City of Tacoma
Department of Public Utilities
Power Division

Cowlitz Falls North Shore Collector Downstream Fish Evaluation
RFP Specification No. PG16-0558F

QUESTIONS and ANSWERS

All interested parties had the opportunity to submit questions in writing to Joe Parris, Purchasing Division by 3:00 PM on January 9, 2017. The answers to the questions received are provided below and posted to the City's website at www.TacomaPurchasing.org. This information IS NOT considered an addendum. Respondents should consider this information when submitting their proposals.

Question 1: In reference to page 1: Is the Downstream Fish Passage Conceptual Design Report available?

Answer 1: Yes, the report was submitted to FERC on February 15, 2012 and will be provided with the responses.

Question 2: In reference to page 6, item #10 - The Required Form only indicates Signature page be included: What is to be done with Appendix A Proposal Form and Contractor Record of Prior Contracts? Are these also to be included as RFP Content to be Submitted?

Answer 2: Yes. Both forms are required in the content to be submitted. An Addendum will be posted to clarify these requirements

Question 3: In reference to page 8 - objective 3b: Define FSC performance.

Answer 3: The primary metric for measuring the CFNSC (rather than the FSC) is Fish Passage Survival (FPS). Target FPS is 95%, with a minimum of 75% while employing the best available technology. Secondary metrics include Fish Collection Efficiency (FCE), Detection Efficiency (DE), Entrance Efficiency (EE), and Retention Efficiency (RE).

Question 4: In reference to page 8, Objective 4b: Is information on outmigration historical run timing available?

Answer 4: Yes, although these data will be limited to periods when the collector has been operated, typically April 1st through August 31st. This will be provided once a contractor is selected.

Question 5: In reference to page 9, Item 4d - Directed study methodology to characterize hydraulic zone of influence at CFNSC: Does this mean the results of the Directed Monitoring will be used to define the hydraulic zones of influence or will these zones of influence will be defined as the "within 20 ft." zone as used in 2014 studies or those defined in Figure 16 of the Draft Adaptive Management Plan?

Answer 5: The zone of influence is estimated from previous computational fluid dynamics modeling. Directed studies in 2017 will help to refine these estimates.

Question 6: **In reference to page 10, Deliverables Item 1e: Will existing Tacoma Power acoustic telemetry equipment be available for use on this project?**

Answer 6: Responses to the RFP should assume that new equipment is necessary to accomplish project goals.

Question 7: **In reference to Page 10, Deliverables Item 2a - To provide livestream or weekly summary statistics to include FPS, FCE, DE, EE, and RE for both the CFNSC and capture zone: Is this FPS for only the CFNSC or is it FPS as defined by the Settlement Agreement? Will other data from Tacoma (or coordinated through other entities?) to be readily available to calculate these metrics?**

Answer 7: This is FPS as defined by the Settlement agreement. Tacoma will provide mortality data from the Cowlitz Salmon Hatchery to complete the FPS estimate.

Question 8: **In reference to Appendix B Partial – Draft Adaptive Management Plan for Cowlitz Falls North Shore Collector: What are the previous studies conducted in comparable Pacific Northwest systems that these protocols are based on and are reports from these previous studies available?**

Most FCRPS dams and FERC licensed projects have implemented some form of downstream fish monitoring which take into account a portion or all of the measures Tacoma is interested in at Cowltiz Falls Dam. Each system uses approaches unique to their own challenges, biology, and infrastructure. In recent years Tacoma has implemented a similar approach on the Skokomish watershed in evaluating the Cushman Floating Surface Collector. Annual Reporting is available through FERC.

Question 9: **Can you provide examples of livestreaming data expectations?**

Livestreaming data expectations could include near-real time interent applications, linked databases, or electronic weekly reports.

Question 10: **What degree of data sharing will be available from other entities (e.g., dam operators), as it relates to livestreaming or weekly reporting of performance measures?**

All necessary data will be made available, however some sources may be more timely than others. Database should allow for placeholders or notation in reporting to reflect missing or incomplete data.

Question 11: **Who has ownership of data?**

All data are owned by the City of Tacoma.

Question 12: **What is the adjudicating entity for CFNSC fisheries projects?**

The Fisheries Technical Committee is the Technical Advisory Committee to Tacoma for the study. However, the license signatories would ultimately appeal to FERC if a challenge were ever required. Communication from the Technical Work Group to the Fisheries Technical Committee to FERC will be key in setting and meeting expectations throughout the program life.

Question 13: How are labor rates evaluated?

Labor is evaluated as cost per position per hour, as well as total costs for the study.

Question 14: What is the difference between collection and processing infrastructure?

Fish will be collected by the CFNSC and existing structures and transported via flumes to the CFFF. Fish are sorted, counted, and processed at the CFFF.

Question 15: What is the PIT tag detection capability at the Cowlitz Salmon Hatchery and Barrier Dam?

There are no stationary PIT antennas at the hatchery or Barrier Dam. Any mortalities found in the recovery ponds at the hatchery will be scanned for PIT tags, and FPS will be adjusted accordingly. Otherwise, fish are assumed to have exited the ponds and resumed migration successfully.

Question 16: Will internet access be provided at the project for data streaming?

Internet access is available at the project, however it can be unreliable at times. After 2017 reliability should improve.

Question 17: Is the CFNSC construction schedule still on track?

The CFNSC is expected to be operational in time for Chinook migration. Balancing is anticipated to be occuring during the steelhead and potentially during the coho migration season. The database should be able to accomodate shifts in operation to accomodate this balancing as necessary.

Question 18: Will the database component still be implemented, even if the CFNSC is not operational?

The CFNSC is anticiapted to be operational during the Chinook season, but either way implementation of the database is anticipated to be required.

Question 19: Will the Powerpoint from this meeting be available?

Yes, the Powerpoint will be made available at the end of this Questions and Answers document.

Question 20: What is the maximum velocity at the CFNSC entrance?

Water velocity at the entrance is 2 feet per second.

Question 21: How does the forebay respond/look during operation?

The CFNSC system of pumps can be used to establish an eddy in the zone of influence, or to provide attraction alternative to bulk flow through turbines.

Question 22: Who owns Cowlitz Falls Dam?

Cowlitz Falls Dam is owned and operated by Lewis County.

Question 23: Are trash spills reflected in dam operations data?

Yes, the data provided by Lewis County should reflect all dam operations.

Question 24: What does the monitoring frame look like?

The monitoring frame is constructed from aluminum c-beam, with a UHMW face. It fits into a channel in the fishway, with the UHMW face flush with the walls of the fishway. Interstitial space provides room for instrumentation, and the UHMW face can be drilled or cut to accommodate antennas, hydrophones, etc. Drawings provided at the end of this Questions and Answers document.

Question 25: Is the behavioral guidance system removeable, and what is the design and material?

Yes it is removable. The materials are 10 foot steel panels suspended on 4' boat buster booms.

Question 26: How can floor geometry of the CFNSC be adjusted?

The floor can be raised or lowered from either end independently or in tandem, providing a nearly infinent level of adjustability with points between 7 and 8 fps.

Question 27: Should degree of floor adjustment be included in the database?

This measure will not be adjusted in the first year, but the ability to modify should be included in the database for future years. There are a number of other adaptive management features that should also be able to be accomodated as well.

Question 28: Should the database be able to accommodate historical data?

Yes, historical data should be able to be incorporated into the database.

Question 29: Where are fish counted and processed?

Fish are sorted, counted, and processed at the CFFF.

Question 30: What is the flow through the flume sections?

Flow through the flume sections is approximately 20 cfs.

Question 31: How many people are typically working in the CFFF?

Typically, there are between 5 and 7 people working in the CFFF during the season with 4 at any one time.

Question 32: Is there a standard water temperature limit at which tagging effort ceases?

There is no standard water temperature at which fish handling ceases. Discretion should be used during periods of high water temperatures.

Question 33: Is the CFFF temperature controlled?

No, but the temperature in the building remains relatively cool during the summer months.

Question 34: Is the proportion of hatchery fish processed at the CFFF expected to change in coming years?

There are no hatchery smolts released in the Upper Cowlitz, therefore none are collected at Cowlitz Falls Dam. Any smolts collected are the result of natural production.

Question 35: What is the average size of coho, steelhead, and Chinook smolts collected?

Smolt lengths can vary greatly, but steelhead, coho, and Chinook average approximately 190 mm, 120 mm, and 110 mm, respectively.

Question 36: What is the study fish holding capacity of the CFFF?

Between the raceways and various holding tanks, the CFFF has a great deal of flexability to float buckets or independent containers in the SbyC tank, through the or in the raceways downstream of the building.

Question 37: Are design drawings availalble for the CFNSC?

Yes, some drawings have been selected and provided at the end of this Questions and Answers document.

COWLITZ FALLS NORTH SHORE COLLECTOR DOWNSTREAM FISH EVALUATION

Pre-Proposal Meeting

PG16-0558F

January 10, 2016

TACOMA POWER
TACOMA PUBLIC UTILITIES

AGENDA

- Introductions 5 min
- Purchasing Guidelines 10 min
- Project Overview 30 min
  - Objectives
  - Methods
  - Approach
  - Schedule
  - Deliverables
- Question and Answer 30 min
- Optional Site Visit 60 min

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TACOMA PUBLIC UTILITIES

PRE-SUBMITTAL QUESTIONS

- In writing via email to Senior Buyer Joseph Parris
  - jparris@ci.tacoma.wa.us
  - By 3:00 pm, Monday January 9, 2017
- Responses: ~5:00 pm, Wednesday Jan. 11, 2017
  - www.TacomaPurchasing.org

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BACKGROUND

- **FERC Requirement**
  - ***Monitor Fish Passage Survival (FPS), as the percentage of smolts entering the upstream end of Scanewa reservoir, and adjusted for natural mortality, that are collected at Cowlitz Falls Dam and Riffe Lake and Mossyrock Dam, that are transported downstream to stress relief ponds, and subsequently leave the stress relief ponds at Barrier Dam as healthy migrants.***

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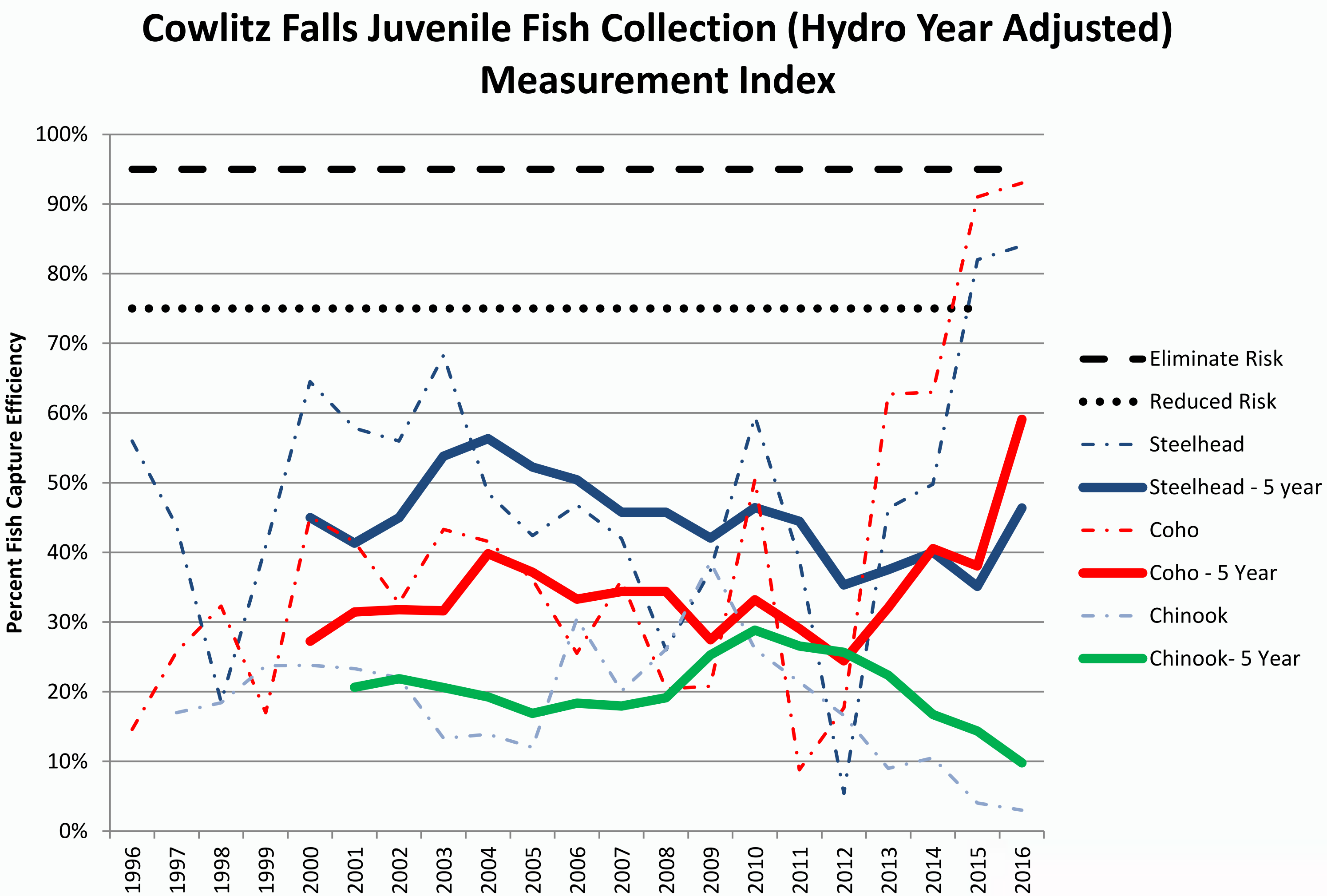
EXISTING ESTIMATES



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EVALUATION MEASURES

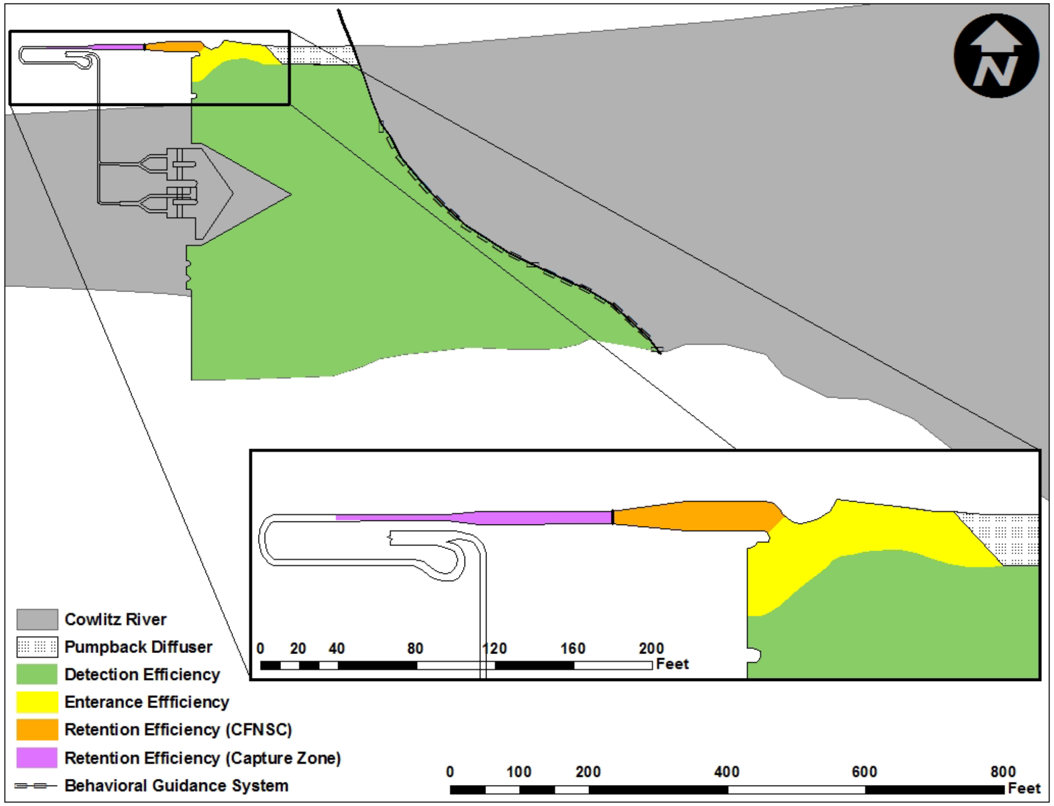
- **FPS and FCE**
  - **PIT Tags**
  - **Released at Day Use Park**
  - **Collected at CFNSC and transported to Stress Relief Ponds prior to downstream migration**
  - **Characterize co-variates**

Interim Natural Mortality Estimates (Kock et al. 2012)

P steelehad = 0.9714
Pcoho = 0.9674
Pchinook = 0.9090

PERFORMANCE METRICS

- Discovery Efficiency
- Entrance Efficiency
- Retention Efficiency
  - PIT Tags/Active Tags
  - Released at Day Use Park or in Forebay
- Paired groups
  - Passive and active tags
  - Assumption that they behave the same and cross "start lines" in similar proportions



CONSULTANT OBJECTIVES

1. Create Database
   - Performance Measures (FPS and FCE)
   - Directed Study Measures (DE, EE, and RE)
   - CFFF daily fish collection counts
   - Co-variates – including environmental and dam operations

2. Measure Discovery, Entrance and Retention Efficiency
   - Multiple release groups of PIT tagged fish
   - Subsample with active tags to estimate Zone of Influence, Entrance Zone, and Retention Zones
   - Provide Behavioral Information

3. Analytical and Statistical Support
   - Analytical Support – report writing and continuous or weekly data reporting

4. Study Methods
   - Study Design Support
   - Estimates of DE, EE, and RE during reporting

APPROACH

- Study Fish Origin
- Release Timing
- Flexibility left to proposer
  - Equipment type (radio or acoustic)
  - Staffing Plan
    - Tacoma field staff assistance
    - Combination of staff
    - All contractor staff

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SCHEDULE

Action	Date
Advertize RFP	January 3, 2017
Pre-Proposal Meeting	January 10, 2017
Questions Due	January 9, 2017
Responses Posted	January 11, 2017
Proposal Due	January 31, 2017
Open Proposals	January 31, 2017
Selection Advisory Committee	February 1-3 ,2017
Public Utility Board Approval	February 8, 2017
Finalize Contract	March 3, 2017
Notice to Proceed	March 3, 2017
Draft Annual Report	September 30, 2017
Final Annual Report	November 31, 2017

DELIVERABLES

- Weekly summary statistics
  - FPS, FCE, DE, EE, RE, Travel time, and relatoinships to major project operations (inflow and outflow) and temperature
- Draft Annual Report
- PowerPoint of Draft Results
- Final Annual Report
- Ownership of Work/Rights in Data
  - Documents and data shall be owned by Tacoma Power

EVALUATION OF PROPOSALS

- Firm’s Experience
  - Minimum of 5 similar projects
- Proposed Scope and Methods
- Principle Investigator Experience
  - Minimum 10 years experience
- Key Support Staff
  - Define roles and responsibilities
- Schedule
- Location – Response Time
- Billing Rates and Estimated Hours
- Response to Questions
  - Approach to determine best available technology
  - List technology planned
  - Additional Studies that would aid in providing data for this project
  - Additional Tasks outside of Scope of Work?
- RFP Compliance and Completeness
- Small Business Enterprise

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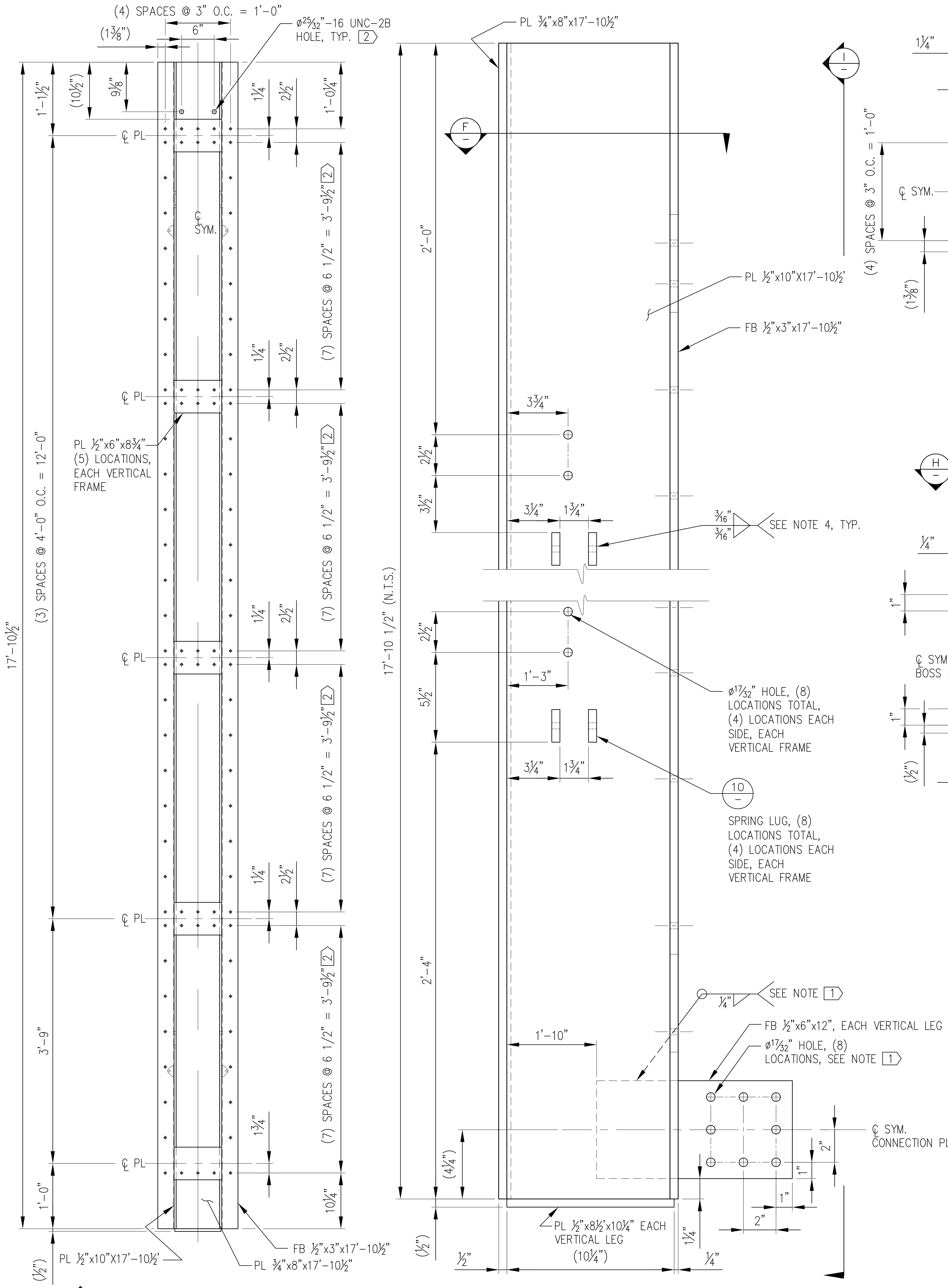
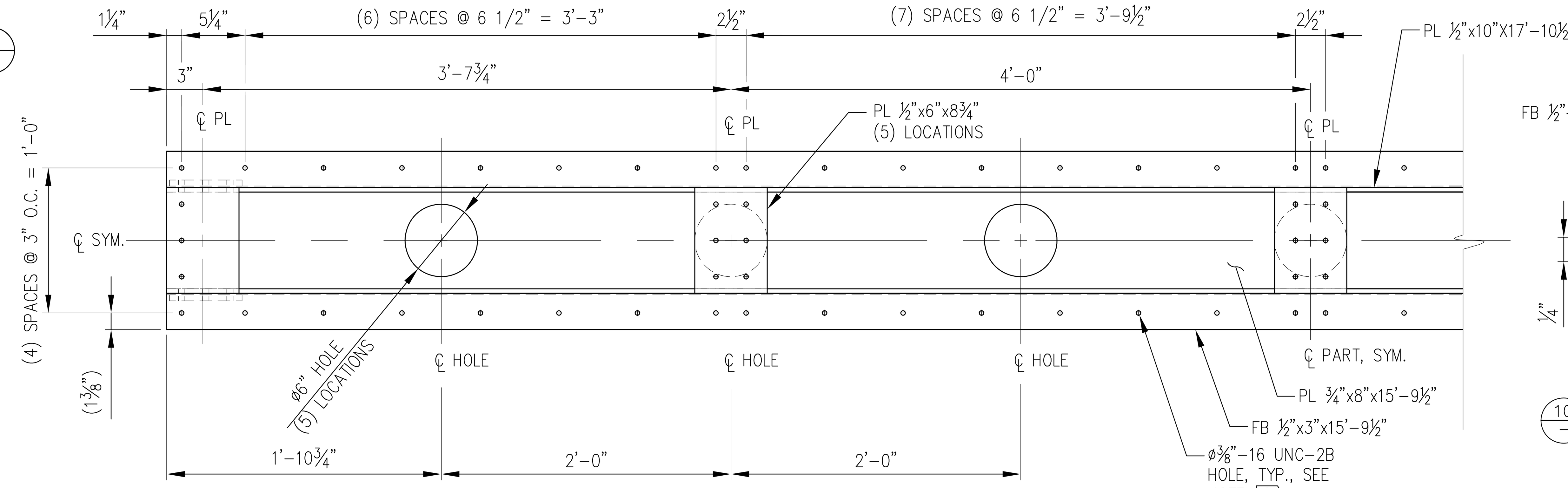
QUESTIONS

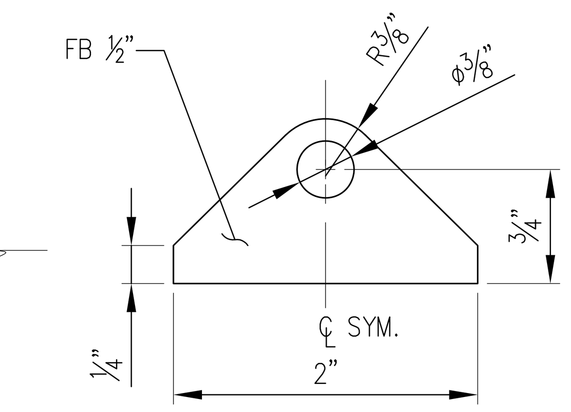


I VERTICAL FRAME – VIEW
SCALE: 1"=1'-0"
NOTE: QUANTITY = (2)

