monolith 1N. Drawing sheets depicting the embedded conduits where located and copied for the conduits of interest. These sheets include: 87 (BDF-4-11/4), 156 (BDP-1-6-1C1/2), 158 (BDP-1-6-1C1/4), 160 (BDP-1-6-1C1/6), 161 (BDP-1-6-1C1/7). Drawing sheet for the C Diffuser gates were also found. These sheets include 74 (BDP-1-3-2/70), 74.1(BDP-1-3-2/71), and 74.2 (BDP-1-3-2/72).

After investigating the available drawings, Pat Hunter and Frank Postlewaite met with Pete Hammerlink (Electrical Foreman). The conduits identified on the drawings were located in the field. Four sets of conduits extend from the elevation 28 level in the erection bay out to the respective control and power connections to abandoned gate actuators on the north and south side of the junction pool. The control conduits terminate in a junction box and the power conduits in a lighting panel. A 3" conduit extends down from the control junction box into panel SA24, which is the ultimate destination for the new conductor. Based on this investigation it appears the existing diffuser gate conduits will serve well as raceways for the proposed level transmitter conductors.

After site investigations were completed a 4:30 PM, Frank met with the lead Rigger and discussed plans for measuring the floating orifice gates later that evening. The lead rigger observed that gate slots that are not used for several years are likely to silt up, making it difficult to install the gate.

Starting at 8:00PM the Riggers (a crew of 5) began preparing for removing the floating orifice gates. The first gate, starting at the north end of the powerhouse, was pulled at 8:30 PM. The gate removal required removing the top slabs and relocating 6 bulkheads (the bulkheads are hung in slots adjacent to the floating orifice gate slots and must be removed to remove the floating orifice gates). The process was delayed by the failure of the boom truck at about 9:00 PM. All the work was performed with the gantry crane.

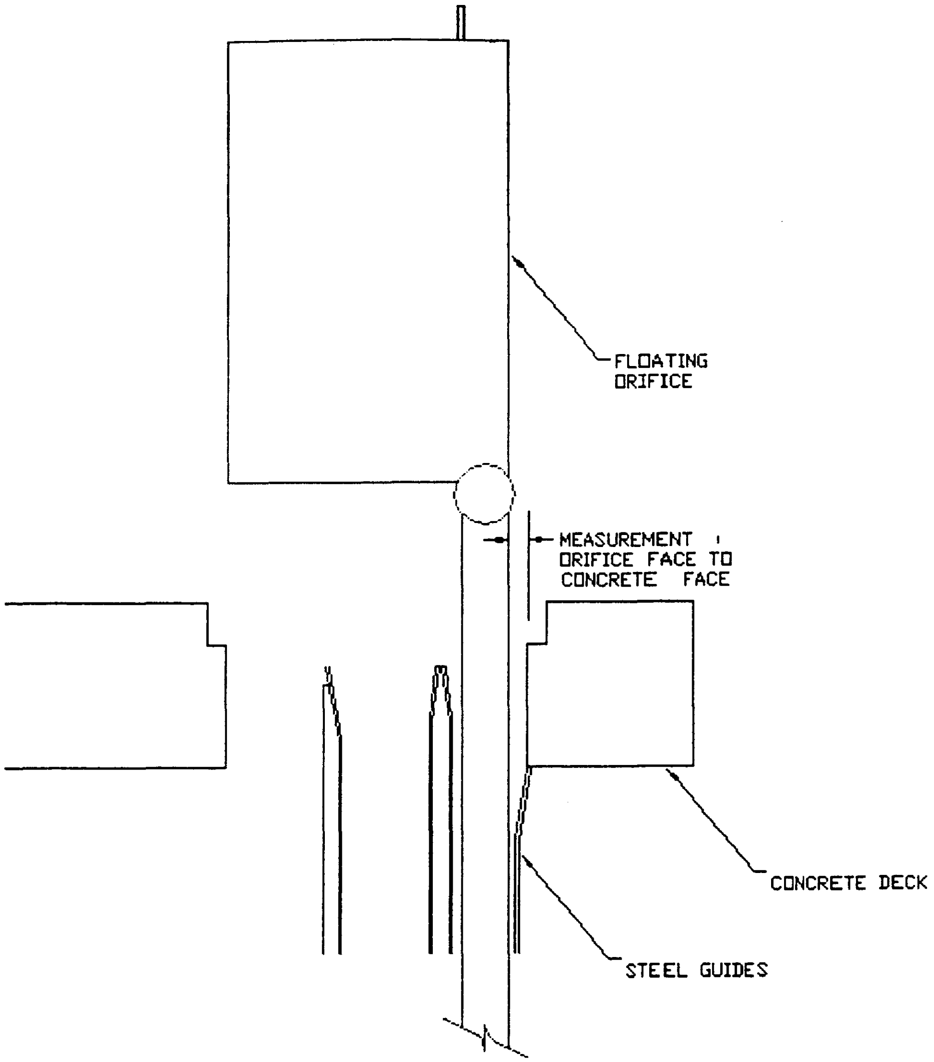
The measurements are summarized on the attached table. Minimum and maximum measurements were taken by shifting the crane position to deflect the floating orifice gate to the upstream limits of positioning the gate (maximum) and the downstream limit (minimum). The locations of the measurements on the gate are depicted on the attached figure (tif file) "Measureb2". The freeboard measurements were difficult to discern from the existing scum lines and wetted surface (the weight of the lifting yoke and hoist block forced the gate down and unknown depth). The last floating orifice gate was replaced at 1:45 AM on Friday. The total elapsed time from pulling the first floating orifice gate to replacing the last was 5.25-hours.

The site visit ended at about 2 AM.

B2 AWS DDR - Floating Orifice Gate Measurements

	Position												
Gate	**1 - Top North**		**2 - Top South**		**3 - Middle North**		**4 - Middle South**		**5 - Bottom North**		**6 - Bottom South**		**Average**
	Min.	Max	Min.	Max	Min.	Max	Min.	Max	Min.	Max	Min.	Max	
1	2.5	3.6	2.9	3.8	0.3	5.6	0.5	3.1	2.0	4.6	2.1	4.8	**2.8**
3	3.6	4.3	3.8	4.3	2.0	6.6	2.1	6.8	3.0	5.6	3.1	5.7	**4.1**
5	3.4	4.5	3.4	4.2	1.8	6.6	1.4	6.8	2.6	5.4	2.7	5.5	**4.1**
7	3.5	4.0	3.6	4.1	1.8	6.4	1.9	6.5	2.4	5.0	2.5	5.1	**4.1**
9	3.8	1.1	3.8	4.1	1.6	6.7	1.9	6.9	1.5	4.8	1.6	4.9	**4.0**
10	3.5	3.8	3.5	3.9	2.0	7.1	2.1	7.1	2.6	5.4	5.3	2.4	**4.5**
11	2.7	3.4	2.8	3.6	0.4	5.5	0.5	5.6	1.3	3.9	1.6	4.3	**3.6**
12	3.3	3.6	3.3	3.8	1.3	6.4	1.4	6.5	2.2	4.8	2.3	4.8	**4.3**
14	3.5	3.8	3.5	3.9	1.5	6.3	1.6	6.5	2.5	5.3	2.6	5.3	**4.6**
16	3.6	3.4	3.6	3.8	1.6	6.0	1.8	5.9	2.6	5.0	2.7	5.1	**4.7**
18	3.9	4.1	3.9	4.1	3.1	4.8	3.1	4.6	3.9	5.1	3.9	5.1	**5.2**
20	4.1	4.1	4.1	4.1	3.1	4.3	2.9	4.3	3.1	4.1	3.1	4.3	**5.0**
Average	3.4	3.6	3.5	4.0	1.7	6.0	1.8	5.9	2.5	4.9	2.8	4.8	
Minimum	2.5	1.1	2.8	3.6	0.3	4.3	0.5	3.1	1.3	3.9	1.6	2.4	
Maximum	4.1	4.5	4.1	4.3	3.1	7.1	3.1	7.1	3.9	5.6	5.3	5.7	

Gate	**Orfice Width, Feet**	**Monolith Location**	Freeboard			
			Upstream		Downstream	
			Min.	Max	Min.	Max
1	4	11 A (out)	29	35	38	42
3	4	11 B (in)	26	30	36	41
5	2	12 A (out)	27	33	38	44
7	2	12 B (in)	27	31	36	47
9	2	13 A (out)	26	30	40	46
10	2	14 A (out)	26	33	40	44
11	2	15 B (out)	26	32	41	48
12	2	16 B (out)	23	33	42	48
14	2	17 A (in)	-	29	-	42
16	2	17 B (out)	-	29	-	43
18	4	18 A (in)	25	28	-	42
20	4	18 B (out)	-	26	-	41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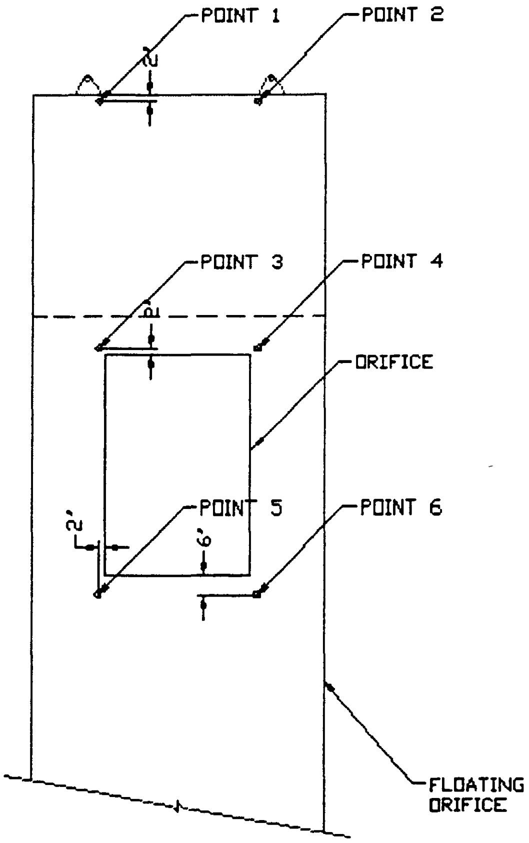
MEASUREMENT ORIFICE FACE TO CONCRETE FACE
CONCRETE DECK
STEEL GUIDES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POINT 5
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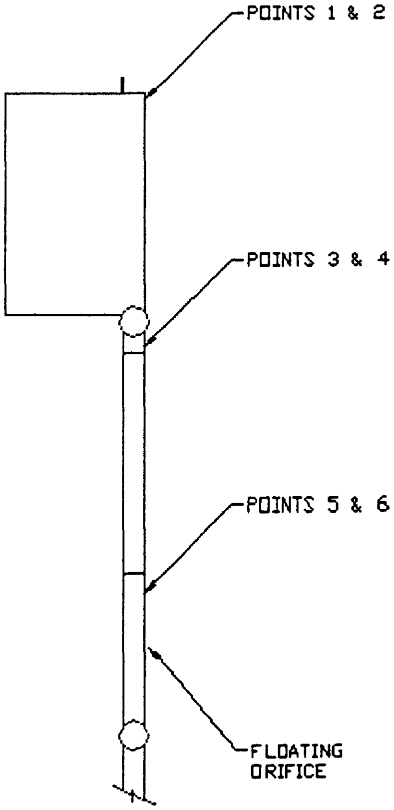
FLOATING ORIFICE


POINTS 1 & 2
POINTS 3 & 4
POINTS 5 & 6
FLOATING ORIFICE

MEMORANDUM

MONTGOMERY WATSON

To: Jerry Maurseth, Dennis Schwartz, Patrick Hunter, Mark Dasso, Lee Miesbauer

Date: 6/20/01

From: Frank Postlewaite and Peter Barton

Reference:

Subject: B2 AWS DDR – Floating Orifice Gates

This memorandum presents a new alternative for closing the floating orifice gates along the B2 powerhouse. *Alternative 3 – Lower Bulkhead From Above* was selected at the 60% PRM for the *Bonneville Second Powerhouse Auxiliary Water Supply Backup System Design Documentation Report (DDR).* This alternative involved inserting a stab plate into guides on the downstream face of the floating orifice gates from the EL 55 deck using a mechanical lifting device. A field effort was undertaken to verify that the stab plate would fit. During the course of the field work (see June 7, 2001 field report), a modification to the concept was developed with input from Bonneville Project staff. This alternative consists of removable aluminum slide plates, placed by hoisting the floating orifices gates through the deck, and installing the slide plates at the deck level. Then the floating orifices would be lowered into position. A line fixed to the top of the top of the slide plate would extend up to the deck and be dogged off. This would allow the slide plate to be removed without removing the floating orifice gate. Several observations led to this alternative. These include the following:

- A slide plate on the downstream side of the floating orifice gate would be readily installed at deck level.
- The riggers expressed concern about sediment fouling gate slots over an extended period of time and inhibiting stab plate installation.
- Raising the floating orifices gates to the deck level would allow slots for the slide plates to be cleaned out.
- The total length of time to remove all the floating orifices was just over 5 hours. Most of the time involved mobilizing, removing deck slabs, and re-arranging bulkheads. Installing slide plates on the floating orifice gates at deck level would likely take the same length of time as the measurements took. This duration is estimated to be at most 2 hours longer than *Alternative 3 – Lower Bulkhead From Above* described in the DDR.
- If fouling of the slots occurred (for the slide gates or stab plates), the slots would need to be cleaned out at the deck level with a pressure washer.
- Proper seating of the stab plates would be difficult to determine from the deck level.

- The floating orifice gates would need to be pulled up to the deck level if improper seating was observed.

- Removal of the floating orifice gates did not require the fish units to be shut down. The flow was throttled back during the June 7th field work and the floating orifice gate was readily lifted to the deck level and readily and re-installed.

- The slide gates would be less than half the size of the stab plates, making them much easier to handle, easier to store, and be would be less expensive.

- No modification to the foatation chamber is anticipated under the new alternative. Aluminum slide gates would be relatively lightweight and would not require adding additional buoyancy to the floating orifice gate floatation chamber. This would also reduce the cost.

- A lifting cable on the gates would allow removal of the slide gate without lifting the floating orifice gate to the deck level. Only the deck slabs would be removed; the bulkheads hanging in the adjacent slot would not need to be handled. With the new alternative, the slide gate removal process will take less time than removing the stab plates.

Based on these considerations and discussions with Jerry Maurseth, we intend to develop the new alternative in the 90% DDR and recommend that it be carried into design. No further development of *Alternative 3 – Lower Bulkhead From Above* will be pursued.

APPENDIX K

BONNEVILLE 2ND POWERHOUSE FISH UNIT DEBRIS STUDY

Bonneville 2nd Powerhouse Fish Unit Debris Study
Reconnaissance Report
Final – July 20, 2000

1.0 Introduction

This document identifies problems caused by the accumulation of debris within the Bonneville Second Powerhouse (B2) auxiliary water supply (AWS) to the adult fishway channels. The accumulation of debris on the fish unit intake screens and diffuser gratings combined with the settlement of bedload material in the supply channel, compromise the reliability of the AWS system. A reconnaissance investigation was conducted and recommendations are made for reducing the potential for downtime and improving overall system reliability. Data and information was collected from site visits and meetings with Project and District personnel, as well as discussion with the A/E contractor conducting the B2-AWS back-up alternative study. A site location map and a plan view of the Bonneville second powerhouse are shown on plates 1 and 2. The location of the two fish units is shown on plate 3.

2.0 Background

Due to heavy runoff seasons and, in particular, the flood of 1996 a large amount of sediment was deposited in and around the fish units and across the forebay of second powerhouse. A purchase order was issued in February of 1997 to dredge directly upstream of the fish units. Approximately 2,850 cy of material was removed. Shortly after the dredging, and possibly due to the sediment and debris stirred up by the dredge operation, the AWS channels became filled with bed load materials consisting of sands, silts and gravels. This was realized only after the AWS diffusers became clogged with sticks and other floating and semi buoyant material. The pressure head across the gratings became so great that many were torn loose, causing an emergency shut down of AWS for inspection and repairs. During this shutdown period the diffuser gratings were repaired and the AWS was excavated to remove the accumulated sediment. A second contract was issued in the fall of 1997 to dredge across the entire length of the powerhouse.

Several problems exist with the AWS system. At tailwater elevations greater than el.12.0 fmsl the turbine discharge is inadequate to operate the fish ladder within criteria. The AWS also experiences head loss due to the buildup of debris across the fish unit intake racks and diffuser gratings. These losses are complimentary to the low discharge condition and inability of the AWS to operate within the criteria that requires one to one and half-foot head differential across the fishway entrances. A poor trash rack cleaning system and the inability to clean AWS diffuser gratings compromises the reliability of the existing AWS. The trash rake does not effectively clean the trash rack. It tends to pack material in between the trash rack bars, clogging the bars and may even push material through bars to accumulate and clog the AWS diffuser gratings. Sedimentation of bed load material in front of the two main fish units and within the AWS channel also restricts the system capacity and ability to meet operating criteria.

Regional fisheries agencies and tribes have asked Portland District to investigate the deficiencies of the AWS and AWS back-up systems. A contract was issued to CH2M Hill/Montgomery Watson to conduct this study. Several alternatives were analyzed and cost estimates for these were prepared. After review by the fisheries agencies, it was decided that the costs of these final alternatives were too high. Emphasis was then put on operational solutions (*Contract No. DACW57-97-D-0004 Task Order No. 0013, Modification case No. 04*). Because a reasonable and cost effective solution has not yet been developed, the performance and reliability of the existing system is critical to the successful operation of the adult fish passage facilities.

3.0 Auxiliary Water Supply

The auxiliary water supply system is a major component of the upstream fish passage system at the Bonneville Second Powerhouse (B2). Water is normally supplied to the AWS by two fish unit turbines on the north side of the powerhouse. The two units discharge into a chamber. This chamber distributes flow to the entrance channel of the north shore ladder and to the AWS conduit running parallel to the collection channel below the powerhouse tailrace deck. Orifices in the AWS conduit discharge into diffusion chambers under the fish collection channel. The attraction water then flows upward through diffuser gratings in the floor of the collection and entrance channels. Each floating orifice along the tailrace deck of the powerhouse discharges approximately 90 cfs from the collection channel and each of the four main entrances discharges approximately 900 to 1000 cfs. The total discharge rate varies with tailwater elevation and the total hydraulic head across the system.

4.0 Fish Units

Two fish unit turbines at the north end of the Bonneville Dam second powerhouse serve as the primary auxiliary water supply to the adult fishway channel. The discharge of each fish unit varies depending on the available head and wicket gate setting. Under ideal conditions each unit can supply up to 2845 cfs to the AWS for a combined flow 5690 cfs. The flow is adjusted to meet requirements of the fishway entrances, within the ability of the existing system. However, at high tailwater elevations the turbines do not supply enough discharge to operate the ladder within criteria. In addition accumulation of debris on the intake trash racks and within the AWS further reduces the hydraulic head and total discharge through the units.

5.0 Ice and Trash Sluiceway.

The existing ice and trash sluiceway was designed and constructed to pass floating debris around the south end of the powerhouse. It also doubles as an inlet supply channel for the AWS back-up system should a fish unit fail or be taken out of service for maintenance. By placing stoplogs at the exit, the chute is back-watered to spill water over a weir, down a shaft and into the south end of the AWS channel. Use of this system is restricted to September 1 to March 31 to reduce the chance for juveniles and adult fish to be pulled into back-up system (ref. *Annual Fish Passage Plan for Corps of Engineers Projects*). When the chute is serving as a backup system the adults can become trapped within the supply channels, and juveniles are impinged on the diffuser gratings. The ice and trash sluiceway will also become and element of the B2 corner collector, eliminating the ability to use this system as part of the AWS back-up supply.

6.0 Forebay Hydraulic Conditions.

The approach flow conditions to the second powerhouse split near the center of the channel, with a flow current circulating to the north in front of the fish units, and one to the south in front of the ice and trash sluiceway intake. During the high flow runoff periods floating debris accumulates within the eddy that forms just upstream of the fish units. Model study investigations also indicate that these same flow patterns will transport and deposit bedload material near the base of the intake structures blocking the lower trash racks and restricting flow to the AWS.

7.0 System Problems

Problems identified with the existing AWS system include:

1. A sediment buildup within the powerhouse forebay and the AWS conduit.

2. Debris accumulation on the trash rack and an inefficient trash rack cleaning.

3. Accumulation of debris on the AWS diffuser gratings, and

4. Management practices that increase risk of unit outages.

These problems are in addition to, but not independent of, the inability of the system to meet fishway entrance discharge requirements and the limitations of the AWS back-up system.

Sedimentation

As a result of the damage sustained to the AWS system and its discharge concerns, sedimentation buildup in the AWS and upstream of the intake trash racks has become an issue. As sediment continues to deposit in the powerhouse forebay an increasing amount will pass through the fish units and settle in the AWS channels. Unless prevented or cleaned it will eventually block (or partially block) the supply channels and restrict flow to the adult fishway entrances. Sediment buildup in front of the intake also contributes to headloss across the intake trash racks. The buildup tends to clog the lower trash rack section. This reduces the water passage area and prevents the trash rake from reaching and cleaning to the bottom of the intake.

Trash Rack Debris

The design of the trash rake and rack system is flawed in several ways:

1. The teeth of the existing rake (photos 1, 2 and 3) do not penetrate between the rack bars. Instead, they tend to push and wedge the smaller floating debris such as small wood chips, pebbles and fir (pine) cones into the small space between the bars (photos 4 and 5).

2. When the rake is lowered it does not have an open position. It pushes much of the larger material downward along the rack adding to the collection of debris and sediment near the bottom of the intake. This creates higher head losses resulting in lower unit discharges.

3. Prior to the 1997 repairs, a large gap at the top of the rack allowed much of the debris being raked to fall back into the units, which then allowed it to collect on the AWS diffuser gratings. This problem has since been corrected.

4. The trash rack openings are the same width but not the same length as the openings of the diffuser gratings. Debris, such as long sticks can pass through the trash racks and collect on the underside of the diffuser gratings.

AWS Diffuser Grating Debris

The openings within the diffuser gratings in the AWS channels must be small enough to prevent adult fish from swimming into the water supply channels (photo 6, unfortunately no photos were taken of the destroyed diffuser gratings). These openings are approximately one inch wide by 4 inches long. The water supply through the conduits must be sufficient to provide adequate attraction flow through the fishway entrances. Entrance flow criteria is typically a one to one and a half-foot head differential across the entrance with exit flow velocities of near 8 feet per second. Any hydraulic losses across the gratings result in less head over the turbine units and lower auxiliary water supply discharges.

The diffusers are easily clogged by debris such as straw, lake weeds and sticks that pass through the fish unit trash racks and there is no method of cleaning the diffusers without shutting down the AWS and de-watering the channel. A pressure sensor in the supply conduit measures the head differential between the supply conduit and collection channel. This single sensor does not have the resolution to measure a pressure increase that may cause damage to any specific diffuser. Relying on this sensor to determine if debris has accumulated on any of the diffuser gratings may give a false sense of acceptable conditions.

Operations

The fish units are shut down approximately 3 hours each night to allow debris to drift away from the fish unit trash racks. This operation increases the "wear and tear" on the fish units resulting in higher maintenance cost and an increased risk of emergency shut downs. Thermal cycling, brake wear and wear due to bearing oil film thickness on start-up are all major causes.