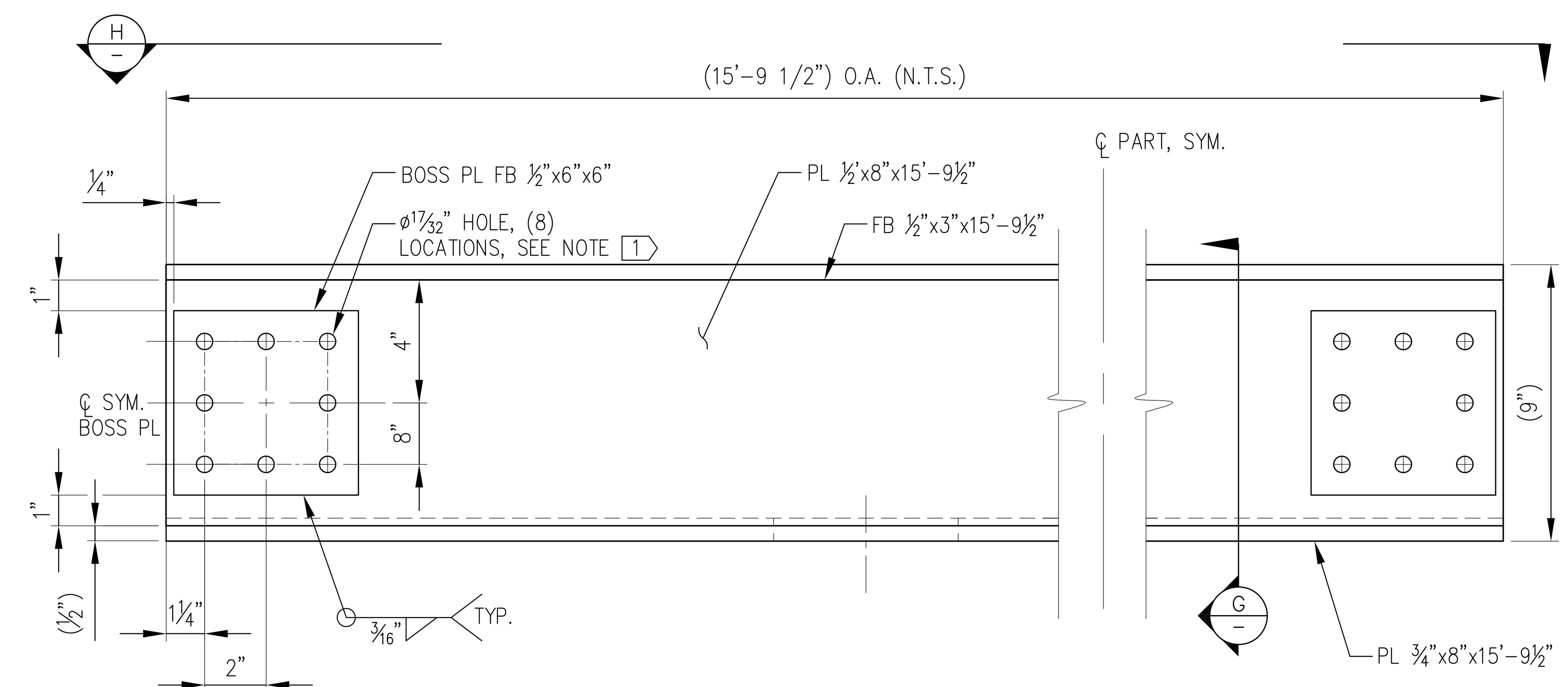
8 MC800 DETAIL VERTICAL FRAME – ELEVATION VIEW
SCALE: 3"=1'-0"
NOTE: QUANTITY = (2)



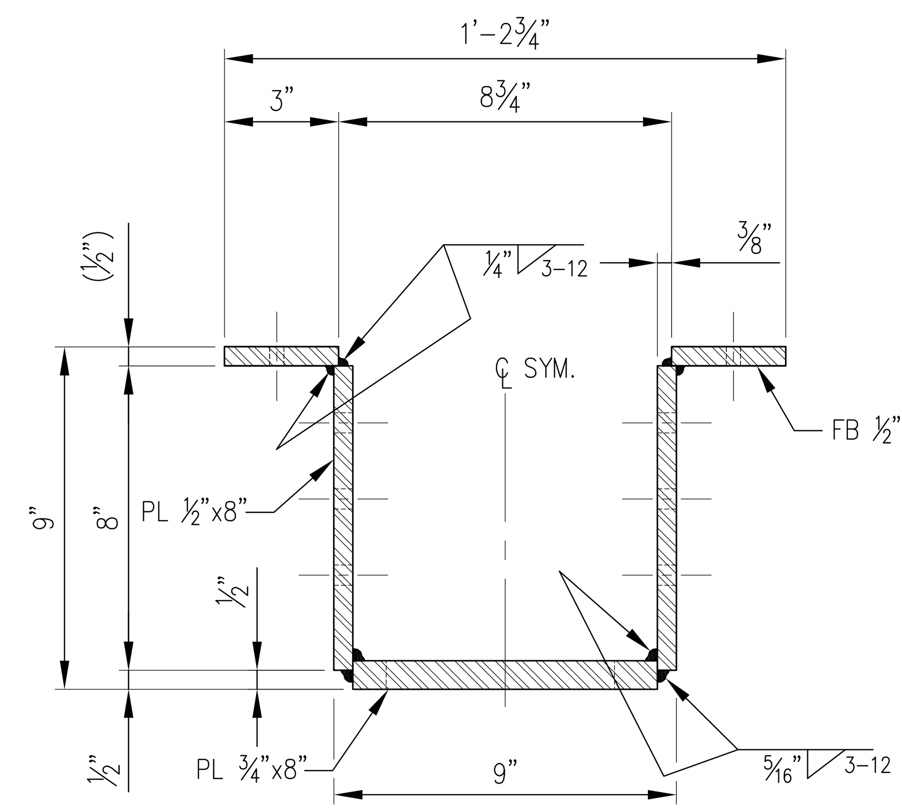
H HORIZONTAL FRAME – SECTION
SCALE: 1½"=1'-0"



10 DETAIL SPRING LUG
SCALE: 1'-0"=1'-0"
NOTES:
1. FOR SPRING INFORMATION SEE DETAIL 13
2. QUANTITY = (8)



9 MC800 DETAIL HORIZONTAL FRAME – ELEVATION VIEW
SCALE: 3"=1'-0"



G HORIZONTAL FRAME – SECTION
SCALE: 3"=1'-0"

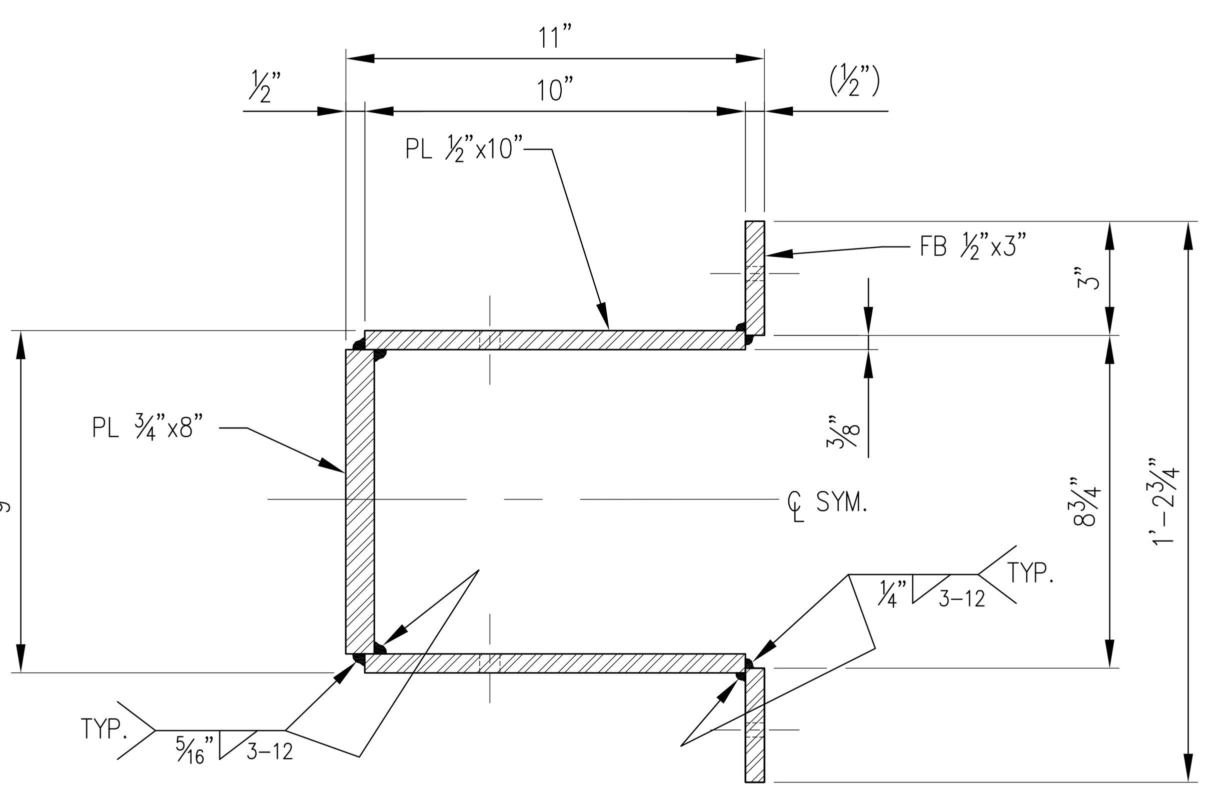
NOTES:

1. ASSEMBLE BOLTED CONNECTIONS FIRST, THEN WELD AT SHOP ASSEMBLY WHILE MAINTAINING ASSEMBLY DIMENSIONS.

2. FABRICATE A DRILL JIG IDENTICAL TO PANEL "A" BUT FITTED WITH DRILL BUSHINGS, CARR LANE PART# P-40-12-XX OR EQUAL TO LOCATE THESE HOLES.

4. INSERT PIN TO HOLD ALIGNMENT WHILE WELDING.

5. MATERIAL: AL6061 T6



F VERTICAL FRAME – SECTION
SCALE: 3"=1'-0"

WARNING
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IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

REVISION NO. 0

STEVEN J. BELVIN, STATE OF WASHINGTON, 27027, REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 5/06/

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
MONITORING FRAME
DETAILS & SECTIONS

SUBMITTED
APPROVED
DRAWN KRT
STAMPED SJB
12/1/16
DATE
DRAWING NO.
MC801
SHT. 2 OF 4

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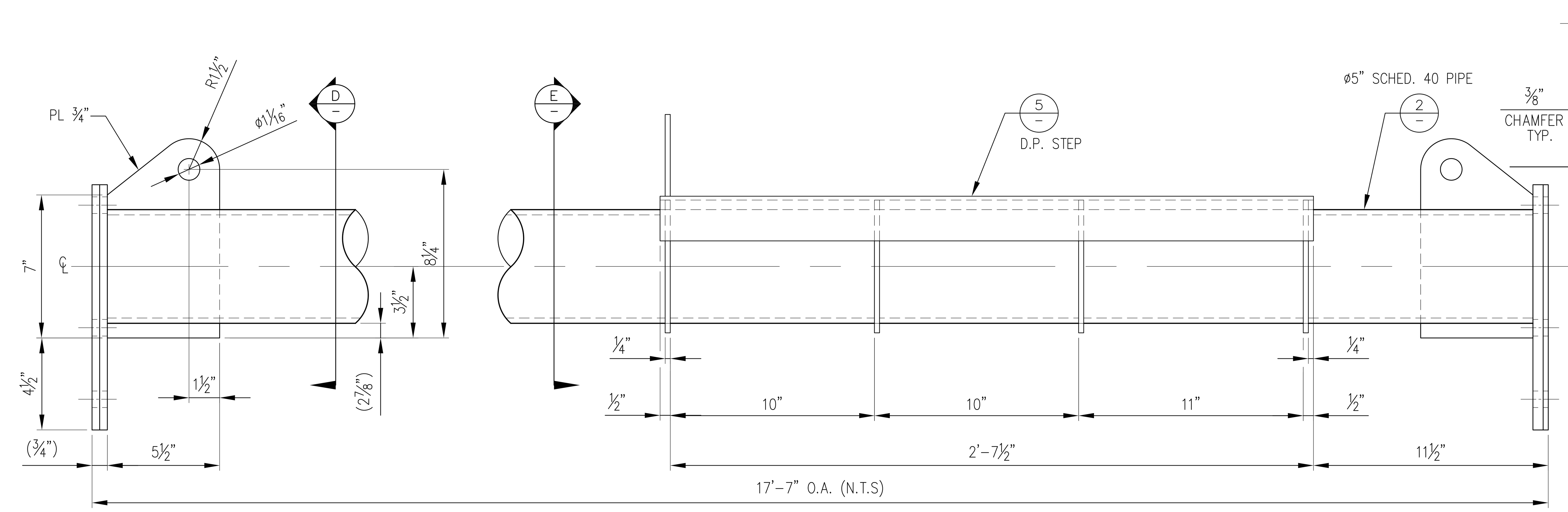
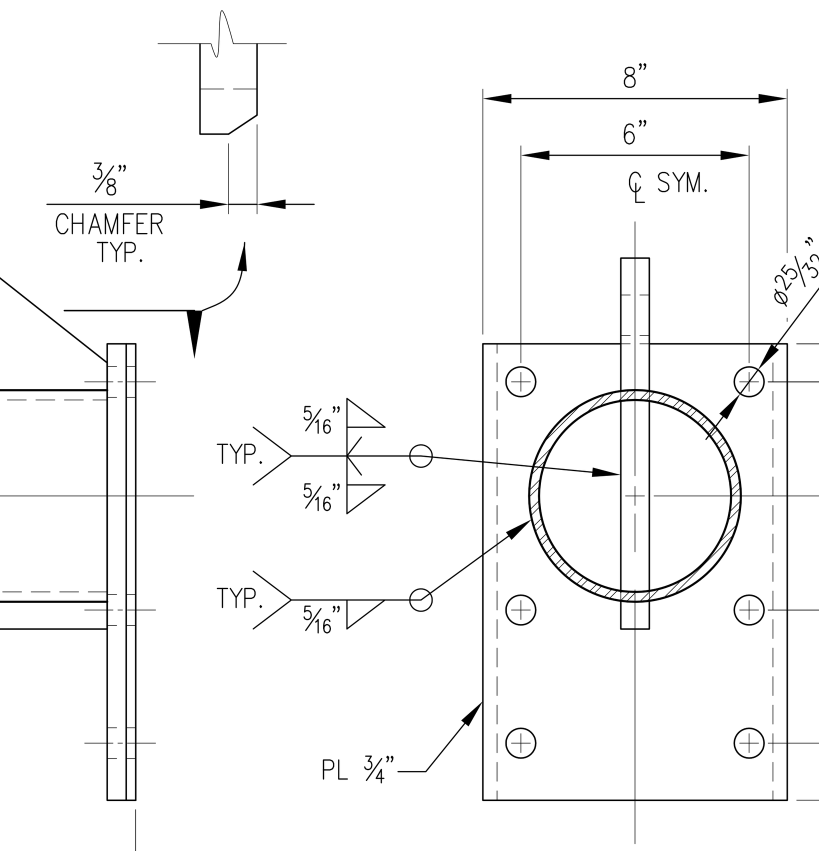
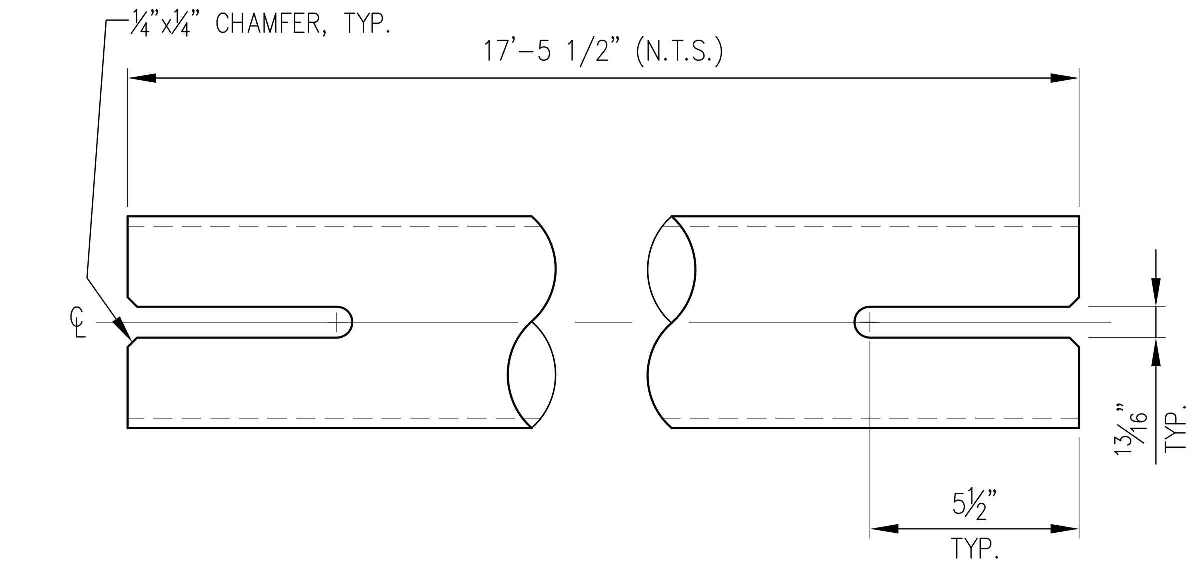


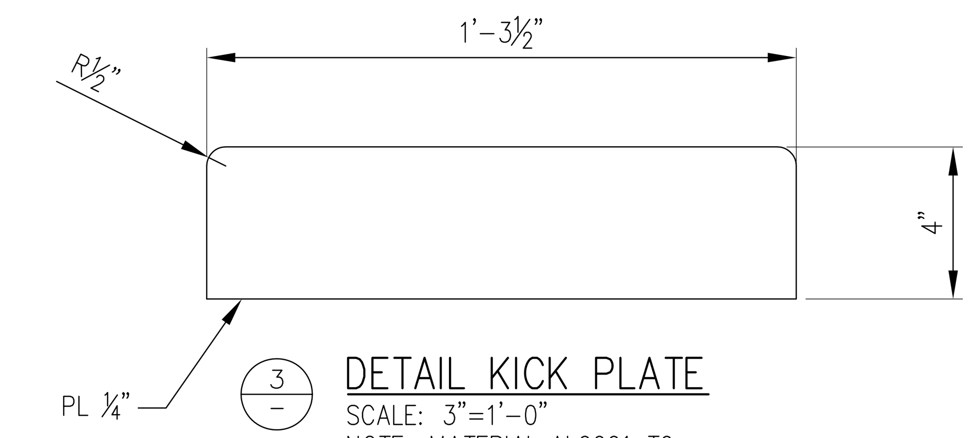
1 MC800 STEP AND BEAM – ELEVATION VIEW
SCALE: 3"=1'-0"
NOTES:
1. MATERIAL: AL6061 T6
2. BEAM IS SYMMETRICAL EXCEPT FOR STEP.



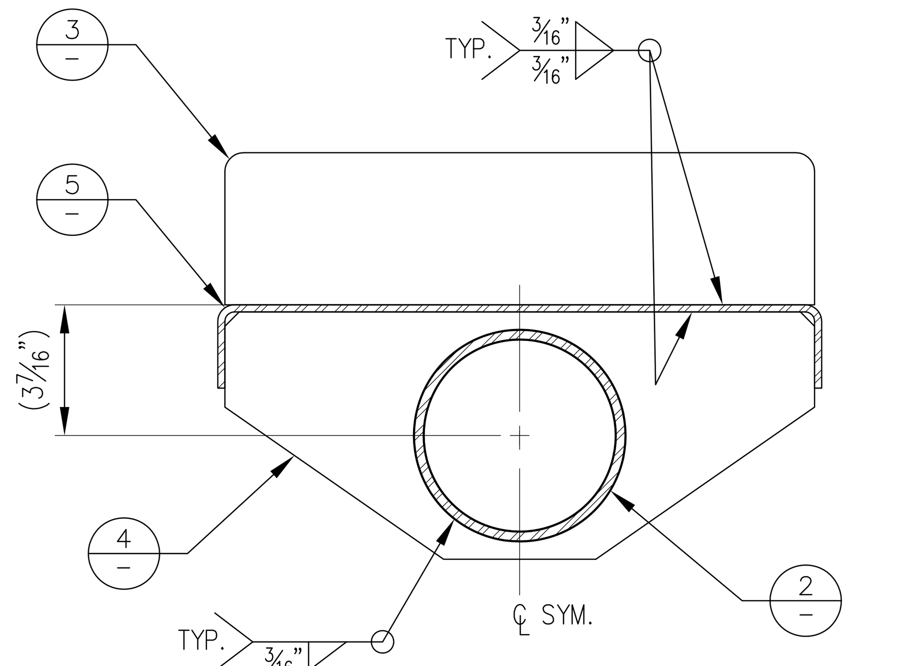
D BOLT PLATE & BEAM – SECTION
SCALE: 3"=1'-0"
NOTES:
1. MATERIAL: AL6061 T6
2. WELD PIPE LAST.



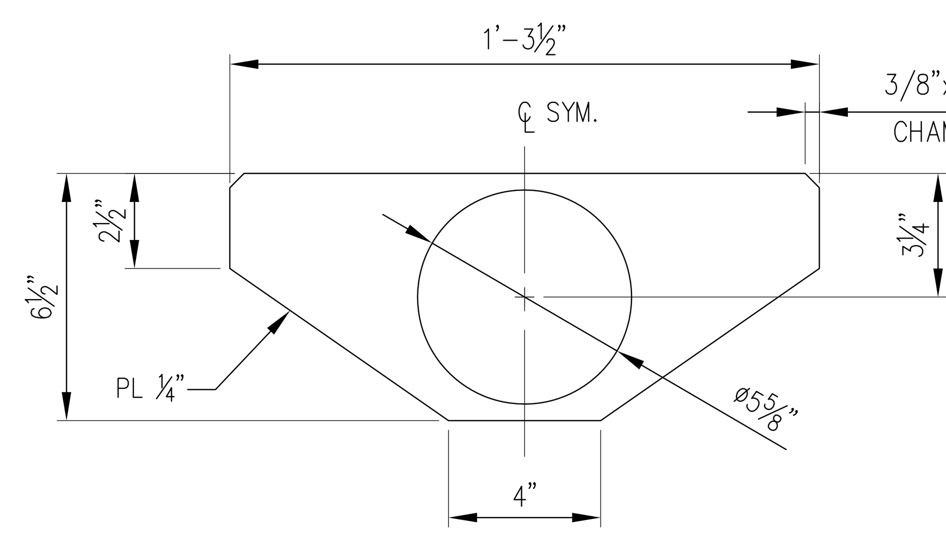
2 DETAIL BEAM
SCALE: 3"=1'-0"
NOTE: MATERIAL: ø5" SCHEDULE 40 PIPE
(ø5.047 I.D. X ø5.563 O.D)



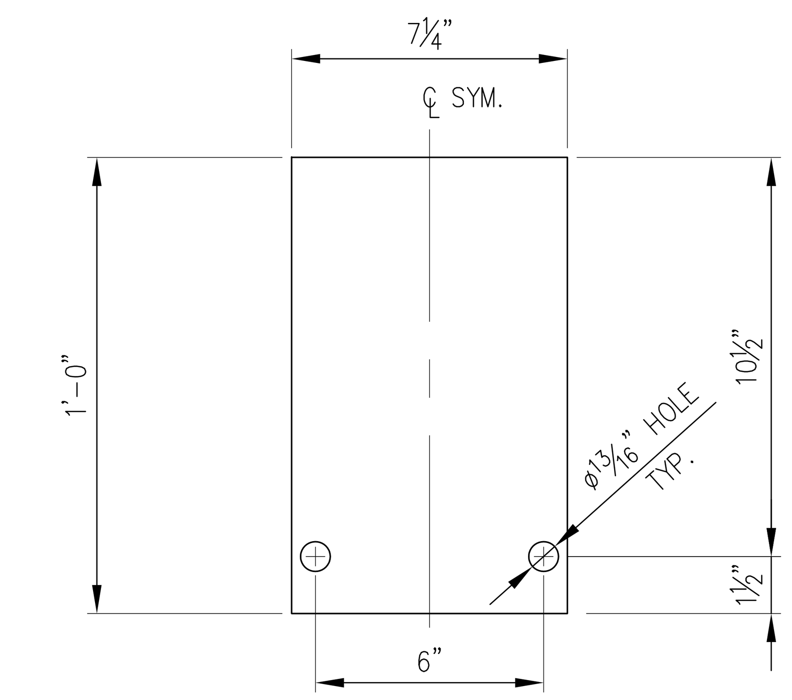
3 DETAIL KICK PLATE
SCALE: 3"=1'-0"
NOTE: MATERIAL: AL6061 T6



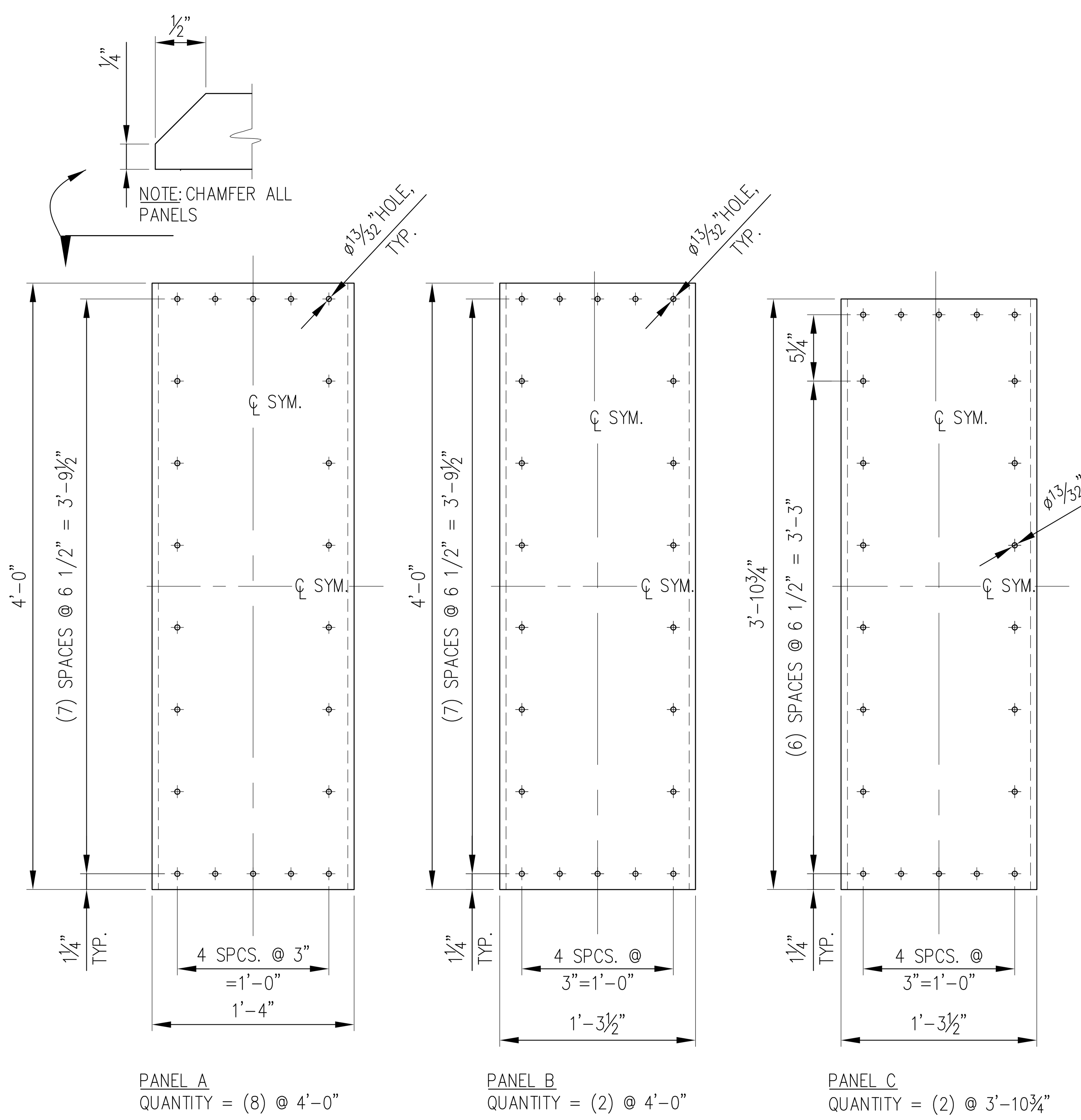
E STEP – SECTION
SCALE: 3"=1'-0"
NOTE: MATERIAL: AL6061 T6



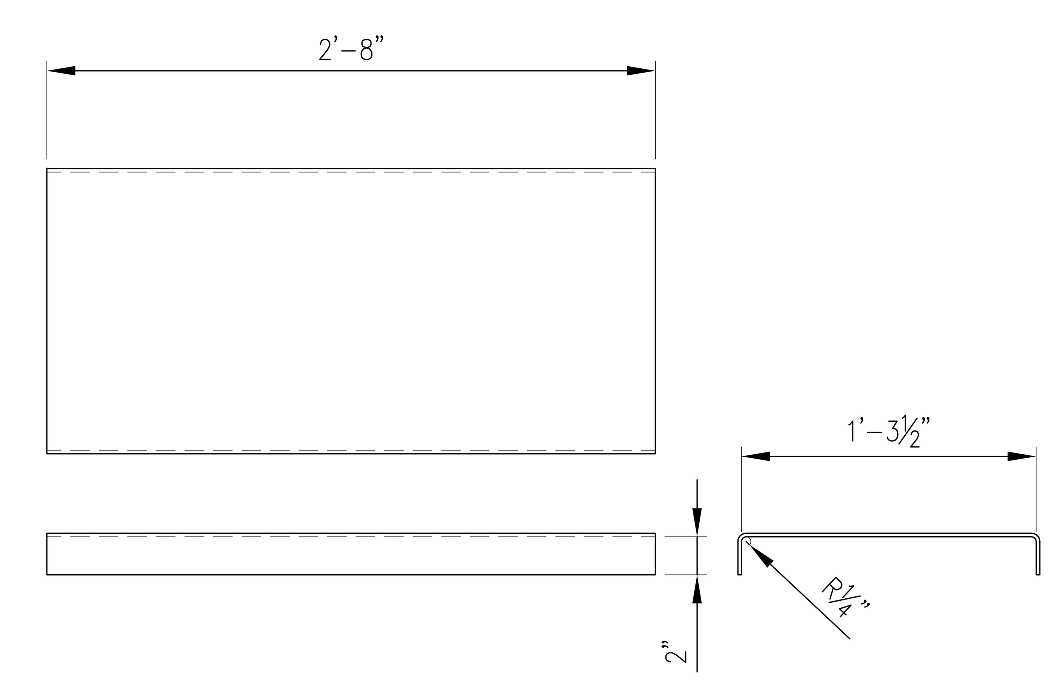
4 DETAIL STIFFENER
SCALE: 3"=1'-0"
NOTES:
1. MATERIAL: AL6061 T6
2. QUANTITY = (4)



7 MC800 DETAIL SHIMS
SCALE: 1½"=1'-0"
NOTES:
1. MATERIAL: AL6061 T6
2. PRODUCE (3) SHIMS, (1) EA. FROM AL. PL ½", ¼" & ⅛"



6 SURFACE PANEL
SCALE: 1½"=1'-0"
NOTES:
1. MATERIAL: ¾" UHMW
2. ø13⁄32" HOLE FOR ⅜"-16 UNC-2B STAINLESS BUTTON HEAD CAP SCREWS



5 DETAIL STEP
SCALE: 1½"=1'-0"
NOTE: MATERIAL: DIAMOND PL 3⁄16", AL 6061-T6

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DETAILS & SECTIONS

SUBMITTED
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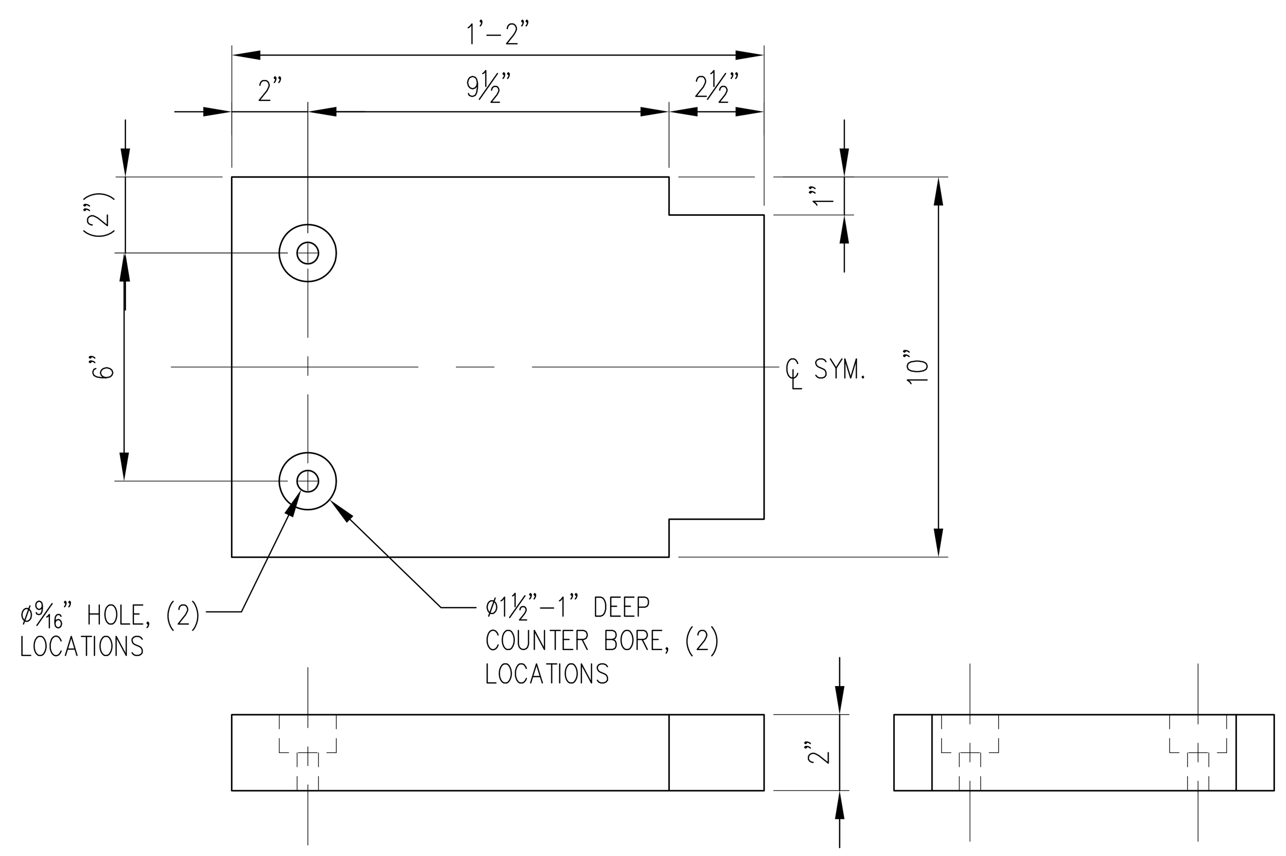
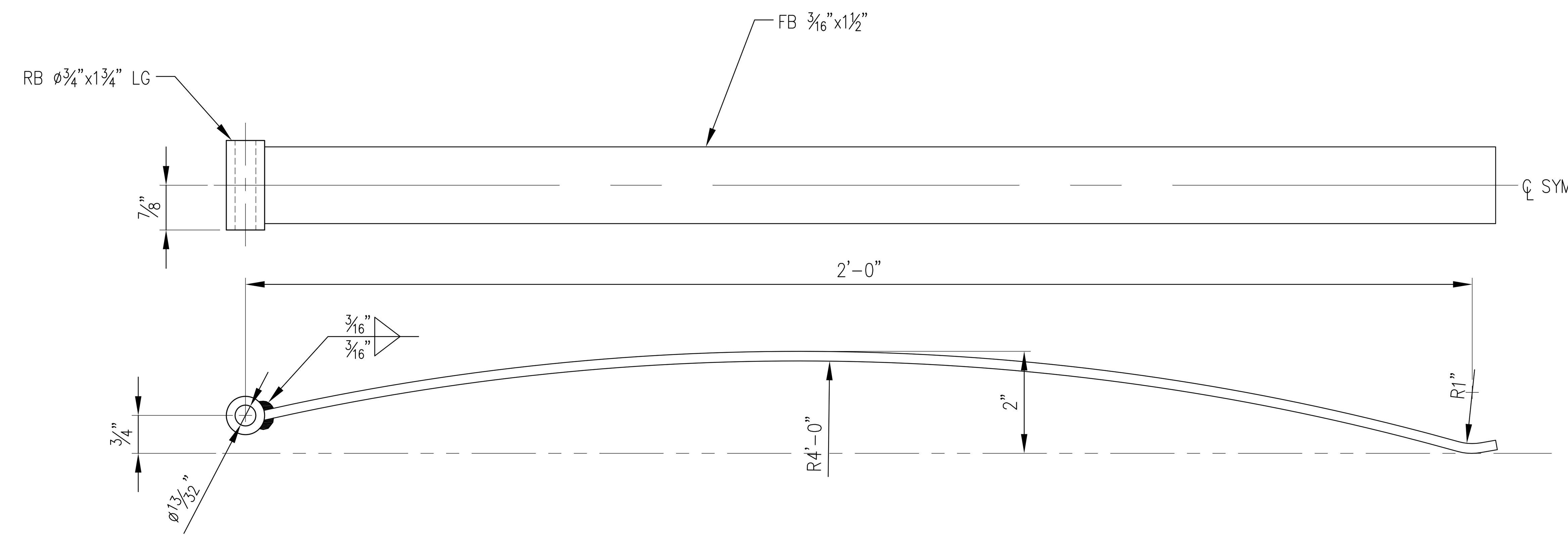
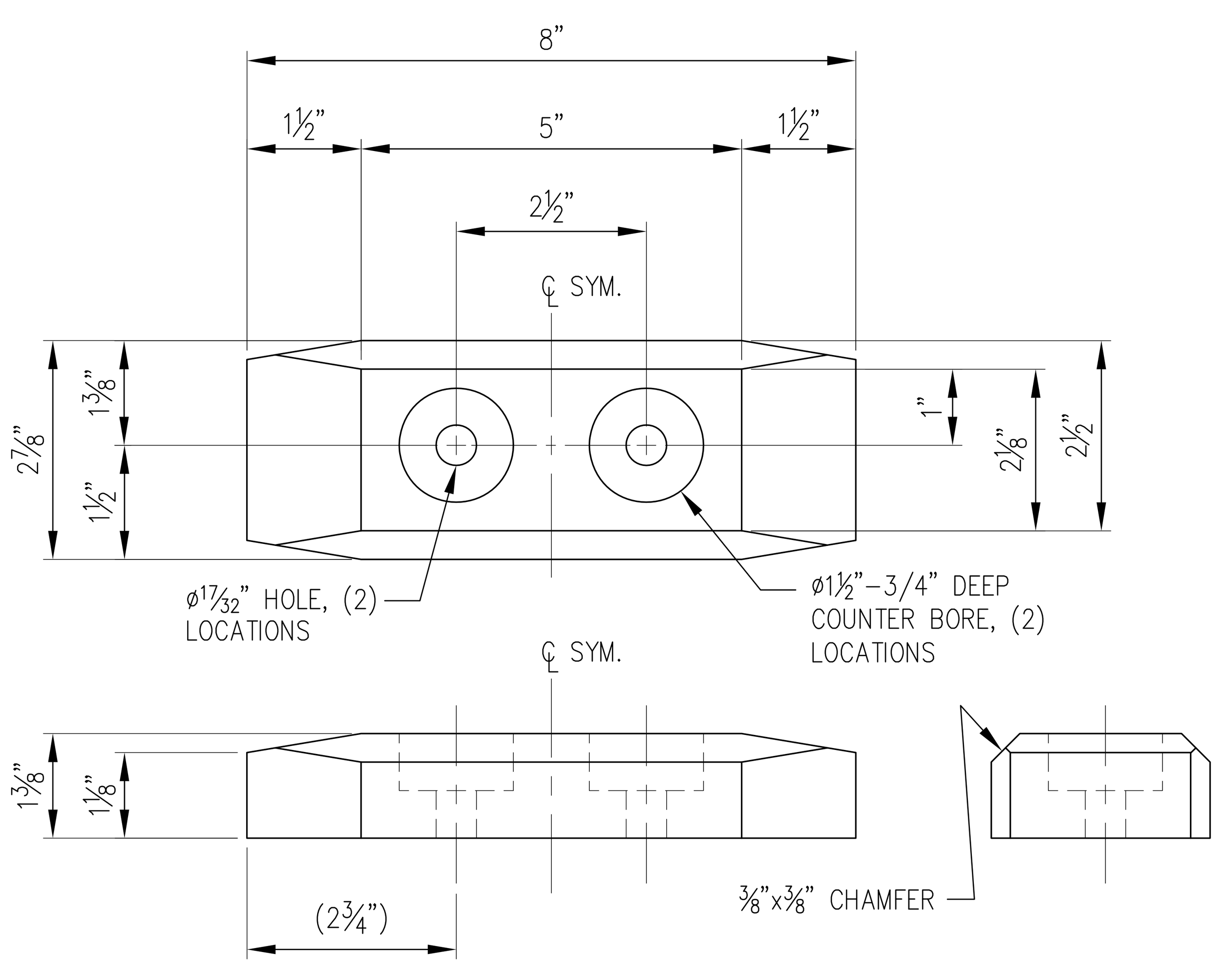
SHT. 3 OF 4



11 MC800 DETAIL EXISTING PAD
SCALE: 3"=1'-0"
NOTES:
1. MATERIAL: UHMW
2. REFERENCE ONLY, PART IS ALREADY BUILT



13 MC800 DETAIL SPRING
SCALE: 6"=1'-0"
NOTES:
1. MATERIAL: 304 SS
2. INSTALL WITH ø⅜" SS ROLL PIN x 3" LG McMASTER PART# 92373A563.
3. FOR LUG INFORMATION SEE DETAIL 10.
4. QUANTITY = (4)



12 MC800 DETAIL ALIGNMENT GUIDE
SCALE: 6"=1'-0"
NOTES:
1. MATERIAL: UHMW
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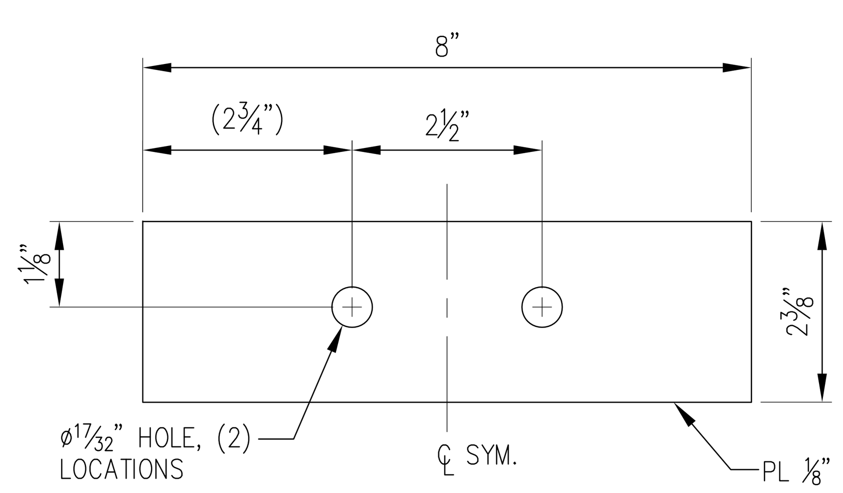

14 MC800 DETAIL ALIGNMENT GUIDE SHIM
SCALE: 6"=1'-0"
NOTES:
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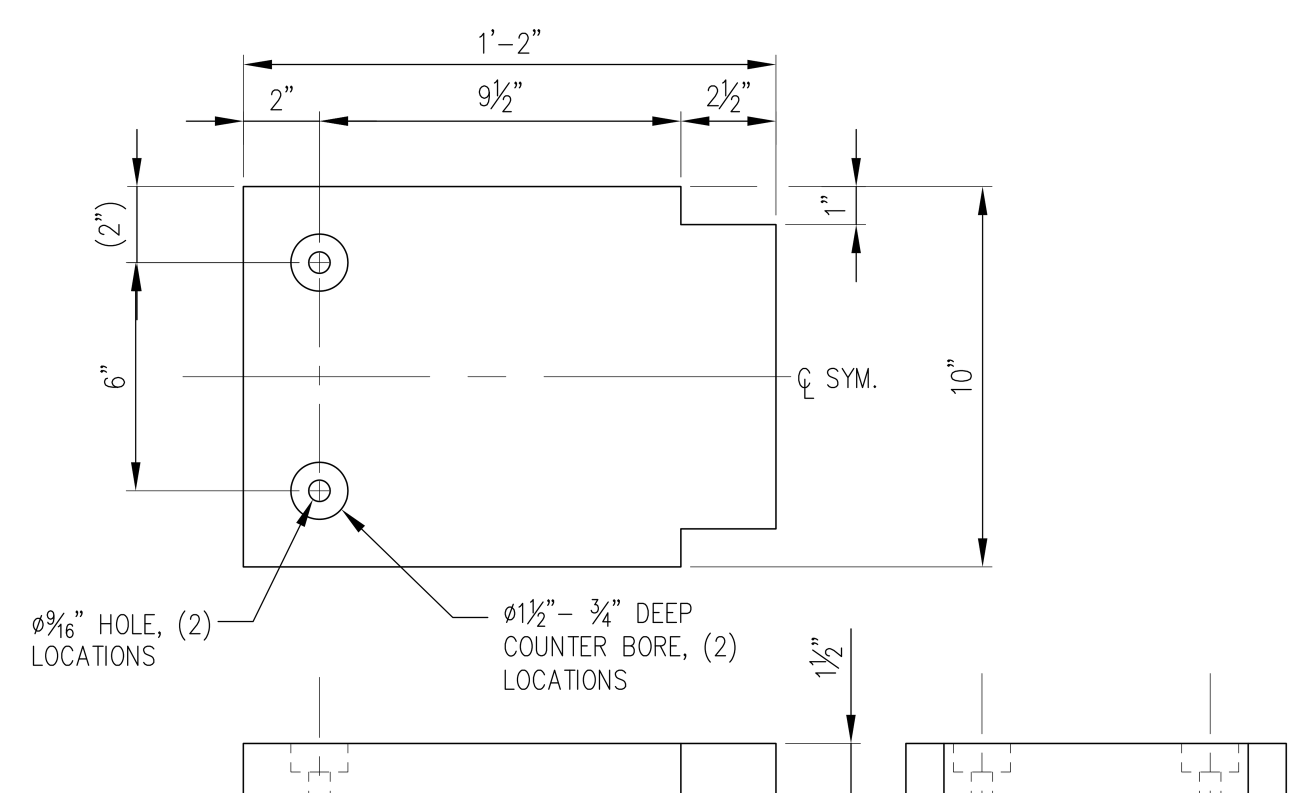
2. QUANTITY = (8)



15 MC800 DETAIL SPARE SHIM PAD
SCALE: 3"=1'-0"
NOTES:
1. MATERIAL: UHMW
2. QUANTITY = (1)

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CITY OF TACOMA
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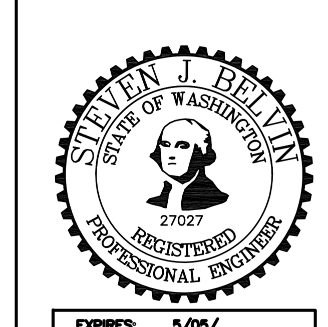
REVISION NO. 0



COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
MONITORING FRAME
DETAILS

SUBMITTED	DRAWN	STAMPED
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	12/1/16 DATE	
APPROVED	DRAWING NO. MC803	

SHT. 4 OF 4

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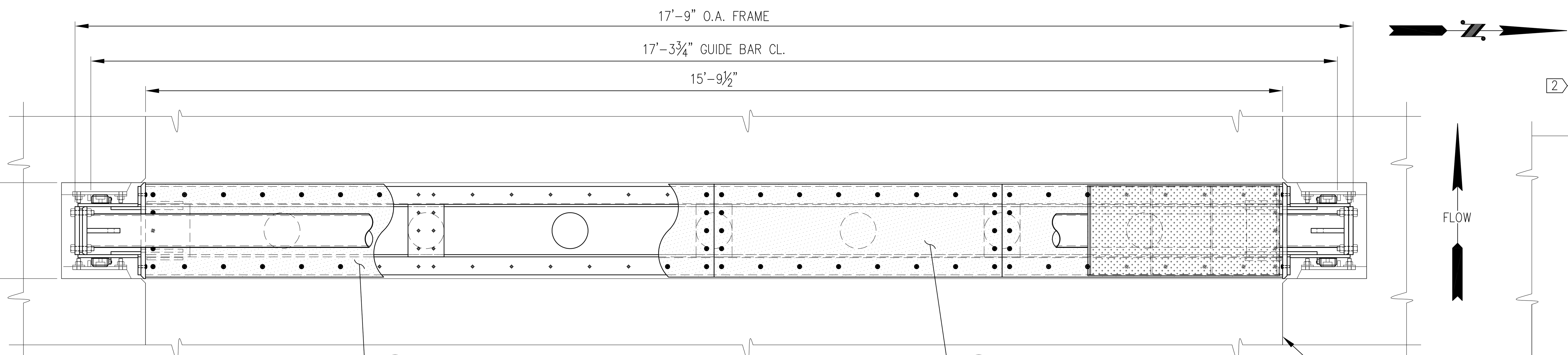
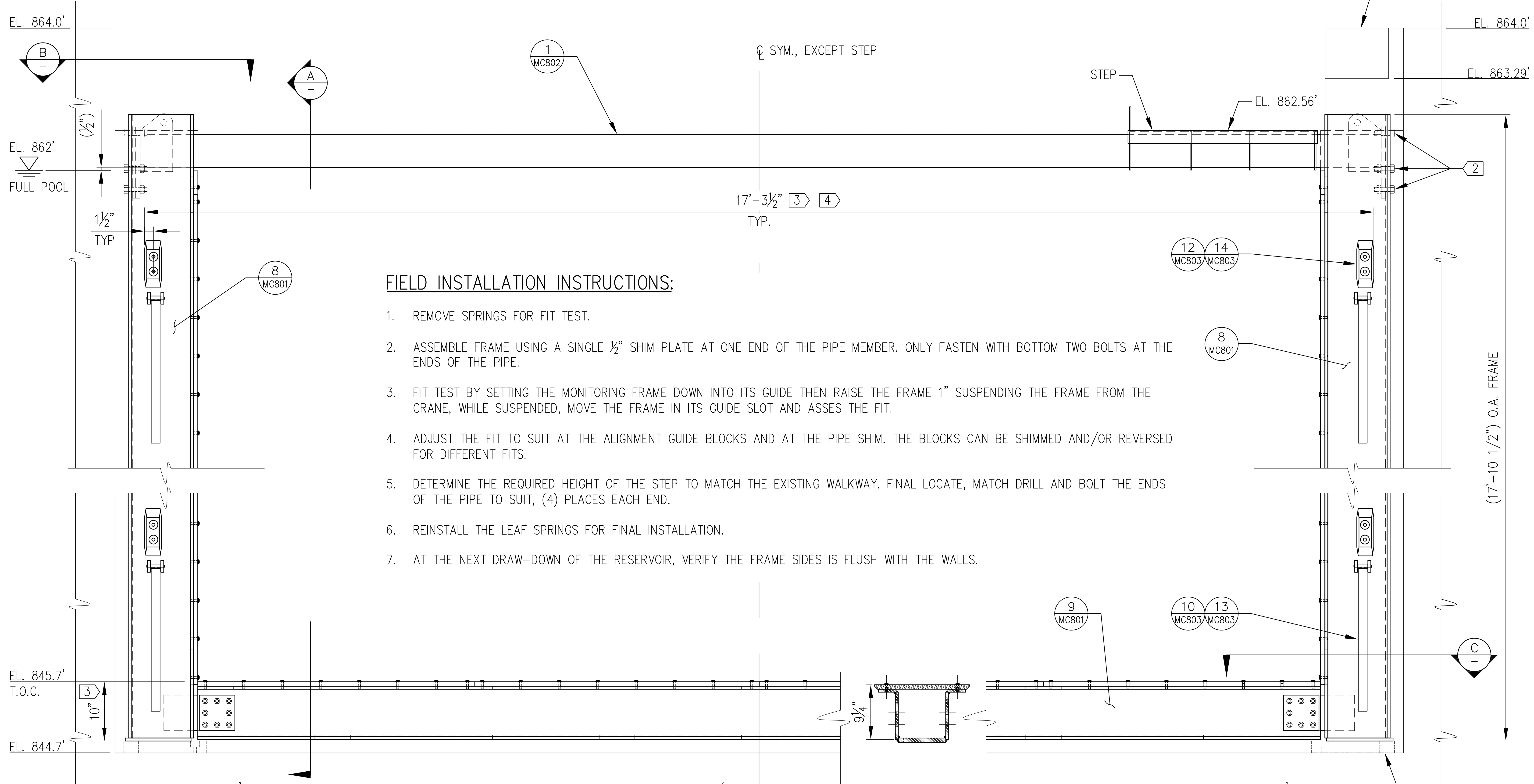