8.0 Management Practices and Maintenance Costs

Sedimentation of the Forebay

Occasional dredging is required to remove the sediment buildup in front of the fish unit intakes. Since the second powerhouse was completed in 1985 the forebay area in front of the fish units was dredge once in 1990 and twice in 1997. Approximately 2,850 cy of material was removed from the base of the fish units in February of 1997 at a unit cost of $27.84/cy. In the fall of 1997 a larger contract was awarded to dredge the entire upstream area of the forebay. A total of 15,582 cy of material was removed from the forebay area across the entire second powerhouse. Of this, 4,550 cy was removed from the area upstream of the fish units. Due to the scope of the work involving large equipment for a short duration, and a contract claim, the unit price rose to $49.69/cy. Assuming that all of material dredged in front of the fish units in 1997 was deposited since 1990, this area would have a fill rate of approximately 1050 cy per year. Assuming a fill rate of 1050 cy per year the annual cost of dredging would be $31,500 at $30.00/cy, and $52,500 at $50.00/cy (not accounting for inflation). However, it is highly likely that that majority of the sedimentation occurred during the most recent high flow events and may not have been a gradual accumulation over a longer period of time.

The 1997 dredging contracts were issued by NWP. Data from those contracts were provided by Mark Dasso, Chief of the Waterways Contract Section of the Operations Division at that time. The 1990 dredging contract was issued by the

Bonneville project; the volume material excavated and the cost of that contract were not available.

Sedimentation within the AWS Channels

In addition to the dredging operations in front of the fish unit intakes, the AWS channel is expected to require periodic excavation. The AWS channels were excavated in 1987 and again in February of 1997. Approximately 2000 cy of material was excavated from the AWS in 1997. Assuming that all of the material removed in 1997 was deposited since 1987 the AWS would have a fill rate of approximately 200 cy per year. The total cost for the 1997 excavation was approximately $100,000, for an annual cost over the ten-year period of $10,000 (not accounting for inflation). Spreading the accumulation rate over the 10-year period may not be entirely accurate. The majority of this accumulation may have occurred over the most recent high flow period or during the 1997 excavation the forebay immediately upstream of the fishway units.

Trash Rack Cleaning and Raking

A 3-hour daily shutdown of the fish units has been adopted to allow accumulated debris to drift away from the trash racks. The effectiveness of this operation is unclear. Some of the material may be drawn through the adjacent powerhouse units and some of it may drift away only to be pulled back into the trash racks and possibly through the units where it may then collect on the diffuser gratings. Incurred costs of daily unit shutdown are minimal, however starting and stopping of the units adds to the wear and tear and higher maintenance costs. These costs have not been identified.

During the spring runoff, trash rack cleaning is typically required two to three times a week but can be daily depending on runoff and debris loading. The project generally cleans the trash racks when the head differential across the trash racks reaches 2 to 3 feet. The estimated annual operating cost of the existing trash rake is $10,000.

Trash Rack Removal

The existing trash racks require a complete removal for cleaning and bar repairs (as needed) once every two years with an estimated total cost of $15,000. Divers are often required to remove debris from the lower rack sections before they can be pulled. In addition to removal and installation costs, the racks are stripped and refinished once every fifteen years at an estimated total cost of $10,000 plus the initial cost of pulling and cleaning.

Monitoring and Maintenance of the Diffuser Gratings

Contract divers inspect the diffuser gratings twice per year, once during the winter in water work period and once during the fish passage season. A pressure sensor is installed within the supply conduit to indicate a build-up of debris by measuring pressure loss across the gratings. The damage to the diffuser gratings in 1997, however was detected only when the biologist noted large "boils" or up-welling of flow in the vicinity of the flow diffusers. This would indicate that the debris accumulation on the diffusers was more or less a sudden event, possibly resulting from the excavation of material in front of the fish units.

The project operational and maintenance information, and cost estimates were provided by Andy DeBriae, project foreman of the structural maintenance crew.

9.0 Biological Impacts

System Reliability

The existing AWS is unable to deliver adequate flow to adult fishway entrance and typically does not meet system criteria when tailwater elevations exceed 12.0 fmsl. A tailwater elevation of 12.0 fmsl during the fish passage season of 1 April to 31 August is exceeded 88 percent of the time. As it exist, the ice and trash sluiceway is only used as a back-up system during the "off" season because of juvenile and adult entrainment concerns. In addition, the ice and trash sluiceway will become an element of the B2 juvenile fish passage corner collector, eliminating any potential use as the AWS back-up.

Without a back-up supply system and the fact that the existing system barely delivers enough flow to keep the entrances within criteria, reliability of the existing system is very critical. Should a unit fail or be taken out of service for cleaning and repair, it is unlikely that the attraction flow exiting the fishway entrances would be sufficient and would likely result in adult passage delays.

Collection of Adults in the AWS Channels

Without the ability to monitor and clean the diffuser gratings daily, the potential for the gratings to be torn loose still exists. If a grating is missing or damaged there is a risk that adult salmon may become trapped within the supply channels.

Operations

The routine operation of shutting down the fish units for three hours for debris removal is scheduled during the night when it has the least impact on adult salmon. However, this operation does not improve the system reliability and may put the system at risk of an unscheduled outage cased by added wear from starting and stopping the units.

10.0 System/Management Improvement Alternatives

Alternatives for improving the existing AWS system and are listed below. These do not include alternatives for the AWS back-up water supply system currently being investigated under the AWS Back-up Supply Alternative Study.

Sedimentation

1. Management and/or Operational Practices.

    a. Conduct routine surveys and planned dredging during periods of least impact to water quality, the Columbia River fisheries and to Project personnel.

    b. Schedule dredging during the winter period when the fish units are shut down for maintenance.

    c. Set unit priorities on the operations of turbine units adjacent the fish units. Operation of these units may draw sediment away from the fish units but may not be consistent with operations proposed for the new corner collector.

    d. Conduct and document routine inspections of the AWS channel. The contract divers may be able to accomplish this during the routine inspections of the AWS diffuser gratings. Documentation will aid in planning system outages for excavation of material which may have settled within the ASW channel.

2. Structural Improvements

    a. Develop a trash rack system that reaches out beyond the toe of the intake to collect bed load deposits, as well as, the debris collected on the trash racks and caught between the trash rack bars.

    b. Large rock berms may be placed in the forebay to redirect the flow patterns and allow the bedload material to deposit in front of the main power units rather than upstream of the fish units. However, this may impact flow patterns upstream of the ice and trash sluiceway intake and may affect the efficiency of the corner collector.

    c. Block the lower section of the trash racks. If the trash racks could be easily maintained and kept free of debris, it may be possible to bulkhead off the lower trash rack sections to keep the bed-load of sediments from passing through the fish units and depositing in the water supply channels. The trash racks would have to remain free of debris to prevent additional head loss or differential across the trash racks. Impact to turbine operation would have to be considered.

d. The problem of sedimentation buildup throughout the AWS may be alleviated with the installation of a "bubbler system" along the length of the conduit. A "bubbler system" may prevent finer sediments and debris from collecting along the length of the conduit, however, it would also increase the amount of dissolved gas content of the water.

e. Redesign the AWS conduits to maintain higher velocities. An efficient hydraulic design may reduce and prevent material from settling out in low velocity areas.

Debris

1. Modify the existing trash rake. It may be possible to modify the rake fingers to reach and clean between the vertical trash rack bars. However the rake would still push much of the debris downward, causing an accumulation on the lower trash rack sections.

2. Design and install a new trash raking system. Head loss due to the collection of debris across the face of the trash racks may be reduced with the installation of a more efficient cleaning system. The new rake system should provide for a full sweeping motion of the rack face without the initial engaged downward pass, and it should be able to dislodge and collect debris caught between the trash rack bars. Trash raking systems are available that allow the rake to be lowered in an opened position. When the rake reaches the base of the intake it closes against the rack collecting debris as it is pulled to the surface. The new system would be designed to assure that the rake fingers reach and clean between the trash rack bars.

3. New racks could be constructed of polymer composite material to reduce the weight, maintenance costs and frequency of required maintenance procedures. The improved design may also reduce head loss across the system and could be constructed compatible with industry standard raking systems. A cleaner trash rack with lower head losses may allow the lower sections to be blocked to prevent the transport of bed load materials through the fish units.

11.0 Improvements

The trash rack opening near the intake deck has been closed to prevent trash from falling into the intake as it is pulled to the deck. A survey of the second powerhouse forebay was conducted in March of 2000 prior to the spring run off to determine the rate of infill since the 1997 dredging. A comparison of the March 2000 bathymetric survey data to the post dredging survey data of 1997 show very little, if any, infill since the forebay was dredged in 1997. However, the time between surveys spanned only the two low flow runoff periods of the 97-98 and 98-99 seasons. Though the historical data is limited, this survey would indicate the sediment transport of any significant volume occurs predominantly during high flow years.

A physical hydraulic model study of the Bonneville Second Powerhouse forebay was conducted at the Corps of Engineers Waterways Experiment station in 1998-99. A 1:40 scale model of the second powerhouse and forebay was used to evaluate the flow patterns and to determine what operations contributed to the deposit of material in front of the fish units. The model was also used to evaluate operational and structural alternatives that may prevent material from settling out in front of the two fish units. The most successful alternative was the placement of a large rock berm upstream of the fish units. The berm redirects the flow causing it to settle in front of or pass through the main power units. A final report from WES has yet to be submitted but is expected mid summer year 2000.

12.0 Conclusions

1. The existing trash rack cleaning system is ineffective. It does not clean between the trash rack bars. The trash racks periodically need to be pulled and cleaned to remove debris that has become wedged between the bars.

2. The trash rake pushes much of the debris to the base of the intake on its downward pass. The debris clogs the lower sections of the trash rack and increases the head differential across the racks and reduces the total operating head across the fish units.

3. Some debris can pass through the trash racks but not the diffuser gratings. The debris blocks the flow through the diffuser gratings and can cause them to be torn loose from their mounts by the build-up of pressure. This has occurred only once since the construction of the project in 1985.

4. The pressure sensor in the supply conduit used to determine if there is a debris build-up across the gratings does not have the resolution to evaluate the pressure or build-up on any single specific diffuser.

5. The diffuser gratings are inspected twice per year to make sure they are not damaged. The inspection could be expanded to include the inspection of the AWS channels to monitor and determine the rate of infill.

6. If the diffuser gratings are damaged and torn free, adult fish can enter and become stranded within the AWS supply channels.

7. Based on the volume of material dredged in 1997, the forebay of second powerhouse adjacent the fish units has a sediment infill rate of approximately 1,050 cy per year. Based on recent surveys it is possible that infill occurs during extreme flow events and not a gradual accumulation.

8. Sands, silts and gravels that pass through the fish unit intakes can settle out in the AWS channels. As the channels become filled, flow to the fishway entrances is restricted. Based on the excavation volume of 1997, the channel has a fill rate of approximately 200 cy per year. It is possible that the infill in the AWS channel was the result of keeping the units operational during dredging operations and/or extreme flow events.

13.0 Recommendations

1. Design and install a new trash rake and cleaning system to improve the cleaning efficiency and overall system reliability.

2. Combine the biannual inspection of the diffuser gratings with an inspection of the supply channels, particularly after high flow events.

3. Develop and install an improved monitoring system that will identify a pressure build-up or debris accumulation across each of the supply conduit diffuser gratings

4. Schedule routine surveys of the Bonneville second powerhouse forebay particularly in front of the two fish units, especially after high flow events.

5. Schedule dredging during the winter when the fish units can be shut down.

If the bathymetric surveys of the forebay region and the inspections of the AWS channel indicate a continuing problem of debris accumulation then the recommendations would also include:

6. Model turbine unit operations to determine if sediment can be pulled from the fish unit intake. Re-evaluate current turbine operational priorities to determine if they can be changed without impact to project or fishery operations.

7. Develop a cost estimate for the sediment diversion berm to determine if this is a feasible and cost beneficial alternative to dredging

8. Conduct a hydraulic analysis of the existing trash rack design to determine if the lower section(s) can be blocked to prevent sediment from passing through the turbines. Evaluate impacts to the AWS and turbine operations.