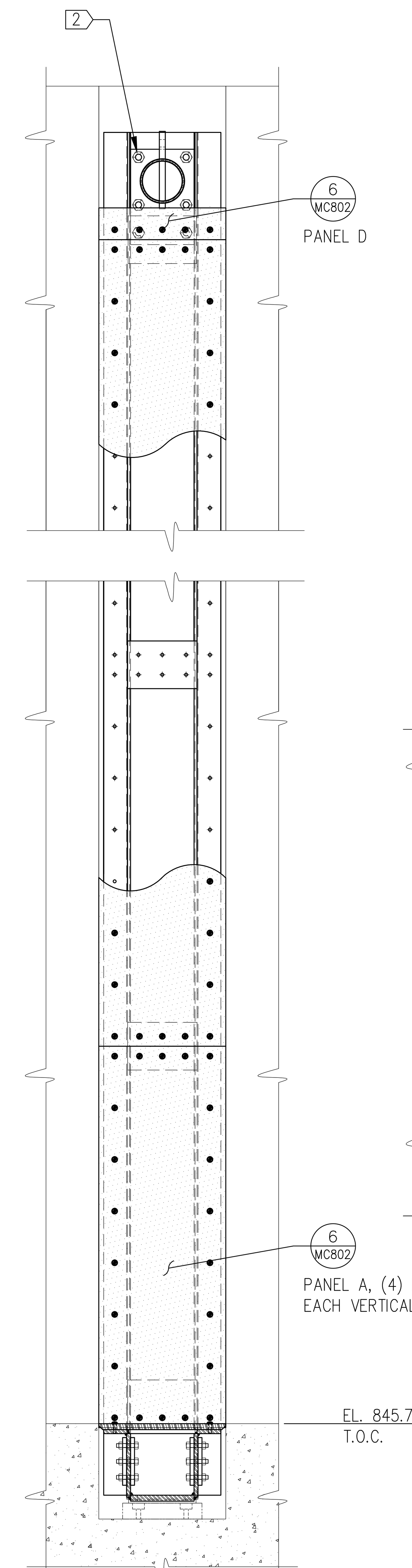
FRAME ASSEMBLY – PLAN VIEW
SCALE: 1"=1'-0"



FIELD INSTALLATION INSTRUCTIONS:

1. REMOVE SPRINGS FOR FIT TEST.
2. ASSEMBLE FRAME USING A SINGLE ½" SHIM PLATE AT ONE END OF THE PIPE MEMBER. ONLY FASTEN WITH BOTTOM TWO BOLTS AT THE ENDS OF THE PIPE.
3. FIT TEST BY SETTING THE MONITORING FRAME DOWN INTO ITS GUIDE THEN RAISE THE FRAME 1" SUSPENDING THE FRAME FROM THE CRANE, WHILE SUSPENDED, MOVE THE FRAME IN ITS GUIDE SLOT AND ASSES THE FIT.
4. ADJUST THE FIT TO SUIT AT THE ALIGNMENT GUIDE BLOCKS AND AT THE PIPE SHIM. THE BLOCKS CAN BE SHIMMED AND/OR REVERSED FOR DIFFERENT FITS.
5. DETERMINE THE REQUIRED HEIGHT OF THE STEP TO MATCH THE EXISTING WALKWAY. FINAL LOCATE, MATCH DRILL AND BOLT THE ENDS OF THE PIPE TO SUIT, (4) PLACES EACH END.
6. REINSTALL THE LEAF SPRINGS FOR FINAL INSTALLATION.
7. AT THE NEXT DRAW-DOWN OF THE RESERVOIR, VERIFY THE FRAME SIDES IS FLUSH WITH THE WALLS.

FRAME ASSEMBLY – ELEVATION VIEW
SCALE: 1"=1'-0"



FRAME ASSEMBLY – SECTION
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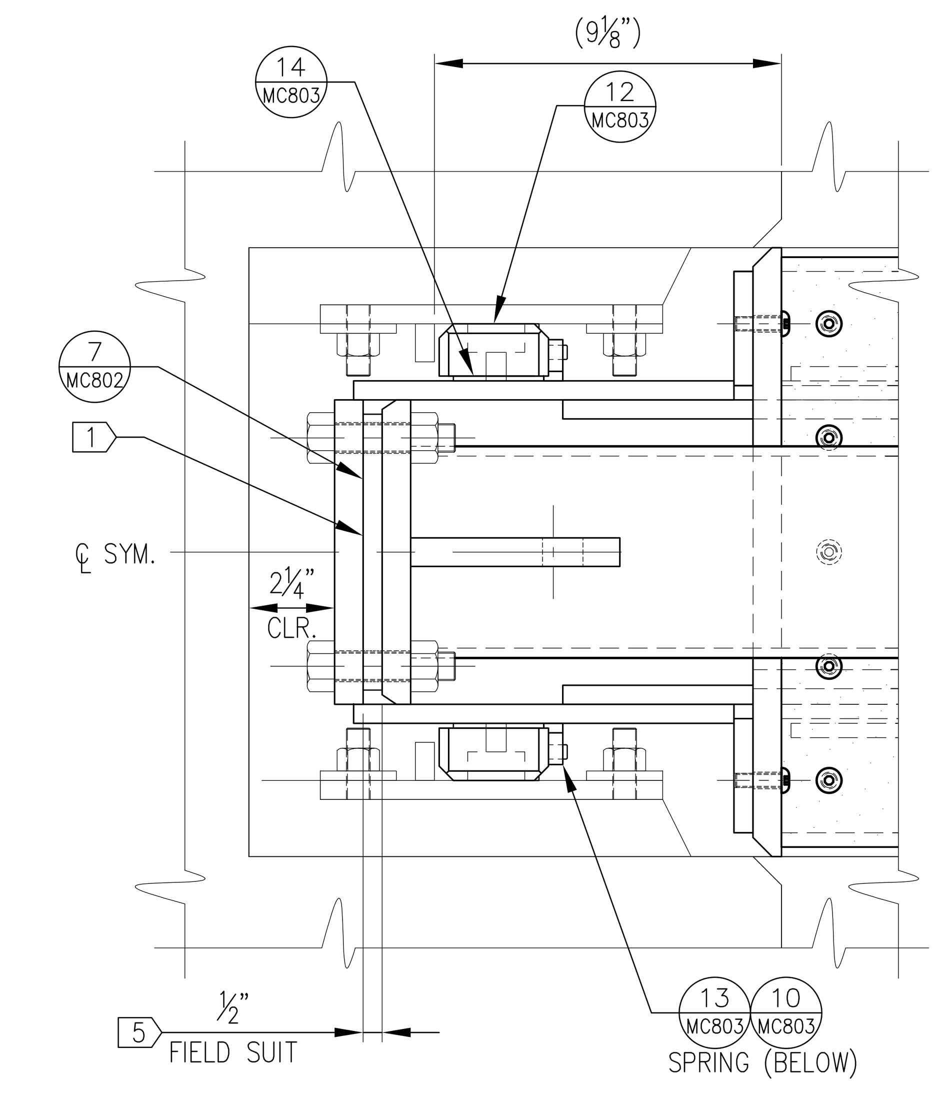

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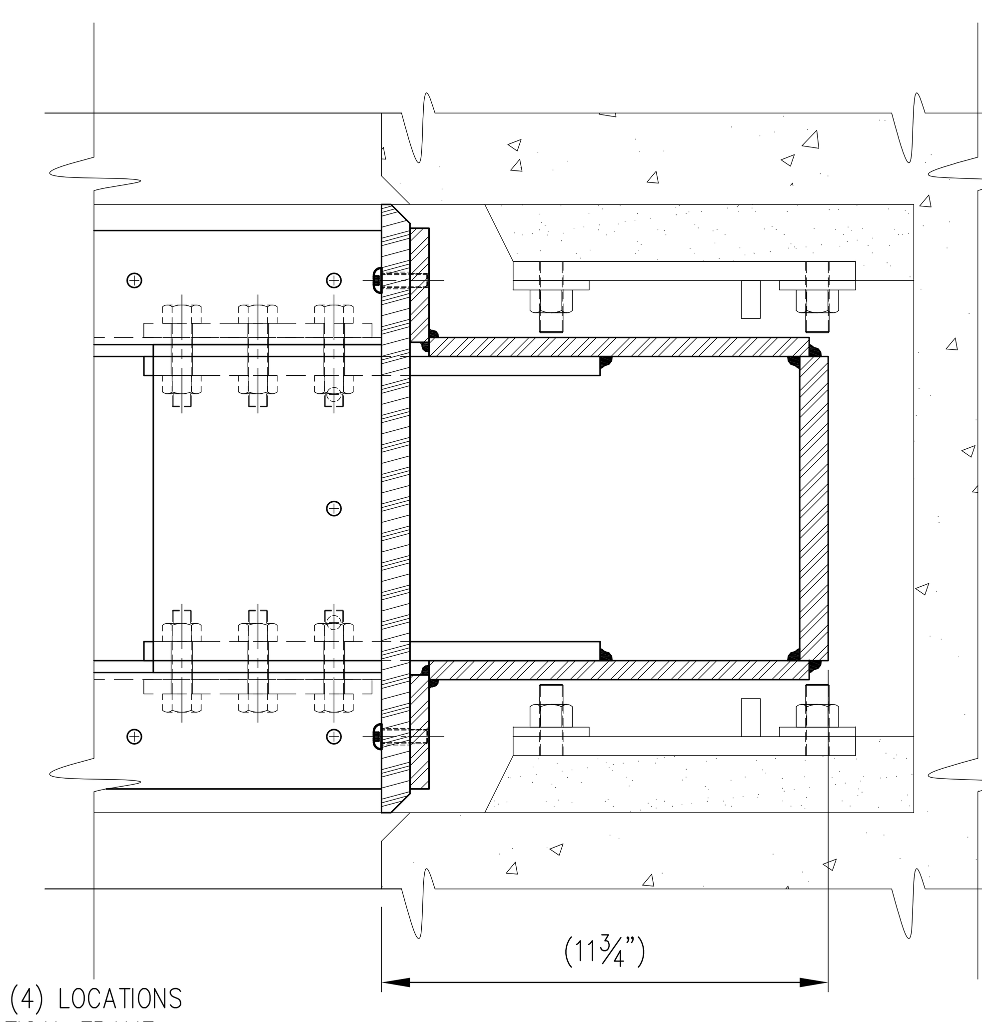


FRAME ASSEMBLY – SECTION
SCALE: 3"=1'-0"
NOTE: HORIZONTAL UHMW PANELS NOT SHOWN

NOTES:

1. SHIM TO SUIT IN FIELD (BEGIN WITH ½", TACK SHIM IN PLACE AFTER ADJUSTING IN THE FIELD).
2. MATCH LOCATE THE UPPER FOUR HOLES IN THE FIELD AFTER VERIFYING THE HEIGHT OF THE STEP IN THE FIELD. USE THE BOTTOM TWO BOLTS ONLY FOR SHOP ASSEMBLY AND INITIAL FIELD INSTALLATION.
3. SHOP INSPECTION HOLD POINT.
4. VERIFY AT SHOP ASSEMBLY.
5. FIRST TIME ASSEMBLY USE THIS SHIM THICKNESS.
6. GENERAL – EXISTING IN FIELD IS SHOWN LIGHT.
7. CALCULATED WEIGHT IS 1,500 LBS.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

NO.	DATE	REVISION DESCRIPTION	DRAWN	CHECKED	STAMPED
0	12/1/16	ORIGINAL DRAWING	KRT		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

REVISION NO. 0

STEVEN J. BELVIN, STATE OF WASHINGTON, 27627, REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 5/08/

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
MONITORING FRAME
GENERAL ARRANGEMENT

SUBMITTED
APPROVED
DRAWN: KRT
STAMPED: SJB
DATE: 12/1/16
DRAWING NO. MC800
SHT. 1 OF 4

TACOMA POWER

3628 South 35th Street
Tacoma, Washington 98409-3192

TACOMA PUBLIC UTILITIES

February 15, 2012

ELECTRONIC FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: City of Tacoma, Cowlitz River Project, FERC No. 2016
Settlement Agreement License Article 1
Downstream Fish Passage: Riffe Lake and Cowlitz Falls Collection and Passage
Filing the Final Conceptual Design Plan

Dear Ms. Bose:

Enclosed for filing is the Final Downstream Fish Passage Conceptual Design Report prepared by the Downstream Technical Team and endorsed by the Fisheries Technical Committee. Tacoma Power, consultants and involved agencies have worked diligently towards improving the fish passage survival of juvenile salmonids to meet the requirements of Settlement Agreement License Article 1. As you are aware, finding a downstream fish collection solution has been difficult due to varying fish behaviors in association with the dynamic hydraulic environment of the upper Cowlitz River and multiple facilities ownership.

The Report recommends a downstream fish collector located on the north shore of the Cowlitz Falls Dam forebay and considers three configurations, of which one will be chosen early in the final design process. The selection will be based on additional hydraulic analysis of the proposed collector configurations and resulting forebay currents. The Report commits to completing an Adaptive Management Plan prior to reaching 30% design of the structure. The Adaptive Management Plan will provide greater detail of performance evaluations and understanding of actions required, if the collection goal is not met. The Fisheries Technical committee will embark on writing the Adaptive Management Plan in early March.

If you have any questions regarding this submittal, please do not hesitate to contact Debbie Young, Natural Resource Manager, at (253) 502-8340 or Keith Underwood, Senior Fisheries Biologist, at (253) 502-8196.

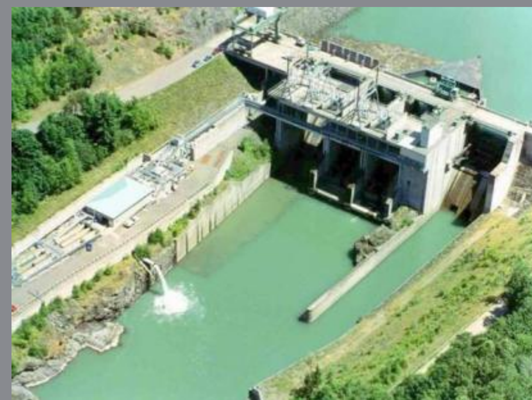
Sincerely,

Patrick D. McCarty
Generation Manager

Attachment

cc: Federal Energy Regulatory Commission, Portland Regional Office
Erich Gaedeke, Federal Energy Regulatory Commission, Portland Office
Fisheries Technical Committee
Downstream Fish Passage Team
Debbie Young
Keith Underwood

Prepared for:
Tacoma Power
Tacoma, Washington



Downstream Fish Passage Conceptual Design Report Cowlitz River Project (FERC No. 2016)

FINAL

Prepared by AECOM in conjunction with:

BioAnalysts, Inc. | **MWH Global, Inc.** | **R2 Resource Consultants, Inc.**

AECOM Inc.
February 15, 2012
Document No.: 60138678-5400

AECOM

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Abbreviations and Acronyms

ADCP	Acoustic Doppler Current Profiler
ADV	Acoustic Doppler Velocimeter
BGS	Behavioral Guidance Structure
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BGS	Behavioral Guidance Structure
CDR	Conceptual Design Report
CFD	Computational Fluid Dynamics
CFFF	Cowlitz Falls Fish Facility
DE	Discovery Efficiency
DFPT	Downstream Fish Passage Team
DOE	Department of Ecology (Washington)
EE	Entrance Efficiency
ESA	Endangered Species Act
FCE	Fish Collection Efficiency
FERC	Federal Energy Regulatory Commission
FPS	Fish Passage Survival
FSC	Floating Surface Collector
FTC	Fisheries Technical Committee
HOR	Hatchery Origin
LCPUD	Lewis County Public Utility District
MR	Mark-Recapture
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service
NOR	Natural Origin

NTS	Net Transition Structure
PLC	Programmable Logic Controller
RT	Radio Telemetry
SFO	Surface Flow Outlet
TDG	Total Dissolved Gas
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
WDFW	Washington Department of Fish and Wildlife

Executive Summary

Tacoma Power owns the Cowlitz River Hydroelectric Project, which consists of two hydroelectric dams on the Cowlitz River in Washington State, Mossyrock Dam and Mayfield Dam. The project is operated under Federal Energy Regulatory Commission (FERC) License No. 2016. Lewis County PUD (LCPUD) owns and operates a third hydroelectric dam on the Cowlitz River, Cowlitz Falls Dam, which is the most upstream dam and impounds Lake Scanewa. Through relicensing of their Cowlitz River Project, Tacoma Power has agreed to improve downstream fish passage. Article 1 of the license issued to the Cowlitz River Project (FERC No. 2016) dated July 18, 2003 includes the following fish passage survival goal (SA FPS Goal) for the project:

Article 1a)2): "proposed facilities and measures most likely to achieve the goal of 95% Fish Passage Survival ("FPS"), as defined in the August 2000 Settlement Agreement, to be funded by the Licensee to contribute to effective downstream passage and collection at or near Cowlitz Falls and/or to be constructed by the Licensee downstream of Cowlitz Falls Dam at Riffe Lake;"

Article 1c): "The Licensee shall implement, or support implementation of, additional downstream passage facility improvements and file additional reports at 18 month intervals in accordance with the preceding paragraph until the Licensee has employed the best available technology and achieved at least 75% FPS for all species"

The Conceptual Design process has included the identification, study, design and evaluation of numerous alternatives with the aim of determining an action or combination of actions that will lead to the achievement of the SA FPS Goal. The Conceptual Design Report is a product of a collaborative effort by the Downstream Fish Passage Team (DFPT). It was submitted to the Fisheries Technical Committee (FTC) for review at 10%, 60% and 90% levels of completion. Since the process began in 2008, thirty-eight measures to improve fish passage survival have been considered, five have been developed to 60% design, seventeen combinations of those five alternatives were methodically evaluated, and two alternatives progressed to 90% conceptual design. This Final Conceptual Design Report does not repeat the documentation of the prior design and evaluation activities; for detail regarding the alternatives that did not move forward to the next phase of design, the reader is directed to earlier versions of this report.

In this Final Conceptual Design Report the DFPT makes a recommendation for two measures to be implemented by 2016 to improve fish passage survival. Recommendations for further studies and a proposed adaptive management process are also presented.

The Recommended Alternative is a surface collector located on the north bank of the reservoir, a short distance upstream of the dam in combination with improvements to the existing collection facility; throughout this document it is referred to as the Partial Flow Capture Facility or the Lake Scanewa Collector. Based on input received during consultations with the DFPT, three potential arrangements of this alternative will be further analyzed prior to selecting one to carry forward to final design and construction. The primary difference between the arrangements is the location of the entrance. The three arrangements are:

Case 1 – Partial Flow Capture Facility w/ Upstream Entrance

Case 2 – Partial Flow Capture Facility w/ Upstream Entrance and Auxiliary Downstream Entrance

Case 3 – Partial Flow Capture Facility w/ Downstream Entrance

In addition to the Recommended Alternative, two weir boxes will be installed in front of the spillway bays to enhance collection at Cowlitz Falls Dam.

The Partial Flow Capture Facility is comprised of the following primary components: Behavioral Guidance Structure (BGS); Exclusionary Net (if feasible); Capture Module; Dewatering Screens; Fish Bypass Pipe; and Screened Flow Conveyance. In addition, Case 1 and Case 2 include a Pump Wall module. The attraction flow is 500 cfs, expandable to 750 cfs, with the dewatering screens sized for 250 cfs design flow.

With the conceptual design complete, the next step will be to undertake preliminary studies, including geotechnical investigations and hydraulic modeling. Tacoma Power intends to proceed with this work during the winter and spring of 2012. Final design is expected to commence in the early summer of 2012. Prototype studies will also continue in 2012, with planned deployments of an updated weir box prototype and exclusionary net testing.

An Adaptive Management Plan will be completed prior to reaching the 30% design level for the Lake Scanewa Downstream Fish Collector. The Adaptive Management Plan will consider actions taken prior to building the downstream fish collector such as deploying interim collection measures while awaiting the completion of the Lake Scanewa Downstream Fish Collector and testing prototype collectors on and downstream of Cowlitz Falls Dam. The Adaptive Management Plan will also describe an iterative and logical process that will be followed to determine facility performance, identify performance issues, and prescribe facility changes necessary to address performance issues that are impeding achievement of the SA FPS Goal.

1.0 Introduction

1.1 Background

Tacoma Power owns the Cowlitz River Hydroelectric Project, which consists of two hydroelectric dams on the Cowlitz River in Washington State, Mossyrock Dam and Mayfield Dam. The project is operated under Federal Energy Regulatory Commission (FERC) License No. 2016. Lewis County PUD (LCPUD) owns and operates a third hydroelectric dam on the Cowlitz River, Cowlitz Falls Dam, which is the most upstream dam and impounds Lake Scanewa.

Completion of the Cowlitz River Project in the 1960s effectively blocked historical Cowlitz River runs of coho, spring and fall Chinook salmon, steelhead and sea-run cutthroat trout from volitional migration to about 80% of their former spawning habitat. Tacoma Power unsuccessfully attempted to maintain the runs through trap and haul of out-migrants upstream from Mossyrock Dam until 1973. In the mid-1990s, Bonneville Power Administration (BPA) began reintroduction of salmon and trout upstream from Cowlitz Falls Dam and added juvenile fish collection facilities at the dam, the Cowlitz Falls Fish Facility (CFFF).

The CFFF was installed in 1996 and initially included one ramped floor screen located downstream from surface collector entrance baffles. The screen was designed to fit between one of four baffle panel slots and one of four flumes entrances installed through the radial gates of the spillway bays to allow fish to pass to the CFFF downstream from the dam, which is operated by Washington Department of Fish and Wildlife (WDFW) under contract to BPA. The collection efficiency of the screen system was less than or only equal to adjacent unscreened slots, and was therefore abandoned after the 1997 fish collection season. The entrance baffles and flume entrances were modified in 2000, resulting in improved fish collection efficiency for steelhead and coho smolts. Research into additional modifications was conducted, but these efforts were suspended when Tacoma Power requested to attempt to meet their SA FPS goals at Cowlitz Falls Dam.

Tacoma Power received a 35-year federal license for its Cowlitz River Hydroelectric Project in 2003. As part of their license requirements Tacoma Power agreed to improve downstream fish passage on the Cowlitz River. Article 1 of the license issued to the Cowlitz River Project (FERC No. 2016) dated July 18, 2003 includes the following fish passage survival goal (SA FPS Goal) for the project:

> *Article 1a)2): "proposed facilities and measures most likely to achieve the goal of 95% Fish Passage Survival ("FPS"), as defined in the August 2000 Settlement Agreement, to be funded by the Licensee to contribute to effective downstream passage and collection at or near Cowlitz Falls and/or to be constructed by the Licensee downstream of Cowlitz Falls Dam at Riffe Lake;"*

> *Article 1c): "The Licensee shall implement, or support implementation of, additional downstream passage facility improvements and file additional reports at 18 month intervals in accordance with the preceding paragraph until the Licensee has employed the best available technology and achieved at least 75% FPS for all species"*

In 2006 Tacoma Power installed a new fish screen, the Tacoma Power screen, at Cowlitz Falls Dam. After an evaluation period, the screen was modified in 2007. However, the performance of the Tacoma Power screen has never approached the SA FPS Goal.

In March of 2008 Tacoma Power convened a 2-day Fisheries Technical Committee (FTC) workshop attended by invited representatives of the consulting engineering community, Tacoma Power, LCPUD and other utilities, federal and state resource agencies, the U.S. Army Corps of Engineers, federal congressional staffs, and various non-Governmental organizations to brainstorm and identify specific fish collection solutions that may improve downstream fish passage. Following the workshop, Tacoma Power convened a Downstream Fish Passage Team (DFPT) comprised of consulting engineers and a consulting biologist, Tacoma Power and LCPUD staff, and state and federal resource agency staff. The DFPT advanced the five most promising alternatives identified at the FTC workshop to 60% conceptual design and presented them in a report dated April 30, 2009 (AECOM et al, 2009). The five concepts developed to 60% design level were:

- A Floating Surface Collector (FSC) in Lake Scanewa;
- Enhancement of the Existing Collector at Cowlitz Falls Dam;
- A Surface Flow Outlet (SFO) at Cowlitz Falls Dam;
- A FSC in Riffe Lake; and
- A FSC at Mossyrock Dam.

Additionally, the 60% Conceptual Design Report called for initiation of the conceptual design for the Riffe Lake Collector preferred alternative to begin once the final design for the recommended alternative was completed. The DFPT also recommended prototype and fish tracking studies, which were conducted during the 2009 and 2010 fish passage seasons (Liedtke and Kock 2009a; Liedtke and Kock 2009b; AECOM 2009; unreferenced 2010). Design development and third party input continued between the publishing of draft 60% CDR in April 2009 and the completion of the 2009 and 2010 prototype and fish tracking studies. As a result, changes were made to the design concepts for the Collector in Lake Scanewa, the SFO at Cowlitz Falls Dam and Enhancement of the Existing Collector at Cowlitz Falls Dam.

From spring 2010 through September 2010 the DFPT worked to develop a method to evaluate the alternatives' biological and technical merits and to come to consensus about which alternatives should be carried forward to 90% conceptual design. Based on the evaluation of alternatives and the information that was available in September 2010, the DFPT recommended that three alternatives be carried forward to 90% conceptual design: two primary alternatives, plus one supplemental alternative that is complimentary to both of the primary alternatives:

- Collector in Lake Scanewa
- SFO near Cowlitz Falls Dam
- Enhancement of Existing System at Cowlitz Falls Dam: Weir Box (Supplemental Alternative)

As the Collector in Lake Scanewa and the SFO near Cowlitz Falls Dam alternatives progressed from 60% conceptual design to 90% conceptual design, it became apparent that they would need to be located in the same place and have many common features, with the most significant differentiators between the alternatives being the entrance structure, and method and location of fish capture. The DFPT provided additional input to the direction of the design of these alternatives at a meeting held on January 26, 2011 resulting in revision of the alternatives to:

- Partial Flow Capture Facility
- Full Flow Capture Facility
- Weir Boxes

These three alternatives, including some potential adaptations, were developed to a 90% conceptual design level and were presented in the 90% Conceptual Design Report.

Since completion of the 90 % CDR, the DFPT evaluated these alternatives and recommended the Partial Flow Capture Facility, in combination with Weir Boxes be carried forward to detailed design and that three variations of the Partial Flow Capture Facility be considered in this process.

1.2 Objective

The objective of this Conceptual Design Report (CDR) is to document the development of the designs recommended for detailed design and implementation.

1.3 Acknowledgements

The authors would like to thank the other members of the DFPT: Steve Fischer, Tacoma Power; Keith Underwood, Tacoma Power; Marc Wicke, Tacoma Power; Mark LaRiviere, Tacoma Power; Bill Iyall, Tacoma Power; Ed Meyer, NOAA Fisheries; Dennis Rondorf, USGS; and Eric Kinne and John Serl, WDFW, without whose valuable input, review, and recommendations, preparation of this report would not have been possible. This report was prepared as a joint effort of the authors, with support from staff from their respective firms, under direction of the FTC, and funded by Tacoma Power.

1.4 Report Organization

Section 1.0 provides an introduction to the history of this project and the objectives of this CDR. Section 2.0 presents the background biological and technical data that have been used as a basis for the design development. Criteria used in developing the designs are presented in Section 3.0. In Section 4.0, the evaluation leading to the recommendation of an alternative to be carried forward to final design is presented. Section 5.0 describes the Recommended Alternative, and Section 6.0 lays out the recommended studies that will inform detailed design and proposes an adaptive management process for implementation of the designs. References are listed in Section 7.0.

Drawings of the existing project are provided for reference in Appendix A.

A list of Abbreviations and Acronyms is provided at the end of the table of contents, prior to the Executive Summary.

2.0 Background Information

2.1 Physical Data

2.1.1 Hydrology

The Cowlitz River basin drains approximately 2,480 square miles of mountainous terrain in southwestern Washington State. Of the total basin area, 1,390 square miles is in the watershed area contributing to Mayfield Dam. The Cowlitz River is formed by the confluence of the Muddy Fork and Ohanapecosh Rivers near the town of Packwood, and flows generally westward entering the Columbia River at RM 68. The headwaters of the Cowlitz River are in the Cascade Mountains. In the upper basin, river flows are influenced by spring snowmelt and dry summer conditions, and peak flows are triggered by rain-on-snow events and snowmelt. A few major tributaries drain glaciers on high Cascade peaks and contribute glacial melt water during summer months. A map of the Cowlitz Basin is provided in Figure 2.1-1.

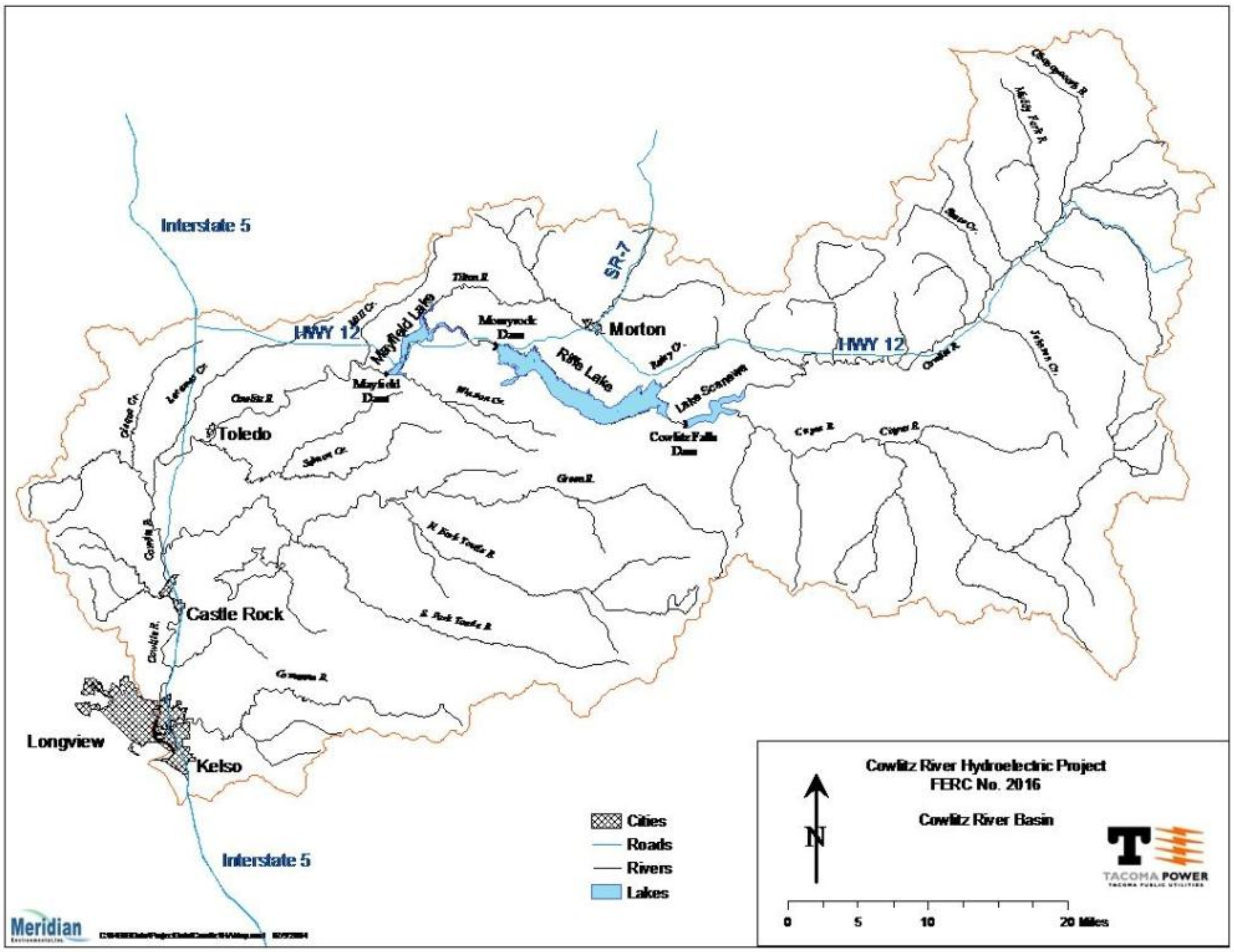


Figure 2.1-1 Cowlitz Basin Map (Meridian 2004)

The general climate of the Cowlitz Basin is described in the Northwest Power and Conservation Council's Lower Columbia Sub basin Plan (2004). The basin has a typical northwest maritime climate with dry and warm summers and cool, wet and cloudy winters. Mean monthly precipitation ranges from 1.9 inches in July to 19 inches in November at Paradise on Mt. Rainier, and from 1.1 inches in July to 8.8 inches in November at Mayfield Dam. Most precipitation occurs between November and March. Snow and freezing temperatures are common in the upper basin, while rain predominates in the middle and lower elevations.

Figure 2.1-2 through Figure 2.1-4 present flow exceedence curves based on 25-years of data collected at USGS gauge 14233500, Cowlitz River near Kosmos, which is located at Cowlitz Falls Dam. The figures each represent a different seasonal division: Figure 2.1-2 presents data for the full year; Figure 2.1-3 presents data for the primary fish migration period and Figure 2.1-4 presents data for the secondary fish migration period. Figure 2.1-5 presents the average annual hydrograph at the gauge and Figure 2.1-6 shows the Cowlitz Falls Dam discharges during the spring-summer smolt collection seasons of 1997 to 2005. These figures demonstrate the typical ranges of flows that must be considered in design of fish passage facilities.

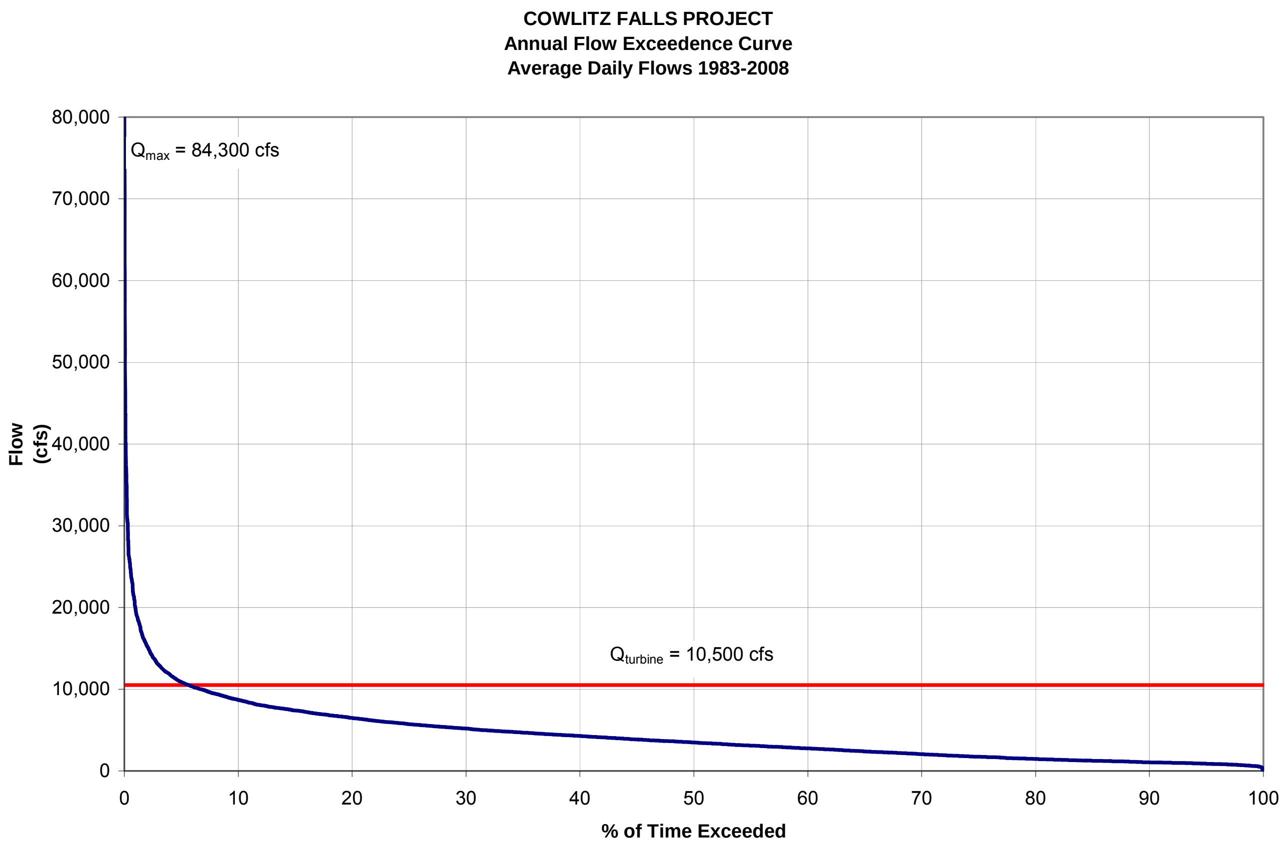


Figure 2.1-2 Cowlitz Falls Dam Flow Exceedence Curve – Annual

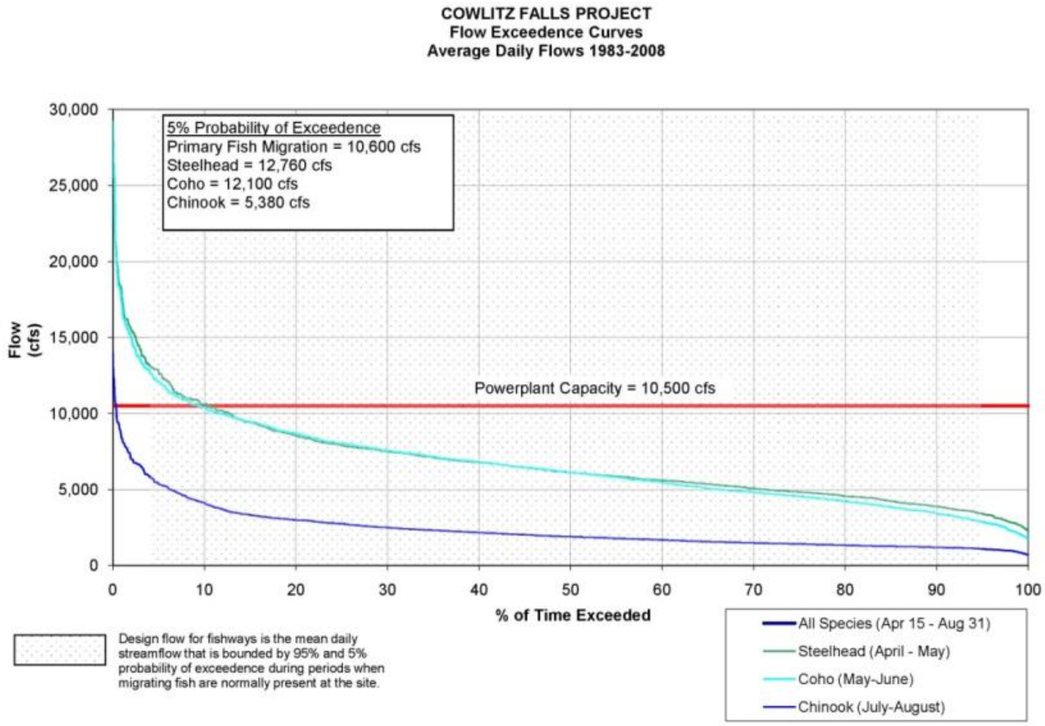


Figure 2.1-3 Cowlitz Falls Dam Flow Exceedence Curve – Primary Fish Migration Period

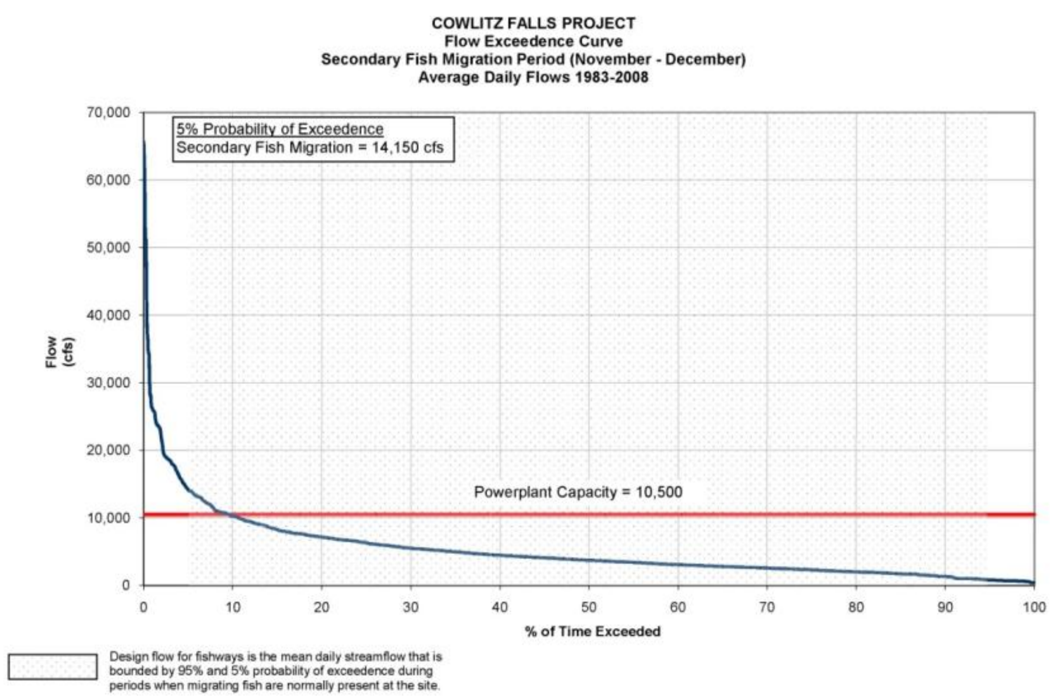


Figure 2.1-4 Cowlitz Falls Dam Flow Exceedence Curve – Secondary Fish Migration Period

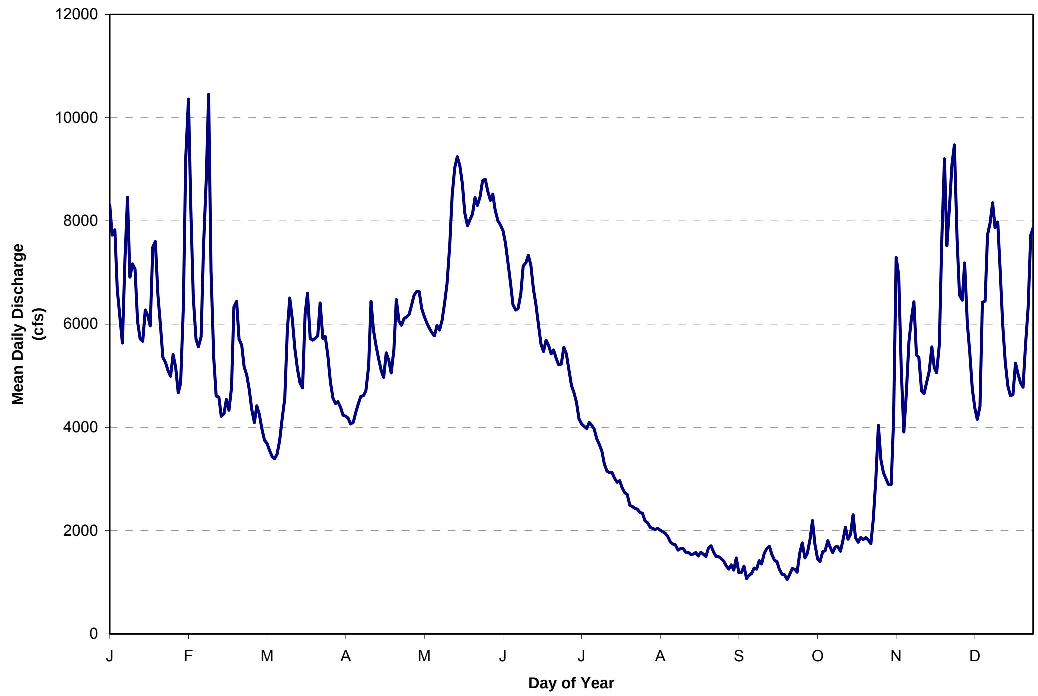


Figure 2.1-5 Mean Daily Hydrograph: Cowlitz River at Kosmos USGS 14233500 (1995 to 2008)

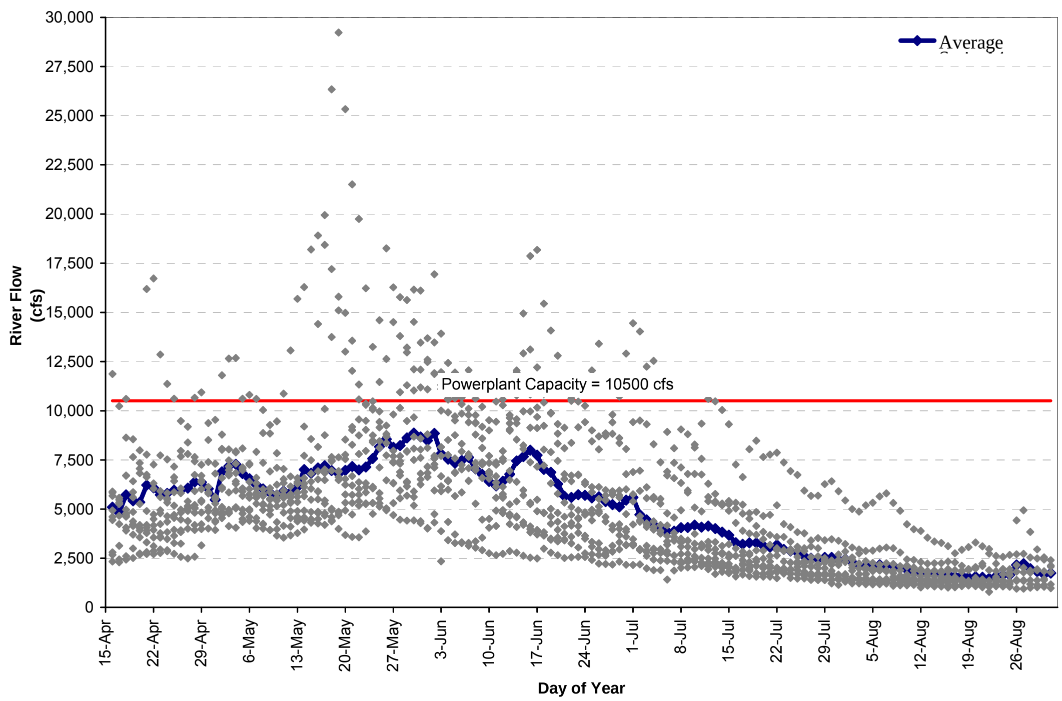


Figure 2.1-6 Cowlitz Falls Dam Discharges During the Spring-Summer Smolt Collection Seasons (1997 to 2008)

NMFS criteria (2011) requires that fish passage facilities be designed for mean daily stream flows between 95% and 5% probability of exceedence during times when fish are expected to be present. The current primary juvenile collection period is mid-April through August but should be evaluated to determine current juvenile migration timing. A secondary collection period should include the remainder of the year. Based on the NMFS criterion, Figure 2.1-3 indicates that the design flow range at Cowlitz Falls Dam varies from a low of 1,080 cfs corresponding to the 95% exceedence value during the primary Chinook migration period to a high of 12,760 cfs corresponding to the 5% exceedence value during the primary steelhead migration period.

Discharge from the Cowlitz Falls Dam and powerhouse flow into Riffe Lake, which is impounded by Mossyrock Dam. Flow exceedence curves of discharge through Mossyrock Dam are provided for the primary and secondary migration periods in Figure 2.1-7 and Figure 2.1-8.