Photo 1. Fish Unit Trash Rack Rake

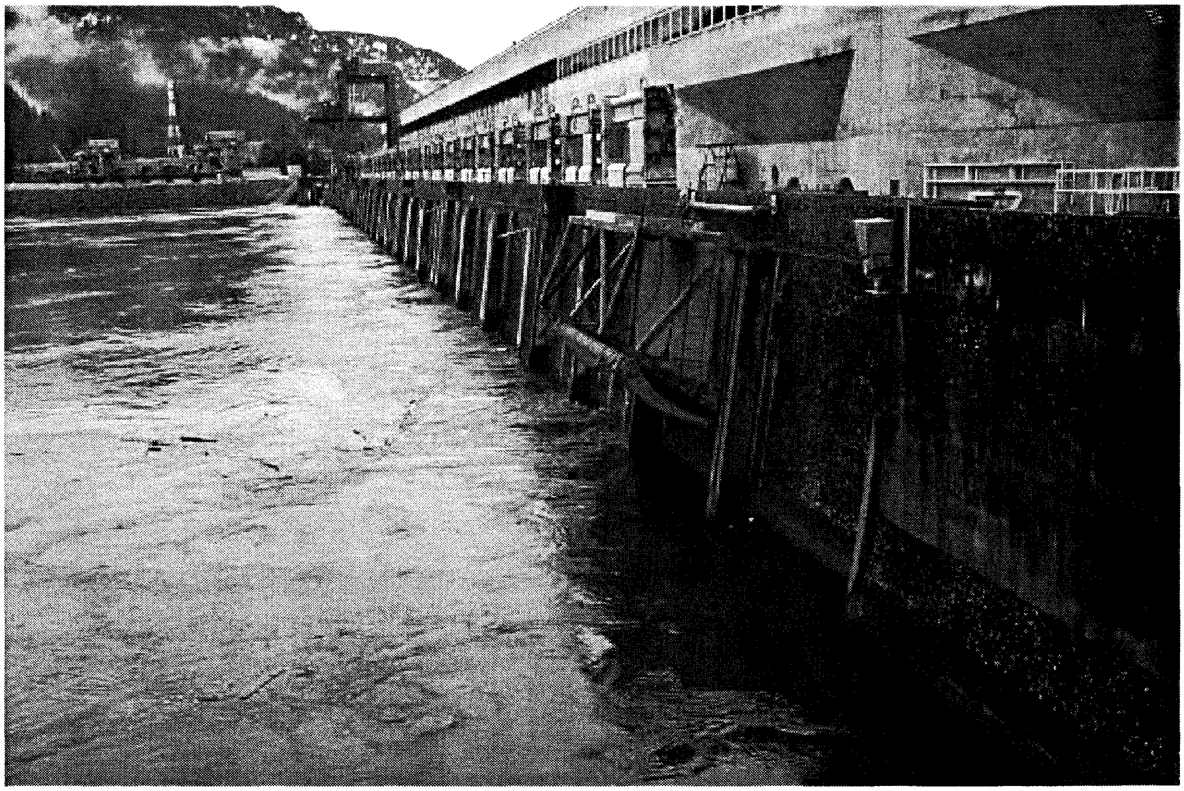


Photo 2. Fish Unit Trash Rack Rake

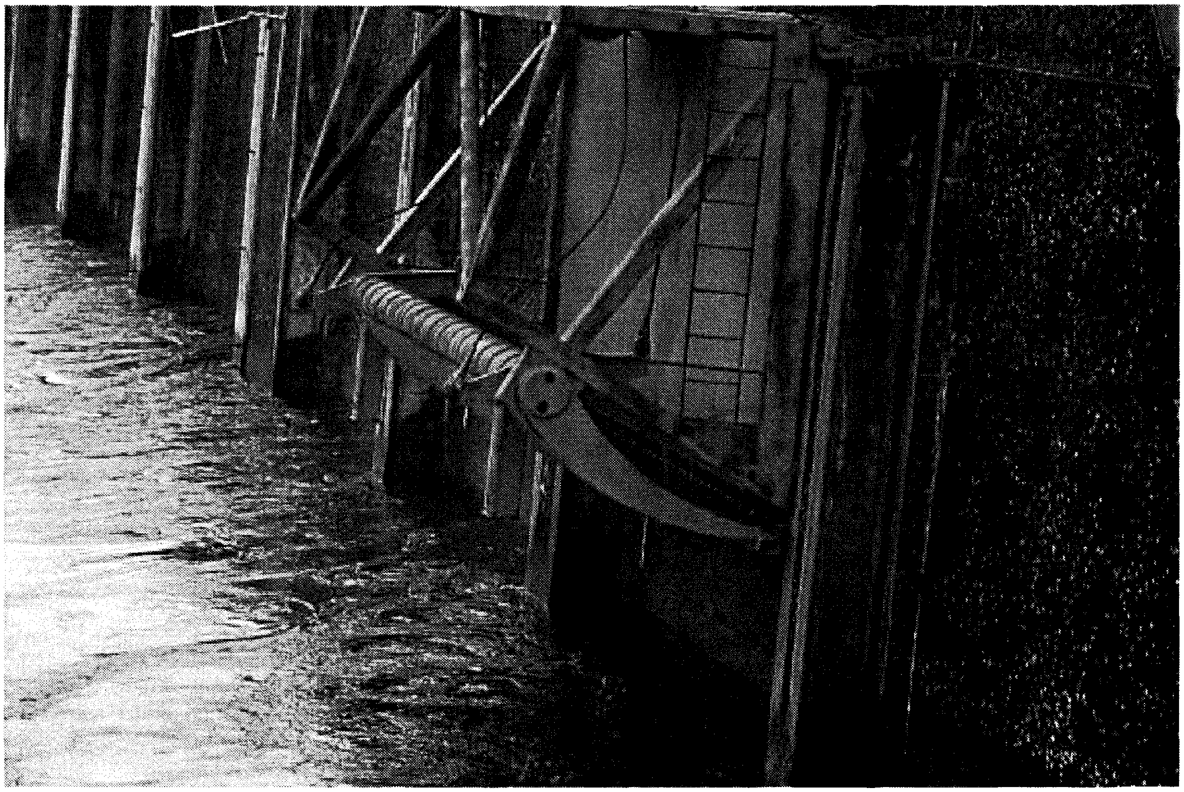


Photo 3. Thrash Rake Teeth

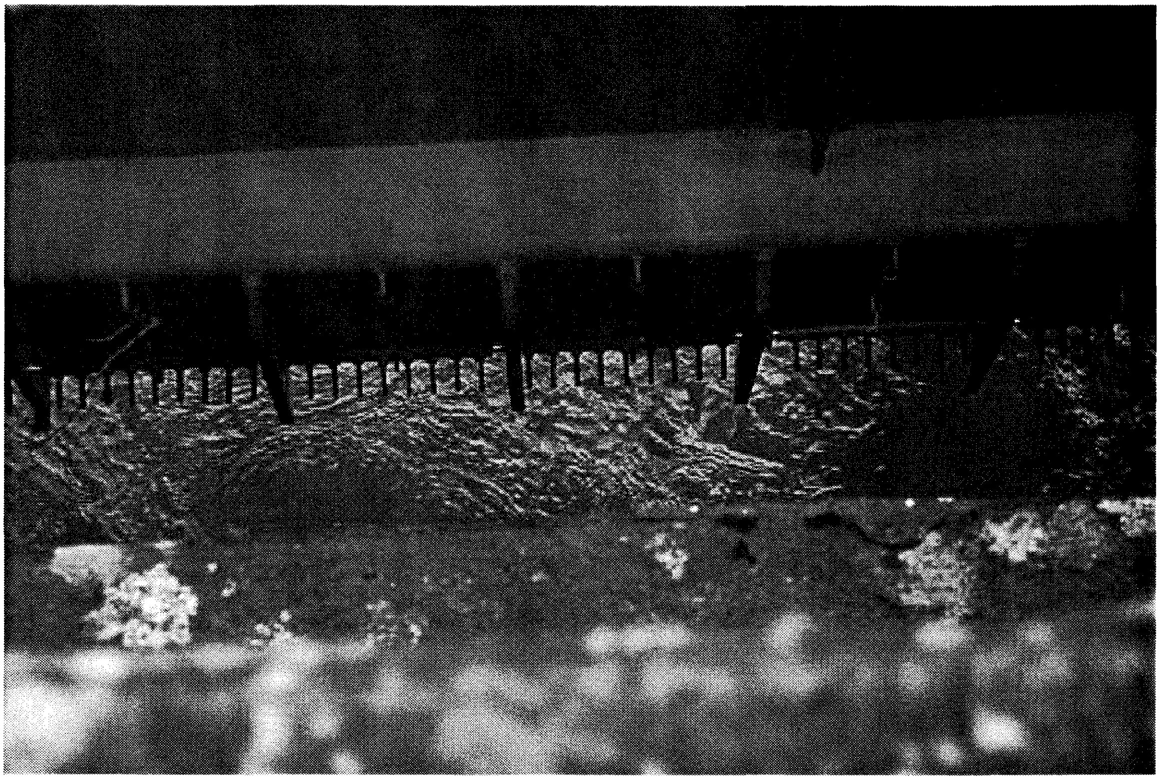


Photo 4. Debris Clogged Fish Unit Trash Rack

Photo 5. Debris Clogged Fish Unit Trash Rack

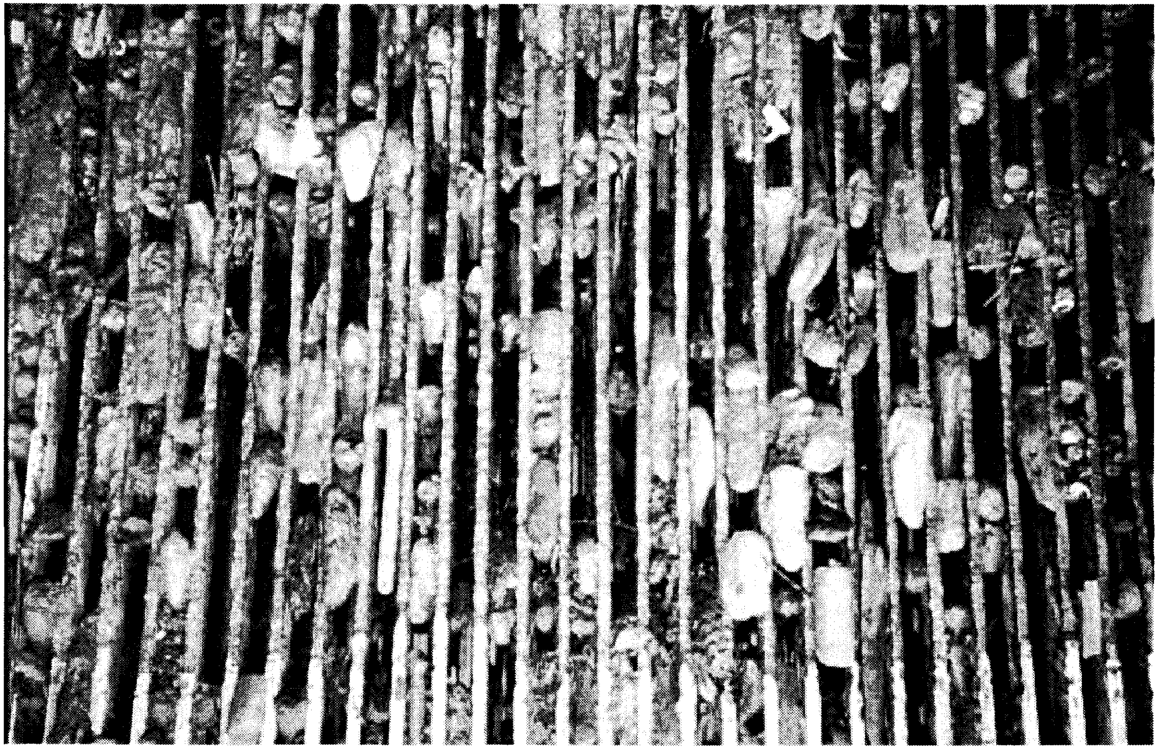
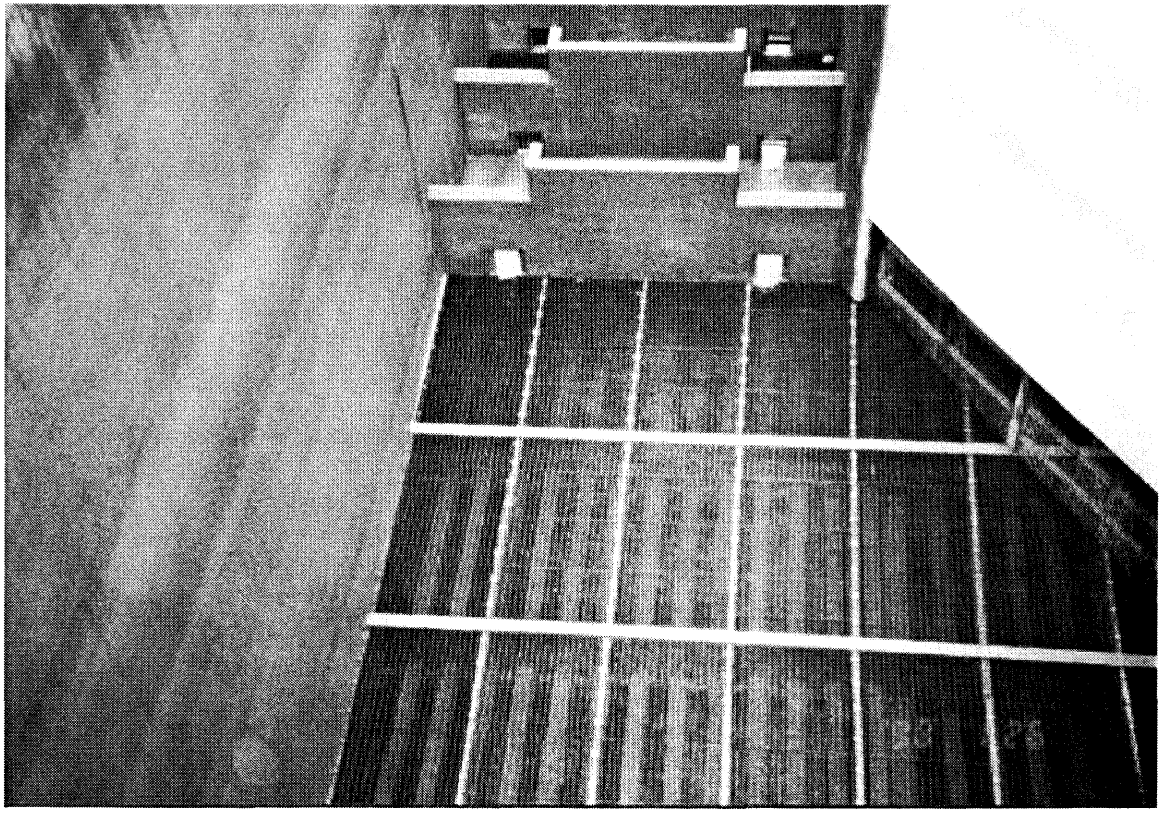
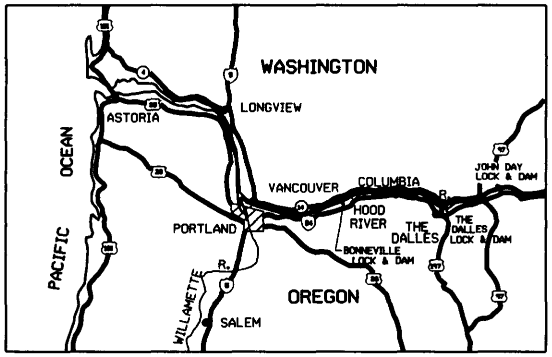
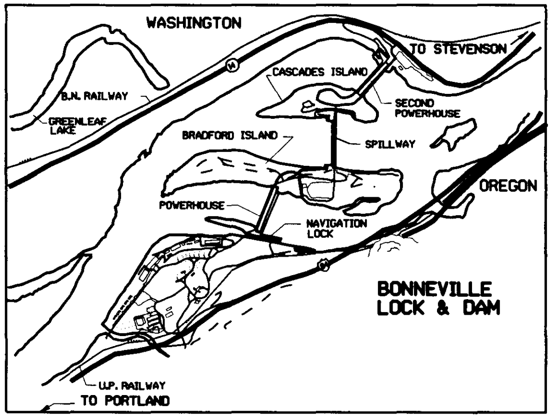


Photo 6. New Diffuser Gratings

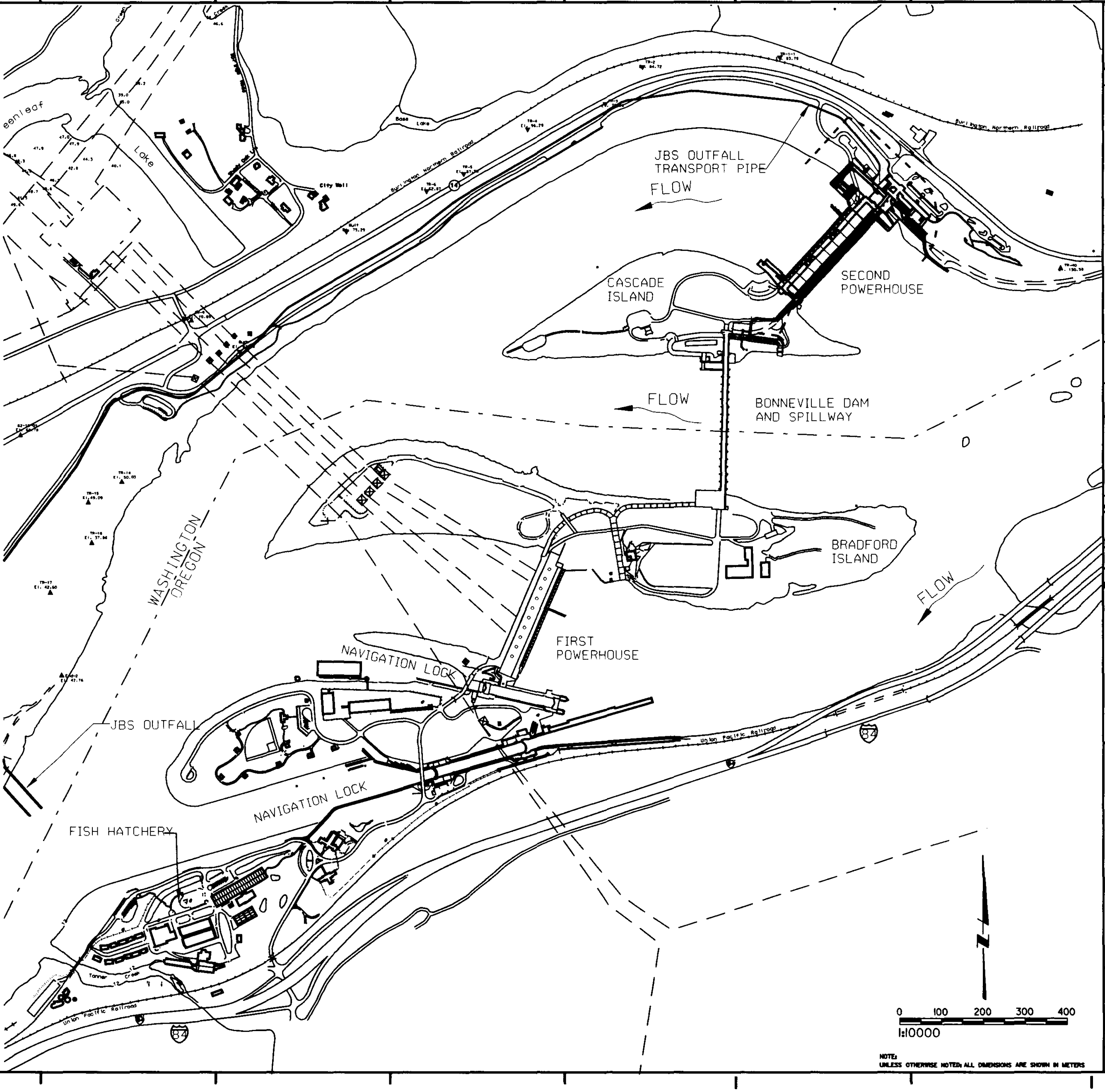




VICINITY MAP



LOCATION MAP



NOTE:
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

US Army Corps of Engineers
Portland District

Designed by: D. PATRICK	Date: 27 SEPT 1999
Drawn by: D. PATRICK	CADD File Name: BONPLATE01.DGN
Checked by:	Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	

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

MONTGOMERY WATSON

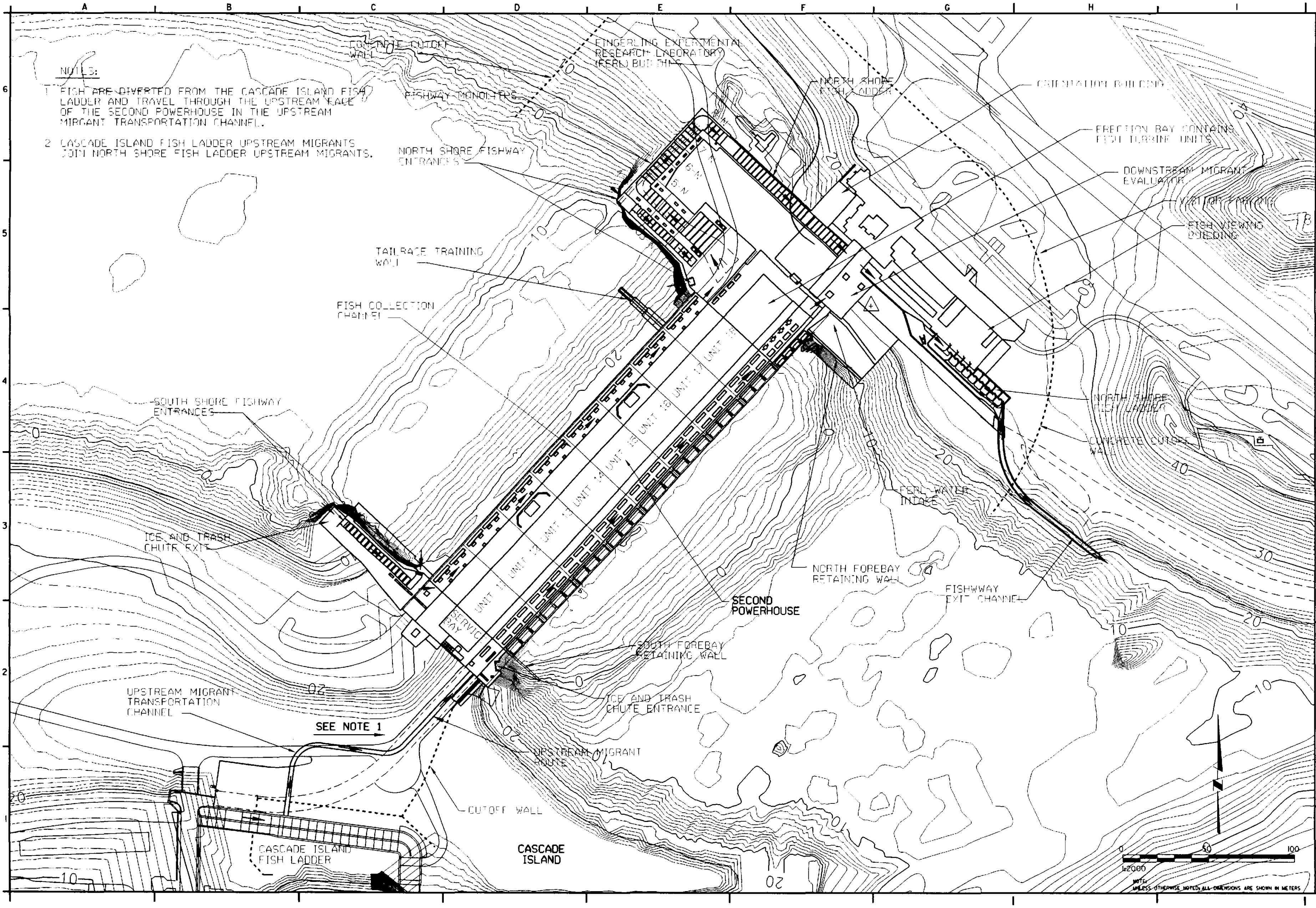
COLUMBIA RIVER
BONNEVILLE LOCK AND DAM
OREGON - WASHINGTON
SECOND POWERHOUSE

LOCATION AND VICINITY MAP
AND SITE PLAN

DRAWING STATUS:

DRAWING NO.

PLATE
1



NOTES:

1 FISH ARE DIVERTED FROM THE CASCADE ISLAND FISH LADDER AND TRAVEL THROUGH THE UPSTREAM FACE OF THE SECOND POWERHOUSE IN THE UPSTREAM MIRGANT TRANSPORTATION CHANNEL.

2 CASCADE ISLAND FISH LADDER UPSTREAM MIGRANTS JOIN NORTH SHORE FISH LADDER UPSTREAM MIGRANTS.

NOTE:
UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE SHOWN IN METERS

US Army Corps
of Engineers
Portland District

Designed by: D. PATRICK
Date: 27 SEPT 1999
Drawn by: D. PATRICK
CADD File Name: BONPLATE02.DGN
Checked by:
Technical Manager:
Submitted by: DALE S. MAZAR, P.E.
Acting Chief, Struct. & Arch. Design

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

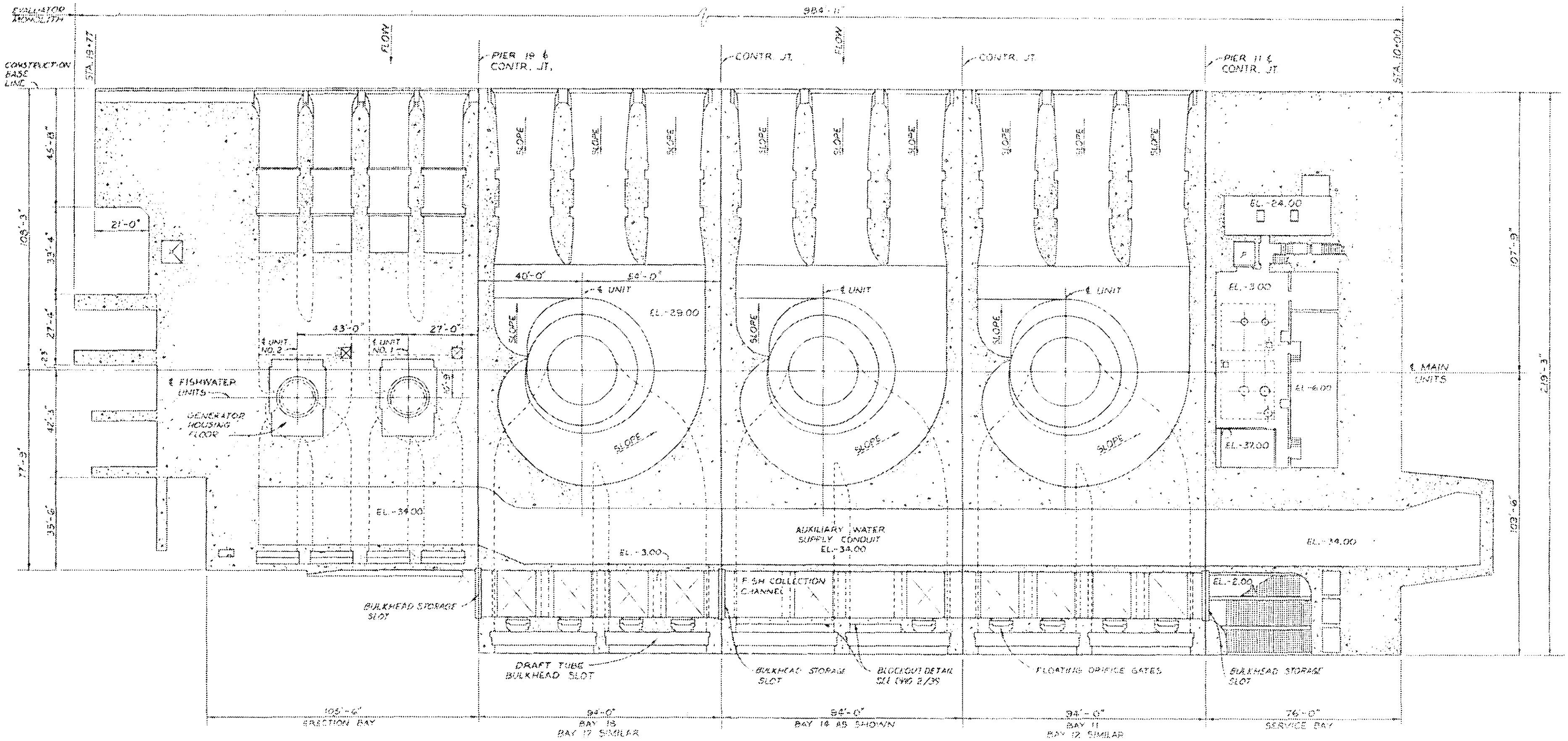
COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE LOCK AND DAM
SECOND POWERHOUSE

SITE PLAN
EXISTING FACILITIES

DRAWING STATUS:

DRAWING NO.

PLATE
2



PLAN EL. 0.875
SCALE: 1/16" = 1'-0"

US Army Corps
of Engineers
Portland District

Designed by:	Date: 27 SEPT 1999
Drawn by: D. PATRICK	CADD File Name:
Checked by:	Technical Manager:
Submitted by: DALE S. MAZAR, P.E. Acting Chief, Struct. & Arch. Design	

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

MONTGOMERY WATSON

COLUMBIA RIVER — OREGON — WASHINGTON
BONNEVILLE LOCK AND DAM

DRAWING STATUS:

DRAWING NO.

APPENDIX L

DATA REPORT

CEERD-HR-F (1110-2-1403b) 4 August 2000

MEMORANDUM FOR Commander, U.S. Army Engineer District, Walla Walla,
ATTN: CENWW-ED-D (Mr. Martin Ahmann),
201 North Third Avenue, Walla Walla, WA 99362

SUBJECT: Data Report, Bonneville Second Powerhouse Debris Model Study

1. The attached Memorandum For Record and videotape document the subject study conducted between December 1998 and November 1999. Velocity patterns and sediment tracers for the as-built condition and for 12 alternatives were documented. These included two sill designs, one fill design, eight deflector designs and a dredged channel design.

2. An existing 1:40-scale Bonneville Second Powerhouse model was used to conduct this study. Model controls were recalibrated and the inflow was modified to more closely match observed flow conditions. Model operations were based on full powerhouse flows with ties in place and the upstream pool at elevation 74.5.

3. Any questions regarding the study should be directed to Mr. Chuck Tate at 601-634-2120.

/s/
THOMAS W. RICHARDSON
Acting Director
Coastal and Hydraulics Laboratory

CEERD-HR-F (1110-2-1403b)

MEMORANDUM FOR RECORD

SUBJECT: Data Report, Bonneville Second Powerhouse Debris Study

1. This data report documents the observations for several options for improving the debris accumulation in front of the Fish Units (FU) (originally the Erection Bays) on the north end of the Bonneville Second Powerhouse. A videotape is included as part of the documentation. Debris accumulation in this area has caused clogging of screens associated with fish facilities on the north side of the powerhouse. Based on this problem, this study was conducted to evaluate several alternatives to prevent the debris accumulation in front of the FU. This Memorandum For Record (MFR) documents the subject study conducted between December 1998 and November 1999. Velocity patterns and sediment tracers for the as-built condition and for 12 alternatives were documented. These included two sill designs, one fill design, eight deflector designs and a dredged channel design. This MFR represents all experiments conducted for the study. Non-excluded photographs were forwarded to the Portland District during the study. A videotape of the various flow conditions is presently being edited and will be provided at a later date.

2. This study used the existing 1:40-scale physical model of the forebay of the Bonneville Second Powerhouse (figures 1 and 2). Prototype velocities measured approximately 440 ft upstream of the powerhouse (model range 11) were used to calibrate the inflow distribution (figure 3). The mid-depth flow distribution in the model was adjusted by modifying the inflow distribution. Calibration of the turbine releases was verified using volumetric measurements. Model operations were based on releasing 15,600 cfs through each of the eight turbines and 3,000 cfs through each of the two FU. The turbines were set to release 36.3 percent through bay A, 35.2 percent through bay B, and 28.5 percent through bay C. FU released 3,000 cfs each with flow

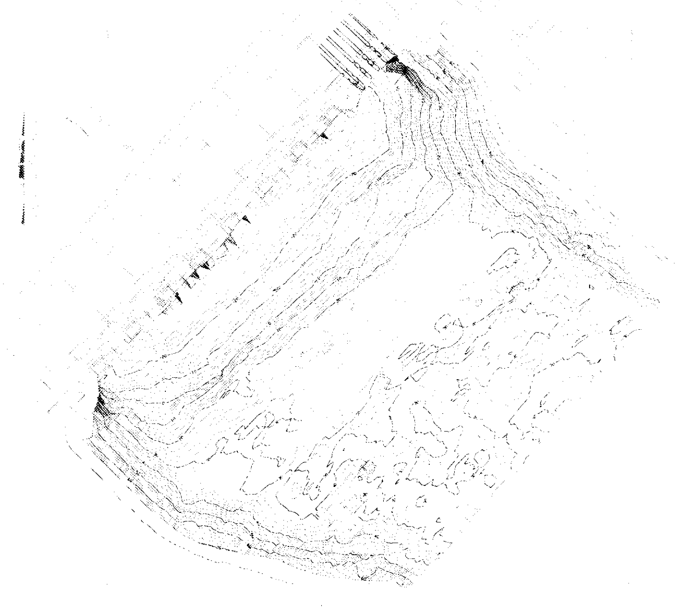


Figure 1: Plan of the Bonneville Second Powerhouse with the 1998 bathymetry

discharged equally through both bays. The upstream pool was maintained at elevation 74.5. The upstream topography was modified in the spring of 1999 to more closely match the 1998 bathymetry. This modification resulted in adding material to the south bank and removing material from the north bank. During this modification a dredged channel was preformed in the north bank and backfilled to the 1998 bathymetry.

Figure 2: Model from the upstream south shore.

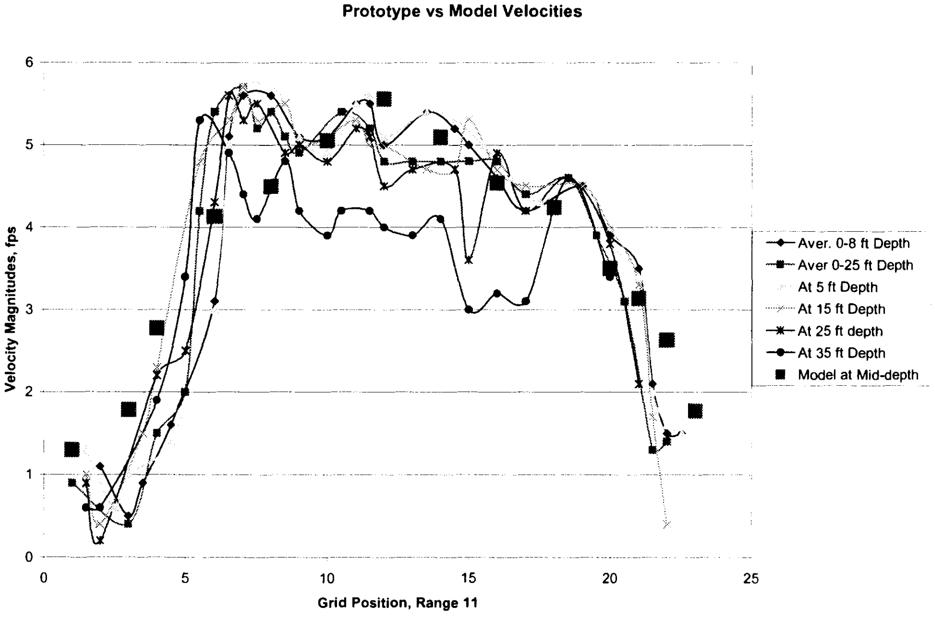


Figure 3: Prototype vs. model velocity magnitude at range 11 (approximately 440 ft upstream of the powerhouse).