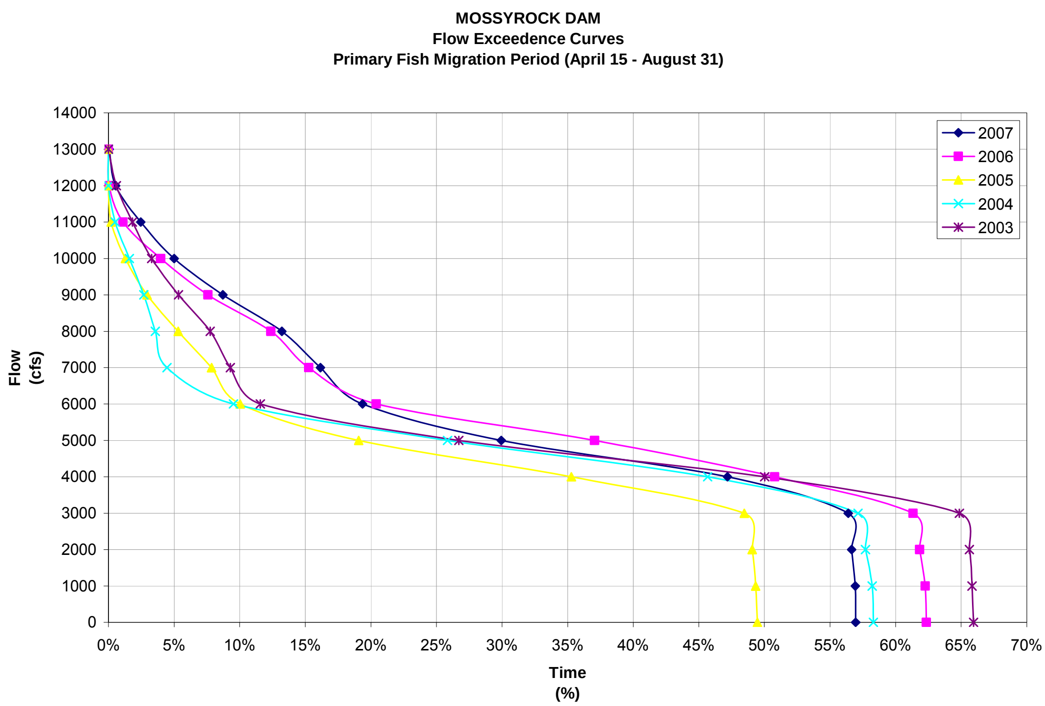


Figure 2.1-7 Mossyrock Dam Flow Exceedence Curve – Primary Fish Migration Period (received from Tacoma Power)

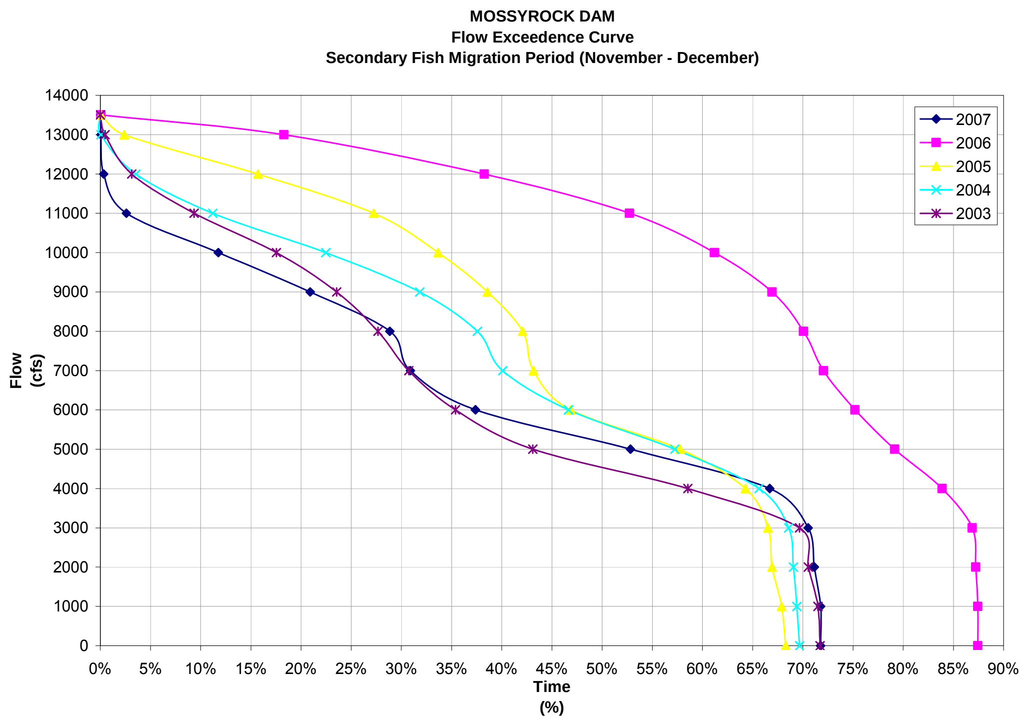


Figure 2.1-8 Mossyrock Dam Flow Exceedence Curve – Secondary Fish Migration Period (received from Tacoma Power)

2.1.2 Bathymetry

The bathymetry extending from Mossyrock Dam to Cowlitz Falls Dam is depicted in Drawing 2.1-9 through Drawing 2.1-14.

Lake Scanewa reservoir is long and narrow, with conditions at Cowlitz Falls Dam influenced by a sharp bend located approximately 2,500 feet upstream of the dam. Approximately 6,000 feet upstream of the dam, the flow is split into the Cowlitz and Cispus Arms. The maximum depth in Lake Scanewa Reservoir is approximately 100 feet at the dam and the top width of the reservoir varies from approximately 350 feet to approximately 700 feet. The reservoir quickly becomes shallower farther away from the dam; the depth at the bend is approximately 55 feet and the depth at the confluence of the Cowlitz and Cispus Arms is approximately 30 feet.

Riffe Lake is the largest of the three reservoirs. The original thalweg meanders considerably. In the proximity of Mossyrock Dam the reservoir depth and width are approximately 375 feet and 1,800 feet respectively. The right bank slopes steeply and extends the full width across the powerplant intakes. Presumably, this will affect flow patterns at Mossyrock Dam.

2.1.3 Hydraulic Setting

There are three hydroelectric dams located on the Cowlitz River. Cowlitz Falls Dam, operated by LCPUD, is located the farthest upstream and impounds Lake Scanewa, a small, narrow reservoir. Below Cowlitz Falls Dam is Riffe Lake, a 23.5 mile long reservoir which is impounded by Mossyrock Dam. Mossyrock Dam is operated by Tacoma Power. The water level in Riffe Lake rises in the spring and is drawn down in the fall to prepare for winter runoff. The lowest dam in the cascade is Tacoma Power's Mayfield Dam, which impounds 13.5 mile-long Mayfield Lake. Mayfield Lake provides little flood storage capacity and flows from Mayfield Dam are largely in response to the regulation of flows through Mossyrock Dam. The Cowlitz Falls Project is primarily operated in run-of-river mode.

Hydraulic conditions in the Cowlitz Falls Dam forebay and the relationship between forebay patterns and project operation are of interest for fish passage design. To better understand the flow conditions in Lake Scanewa and to provide information necessary for a conceptual design developed by Harza in 1994, ENSR conducted a physical model study of the area extending from the dam up to and including a large bend in the river located approximately 2,500 feet upstream from the dam (Harza/ENSR 1993). The model testing was conducted for unmodified conditions (i.e. without any fish passage facilities), and for revised conditions with the conceptual fish passage facilities in place. The tests were conducted for total flows ranging from 5,000 to 23,000 cfs, turbine flows from 5,000 cfs to 10,500 cfs and sluice flows from 0 to 12,500 cfs.

Testing of the unmodified conditions indicated that two large and one smaller surface eddy formed in the forebay. One large eddy formed downstream of the river bend and extended for approximately 1,400 feet along the north shore of the reservoir. The second large eddy formed over the sluice channel centered approximately 300 feet upstream of the dam and extended to a point on the south shoreline about 700 feet away from the dam. The smaller eddy was located in the northwest corner of the forebay between the debris deflector and the north shoreline. Many secondary currents, which included expansions and horizontal rollers, were present in the forebay. At higher flows, much of the flow approached the dam along the river thalweg while surface velocities remained consistent with lower flow data. A northward movement of flow parallel with the dam face originated near the embayment created by Spillway #4, and was present for all conditions. Flow was usually observed to approach the intake of Unit #2 from the sluice channel, passing over the retaining wall for all but the highest flow condition. Testing of modifications to improve fish passage hydraulics indicated that the following would improve the forebay hydraulics and enhance the efficiency of the attraction facilities: Installing flow restricting baffles would maximize the attraction zone; adding a submerged beam across the entrance to Spillway #4 would counteract the formation of a strong vortex during sluice operation; lowering the cofferdam and retaining wall to elevation 810 feet would improve flow patterns approaching the dam; and using the debris passing flap gates sparingly would reduce the frequency in which a strong competing surface attraction flow would be generated. These modifications were implemented during construction of the CFFF. Tests showed that the optimal withdrawal flow through the passage system to be 10% of the flow through each unit.

Detailed studies have not been conducted to evaluate the flow patterns in Riffe Lake. The Mossyrock Dam spillways are approximately in line with the original Cowlitz River thalweg and the powerplant is located to the right of the thalweg. The slope of the right bank is quite steep, approximately 1.5H:1V, and this slope extends across the full width of the powerplant intakes. As a result of this bathymetry, it is likely that when the spillway is operating, the flow will tend to follow the original thalweg alignment. When the powerplant is operating and the spillway is not, the flow will be drawn across the original thalweg, and it is possible that a recirculation pattern may form in front of the spillway and along the left bank.

2.1.4 Existing Structures

2.1.4.1 Cowlitz Falls Dam

The Cowlitz Falls Dam and associated facilities include a concrete gravity dam with an integral powerhouse (hydrocombine) and a fish collection facility. The dam is 700 feet long and 140 feet high with a head of 87.5 feet and has four radial spill gates, one ungated emergency spillway, and two sediment sluiceways. The two outer radial gates are equipped with flap gates to pass excess flows and small debris. Two Kaplan turbines with a total generating capacity of 70 MW are located below the two center spillways. Each turbine can operate over a flow range from 1,800 cfs to 5,250 cfs, with a peak efficiency level at about 3,500 cfs. Drawing 2.1-15 illustrates the general site layout. Drawing 2.1-16 and Drawing 2.1-17 provide a cross-section through the dam and an upstream elevation view.

BPA's CFFF provides for downstream fish collection and transport. The CFFF includes a fish attraction flow system, fish collection system and fish bypass facilities. The primary components of the fish passage system are shown in Drawing 2.1-15.

The fish attraction flow system, which is located in spillway bays 2 and 3, includes four baffle panels per intake gate slot. Each panel is divided into nominal 4-foot square grids that have solid steel plates over the framework, which allows openings to be created by adding or removing plates. The current deployment includes three baffle panels per slot, with the top and bottom panels being solid. The mid-baffle panel has a horizontal opening four feet high as its lowest quarter. The purpose of the baffle panels is to control the flow to the screens and create uniform flow velocity at the screen face. The location of the baffle panel slots is shown in Drawing 2.1-20 and Drawing 2.1-21. The baffle panel detail is shown in Drawing 2.1-18. Attraction flow of up to 200 to 300 cfs can be induced down each intake gate well at full turbine flow for a total attraction flow of 800-1200 cfs.

The fish bypass facilities are comprised of fish flap gates and a bypass flume. There are two flumes penetrating each of the two spillway gates and each flume has an independent fish flap gate used to control flow. The fish flap gates are hydraulically operated to provide a constant depth of flow over the top of the gates and to control the amount of water flowing down the bypass flumes. Spillway Gates 2 and 3 have each been retrofitted with two fish flap gates, the locations of which are illustrated in Drawing 2.1-20 and Drawing 2.1-21. The fish bypass flumes are designed to convey 20 cfs through each of the upstream sections at the fish gates, with a total of 80 cfs going to the secondary dewatering system when all four fish gates are operating. Downstream of the flume, there are dewatering facilities, a pumpback system, fish separator, control building, adult and juvenile fish holding ponds, fish truckload facilities, and a fish sampling building.

A Tacoma Power prototype fish screen was installed in Spillway Bay 3 on a seasonal basis for the 2006 through 2009 seasons. The Tacoma Power prototype fish screen structure consists of four sections. The first three sections contain screen panels in the walls for dewatering the system. The last section is solid for smooth flow acceleration. The floor is solid in all directions and slopes up from elevation 841.5 feet at the start of the first section at the baffle panel, to elevation 856.6 feet at the end of the third section. At this point the slope changes and the fourth section ties into the fish gate with an invert elevation of 857.06 feet. The fish screen sections each narrow along their length, beginning with a width of 16.25 feet at the baffle panel location and ending at the 2-foot wide fish gate entrance at the downstream end. The Tacoma Power prototype fish screen is shown in Drawing 2.1-21.

2.1.4.2 Mossyrock Project

The Mossyrock development, completed in 1968, includes a 606-foot-high (365 feet above the riverbed), 1,300-foot long, double curvature concrete arch dam with two 300-foot-long gravity-type concrete wing walls; a rock fill embankment on the left abutment and a spillway having a combined discharge capacity of 240,000 cfs. Three penstocks, varying in length from 248 to 285 feet, extend down to the powerhouse, which is adjacent to the base of the dam. The powerhouse contains two generating units with room for a third, and has a total installed generating capacity of 300 MW; the hydraulic capacity of the Mossyrock power plant is approximately

14,000 cfs. Drawing 2.1-22, Drawing 2.1-23, and Drawing 2.1-24 provide an overview of the Mossyrock Project structures. There are currently no fish passage facilities at Mossyrock Dam.

2.1.5 Debris Loading

Debris management will be required for structures placed in Lake Scanewa, Riffe Lake or at Cowlitz Falls Dam. As described by MWH/ENSR (2005), Lake Scanewa can experience severe debris inflow during flood events. The trash rack rakes at Cowlitz Falls Dam are operated most frequently during, and immediately after, high flow events. During these events, the rakes may be operated up to three times per day. Trash rake use is less frequent from July through October, when large flow events are less likely to occur. During this period, trash rake use may decrease to approximately once every two months.

Cowlitz Falls Dam has a debris deflector immediately upstream of spillway bays 2 and 3, as shown in Drawing 2.1-15. The debris deflector helps minimize the amount of large woody debris that can enter these spillway bays, although some semi-buoyant material passes under the debris barrier. During spill events which utilize spillway bays 2 and 3, large woody debris passes under the debris deflector. Leaf debris and summer algae growth also occur.

Debris is also present in Riffe Lake. During floods, debris is released into the lake. The lake level is abruptly drawn down for flood control after major storms, resulting in deposits of debris on the shoreline at the elevation of the storm crest. In spring, as the lake refills, the debris floats again. Tacoma Power gathers and processes as much debris as possible before the spring crest is reached; any debris that is not collected during the period of reservoir rise is deposited on the shoreline at the spring crest elevation.

The flood of record at Riffe Lake occurred in February 2006. During this flood, approximately 130,000 cubic yards of debris were deposited at Mossyrock Dam, with an estimated additional 70,000 cubic yards deposited on the banks of the reservoir.

2.1.6 Geotechnical

Geotechnical needs related to foundations for support and mooring structures, nets, Behavioral Guidance Structure (BGS) and Floating Surface Collector (FSC) anchoring, and related facilities will be evaluated during final design process.

2.2 Cowlitz Falls Project Operations

2.2.1 Design Flow and Water Level Ranges

The Upper Cowlitz and the Cispus rivers feed the Lake Scanewa reservoir. The reservoir is about 14 miles long in the Cowlitz Arm and less than two miles long in the Cispus arm, and has a maximum depth of about 90 feet immediately upstream of the dam. The reservoir water surface is normally maintained between elevation 860.0 and 862.0 feet with daily water level variations of two feet per day authorized under the FERC license. When flows measured at the USGS Randle Gage reach 15,000 cfs, the reservoir is drawn down to elevation 846 feet (LCPUD 2009). When inflow, measured at the Cowlitz Falls Dam reaches 27,000 cfs, the reservoir may be drawn down an additional 10 feet. The passage of flows in excess of 70,000 cfs requires the opening of Spillway Gates 2 and 3 to maintain a reservoir elevation of 852.0 feet. The Cowlitz Falls Project operating sequence is summarized in Table 2.2-1.

2.2.2 Power Plant and Spill Operations

The Cowlitz Falls power plant is designed to be operated in an automatic, unattended mode. The turbine discharge varies from 1,800 to 5,250 cfs, per unit, with dominant unit flow at 3,400 cfs. The turbines and gates can be controlled automatically without warning. Table 2.2-1 summarizes the Cowlitz Falls Project operating sequence as described by LCPUD (2009).

Table 2.2-1 Cowlitz Falls Project Operating Sequence

River Discharge[a] (cfs)	Reservoir Elevation (feet)	Operation Remarks
0-1,800	860-862	Low flow conditions, units not running. When Riffe Lake is below elevation 750 feet, a minimum of 1,000 cfs must be released from the Cowlitz Falls Project. Spill through spill gates 1 or 4.
1,800-10,500	860-862	Normal operating range. 1 or 2 units may be operating. Reservoir level automatically adjusted by turbines via reservoir level and inflow.
10,500 - 15,000[b]	860-860	Generate and spill as required to maintain elevation 860 ft.
15,000[b]-27,000	846	When flow reaches 15,000 at the Randle gauge, reservoir level is lowered to elevation 846 feet. LCPUD is in the process of modifying this procedure and may draw down to elevation 842 feet in the future. Operational sequence and drawdown level may change with each drawdown. Both units at full load. Spill through spill gates 1 and 4.
>90,000	846-852	100-year flood event. Same as above plus open spillway bays #2 and #3 (over units). This event is the only scheduled use of spillway bays #2 and #3, other than routine maintenance.

a. Flow measured at USGS Kosmos gauge unless noted otherwise.
b. Flow measured at USGS Randle gauge.

In addition to the requirements listed in Table 2.2-1 above, Cowlitz Falls Dam must discharge at least 1,000 cfs whenever the water surface elevation in Riffe Lake is below 750 feet. Historically, sluice gates were used to adjust discharge from Cowlitz Falls Dam when the river discharge exceeded 12,500 cfs. Under current operations the sluice gates are never used at full reservoir.

The flow record from the USGS Randle gauge was reviewed to determine the frequency of high flow events during the primary fish migration period (April 15 – August 31) that would require reservoir drawdown. Between

1997 and 2010 there was only one such occurrence; from May 17, 2008 to May 20, 2008, flow measured at the Randle gauge exceeded 15,000 cfs indicating that the reservoir would have been drawn down to El. 846 ft.

Figure 2.2-1, Figure 2.2-2, and Figure 2.2-3 provide spill exceedence curves at Cowlitz Falls Dam for the full year, primary fish migration period and secondary fish migration period, respectively.

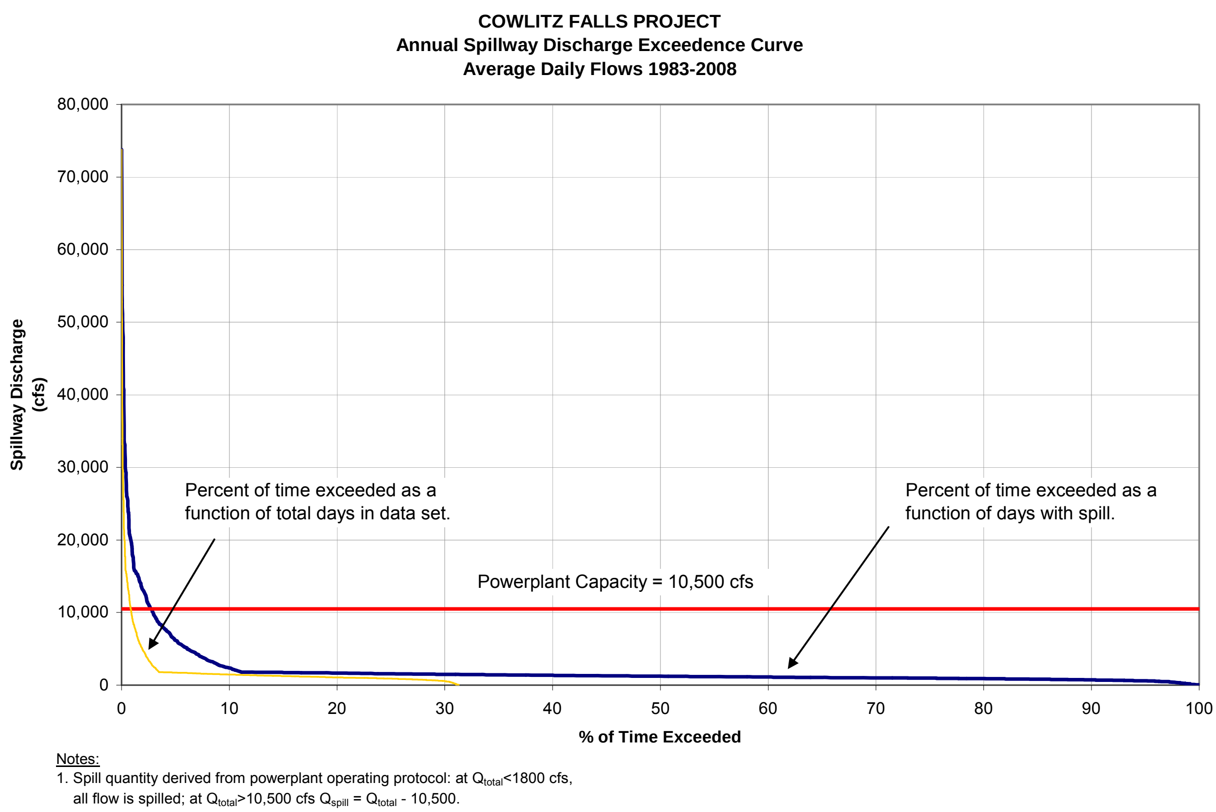


Figure 2.2-1 Cowlitz Falls Dam Spillway Discharge Exceedence Curve – Annual

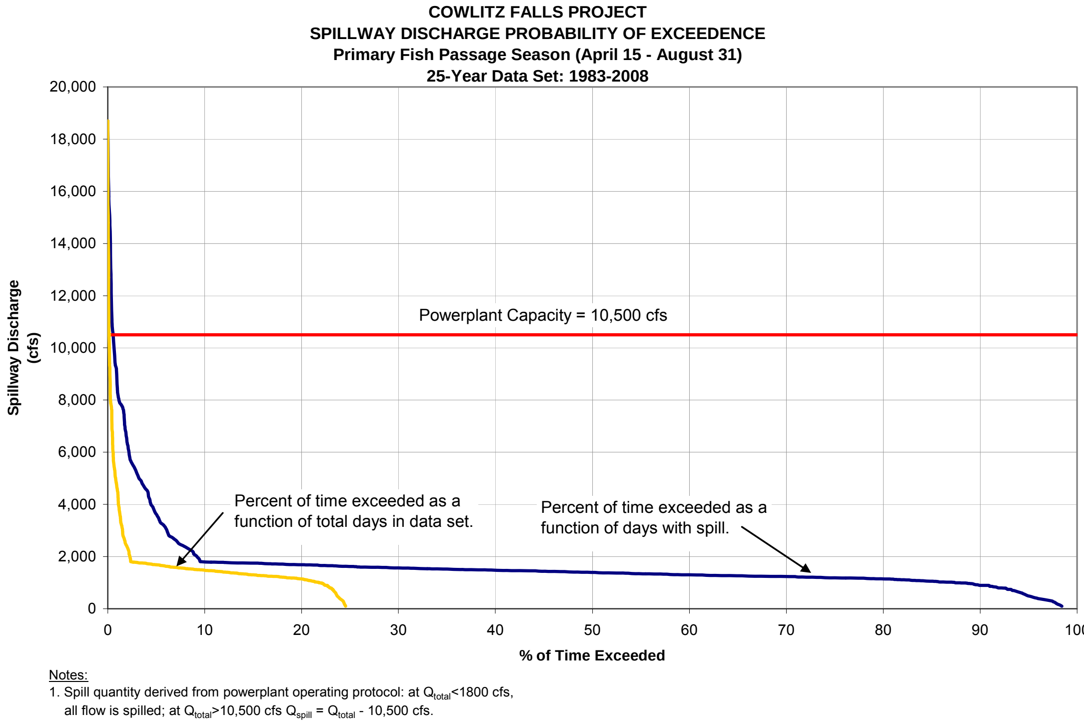


Figure 2.2-2 Cowlitz Falls Dam Spillway Discharge Exceedence Curve – Primary Fish Migration

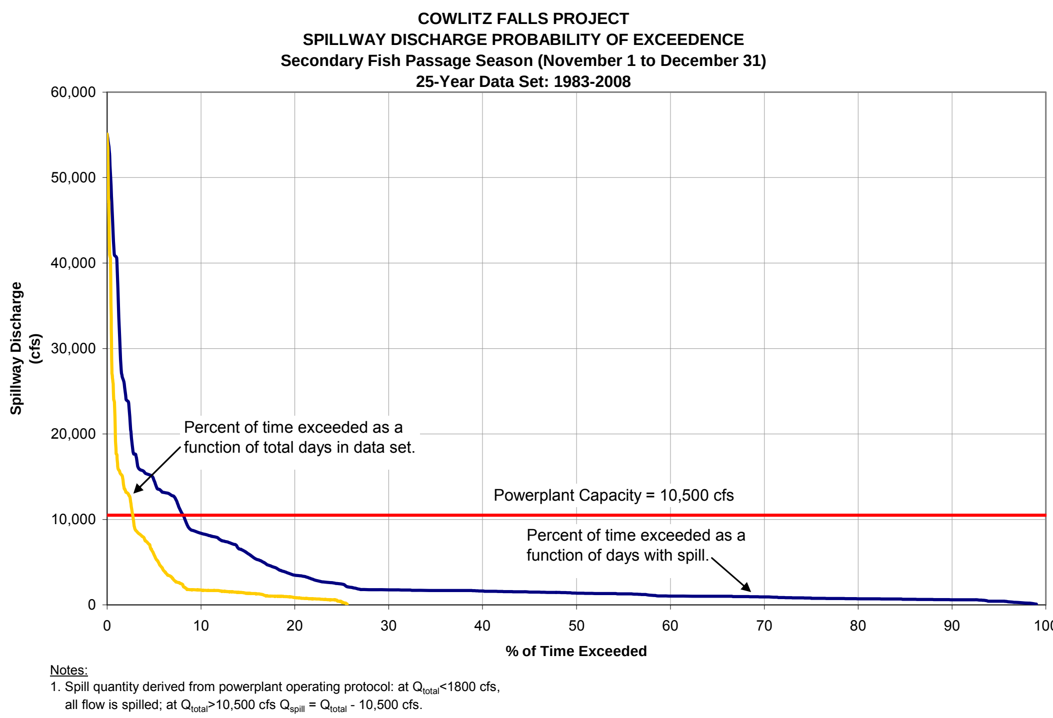


Figure 2.2-3 Cowlitz Falls Dam Spillway Discharge Exceedence Curve – Secondary Fish Migration

2.2.3 Safety Requirements at Cowlitz Falls Dam

As a component of the Fish Attraction Flow System, flow baffle panels are installed in Spillway Bays 2 and 3. When the baffle panels are in place, they essentially block the center spillway bays, severely restricting their flow passing capability. The baffle panels are removed by mid-October to restore spillway capacity prior to the winter season. An emergency action plan was developed to address the possibility that discharge through the center spill bays might be required while the panels are in place. In the event of an extreme emergency, the baffle panels are designed to fail and wash downstream through the spillways.

The Tacoma Power fish screen interferes with the originally designed turbine intake gate storage location and intake gate deployment. The turbine intake gates must remain operational at all times to provide for emergency turbine shutdown in the event that the wicket gates are inoperable. To accommodate the fish screen and maintain intake gate function, an alternate intake gate storage location and deployment sequence was developed. The intake gate storage location was relocated to a submerged storage location immediately below the spillway floor and slot covers. The estimated time required to complete an emergency gate closure is 33 minutes.

In 2009 Tacoma Power was informed that for reasons of dam safety, there could be no facility constructed that would impede flood passage via the emergency spillway: therefore, the Tacoma fish screen can no longer be deployed at Cowlitz Falls.

2.3 Mossyrock Project Operations

2.3.1 Design Flow and Water Level Ranges

Riffe Lake is a 23-mile long, 11,830-acre reservoir with 52 miles of shoreline and 1,685,100 acre-feet of gross storage, created by the Mossyrock Dam. Riffe Lake supports several parks and other recreational facilities and is generally used for flood control. Typically, Riffe Lake is held at or below elevation 745.5 feet between December 1 and January 31 to provide storage for winter flood flows, with the objective of keeping flows below 70,000 cfs at the downstream community of Castle Rock. From February 1 to June 1, Riffe Lake is allowed to fill in an attempt to have the reservoir at, or near, full pool for the summer recreation season. Gradual drawdown to the winter pool level begins between Labor Day and October 1. Tacoma Power tries to maintain Riffe Lake at or above elevation 767 feet from June 1 to September 1 of each year. The month end elevations of Riffe Lake are presented in Figure 2.3-1 and the flood control rule curve is provided in Table 2.3-1. The maximum prescribed reservoir elevation is 778.5 feet; however Figure 2.3-1 demonstrates that, on average, the prescribed maximum level is not reached.

The Riffe Lake rule curve targets a reservoir elevation of 765.7 feet at the start of the primary fish migration period. The hydraulic control elevation for the Cowlitz Falls Dam tailwater is around 759-760 feet (July 2005 bathymetry survey data); Figure 2.3-1 shows that on average Riffe Lake reaches elevation 759-760 feet in mid-May. Figure 2.3-2 depicts reservoir elevation duration curves for each month during the primary migration period. The duration data and historic month-end reservoir elevations indicate that the tailwater below Cowlitz Falls Dam is controlled by the backwater from Riffle Lake from about mid-May to the end of the primary migration period, except in drier years. When water levels are not controlled by the backwater from Riffe Lake, the river is effectively free flowing in the reach immediately below Cowlitz Falls Dam, with a stage-discharge rating curve approximated by Figure 2.3-3.

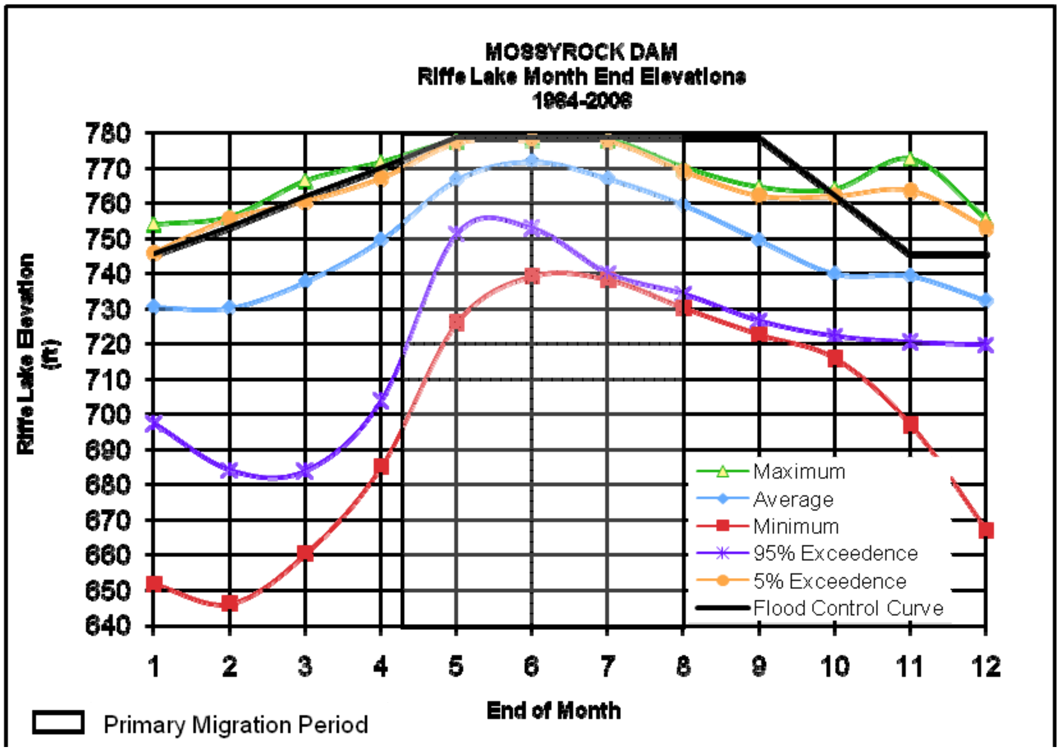


Figure 2.3-1 Mossyrock Dam – Riffe Lake Month End Elevations (Provided by Tacoma Power)

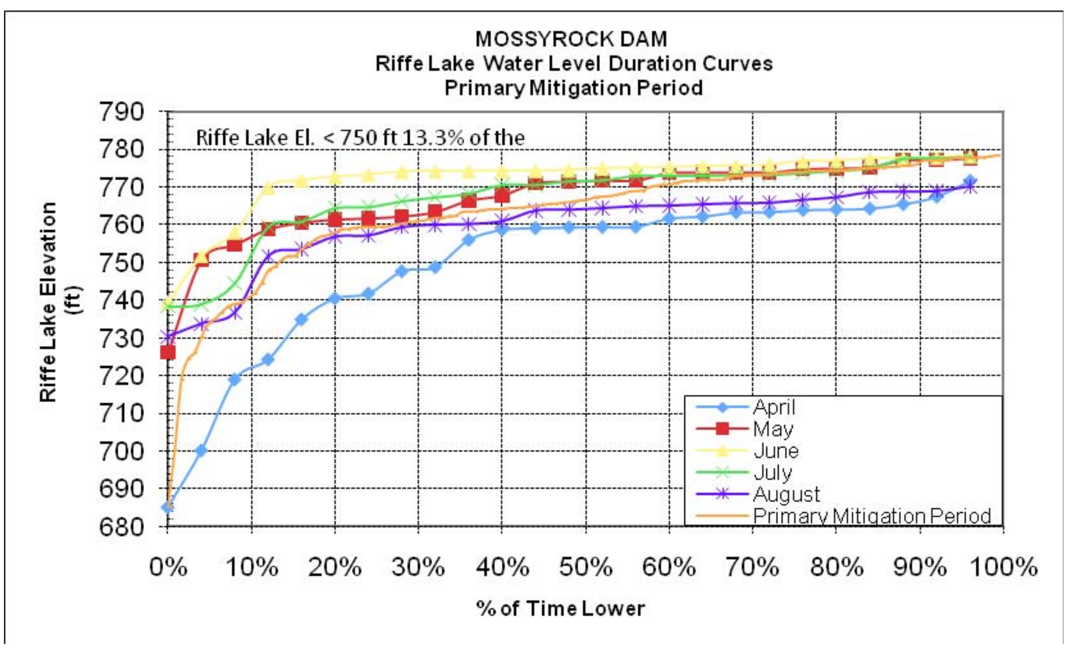


Figure 2.3-2 Daily Water Level Duration Statistics for Riffe Lake Summarized by Month during the Primary Migration Period (Provided by Tacoma Power)

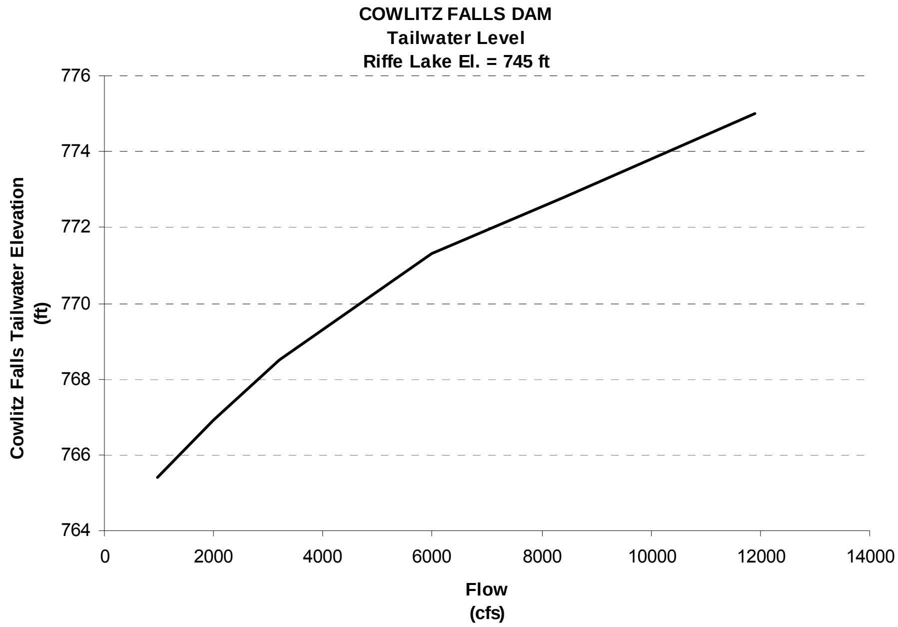


Figure 2.3-3 Stage-Discharge Rating Curve for the Cowlitz River at the Base of Cowlitz Falls Dam when Riffe Lake is at El. 745 feet

2.3.2 Power Plant and Spill Operations

Mossyrock Dam is operated primarily for the purpose of flood control. Under normal operations, there is no spill at Mossyrock Dam. In the event of a flood, the Mossyrock power plant is shut down and Mayfield dam spills as a result of high flows from the Tilton River. After the peak of the flood has passed, the Mossyrock powerplant will generate at full capacity until the water level is reduced to the reservoir elevation specified by the flood control rule curve, see Table 2.3-1. The only scenario under which Mossyrock Dam would be expected to spill is if additional flooding is expected and the reservoir cannot be drawn down quickly enough using power plant discharge alone.

Table 2.3-1 Mossyrock Dam Flood Control Rule Curve

Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation
1-Jan	745.5	1-Mar	753.41	1-May	770.05	1-Jul	778.5	1-Sep	778.5	1-Nov	761.47
2-Jan	745.5	2-Mar	753.68	2-May	770.32	2-Jul	778.5	2-Sep	778.5	2-Nov	760.94
3-Jan	745.5	3-Mar	753.95	3-May	770.59	3-Jul	778.5	3-Sep	778.5	3-Nov	760.4
4-Jan	745.5	4-Mar	754.23	4-May	770.86	4-Jul	778.5	4-Sep	778.5	4-Nov	759.87
5-Jan	745.5	5-Mar	754.5	5-May	771.14	5-Jul	778.5	5-Sep	778.5	5-Nov	759.34
6-Jan	745.5	6-Mar	754.77	6-May	771.41	6-Jul	778.5	6-Sep	778.5	6-Nov	758.81
7-Jan	745.5	7-Mar	755.05	7-May	771.68	7-Jul	778.5	7-Sep	778.5	7-Nov	758.27
8-Jan	745.5	8-Mar	755.32	8-May	771.95	8-Jul	778.5	8-Sep	778.5	8-Nov	757.74
9-Jan	745.5	9-Mar	755.59	9-May	772.23	9-Jul	778.5	9-Sep	778.5	9-Nov	757.21
10-Jan	745.5	10-Mar	755.86	10-May	772.5	10-Jul	778.5	10-Sep	778.5	10-Nov	756.68
11-Jan	745.5	11-Mar	756.14	11-May	772.77	11-Jul	778.5	11-Sep	778.5	11-Nov	756.15

Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation
12-Jan	745.5	12-Mar	756.41	12-May	773.05	12-Jul	778.5	12-Sep	778.5	12-Nov	755.61
13-Jan	745.5	13-Mar	756.68	13-May	773.32	13-Jul	778.5	13-Sep	778.5	13-Nov	755.08
14-Jan	745.5	14-Mar	756.95	14-May	773.59	14-Jul	778.5	14-Sep	778.5	14-Nov	754.55
15-Jan	745.5	15-Mar	757.23	15-May	773.86	15-Jul	778.5	15-Sep	778.5	15-Nov	754.02
16-Jan	745.5	16-Mar	757.5	16-May	774.14	16-Jul	778.5	16-Sep	778.5	16-Nov	753.48
17-Jan	745.5	17-Mar	757.77	17-May	774.41	17-Jul	778.5	17-Sep	778.5	17-Nov	752.95
18-Jan	745.5	18-Mar	758.05	18-May	774.68	18-Jul	778.5	18-Sep	778.5	18-Nov	752.42
19-Jan	745.5	19-Mar	758.32	19-May	774.95	19-Jul	778.5	19-Sep	778.5	19-Nov	751.89
20-Jan	745.5	20-Mar	758.59	20-May	775.23	20-Jul	778.5	20-Sep	778.5	20-Nov	751.35
21-Jan	745.5	21-Mar	758.86	21-May	775.5	21-Jul	778.5	21-Sep	778.5	21-Nov	750.82
22-Jan	745.5	22-Mar	759.14	22-May	775.77	22-Jul	778.5	22-Sep	778.5	22-Nov	750.29
23-Jan	745.5	23-Mar	759.41	23-May	776.05	23-Jul	778.5	23-Sep	778.5	23-Nov	749.76
24-Jan	745.5	24-Mar	759.68	24-May	776.32	24-Jul	778.5	24-Sep	778.5	24-Nov	749.23
25-Jan	745.5	25-Mar	759.95	25-May	776.59	25-Jul	778.5	25-Sep	778.5	25-Nov	748.69
26-Jan	745.5	26-Mar	760.23	26-May	776.86	26-Jul	778.5	26-Sep	778.5	26-Nov	748.16
27-Jan	745.5	27-Mar	760.5	27-May	777.14	27-Jul	778.5	27-Sep	778.5	27-Nov	747.63
28-Jan	745.5	28-Mar	760.77	28-May	777.41	28-Jul	778.5	28-Sep	778.5	28-Nov	747.1
29-Jan	745.5	29-Mar	761.05	29-May	777.68	29-Jul	778.5	29-Sep	778.5	29-Nov	746.56
30-Jan	745.5	30-Mar	761.32	30-May	777.95	30-Jul	778.5	30-Sep	778.5	30-Nov	746.03
31-Jan	745.5	31-Mar	761.59	31-May	778.23	31-Jul	778.5	1-Oct	777.97	1-Dec	745.5
1-Feb	745.77	1-Apr	761.86	1-Jun	778.5	1-Aug	778.5	2-Oct	777.44	2-Dec	745.5
2-Feb	746.05	2-Apr	762.14	2-Jun	778.5	2-Aug	778.5	3-Oct	776.9	3-Dec	745.5
3-Feb	746.32	3-Apr	762.41	3-Jun	778.5	3-Aug	778.5	4-Oct	776.37	4-Dec	745.5
4-Feb	746.59	4-Apr	762.68	4-Jun	778.5	4-Aug	778.5	5-Oct	775.84	5-Dec	745.5
5-Feb	746.86	5-Apr	762.95	5-Jun	778.5	5-Aug	778.5	6-Oct	775.31	6-Dec	745.5
6-Feb	747.14	6-Apr	763.23	6-Jun	778.5	6-Aug	778.5	7-Oct	774.77	7-Dec	745.5
7-Feb	747.41	7-Apr	763.5	7-Jun	778.5	7-Aug	778.5	8-Oct	774.24	8-Dec	745.5
8-Feb	747.68	8-Apr	763.77	8-Jun	778.5	8-Aug	778.5	9-Oct	773.71	9-Dec	745.5
9-Feb	747.95	9-Apr	764.05	9-Jun	778.5	9-Aug	778.5	10-Oct	773.18	10-Dec	745.5
10-Feb	748.23	10-Apr	764.32	10-Jun	778.5	10-Aug	778.5	11-Oct	772.65	11-Dec	745.5
11-Feb	748.5	11-Apr	764.59	11-Jun	778.5	11-Aug	778.5	12-Oct	772.11	12-Dec	745.5
12-Feb	748.77	12-Apr	764.86	12-Jun	778.5	12-Aug	778.5	13-Oct	771.58	13-Dec	745.5
13-Feb	749.05	13-Apr	765.14	13-Jun	778.5	13-Aug	778.5	14-Oct	771.05	14-Dec	745.5
14-Feb	749.32	14-Apr	765.41	14-Jun	778.5	14-Aug	778.5	15-Oct	770.52	15-Dec	745.5
15-Feb	749.59	15-Apr	765.68	15-Jun	778.5	15-Aug	778.5	16-Oct	769.98	16-Dec	745.5
16-Feb	749.86	16-Apr	765.95	16-Jun	778.5	16-Aug	778.5	17-Oct	769.45	17-Dec	745.5
17-Feb	750.14	17-Apr	766.23	17-Jun	778.5	17-Aug	778.5	18-Oct	768.92	18-Dec	745.5
18-Feb	750.41	18-Apr	766.5	18-Jun	778.5	18-Aug	778.5	19-Oct	768.39	19-Dec	745.5
19-Feb	750.68	19-Apr	766.77	19-Jun	778.5	19-Aug	778.5	20-Oct	767.85	20-Dec	745.5
20-Feb	750.95	20-Apr	767.05	20-Jun	778.5	20-Aug	778.5	21-Oct	767.32	21-Dec	745.5
21-Feb	751.23	21-Apr	767.32	21-Jun	778.5	21-Aug	778.5	22-Oct	766.79	22-Dec	745.5
22-Feb	751.5	22-Apr	767.59	22-Jun	778.5	22-Aug	778.5	23-Oct	766.26	23-Dec	745.5
23-Feb	751.77	23-Apr	767.86	23-Jun	778.5	23-Aug	778.5	24-Oct	765.73	24-Dec	745.5
24-Feb	752.05	24-Apr	768.14	24-Jun	778.5	24-Aug	778.5	25-Oct	765.19	25-Dec	745.5
25-Feb	752.32	25-Apr	768.41	25-Jun	778.5	25-Aug	778.5	26-Oct	764.66	26-Dec	745.5

Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation	Date	Flood Control Curve Elevation
26-Feb	752.59	26-Apr	768.68	26-Jun	778.5	26-Aug	778.5	27-Oct	764.13	27-Dec	745.5
27-Feb	752.86	27-Apr	768.95	27-Jun	778.5	27-Aug	778.5	28-Oct	763.6	28-Dec	745.5
28-Feb	753.14	28-Apr	769.23	28-Jun	778.5	28-Aug	778.5	29-Oct	763.06	29-Dec	745.5
		29-Apr	769.5	29-Jun	778.5	29-Aug	778.5	30-Oct	762.53	30-Dec	745.5
		30-Apr	769.77	30-Jun	778.5	30-Aug	778.5	31-Oct	762	31-Dec	745.5
						31-Aug	778.5				

2.4 Mayfield Project Operations

2.4.1 Design Flow and Water Level Ranges

Mayfield Dam is operated in a run-of-river fashion, dependent entirely upon discharge from the Mossyrock Project and inflow mainly from the Tilton River. Inflow in excess of the capacity of the turbines is spilled.

2.4.2 Power Plant and Spill Operations

Minimum flow to the Cowlitz River, measured below Mayfield Dam, is prescribed by the License and varies by date as outlined in Table 2.4-1 below:

Table 2.4-1 Minimum Flow to Cowlitz River below Mayfield Dam

Date	Minimum Flow (cfs)	Operations Remarks
Mar. 1 – Jun. 30	5,000 cfs	Flow may be lower if inflow forecasts indicate that 5,000 cfs cannot be achieved and assure reservoir refill Once per week, a 12-hour release at the lesser of 8,000 cfs or 120% of the preceding flows is required.
Jul. 1 – Aug. 14	2,000 cfs	
Aug. 15 – Sep. 30	2,000 cfs	If releases meet or exceed 5,000 cfs for a consecutive 5-day period, flows may not be decreased below 5,000 cfs until a spawning survey has been performed. If redds are present the minimum flows for the remainder of the period will be established after consultations with the FTC or agencies.
Oct. 1 – Nov. 20	3,500 cfs	When releases during the August 15 to September 30 period meet or exceed 5,000 cfs, minimum flows shall be maintained at the lesser of 5,000 cfs or 8 inches of river stage height below the highest consecutive 5-day average flow during which active spawning occurred.

Date	Minimum Flow (cfs)	Operations Remarks
Nov. 1 – Nov. 20	5,000 – 8,000 cfs	Good faith attempt to provide flows for the purpose of protecting spawning habitat. Duration extends until Nov. 20 or completion of spawning, whichever comes first.
Nov. 21 – Feb. 28	Lesser of: 5,000 cfs 8 inches river stage below highest consecutive 5-day average flow during which active spawning occurred Lower flow authorized by FTC or agencies, based upon results of spawning surveys	

The ramping rates prescribed in the License, applicable for flows below 6,000 cfs, are summarized below in Table 2.4-2.

Table 2.4-2 Project Ramping Rates

Time of Year	Daylight Rates	Night Rates
February 16 to June 15	No Ramping	2 inches/hour
June 16 to October 31	1 inch/hour	1 inch/hour
November 1 to February 15	2 inches/hour	2 inches/hour

2.5 Biological Data

2.5.1 Species

At the Cowlitz Falls Project the primary fish species targeted for collection and transport as juveniles are anadromous salmonids. These include; coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), and steelhead (*O. mykiss*). Additionally, small numbers of juvenile cutthroat trout (*O. clarki*) pass the dam and are destined for transport to the lower river. Sea-run cutthroat were once abundant in the system, including locations upstream of Mossyrock Dam (GAIA Northwest 1993). Also, John Serl (personal communication) reports that resident cutthroat trout inhabit watersheds upstream from Cowlitz Falls Dam. Cutthroat collected at Cowlitz Falls Dam could be either resident or anadromous. Historically, these fish would have most likely expressed both life history strategies.

Historically, both spring and fall races of Chinook inhabited the basin and were abundant (GAIA Northwest 1993). Currently, both fall and spring Chinook have been reintroduced above Cowlitz Falls Dam. Coho salmon were also abundant in the upper Cowlitz Basin and reintroduction efforts are in progress. The steelhead is a winter-run race that was historically present in the upper Cowlitz Basin, and releases of adult winter steelhead above Cowlitz Falls Dam are currently underway. Some or all of these species and their unique life history patterns could become established in the basin.

2.5.2 Migration Timing and Related Topics

The time of the year that fish migrate past the dam dictates when the collection facility needs to be operating. Estimates of migration timing are based on the WDFW fish sampling program, which has been conducted at the CFFF since 1996. As part of the WDFW program, juvenile fish that are migrating and collected by the existing CFFF are regularly enumerated. These abundance data are reported as weekly and season-wide values. Weekly catch abundance provides an index of migration timing from the watershed over the sampling period (Figure 2.5-1 and Figure 2.5-2). The sampling period typically extends from mid-April through late-August. Fish moving downstream outside this window are not included in the index.

The data reported by Serl and Morrill (2008) for the migration year 2007 are generally representative of most years with respect to the frequency distribution and timeframe in which the different species pass Cowlitz Falls Dam (Figure 2.5-1 and Figure 2.5-2). Steelhead and coho dominate the catch from mid-April through June, with coho being the most abundant species. Small numbers of Chinook (yearlings) can appear in the collection as early as April. However, late-migrating subyearlings are the dominant life history form for this species, peaking in July and extending into late-August when collection generally ceases.