4. As-built Design: In general, lateral currents to the north shore started in front of unit 16 and increase in strength in front of units 17 and 18 for surface and bottom flows while mid-level flows entered the turbines with a lateral velocity component. Initial and final tracer patterns are shown in the following photographs (figures 4 and 5).

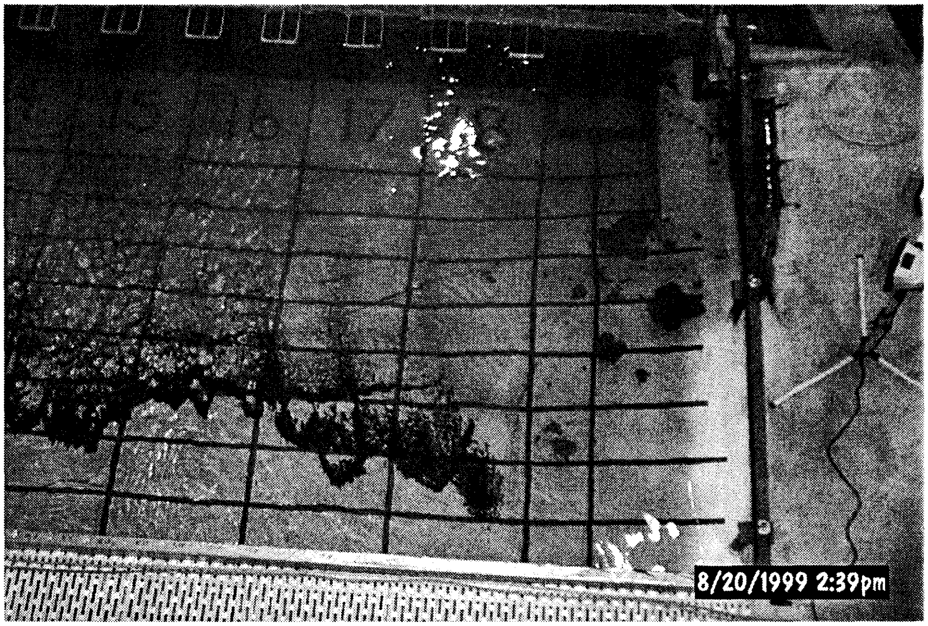


Figure 4: As-built design with initial tracer pattern.

Figure 5: As-built design with final tracer pattern.

5. Sill, Elevation 17.33: A sill with a crest elevation of 17.33 (figure 6) was installed in front of the FU. In general, a clockwise eddy existed in the north corner for surface and bottom flows with mid-level flows being pulled into the turbines. The design and final tracer pattern are shown in the following photograph (figure 7).

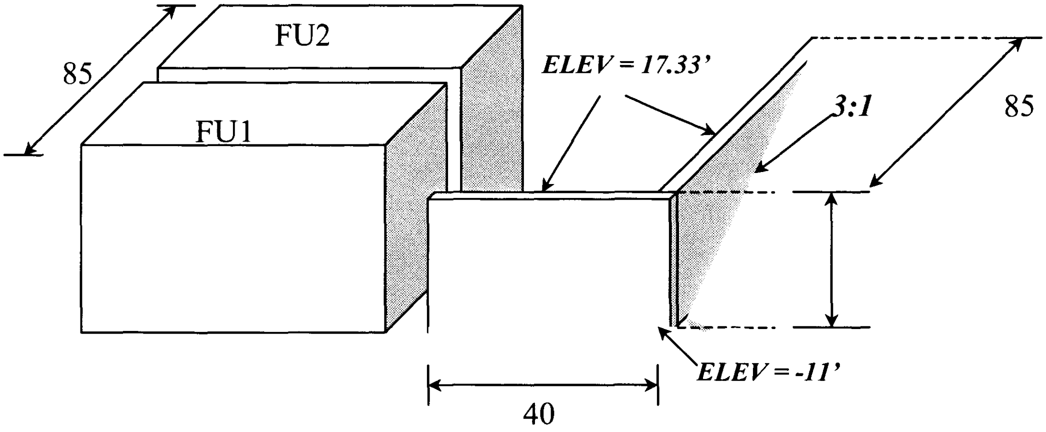


Figure 6: Sill at elevation 17.33: Orthogonal view of sill placed in front of the two fish units on the north shore of Bonneville's Second Powerhouse to prevent debris accumulation in front of and inside of the fish units.

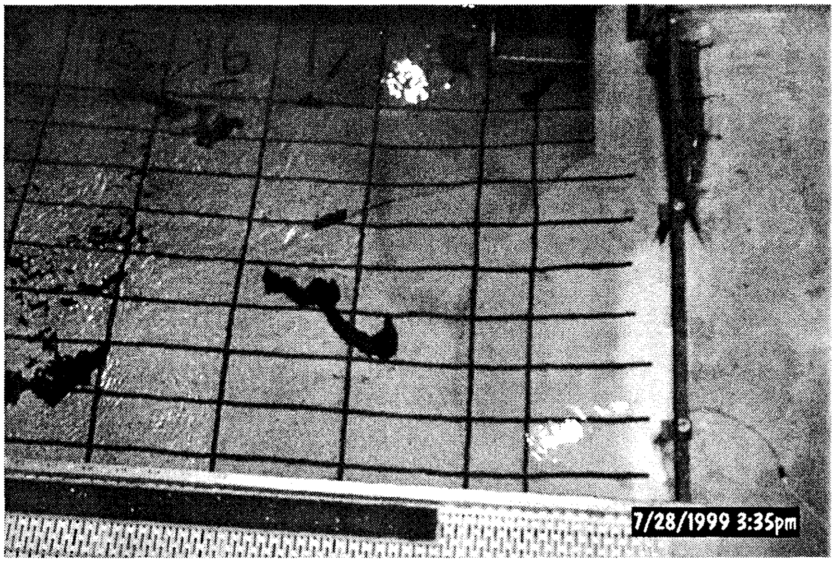


Figure 7: Sill at elevation 17.33 with the final tracer pattern.

6. Sill, Elevation 0.33: A sill at elevation 0.33 was installed in front of the FU as shown in figure 8. Flow patterns were generally the same as for the other sill and the as-built condition. The final tracer pattern is shown in the following photograph (figure 9).

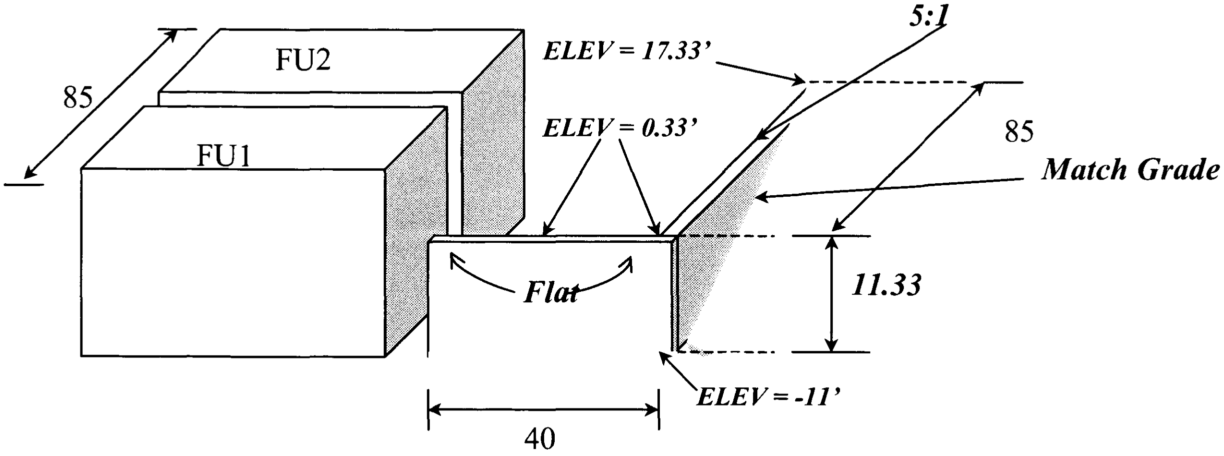


Figure 8: Sill at elevation 0.33

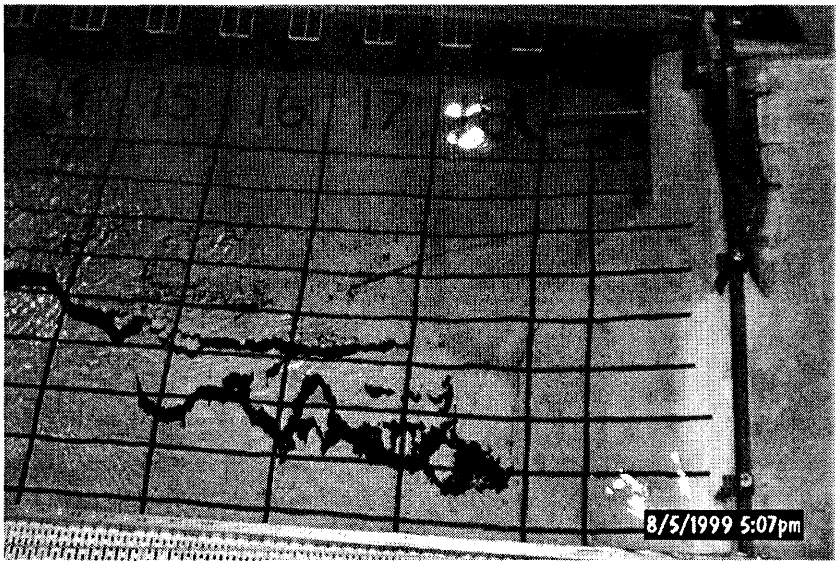
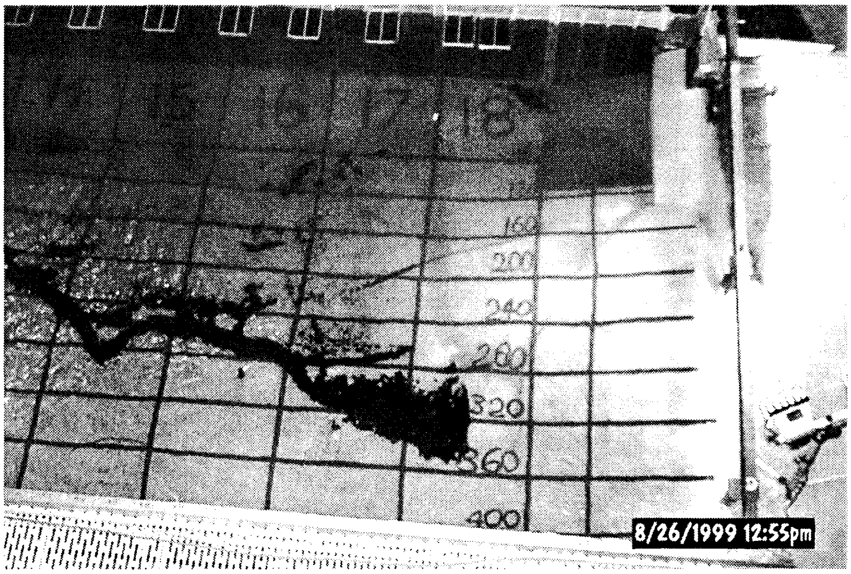


Figure 9: Sill at elevation 0.33 with the final tracer pattern.

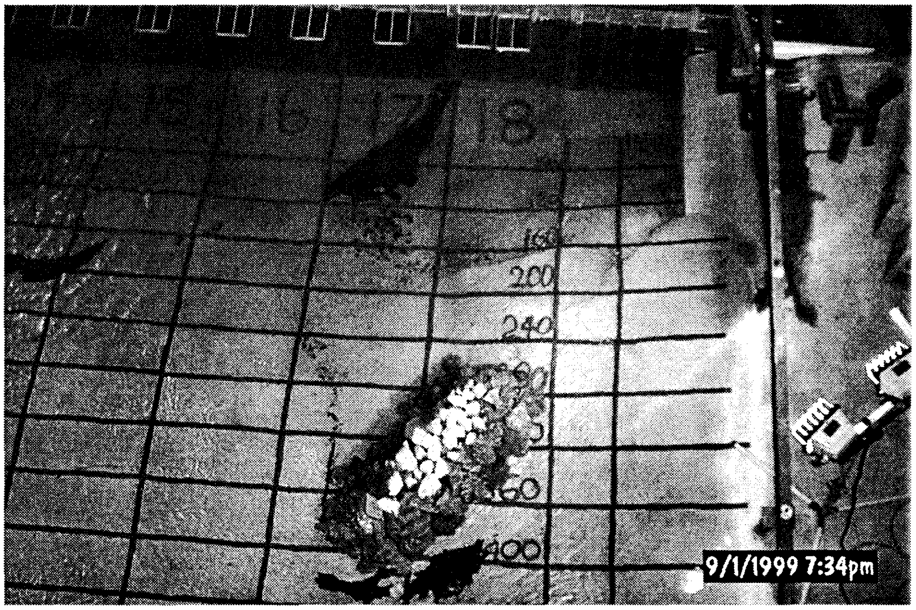
7. Sloping fill in front of the FU: Flow conditions were essentially the same as for the as-built design. Lateral flow to the north shore was slightly stronger on the bottom in front of the FU. The design and the residual tracer are shown in the following photograph (figure10).



8/26/1999 12:55pm

Figure 10: Side slope fill with final tracer photo.

8. Deflectors 1-8: Stone dikes were constructed in front of the northern section of the powerhouse to deflect some of the approaching flow to the north bank with the intention of pushing the flow from the north bank towards unit 18. This would prevent deposits from forming in front of the FU and eliminate the surface eddy in front of the FU. The dikes had approximately 1 on 1 side slopes and were constructed of large stone. All deflector designs formed an eddy between the deflector and the powerhouse. Deflectors 6-8 caused flushing flow in front of the FU but still retained a minor surface eddy along the north shore. Deflector 8 had the least amount of surface eddy. The alignment and final tracer patterns are shown in the following photographs (figures 11-18).



9/1/1999 7:34pm

Figure 11: Deflector 1 with the final tracer pattern.

Figure 12: Deflector 2 with the final tracer pattern.

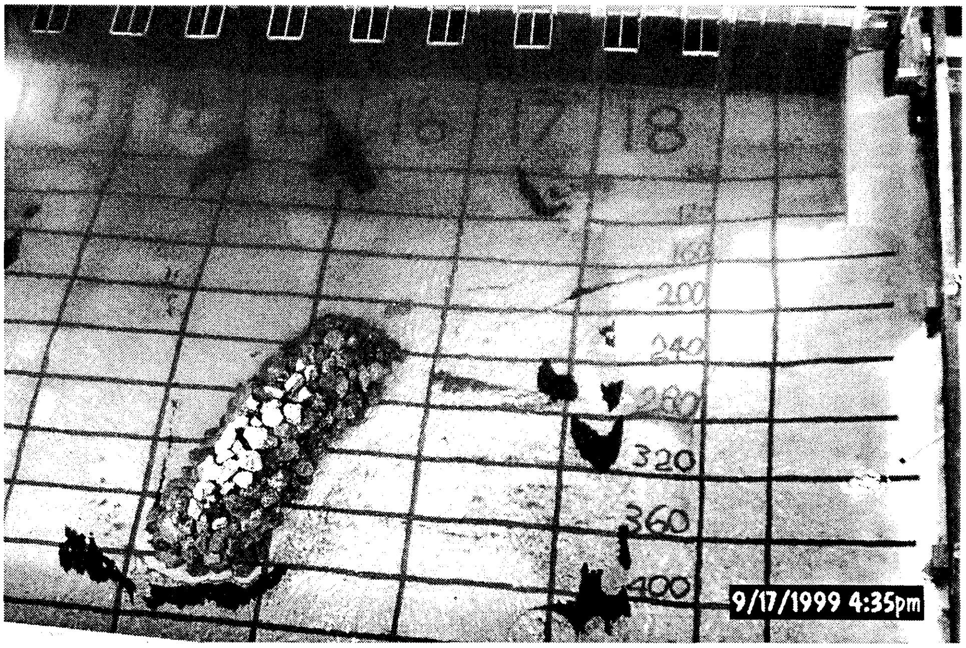
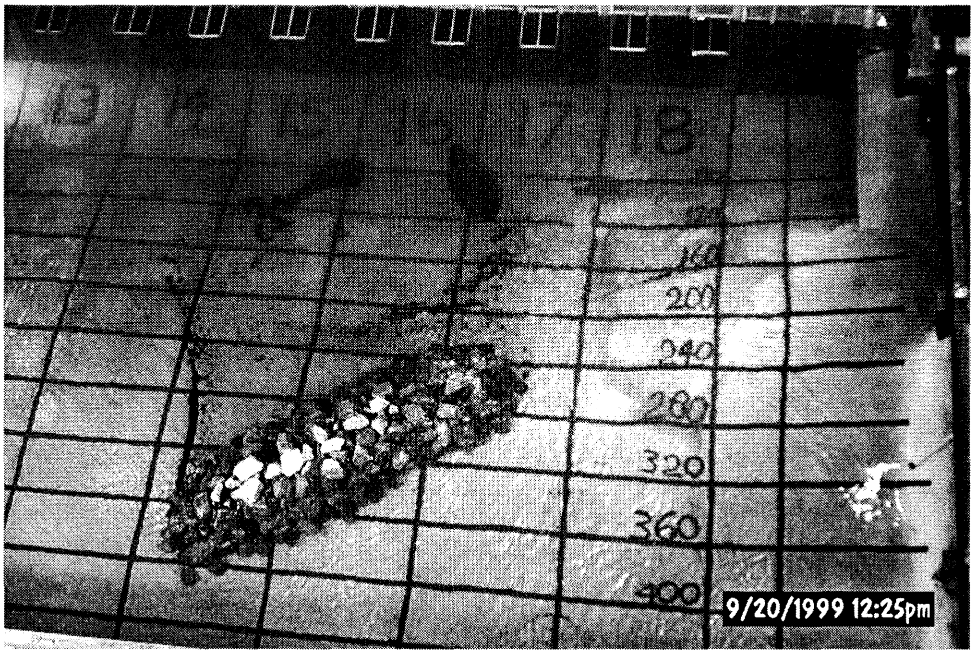


Figure 13: Deflector 3 with the final tracer pattern.

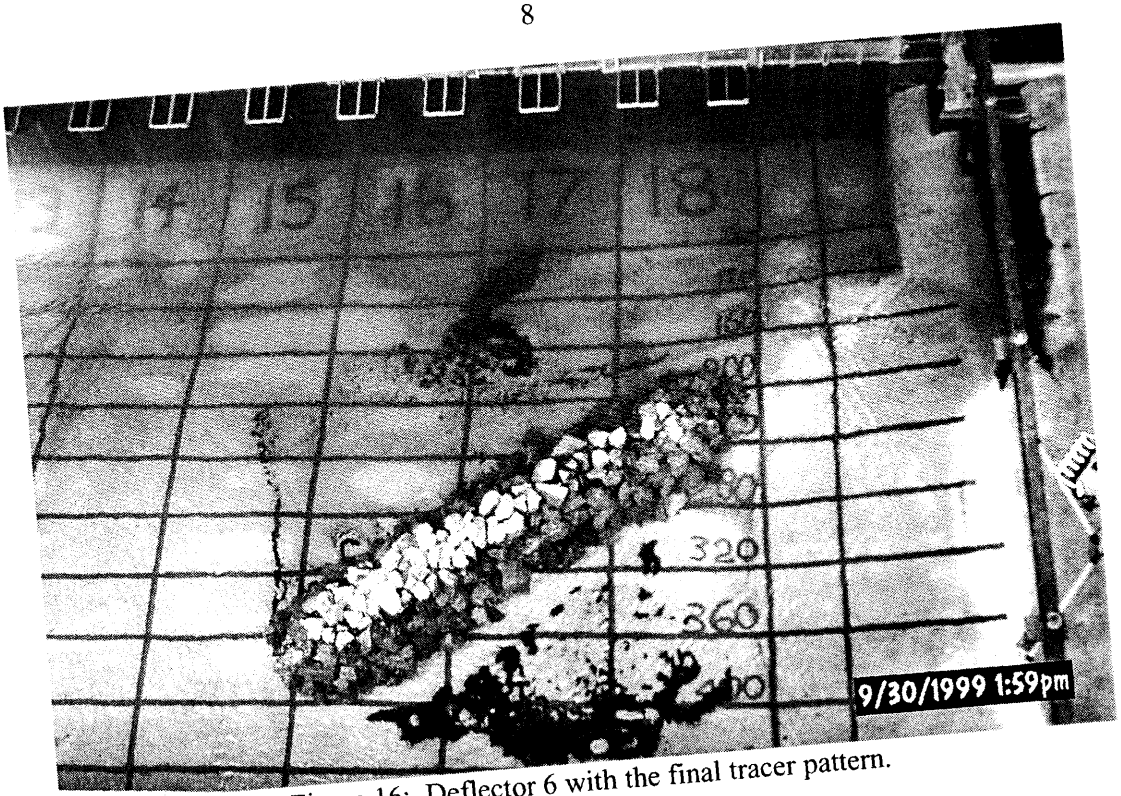


9/20/1999 12:25pm

Figure 14: Deflector 4 with the final tracer Pattern.

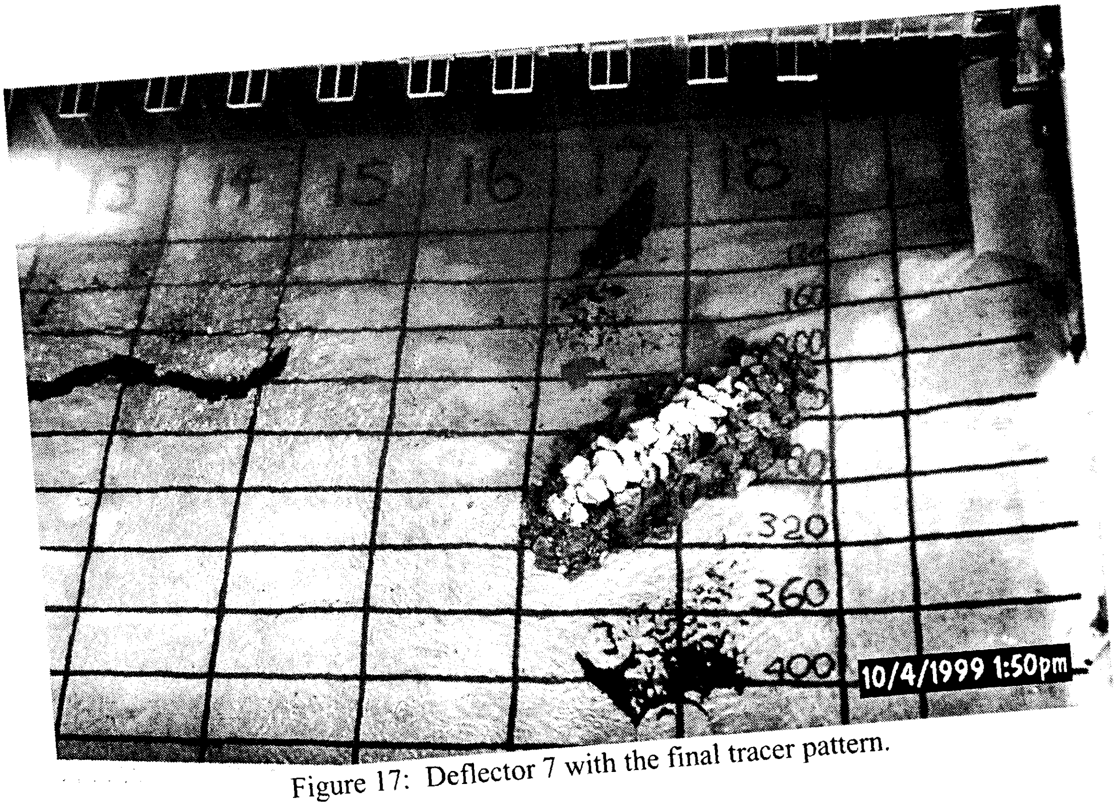
9/24/1999 1:59pm

Figure 15: Deflector 5 with the final tracer pattern.



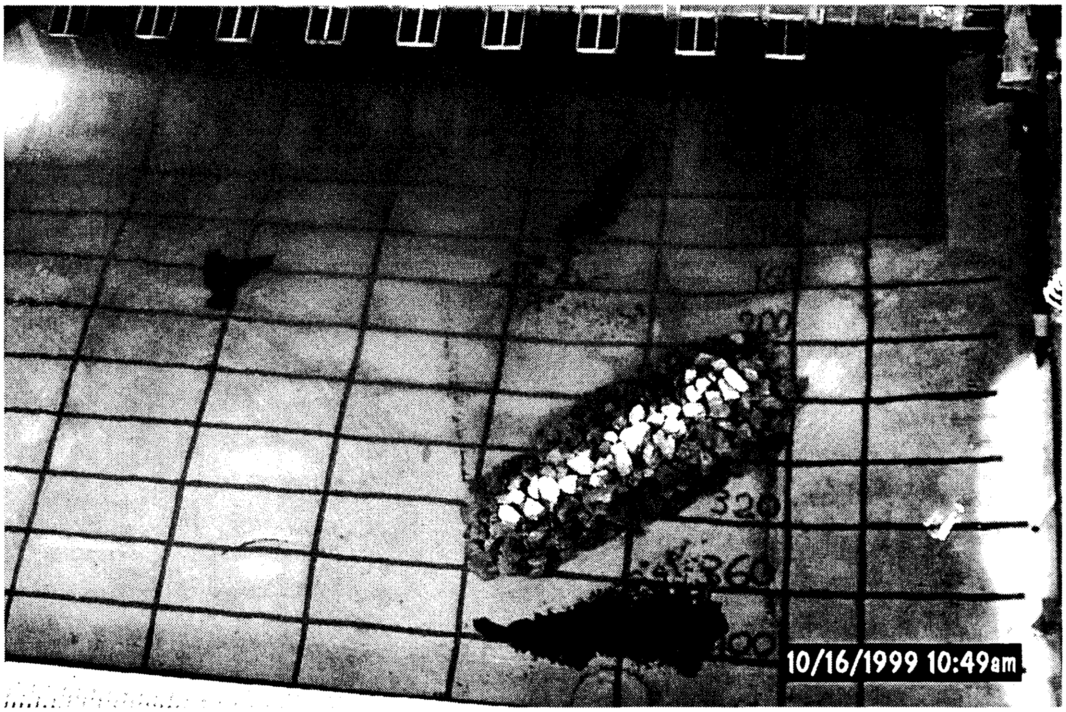
9/30/1999 1:59pm

Figure 16: Deflector 6 with the final tracer pattern.



10/4/1999 1:50pm

Figure 17: Deflector 7 with the final tracer pattern.



10/16/1999 10:49am

Figure 18: Deflector 8 with the final tracer pattern.

9. Dredged channel: The north shore was reformed to simulate the maximum dredged cut envisioned by NWP personnel. For this design, flow along the face of the powerhouse was changed with approaching flow increased along the north shore and flow along the face of the powerhouse being directed into the turbines or having a southerly directional component. An eddy did exist in front of the FU, however flow was strong enough to flush this area. The final tracer arrangement is shown in the following photograph (figure 19).

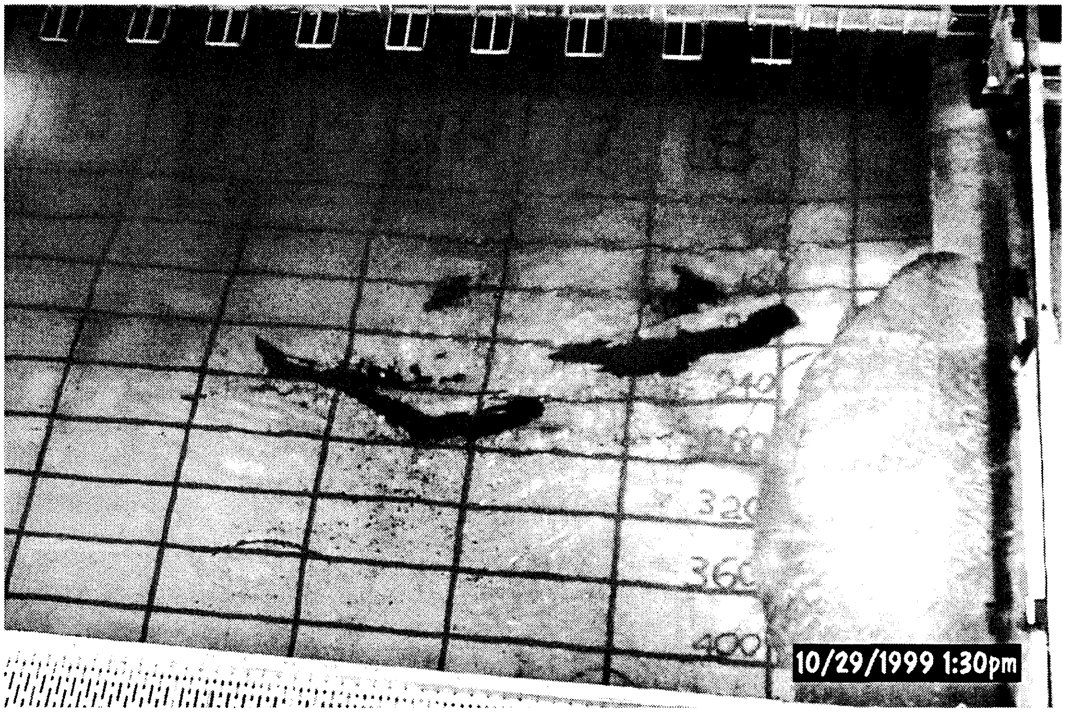


Figure 19: Dredged channel with final tracer pattern.

10. No additional designs were documented. Model operations ended in November 1999.

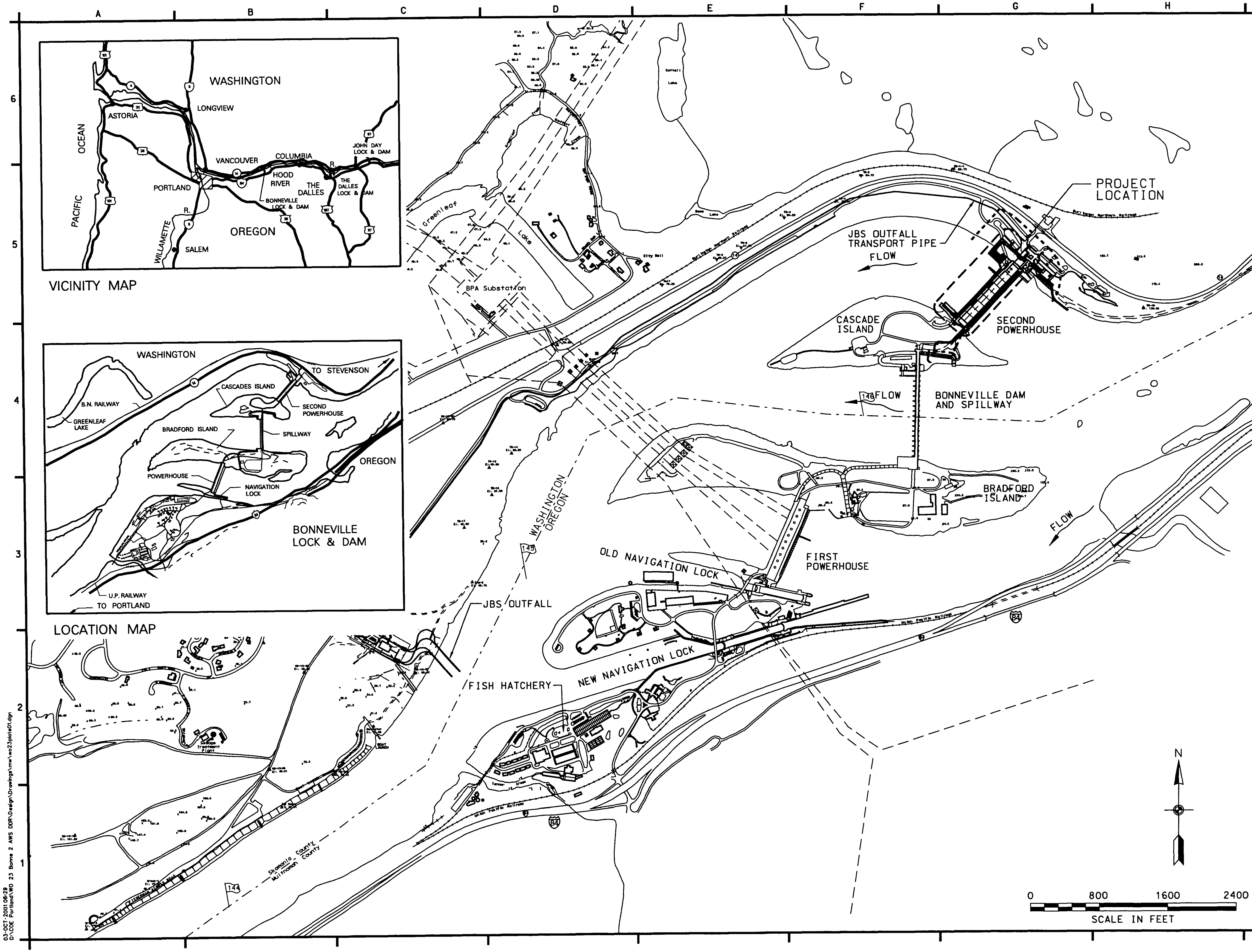
CHUCK TATE
Research Hydraulic Engineer
Coastal and Hydraulics Laboratory

APPENDIX X

PLACE HOLDER

APPENDIX XX

PLACE HOLDER



US Army Corps of Engineers
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Revision	Date	Description	By

Designed by:
POSTLEWAITE

Drawn by:
PATRICK

Checked by:

Submitted by:

Date:
26 SEP 01

CADD File Name:
WO23PLATE01.DGN

Technical Manager:

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PORTLAND, OREGON

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

LOCATION MAP, VICINITY MAP
AND SITE PLAN

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
1

03-OCT-2001 06:29
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03-OCT-2001 06:32
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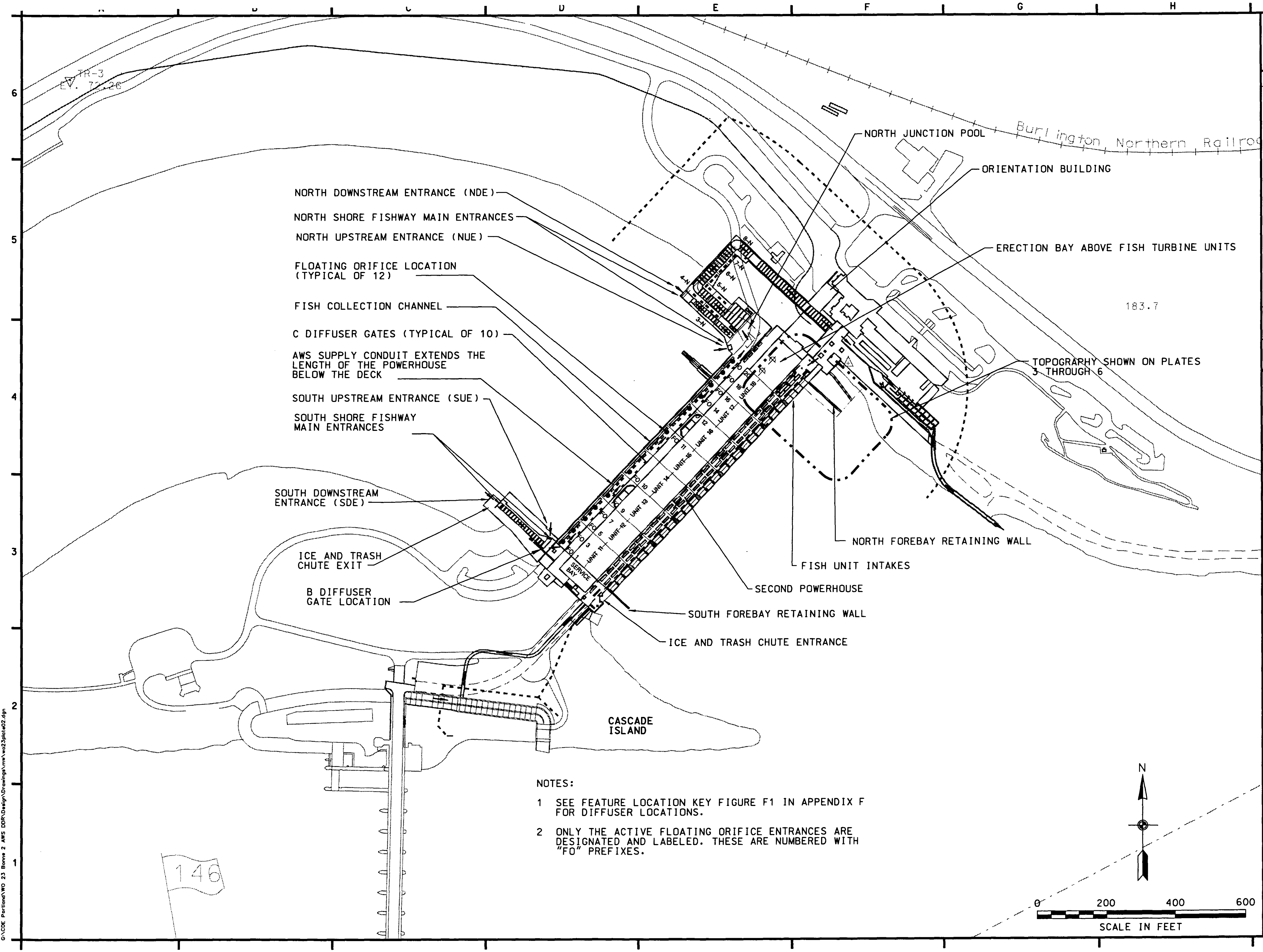

NOTES:

1 SEE FEATURE LOCATION KEY FIGURE F1 IN APPENDIX F FOR DIFFUSER LOCATIONS.

2 ONLY THE ACTIVE FLOATING ORIFICE ENTRANCES ARE DESIGNATED AND LABELED. THESE ARE NUMBERED WITH "FO" PREFIXES.

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AUXILIARY WATER SUPPLY BACKUP
DDR

SITE PLAN
EXISTING FACILITIES

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FINAL

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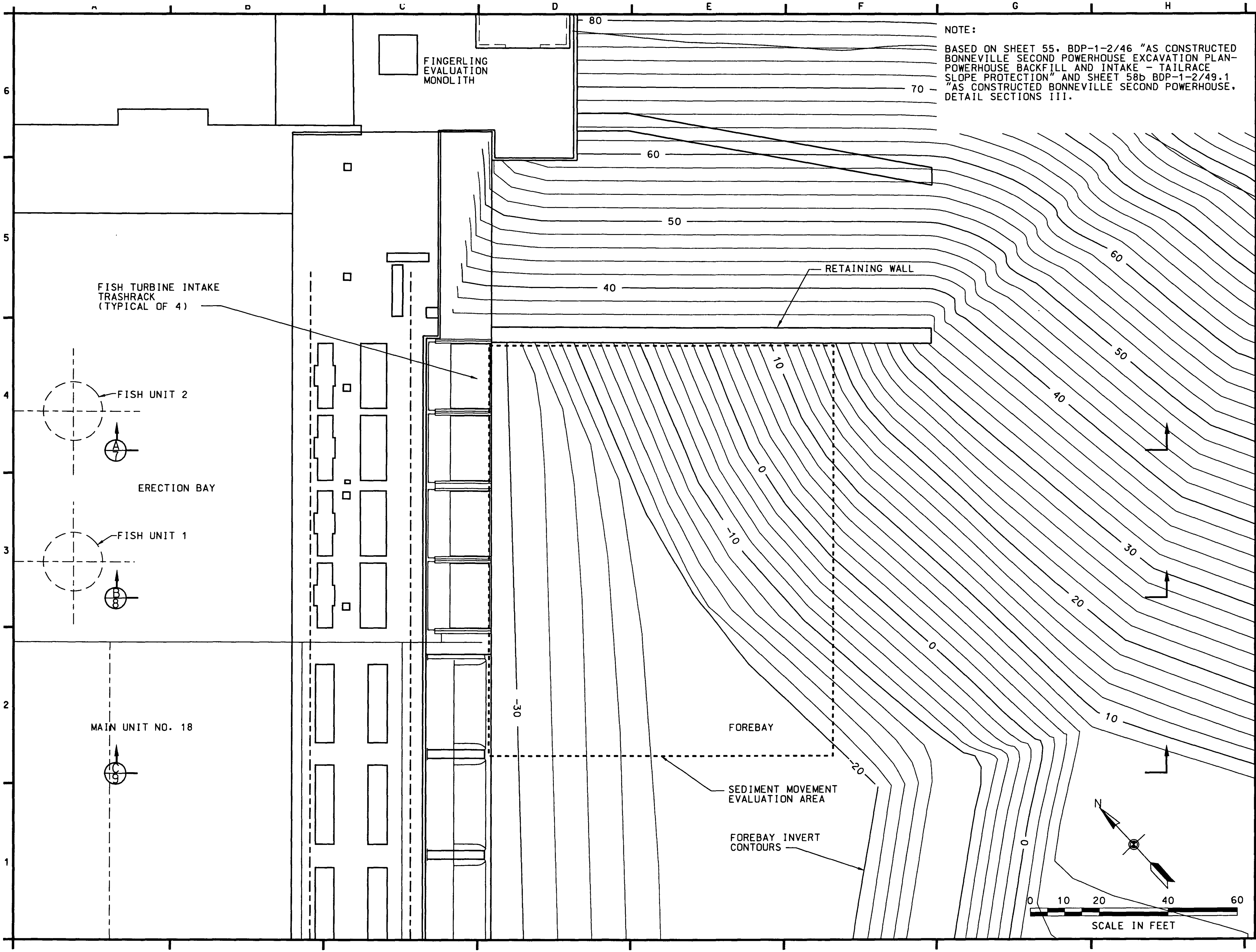
PLATE
2



NOTE:

BASED ON SHEET 55, BDP-1-2/46 "AS CONSTRUCTED BONNEVILLE SECOND POWERHOUSE EXCAVATION PLAN-POWERHOUSE BACKFILL AND INTAKE – TAILRACE SLOPE PROTECTION" AND SHEET 58b BDP-1-2/49.1 "AS CONSTRUCTED BONNEVILLE SECOND POWERHOUSE, DETAIL SECTIONS III.

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BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

1986 BACKFILL GRADE

DRAWING STATUS:
FINAL

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PLATE
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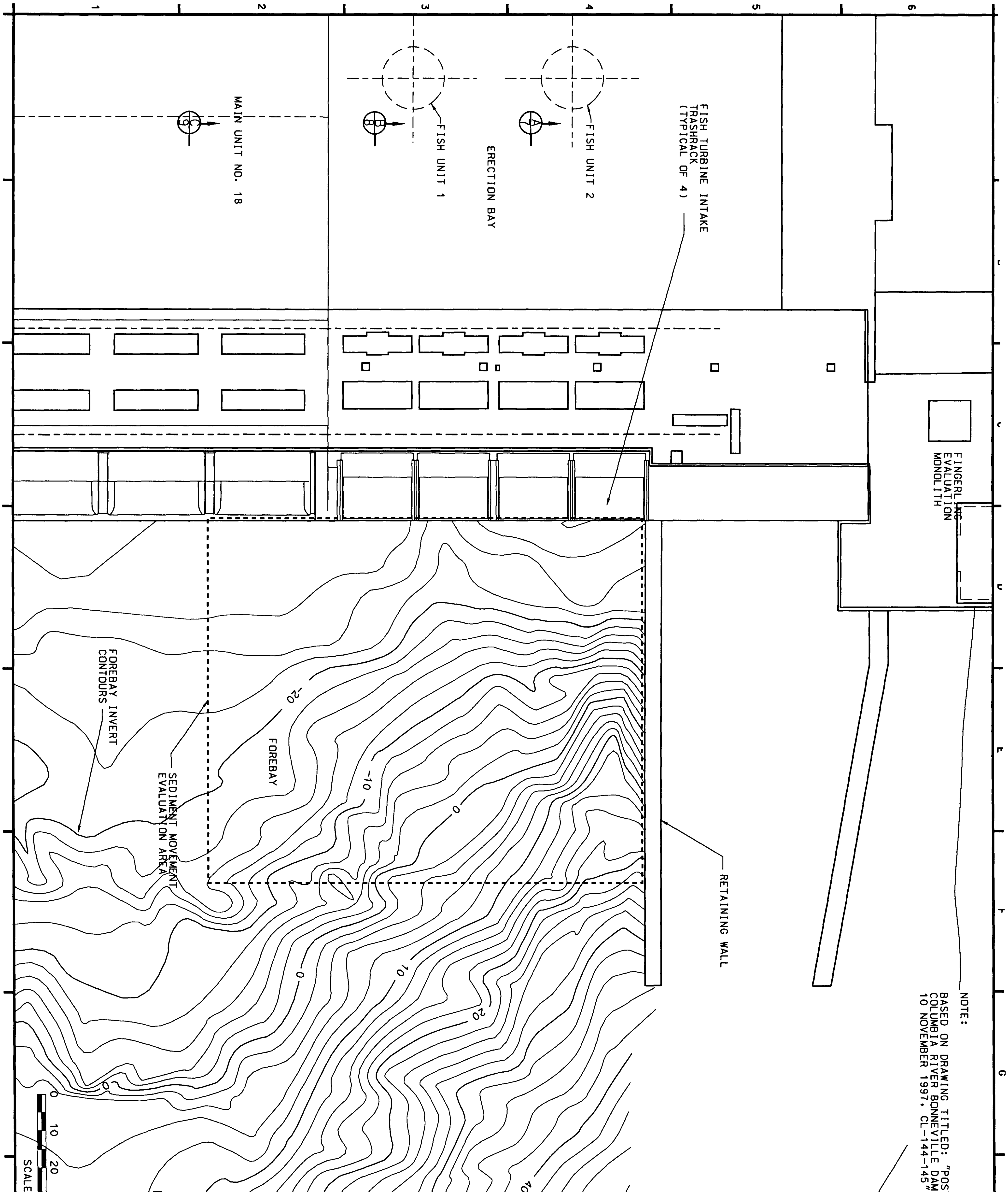

NOTE:
BASED ON DRAWING TITLED: "POST DREDGE SURVEY, COLUMBIA RIVER BONNEVILLE DAM SECOND POWERHOUSE 10 NOVEMBER 1997, CL-144-145".

COLUMBIA RIVER — OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

1997 POST-DREDGE SOUNDINGS

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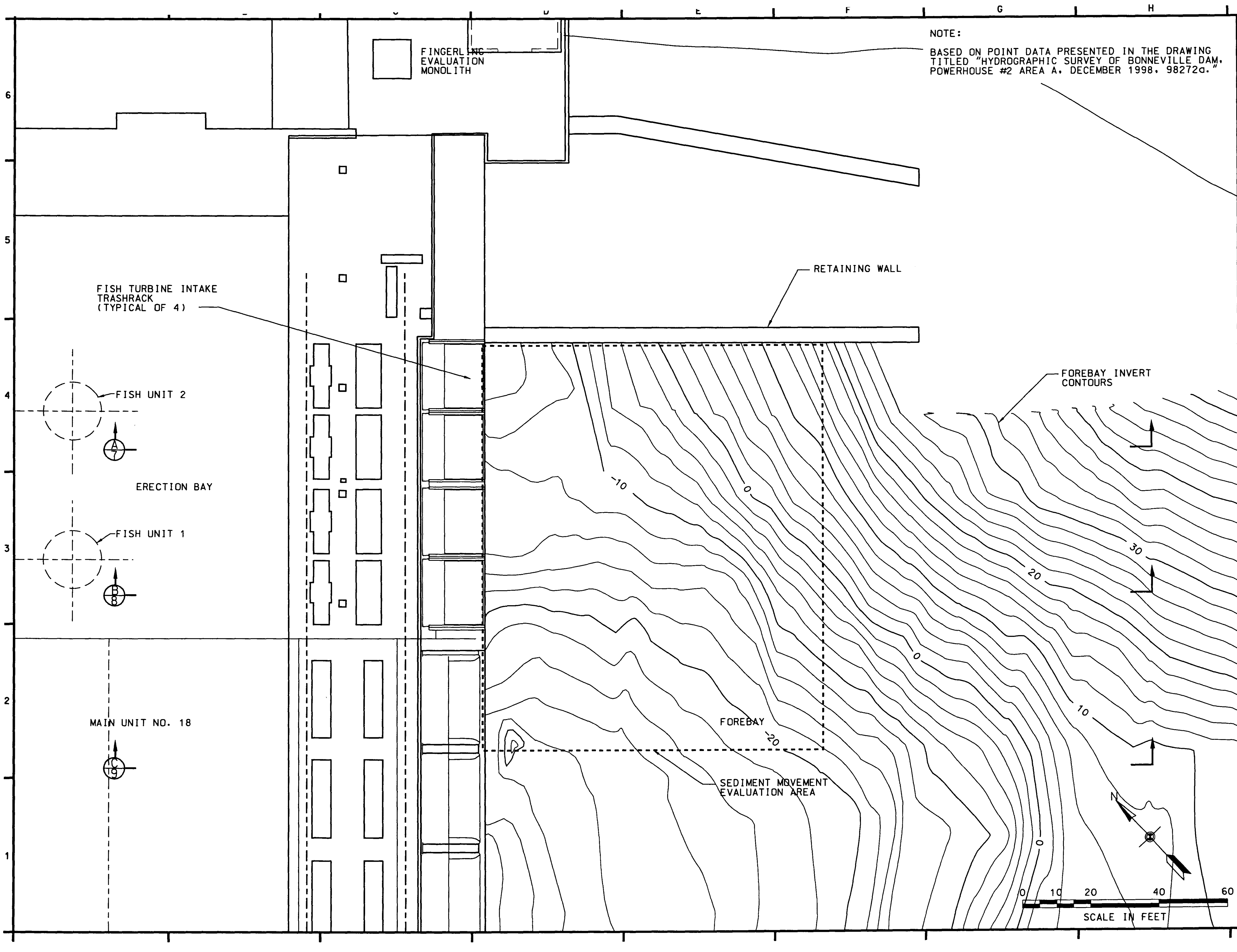
PLATE 4

US Army Corps of Engineers
Portland District



NOTE:

BASED ON POINT DATA PRESENTED IN THE DRAWING TITLED "HYDROGRAPHIC SURVEY OF BONNEVILLE DAM, POWERHOUSE #2 AREA A, DECEMBER 1998, 98272a."

US Army Corps of Engineers
Portland District

Revision	Date	Description	By

Designed by: POSTLEWAITE
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BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

DECEMBER 1998 BATHYMETRY

DRAWING STATUS:
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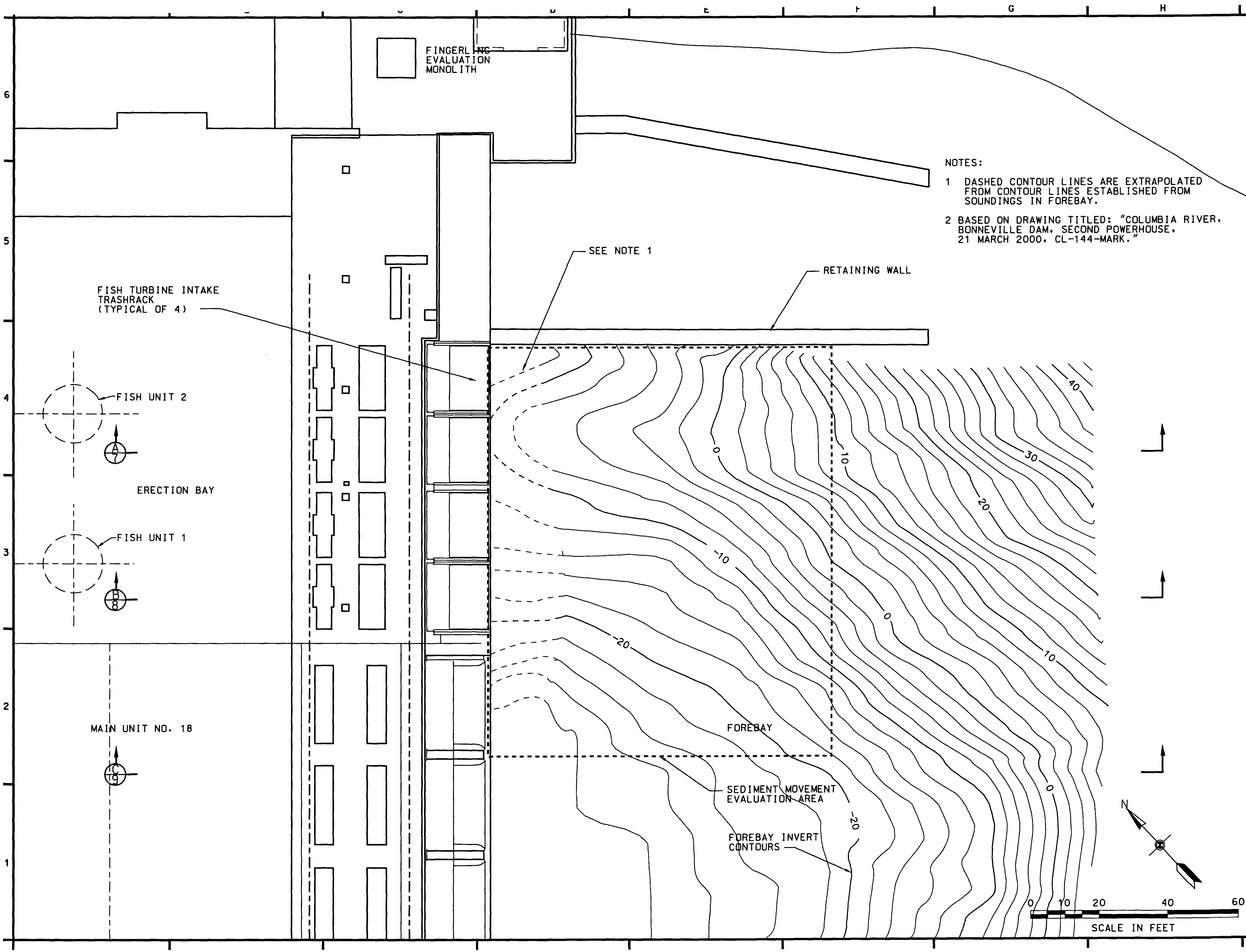

NOTES:

1 DASHED CONTOUR LINES ARE EXTRAPOLATED FROM CONTOUR LINES ESTABLISHED FROM SOUNDINGS IN FOREBAY.

2 BASED ON DRAWING TITLED: "COLUMBIA RIVER, BONNEVILLE DAM, SECOND POWERHOUSE, 21 MARCH 2000, CL-144-MARK."

US Army Corps of Engineers
Portland District

Revision	Date	Description	By

Date:
26 SEP 01
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WO23PLATE06.DGN
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COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

MARCH, 2000 SOUNDINGS

DRAWING STATUS:
FINAL

DRAWING NO.
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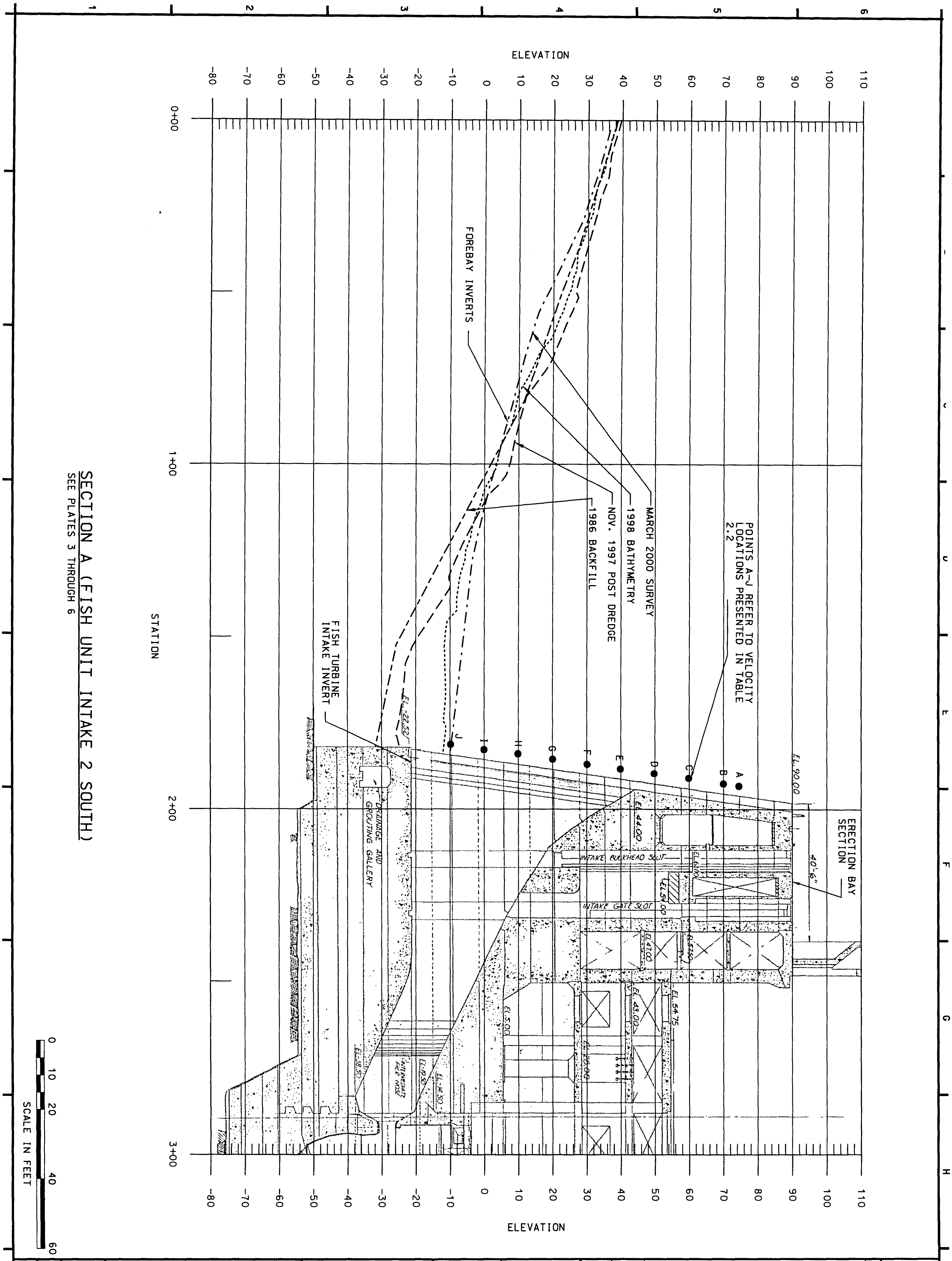

SECTION A (FISH UNIT INTAKE 2 SOUTH)

SEE PLATES 3 THROUGH 6

COLUMBIA RIVER	OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE AUXILIARY WATER SUPPLY BACKUP DDR	
FOREBAY AND B2 POWERHOUSE SECTION A	

DRAWING STATUS: FINAL

DRAWING NO.

PLATE 7

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PORTLAND, OREGON

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JOINT VENTURE

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Submitted by:	

Revision	Date	Description	By

US Army Corps of Engineers
Portland District

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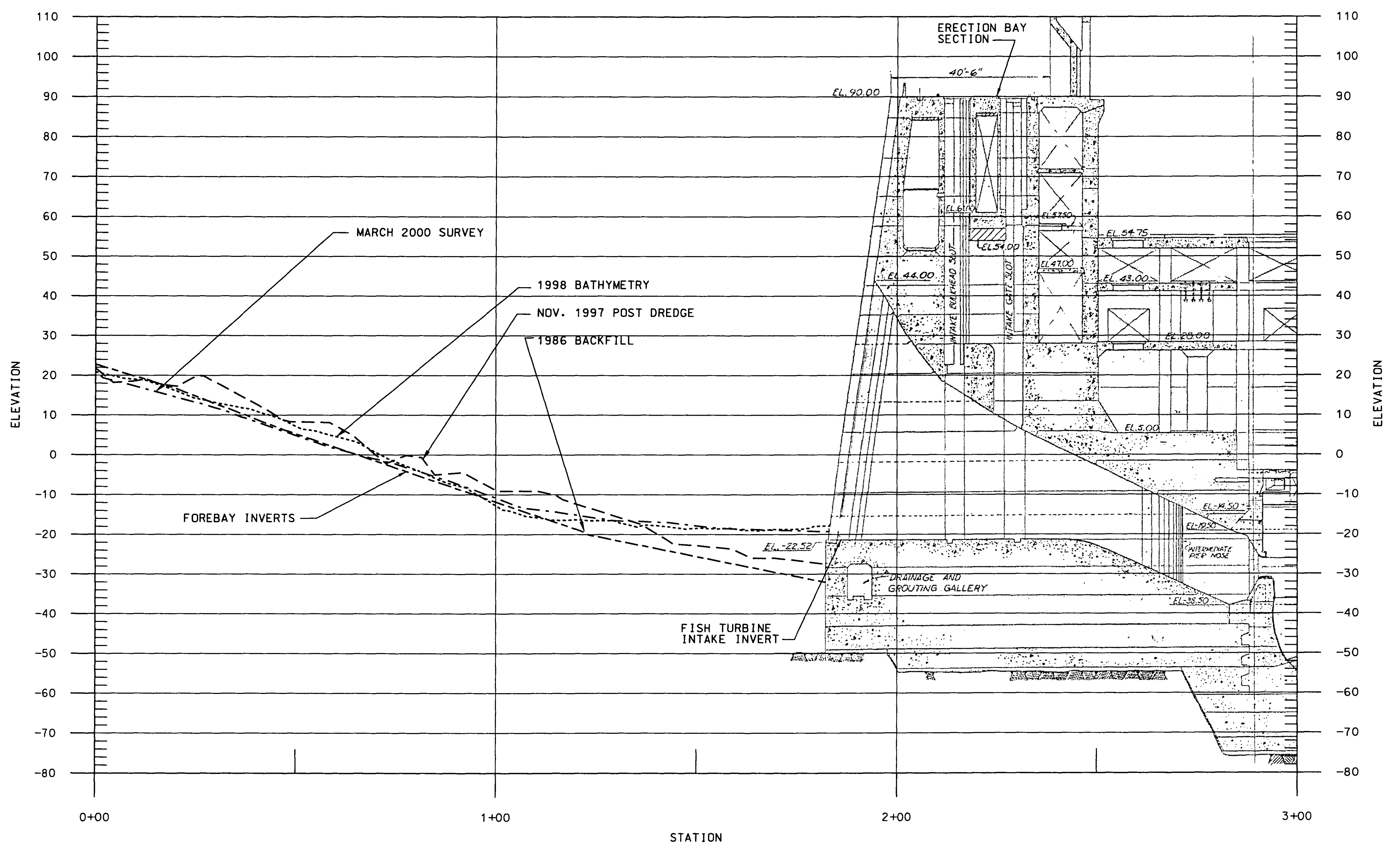

SECTION B (FISH UNIT INTAKE 1 SOUTH)

SEE PLATES 3 THROUGH 6

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Portland District

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BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

FOREBAY AND B2 POWERHOUSE
SECTION B

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
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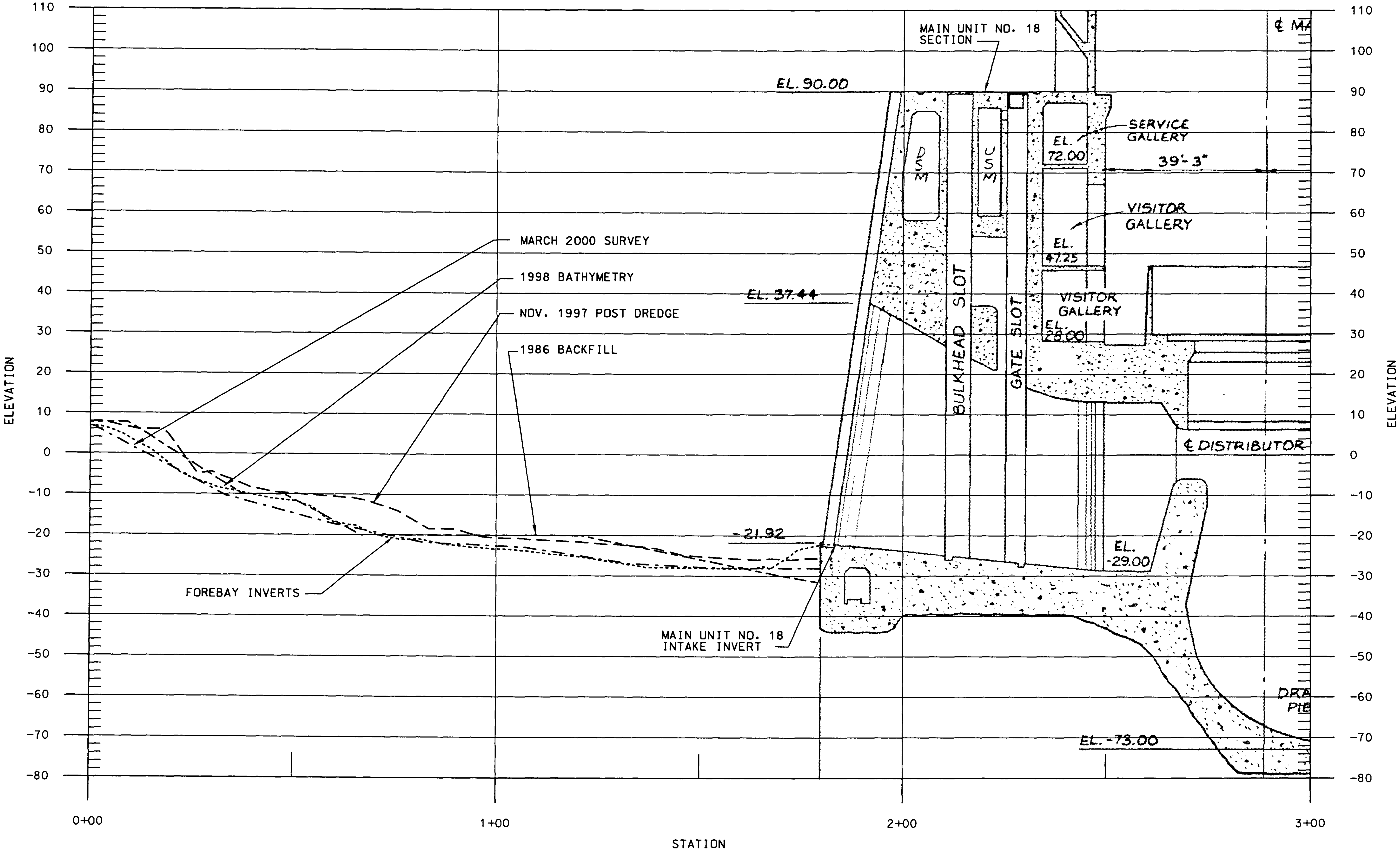

SECTION C (MAIN UNIT NO. 18 NORTH)
SEE PLATES 3 THROUGH 6

0 10 20 40 60
SCALE IN FEET

US Army Corps
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Portland District

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Submitted by:

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OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

FOREBAY AND B2 POWERHOUSE
SECTION C

DRAWING STATUS:
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DRAWING NO.

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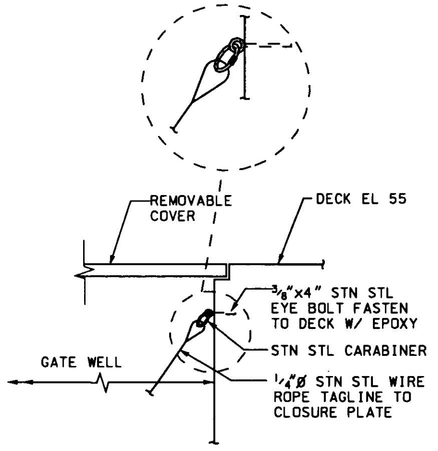

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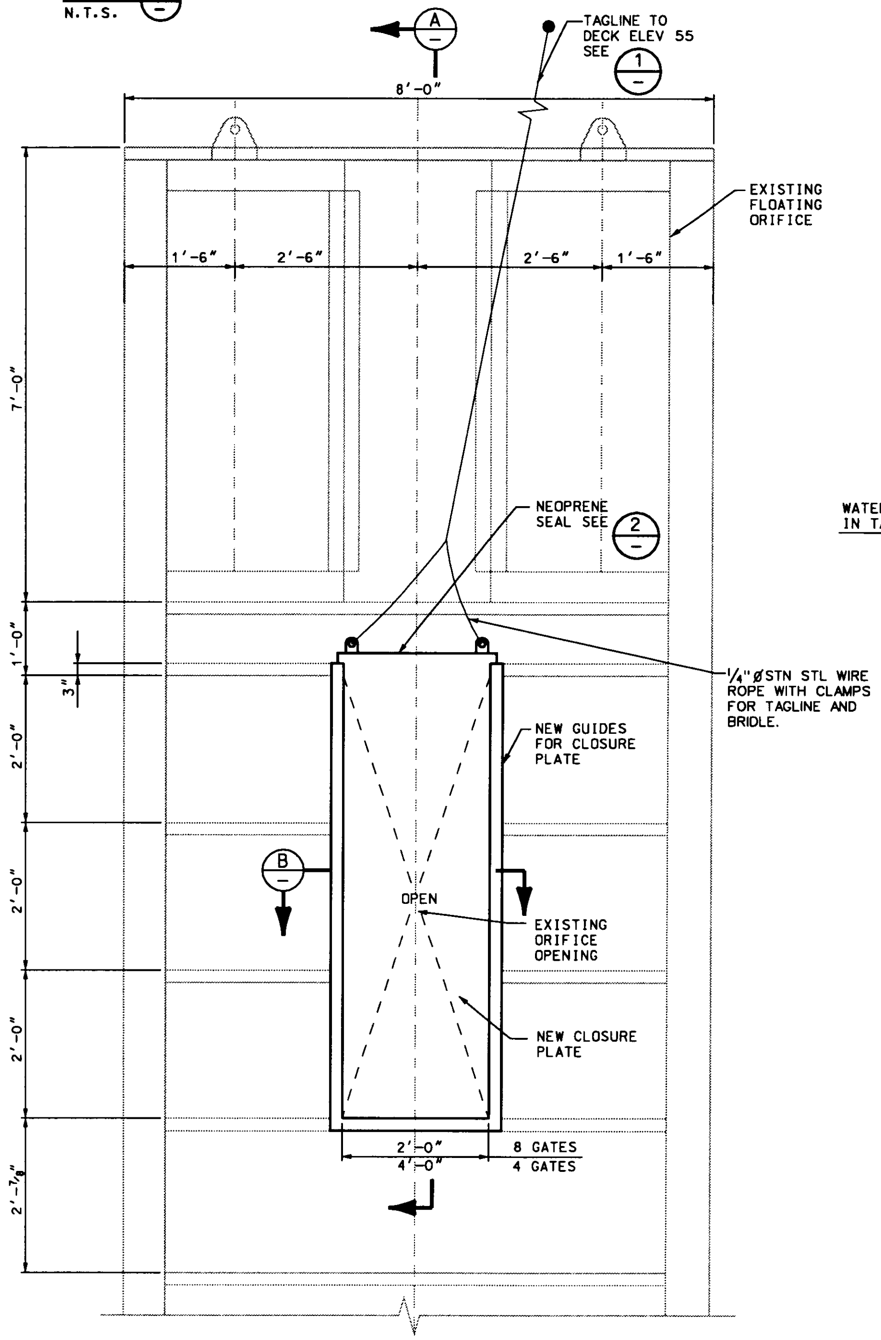

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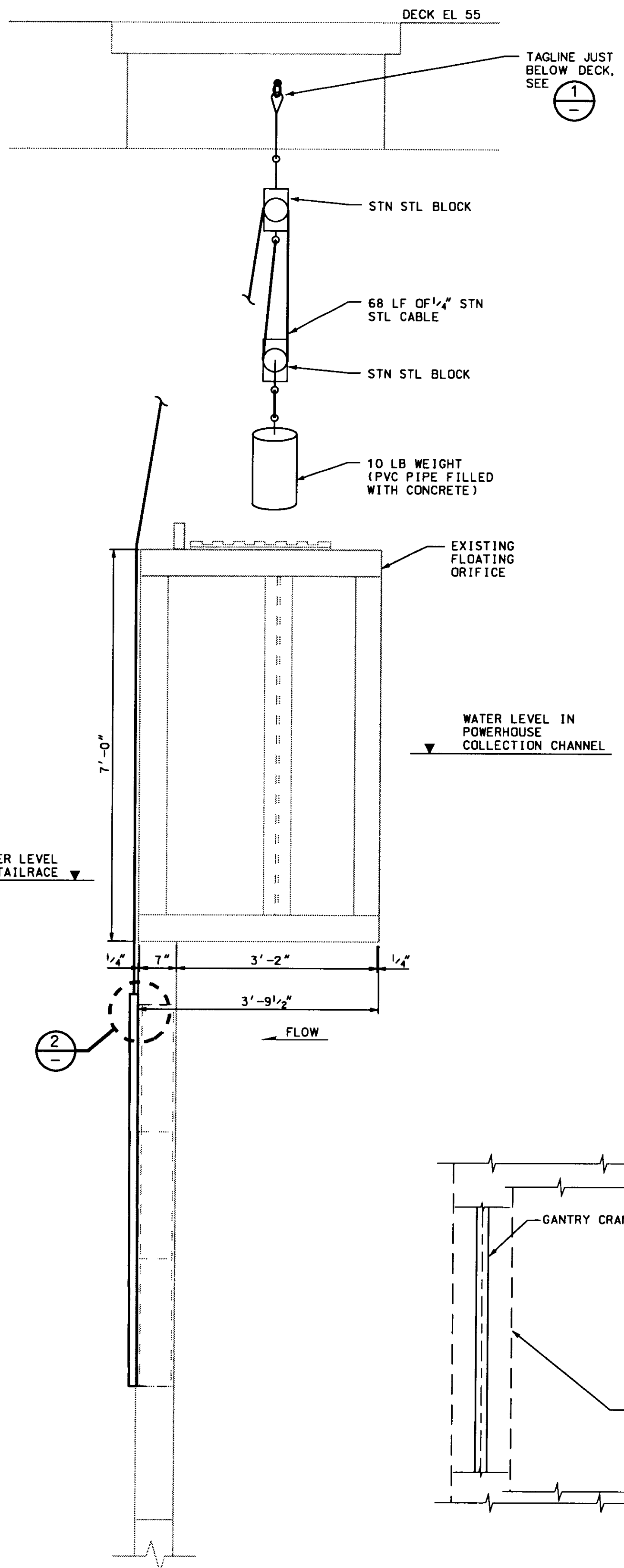

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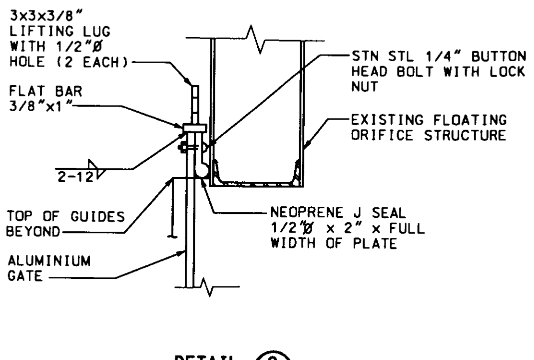

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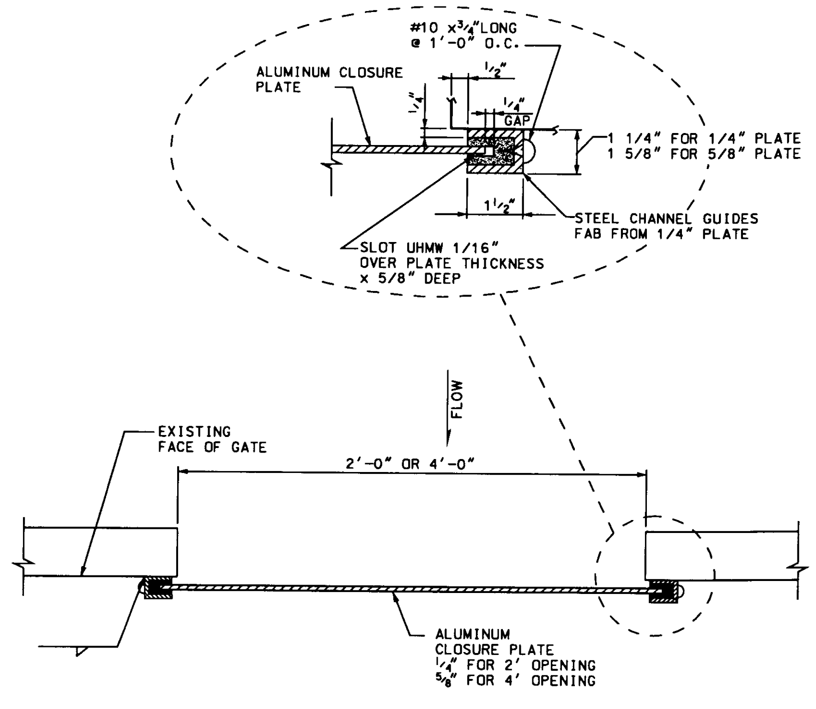
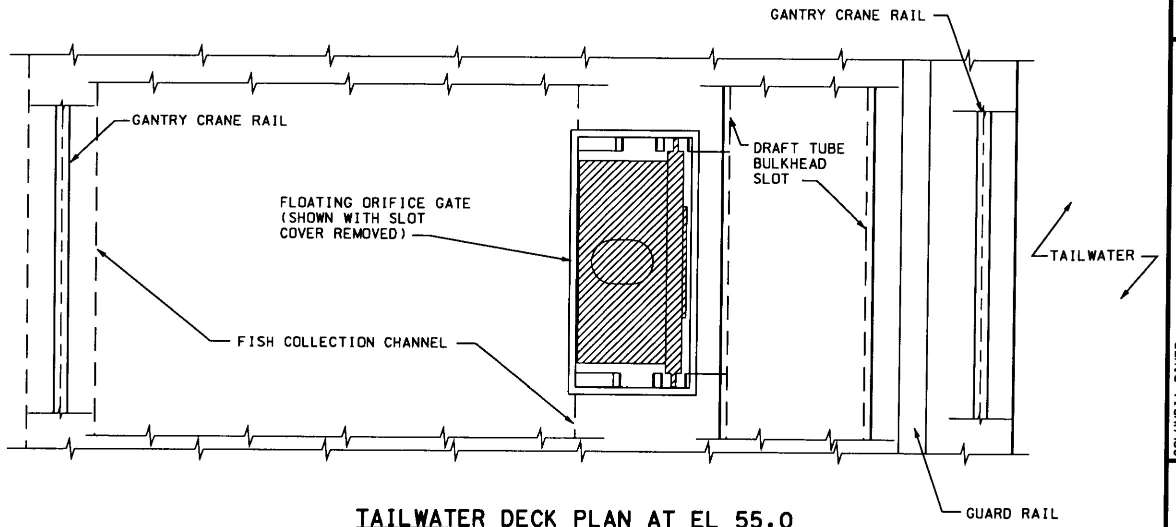


SECTION Ⓑ
N.T.S.



TAILWATER DECK PLAN AT EL 55.0
N.T.S.

0 1 2 4 6 FT
SCALE IN FEET

US Army Corps of Engineers
Portland District

Revision	Date	Description	By

Designed by: MIESBAUER
Drawn by: ROBERTS
Checked by: MIESBAUER
Submitted by:
Date: 16JULY2001
CADD File Name: BDSOP4POL01.DGN
Technical Manager:

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

FLOATING ORIFICE CLOSURE

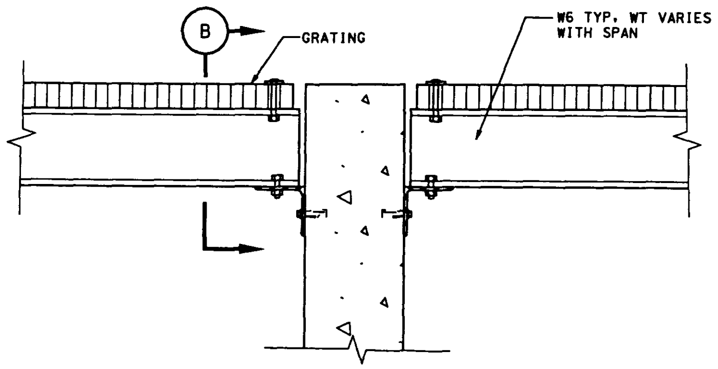
DRAWING STATUS:
FINAL

DRAWING NO.

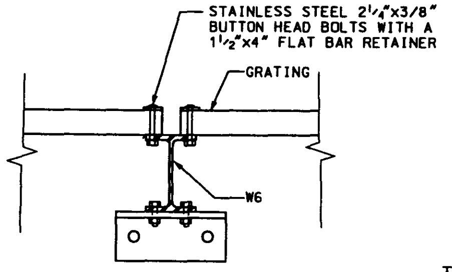
PLATE
10

NOTES:

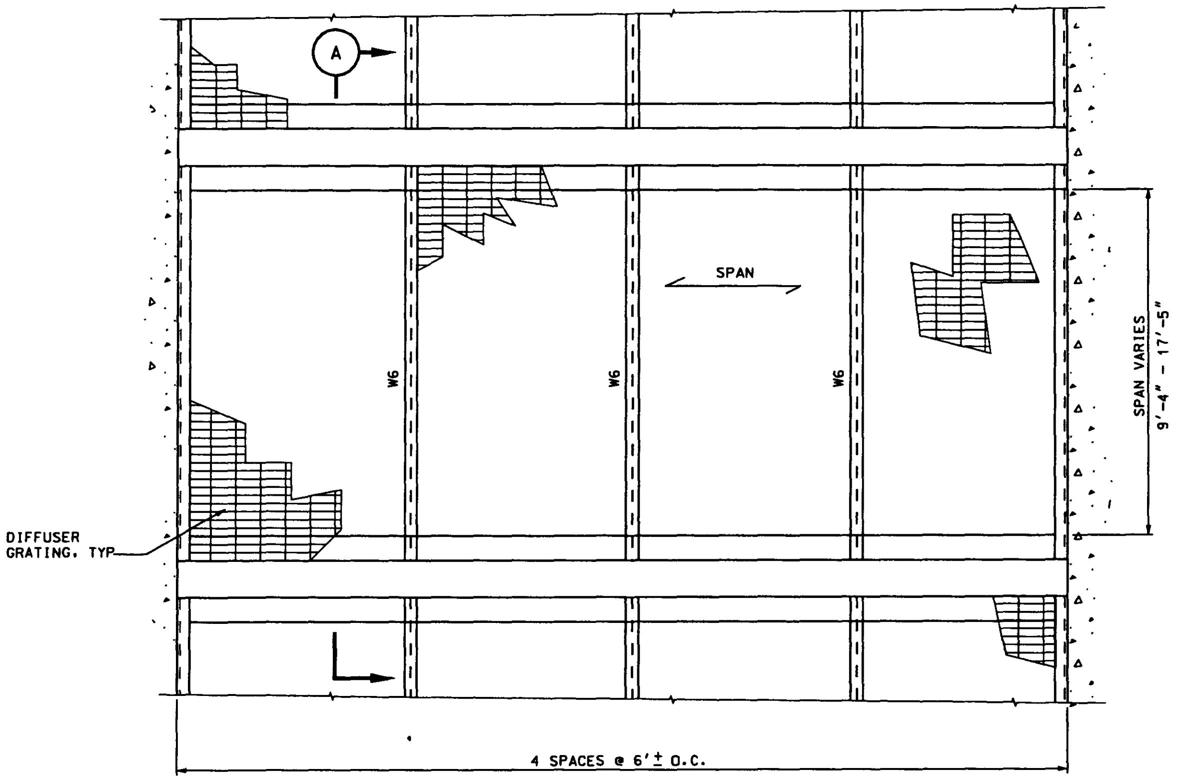
1 DIFFUSER GRATING:
BEARING BARS - 3/16" x 1/4" AT 1 3/16" ON CENTER
CROSS BARS - 1/4" DIAMETER AT 4" ON CENTER.



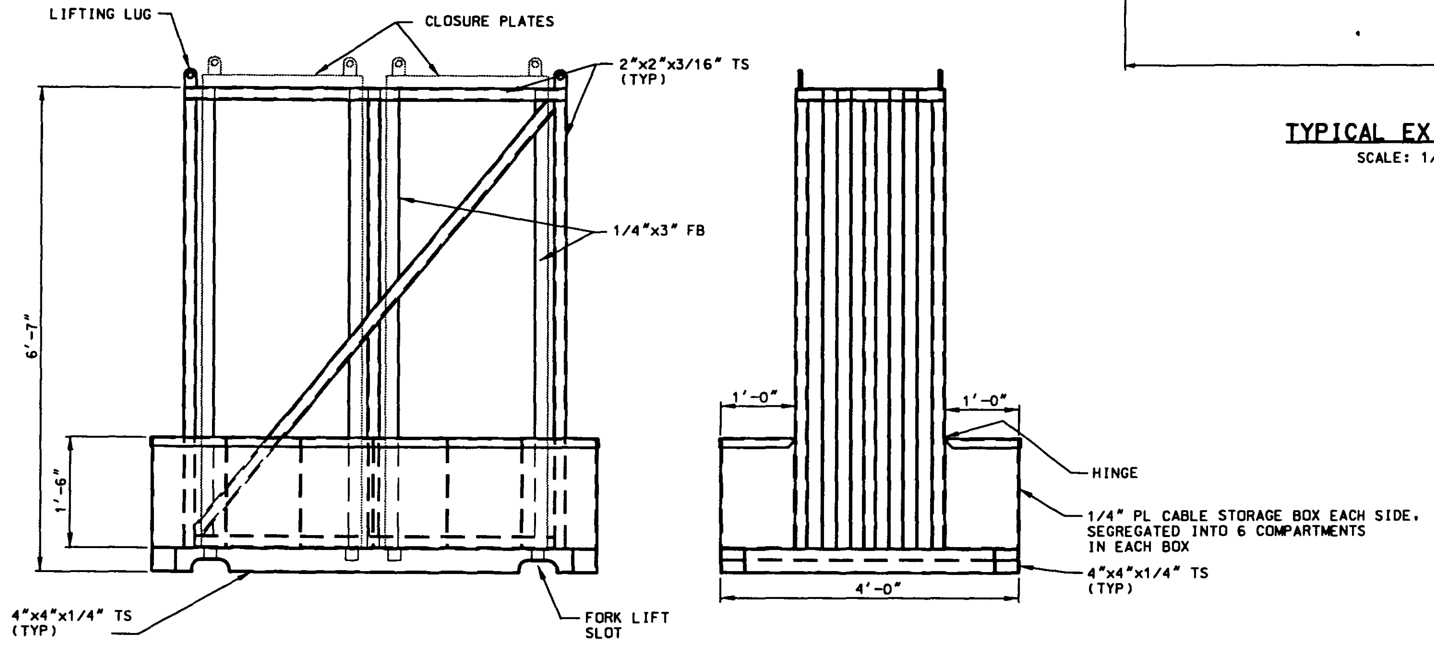
SECTION A



SECTION B



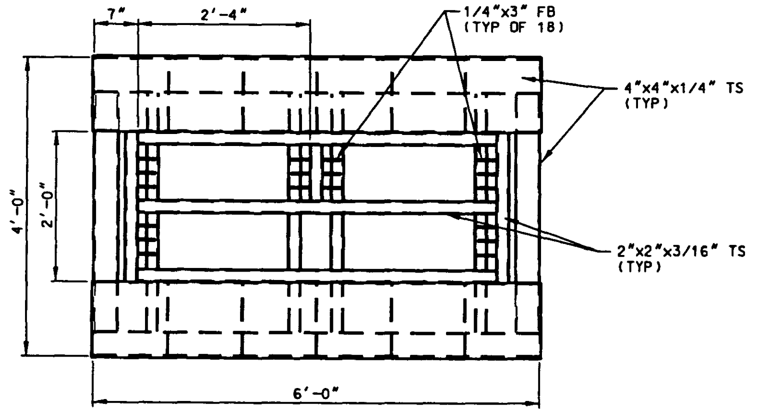
TYPICAL EXISTING DIFFUSER GRATING FRAMING PLAN
SCALE: 1/4" = 1'-0"



SIDE ELEVATION

END ELEVATION

NOTES:
1 GALVANIZE RACK ASSEMBLY AFTER FABRICATION
2 LINE SLOT GUIDES WITH 1/4" UHMW PLASTIC PANELS FASTEN WITH #12 MACHINE SCREWS



PLAN

SLIDE GATE STORAGE RACK
SCALE: 1/2"=1'-0"

0 2 4 8 12 FT
SCALE IN FEET

US Army Corps of Engineers
Portland District

Revision	Date	Description	By

Designed by: MIESBAUER
Date: 16JULY2001
Drawn by: ROBERTS
CADD File Name: BDSOPSPOL01.DGN
Checked by: MIESBAUER
Technical Manager:
Submitted by:

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AUXILIARY WATER SUPPLY BACKUP
DDR

DIFUSER GRATINGS (& FRAMES)
AND SLIDE GATE RACK

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
11

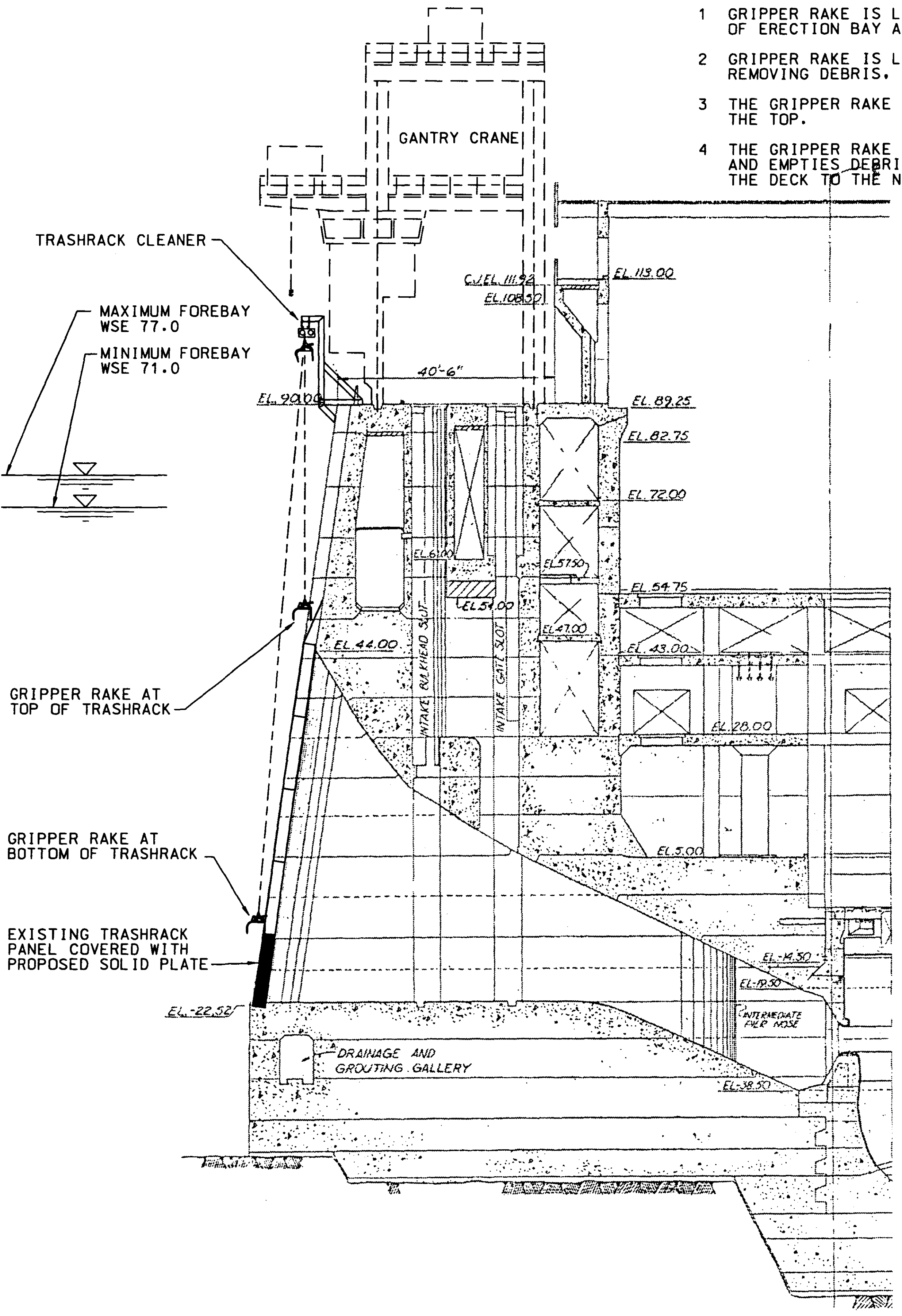
TRASH RAKE OPERATION:

1 GRIPPER RAKE IS LOWERED ON CABLES DOWN THE FACE OF ERECTION BAY AND ENGAGES IN THE TRASHRACK.

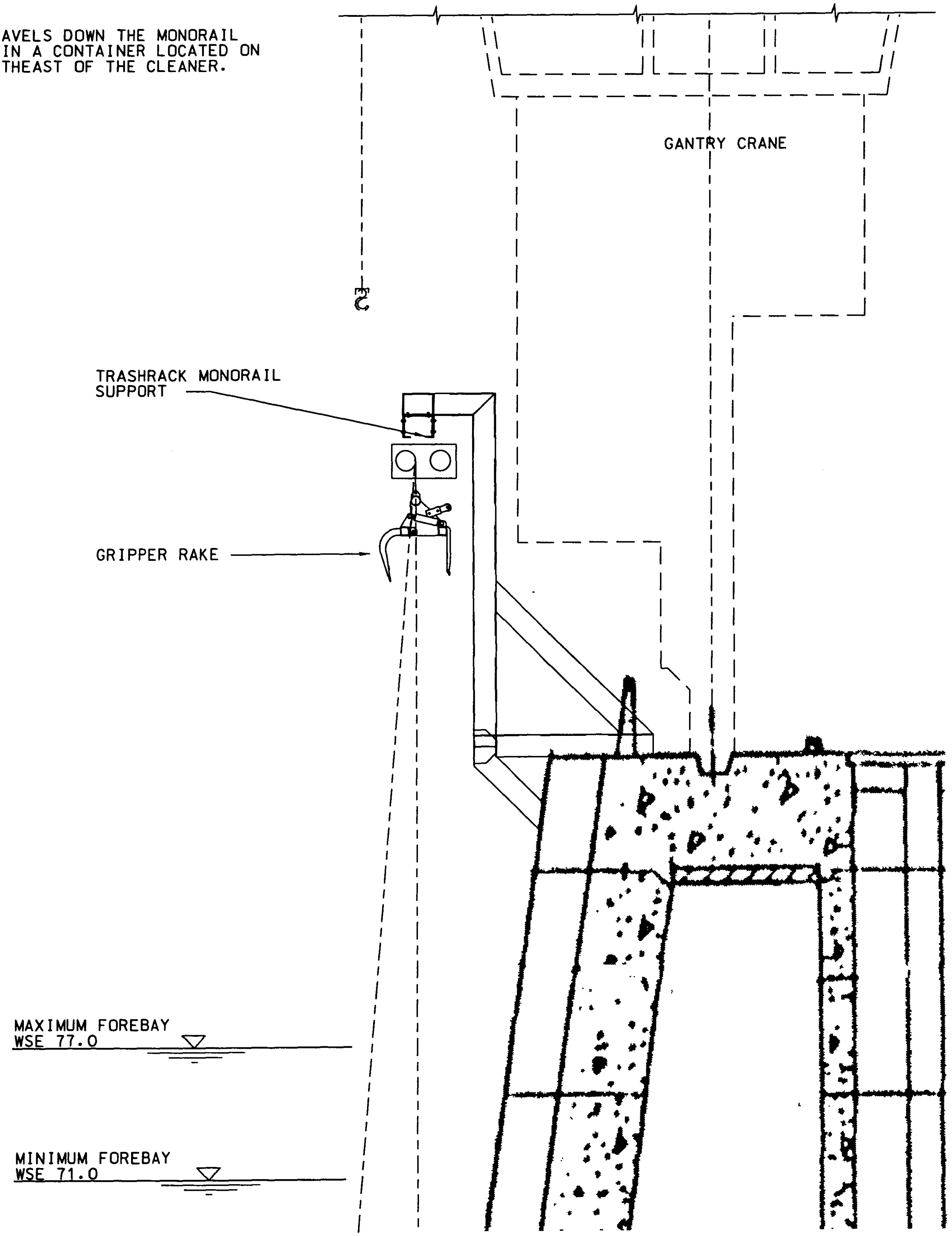
2 GRIPPER RAKE IS LOWERED DOWN THE TRASHRACK, REMOVING DEBRIS, TO THE BOTTOM.

3 THE GRIPPER RAKE CLOSES AND IS DRAWN BACK TO THE TOP.

4 THE GRIPPER RAKE TRAVELS DOWN THE MONORAIL AND EMPTIES DEBRIS IN A CONTAINER LOCATED ON THE DECK TO THE NORTHEAST OF THE CLEANER.



ERECTION BAY SECTION



DETAIL SECTION

US Army Corps of Engineers
Portland District

Revision	Date	Description	By

Designed by: POSTLEWAITE
Drawn by: PATRICK
Checked by:
Submitted by:
Date: 26 SEP 01
CADD File Name: WO23PLATE14.DGN
Technical Manager:

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

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TRASHRACK CLEANER SECTION
GRIPPER RAKE ALTERNATIVE

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
12

03-OCT-2001 06:38
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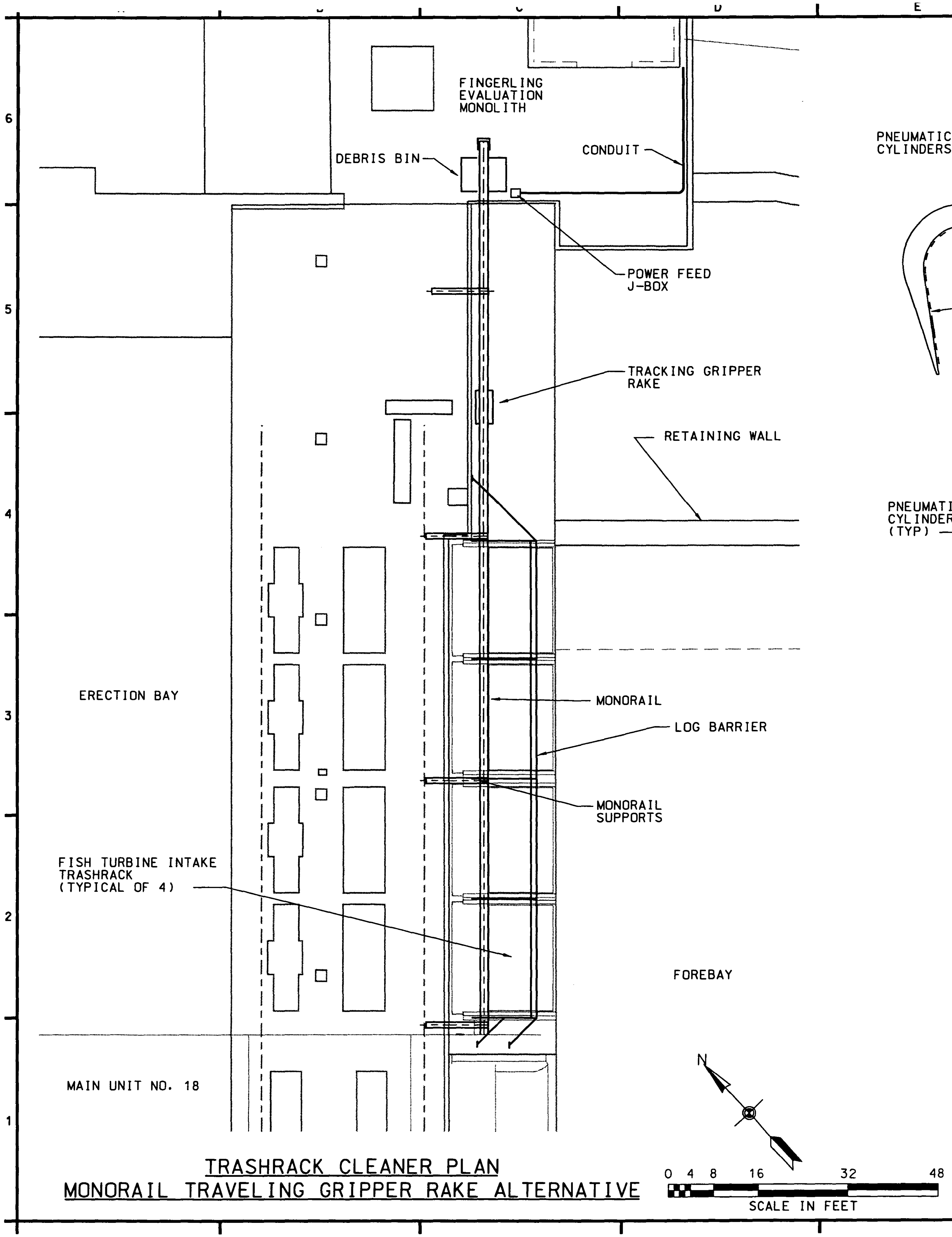
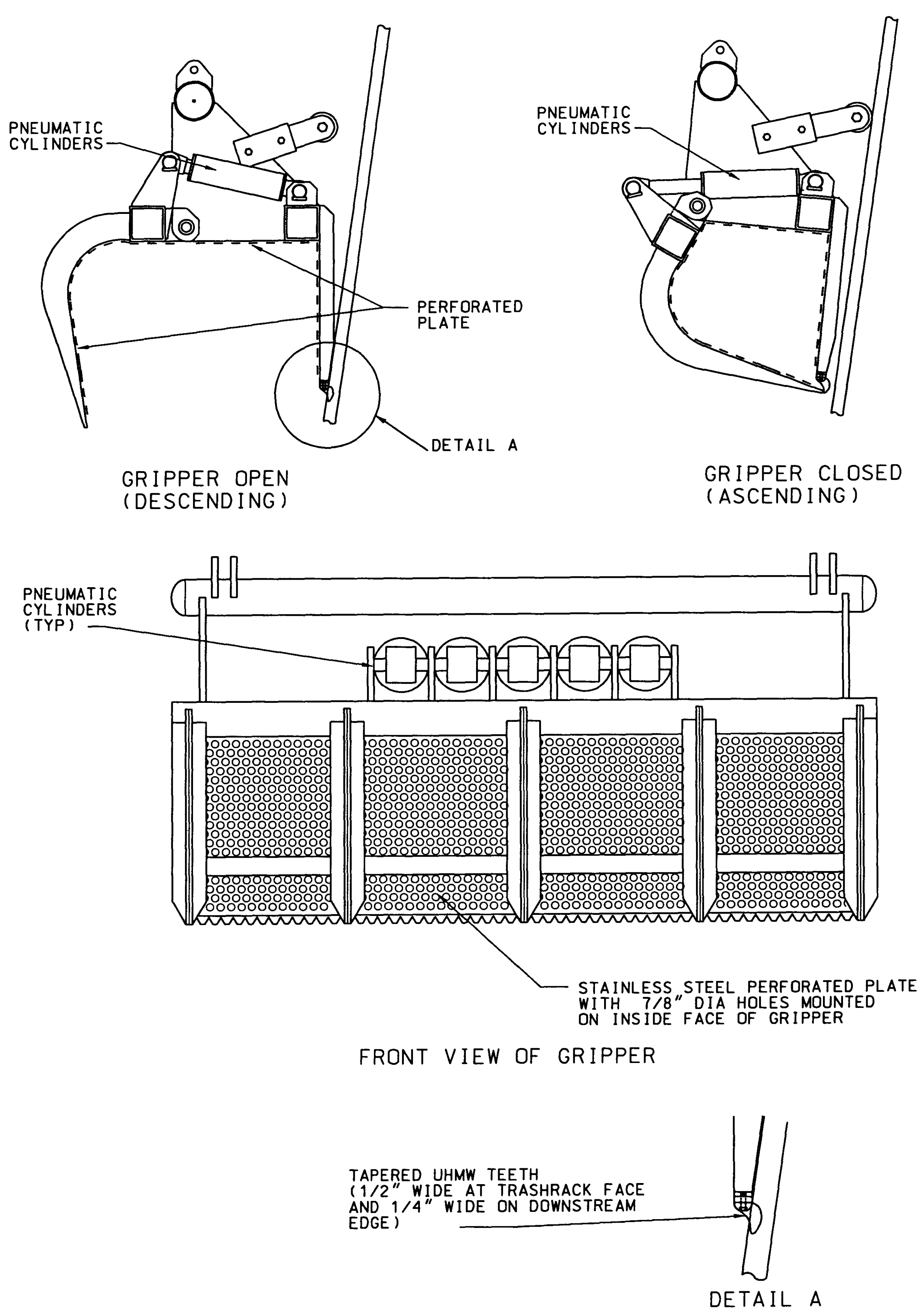


TRASHRACK CLEANER PLAN
MONORAIL TRAVELING GRIPPER RAKE ALTERNATIVE



GRIPPER OPEN
(DESCENDING)

GRIPPER CLOSED
(ASCENDING)

FRONT VIEW OF GRIPPER

DETAIL A

GRIPPER RAKE DETAILS
NOT TO SCALE

US Army Corps
of Engineers
Portland District

By
Description
Date
Revision

Designed by:
POSTLEWAITE
Drawn by:
PATRICK
Checked by:
Submitted by:

Date:
26 SEP 01
CADD File Name:
W023PLATE15.DGN
Technical Manager:

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

COLUMBIA RIVER
OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

TRASHRACK CLEANER PLAN
GRIPPER RAKE ALTERNATIVE

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
13

03-OCT-2001 06:39
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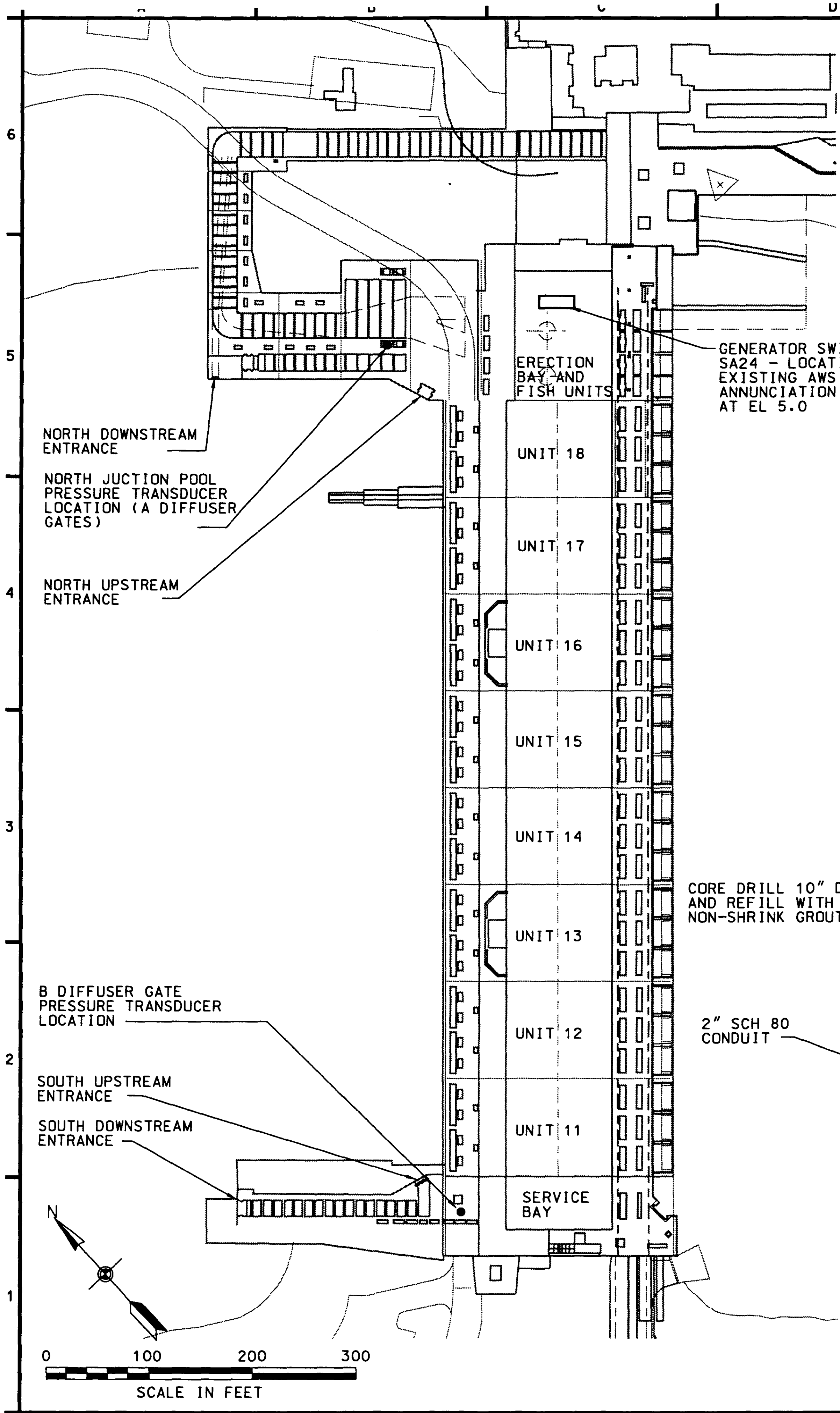
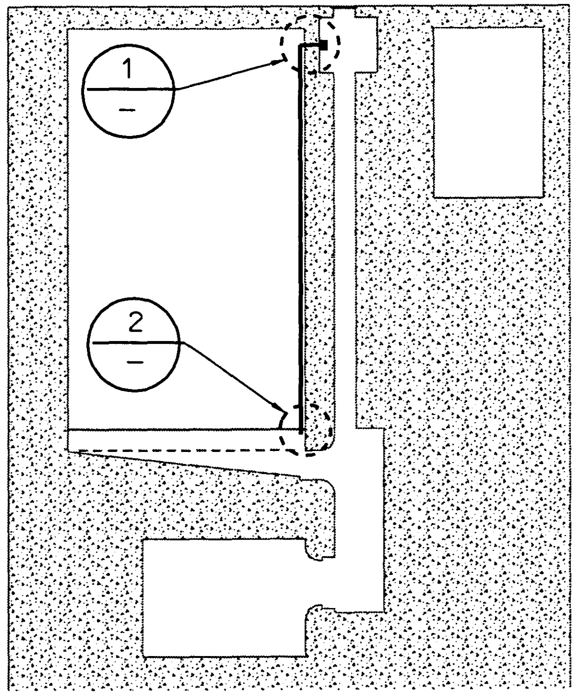
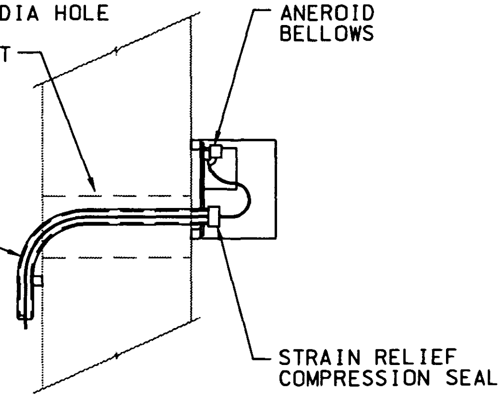


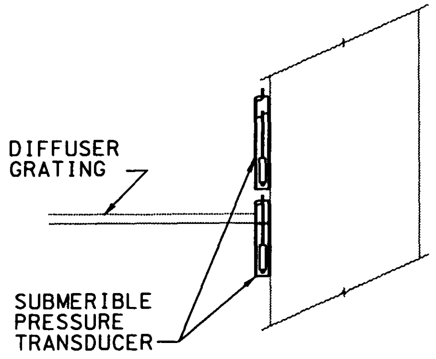


B-2 PRESSURE TRANSDUCER SECTION

(NORTH JUNCTION POOL LOCATION IS SIMILAR)



DETAIL ①



DETAIL ②

US Army Corps
of Engineers
Portland District

Revision	Date	Description	By

Designed by: POSTLEWAITE
Date: 26 SEP 01
Drawn by: PATRICK
CADD File Name: WO23PLATE16.DGN
Checked by:
Technical Manager:
Submitted by:

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

CH2M HILL
MONTGOMERY WATSON
JOINT VENTURE

COLUMBIA RIVER OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

PRESSURE TRANSMITTER
PLANS AND SECTIONS

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
14

03-OCT-2001 06:40
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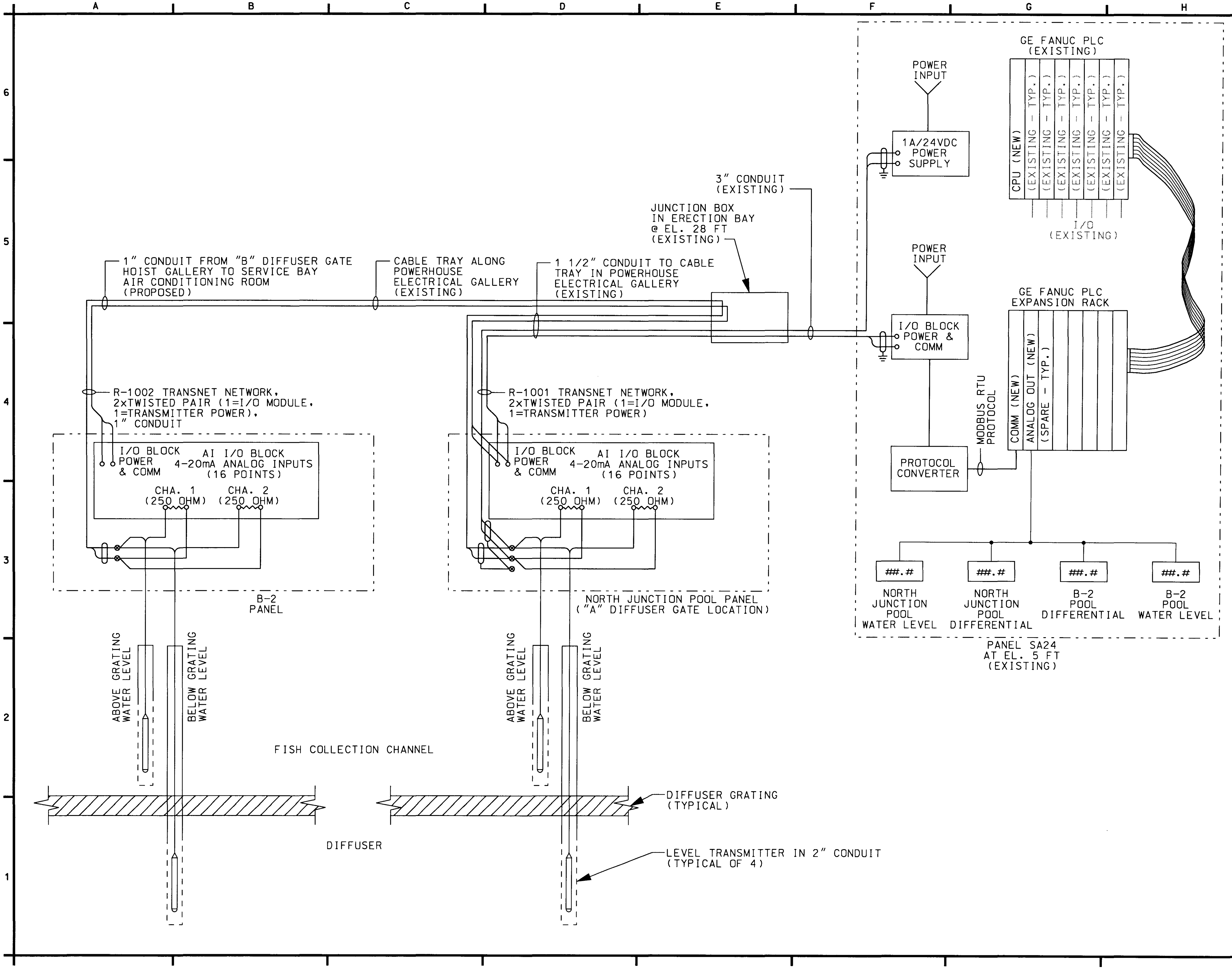

05-NOV-2001 11:10
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US Army Corps of Engineers
Portland District

Revision	Description	Date	By

Designed by: POSTLEWAITE
Drawn by: J.C. DEERKOP
Checked by:
Submitted by:
Date: 30 JUL 01
CADD File Name: WO23PLATE15.DGN
Technical Manager:

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

CH2MHILL
MONTGOMERY WATSON
JOINT VENTURE

COLUMBIA RIVER
OREGON - WASHINGTON
BONNEVILLE DAM-SECOND POWERHOUSE
AUXILIARY WATER SUPPLY BACKUP
DDR

ELECTRICAL
DIFFUSER GRATING MONITORING
SYSTEM SCHEMATIC

DRAWING STATUS:
FINAL

DRAWING NO.

PLATE
15