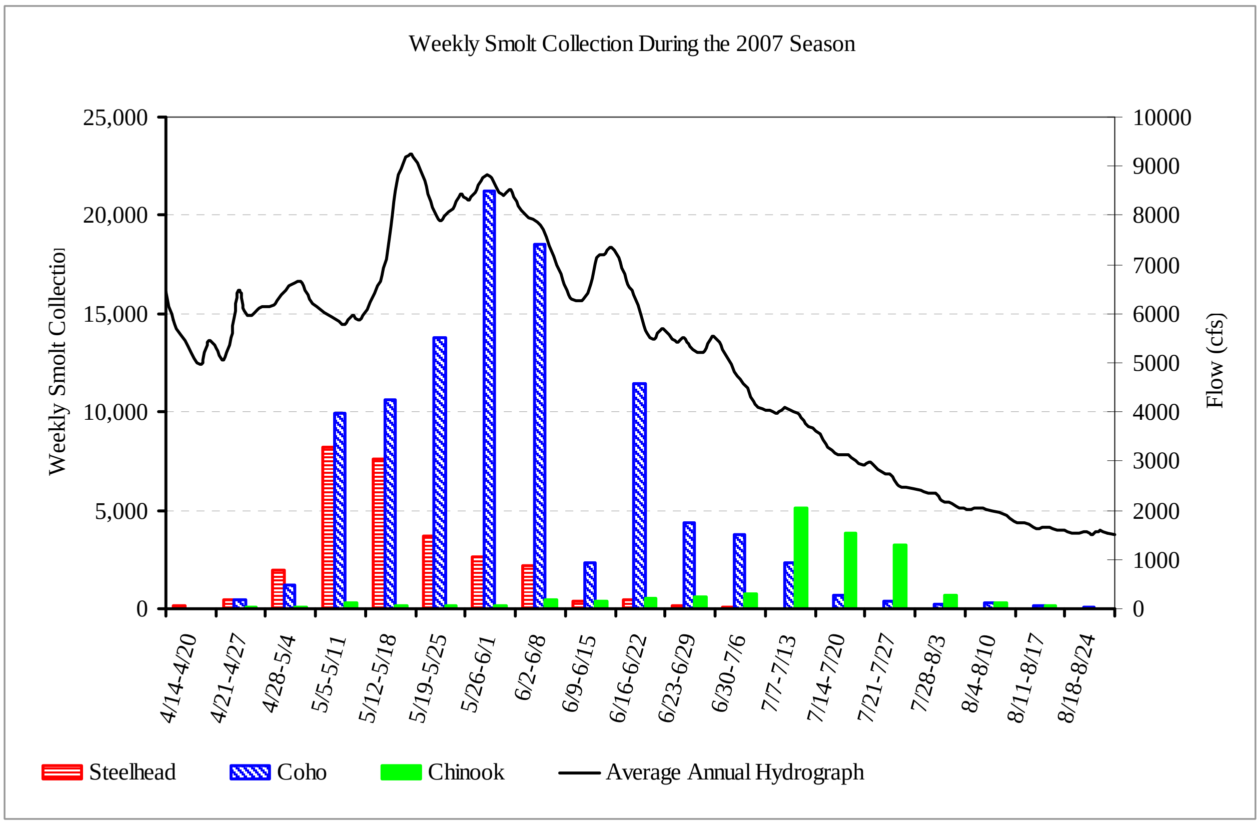


Figure 2.5-1 Example of Migration Timing and Frequency Distribution of Juvenile Steelhead, Coho, and Chinook, 2007 (Serl and Morrill 2008)

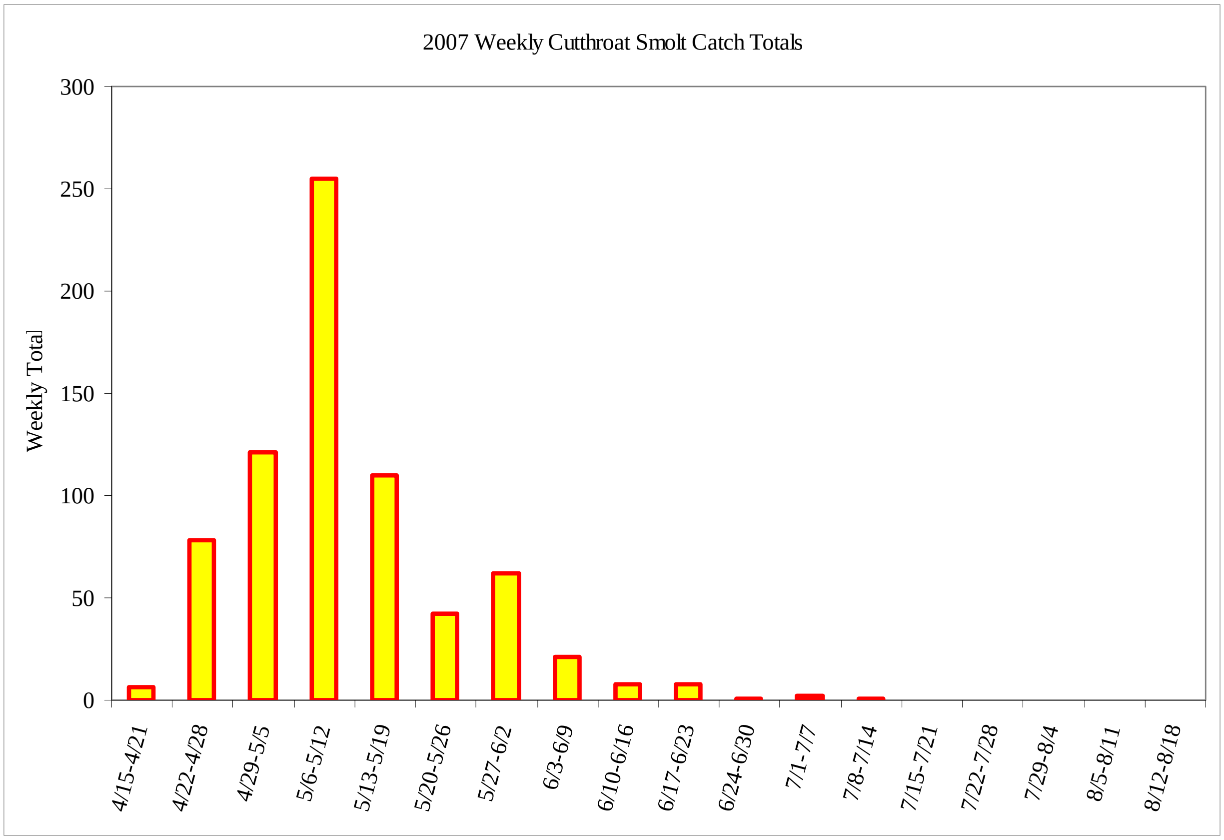


Figure 2.5-2 Example of Migration Timing and Frequency Distribution of Juvenile Cutthroat Trout, 2007 (Serl and Morrill 2008)

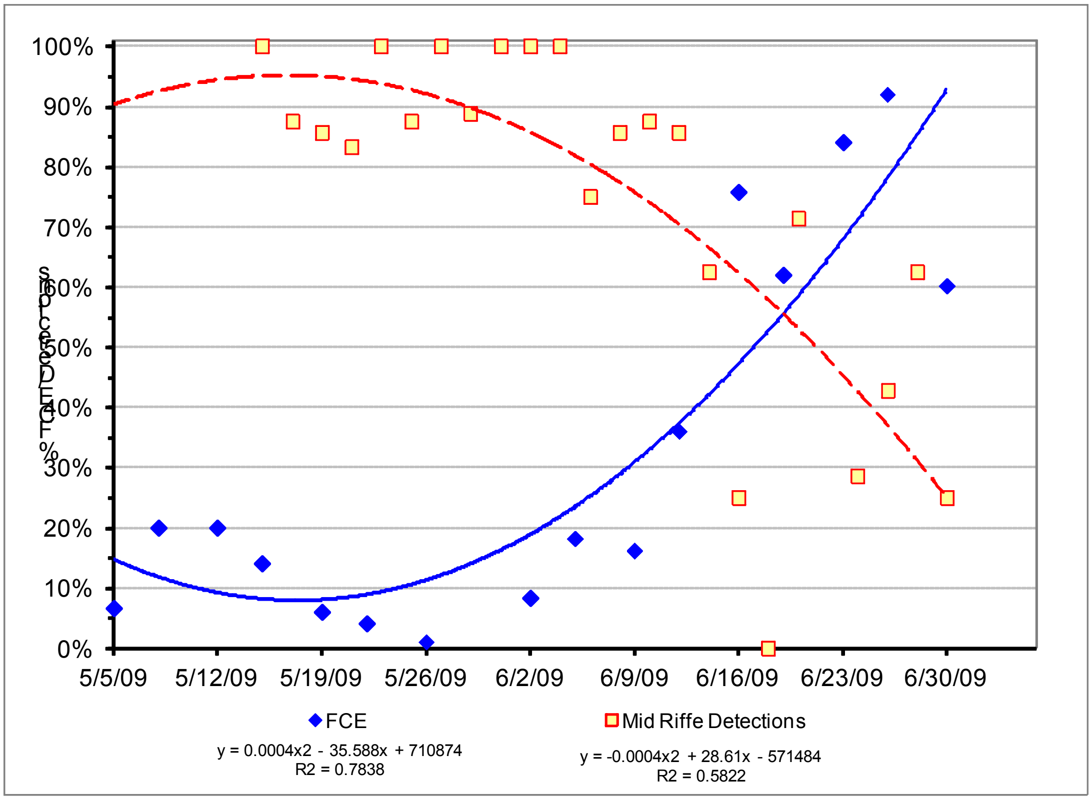
Historically, migration timing in the vicinity of the Cowlitz Falls Dam site likely differed from contemporary patterns. Information gathered at the Mayfield Dam site prior to construction (1955-56) provides insight on historic migration timing. Stockley (1961) described the protracted migration timing of juvenile coho, Chinook, and chum salmon at the Mayfield Dam site. Tables and graphs in Stockley's report indicate that from March 1955 through July 1956 juvenile coho and/or Chinook salmon migrated past the Mayfield Dam site every month during the 17-month sampling period. Peaks were observed during March through July and again in the fall and sustained through the winter; lowest juvenile abundance estimates were reported for the months of August and September. For both species, zero-age and yearling fish comprised the migrant population. Chum salmon exhibited a compressed migration, restricted to the months of March through May. Steelhead also migrate throughout the year with peak migration from Mid April through Mid June. Given that the Fisheries and Hatchery Management Plan (currently under review by FERC) calls for the reintroduction of spring and fall Chinook, winter steelhead and coho upstream from Cowlitz Falls Dam, it is possible that the historically diverse life history patterns may be re-expressed. If this were to occur, a collection facility would be required to operate over most, if not all of the year. For purposes of the CDR, it was assumed that the operation period could extend throughout the entire year, but operation time may be tailored to accommodate the specific species and life history patterns that are ultimately expressed by the salmonid populations following reintroduction. This premise applies to any site selected in this process, because there is no way of predicting which species and life history patterns will become self-sustaining in the basin upstream from the selected collection facility.

To determine the potential merits of deploying a collector in Riffe Lake or near Mossyrock Dam, data regarding smolt migration characteristics are required. Smolt survival and travel time estimates would be most instructive. Prior to the formation of the DFPT, there was limited information available from studies conducted by Harza in 1997, and by USGS in 2007. According to Harza (1999):

“During the 1997 telemetry releases, 32 percent of the 96 radio-tagged steelhead were recorded at the dam, while none of the 46 tagged coho or 55 spring Chinook reached the dam. These fish may have been lost to predation, yet it is equally likely that the fish were not recorded due to equipment limitations or they became disoriented, unable to successfully navigate the length of the reservoir (Harza 1997). It is not possible from this data to assess the implications of predation on smolt survival through Riffe Lake.”

More recently a 2007 USGS telemetry study reported that 63% of the steelhead and 17% of coho successfully passed Riffe Lake and were detected at Mossyrock Dam. However, none of the 105 radio-tagged Chinook were detected at the dam. Mean travel time to Mossyrock was estimated at 3.6 days for steelhead, and 5.6 days for coho. In 2008, 76% of the radio tagged steelhead and 0% of Chinook that were detected in the tailrace of Cowlitz Falls Dam were subsequently detected at Mossyrock Dam. The causes for the low detection rates at Mossyrock Dam are unclear. High levels of predation, slow travel times combined with limited transmitter life or detection system limitations at the dam are all plausible explanations. It is also possible that radio tagged smolts may have remained deeper than about 30 feet due to thermocline presence, therefore they may not have been detectable. However there is no direct evidence to support this hypothetical scenario.

In 2009, a reservoir survival study was conduced by the USGS (USGS 2010) to clarify smolt survival estimates; the results are presented in Table (4-3 of the 60% CDR). The study found that smolt survival from the tailrace of Cowlitz Falls Dam to Mossyrock Dam was highest for steelhead (84%), substantially less for coho (36%) and negligible for Chinook (0%). The 2009 study also reported separate survival estimates through the upper Mossyrock Dam reservoir to the proposed site of the mid-Riffe Lake collector. Steelhead smolts moved quickly to the mid-Riffe location in a median 1.6 days with 92% survival. Coho smolts moved slightly slower to the mid-Riffe location in a median 4.1 days with a survival of 72%. Coho survival was high in the early season, but declined after mid-June in an inverse relationship to collection efficiency at Cowlitz Falls Dam (Figure x). This demonstrates the potential synergistic effect where high flows will likely decrease collection at Cowlitz Falls based collectors but may have potential to increase the opportunity for collection within Riffe Lake. Chinook moved more slowly to the mid-Riffe location in 14.2 days. Chinook survived to this location at 72% with an additional 18% detected alive upstream of the proposed collector site. Chinook to migrate slowly but survive at high rates in the Riffe Lake and may reinitiate migration later in the season.



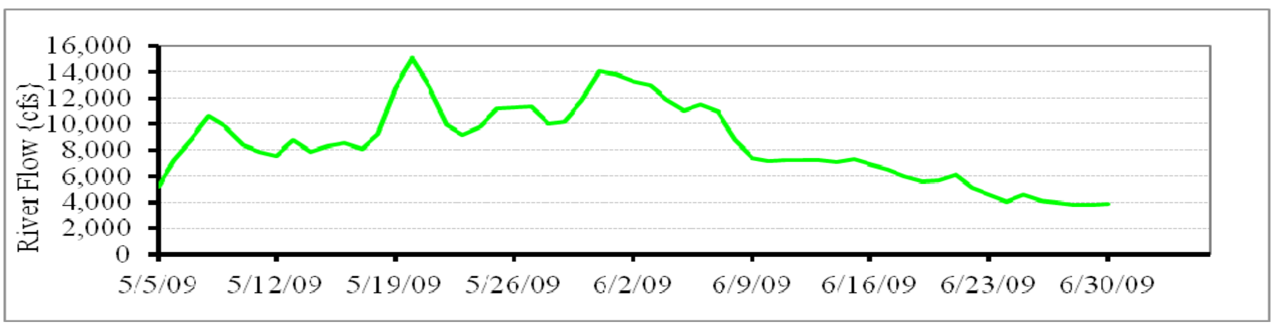


Figure 2.5-3. Acoustic tagged coho smolts detected at mid-Riffe Lake array by date versus Cowlitz Falls Fish Facility mark-recapture group recapture rates by date during the 2009 season. River flow at Cowlitz Falls Dam is show by date beneath (USGS 2010).

In general, information describing the migration characteristics of juvenile salmonids in Riffe Lake is deficient.

2.5.3 Migration Characteristics

2.5.3.1 Upstream Migration

Under the reintroduction program, adult fish collected below Mayfield dam are captured, transported, and released at strategic locations upstream from Cowlitz Falls Dam. Adult life stages of all species are treated in this manner (Table 2.5-1). Based on discussions with FTC members, it is our understanding that the final strategy for releasing adults in the system has not been established. Given this uncertainty, each alternative may need to have an accompanying adult passage system in the vicinity of the collector. For example, if a collector is situated at Cowlitz Falls Dam, and adults are released somewhere downstream from the dam, then either a ladder or trap and haul facility will be required at the dam. It is beyond the scope of this CDR to design adult passage systems, but we recognize that they may ultimately be required.

Separately, alternatives must be able to accommodate adults which fall back downstream, or migrate downstream as kelts. Steelhead in particular are a concern because adults do move downstream while mature, and are collected in the existing CFFF during the spring (Table 2.5-2). This has implications regarding structural and operational aspects of the selected alternative, since adults will be comingled with much smaller juveniles.

Table 2.5-1 Adult Coho, Steelhead, Spring Chinook and Cutthroat Transported and Released in the Upper Cowlitz Basin during the 2006 to 2007 Season (Serl and Morrill 2008)

Coho: October 2006-March 2007	Female	Male	Jack	Total
Unmarked	2,181	3,305	242	5,728
AD- clipped	10,950	14,624	2,907	28,481
Total	13,131	17,929	3,149	34,209
Steelhead : January-June 2007				
Unmarked	309	304	9	622
RV	28	16	0	44
RVAD	104	129	1	234
AD	123	228	2	353
Total	564	677	12	1,253
Spring Chinook: April-September 2007				
Unmarked	24	46	9	79
LV-clipped	0	0	4	4
RV-clipped	0	0	1	1
AD- clipped	621	805	414	1,840
Total	645	851	428	1,924
Cutthroat: August-December 2007				
Smolted in 2007				12
Smolted in 2006				4
Smolted in 2005				0
Unknown				5
Total				21

Table 2.5-2 Adult Steelhead Collected at the CFF during the Spring of 2007 (Serl and Morrill 2008)

Steelhead Transported to Lake Scanewa

	Unmarked "wild"		Right Ventral Clip		RV+AD clip		Hatchery AD clip	
	Females	Males	Females	Males	Females	Males	Females	Males
Totals	**309**	**304**	**28**	**16**	**104**	**129**	**123**	**228**

Unspawned Fallbacks - Returned to Upper Watershed

	Unmarked "wild"		Right Ventral Clip		RV+AD clip		Hatchery AD clip	
	Females	Males	Females	Males	Females	Males	Females	Males
Totals	9	5	0	0	55	61	27	15
April	4	4	0	0	31	33	23	9
May	5	1	0	0	24	28	4	6
June	0	0	0	0	0	0	0	0
% Fallback	**3%**	**2%**	**0%**	**0%**	**53%**	**47%**	**22%**	**7%**

Kelts - Transported to the Barrier Dam Boat Launch

	Unmarked "wild"		Right Ventral Clip		RV+AD clip		Hatchery AD clip	
	Females	Males	Females	Males	Females	Males	Females	Males
Totals	136	72	17	4	35	24	29	27
April	34	5	0	2	10	1	9	2
May	97	52	11	1	21	14	16	13
June	5	15	6	1	4	9	4	12
% Kelts	**44%**	**24%**	**61%**	**25%**	**34%**	**19%**	**24%**	**12%**

Mortalities - Collected at CFFF

	Unmarked "wild"		Right Ventral Clip		RV+AD clip		Hatchery AD clip	
	Females	Males	Females	Males	Females	Males	Females	Males
Totals	14	9	3	2	8	3	2	9
April	1	0	0	0	0	1	0	1
May	11	6	1	1	8	2	0	6
June	2	3	2	1	0	0	2	2
% Morts	**5%**	**3%**	**11%**	**13%**	**8%**	**2%**	**2%**	**4%**

2.5.3.2 Fish size

The size of migrating fish is a consideration for establishing screen criteria and determining the porosity or mesh size of a guidance structure or exclusionary barrier net. The size range of fish collected at Cowlitz Falls Dam in 2007 (Serl and Morrill 2008) is generally representative for most years. The size range for juveniles of each species differs considerably as illustrated in Figure 2.5- and Figure 2.5-. Life history stages span fry through smolt. Cutthroat comprise the largest sized segment of all collected juveniles, ranging from about 150-280 mm, followed closely by steelhead (approximately 125-250 mm), then coho (approximately 80-200 mm), and lastly Chinook (approximately 60-150 mm). At the extreme, including all outliers, the range in size for the entire migrant population in 2007 was 50-280 mm based on visual inspection of Figure 2.5- and Figure 2.5-. For design purposes a target size range for juveniles of 60-280 mm fork length was adopted. It was recognized that larger fish including adult stages of these and other species are collected at the dam and accommodating them may factor into some design considerations. Additionally, as noted previously adult life stages are also collected at the CFFF (Table 2.5-1). Any new collection system will have to be designed to accommodate their presence.

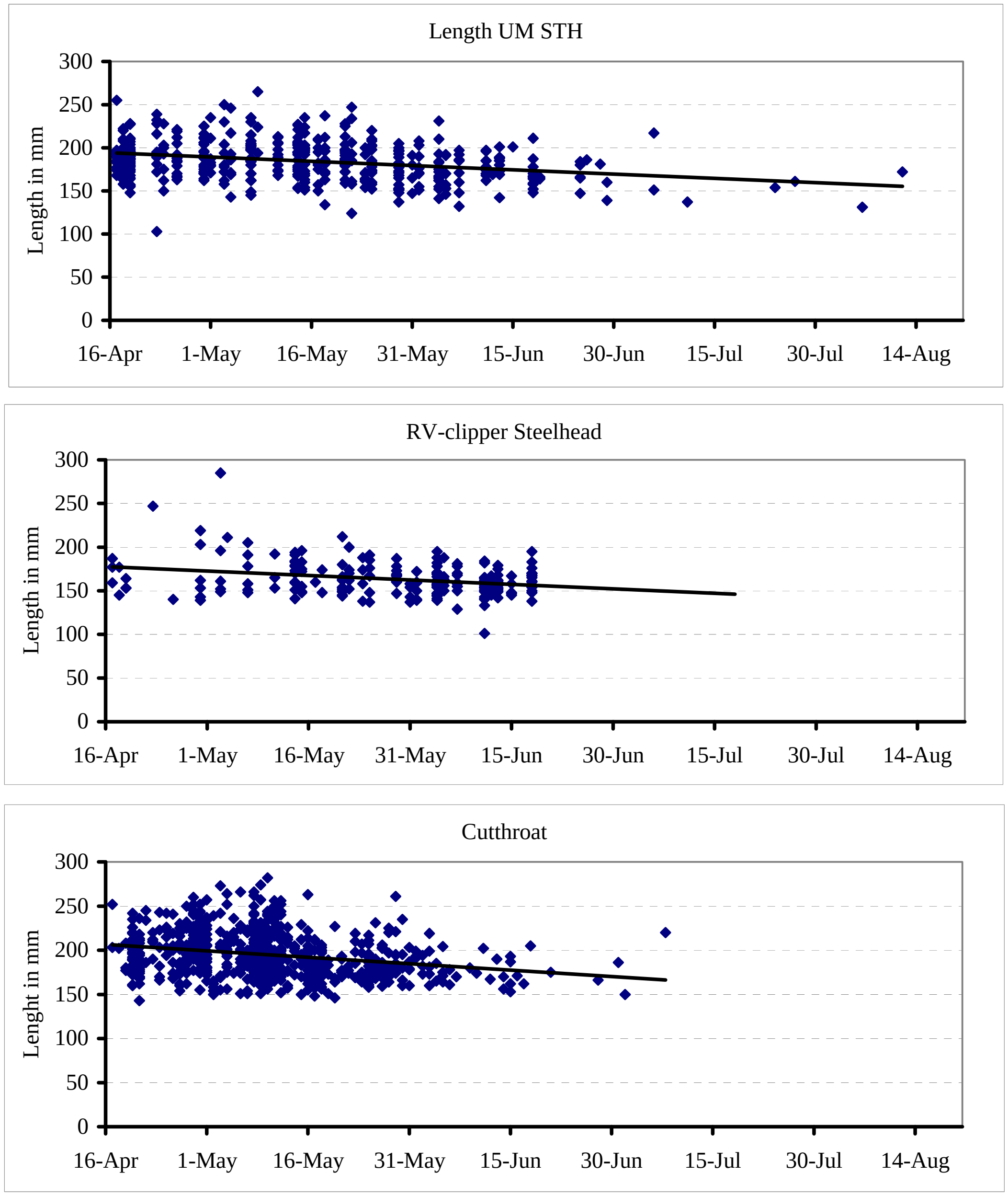


Figure 2.5-4 Fork Lengths of Juvenile Fish Collected at the CFFF, 2007 (Serl and Morrill 2008)

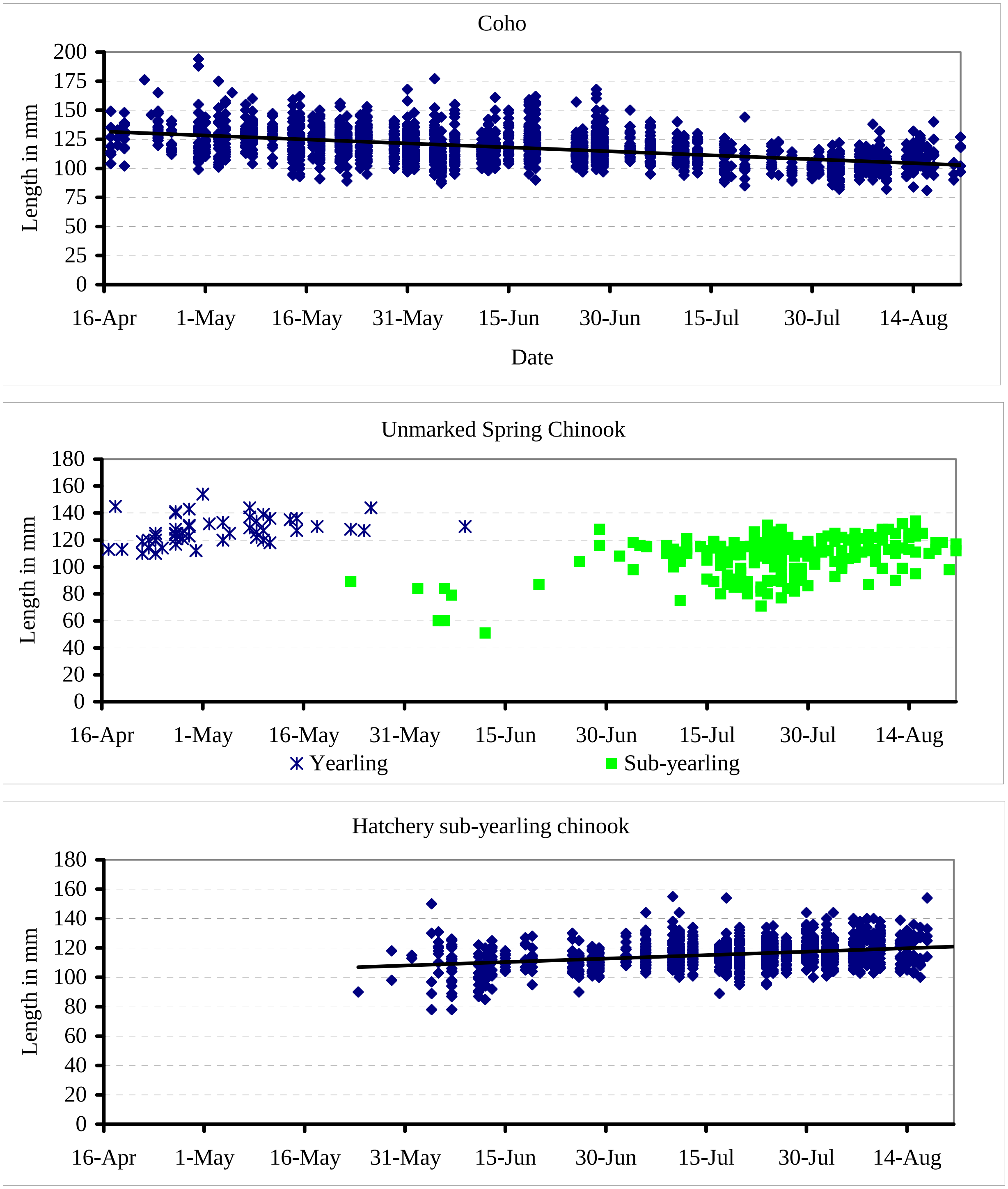


Figure 2.5-5 Fork Lengths of Juvenile Fish Collected at the CFFF, 2007 (Serl and Morrill 2008)

2.5.3.3 Fish abundance

Scaling the size of collection and holding components of a new system requires some estimate of maximum daily influx of fish. Figure 2.5- presents the maximum estimated abundance of smolts arriving at Cowlitz Falls Dam. Since 1997, the maximum estimated abundance of smolts exceeded 1,000,000 one year, 2001. In 2001 the maximum estimated number of smolts arriving at Cowlitz Falls Dam exceeded 26,000 juveniles one day, and exceeded 10,000 individuals on four occasions (Serl and Morrill 2008). Presuming that the reintroduction program will continue to succeed in expanding the population, and that the collection efficiency of the new alternative improves substantially, the maximum number of fish collected could increase considerably. Reasonable future production targets for the Upper Cowlitz River system will be established with input from agency representatives.

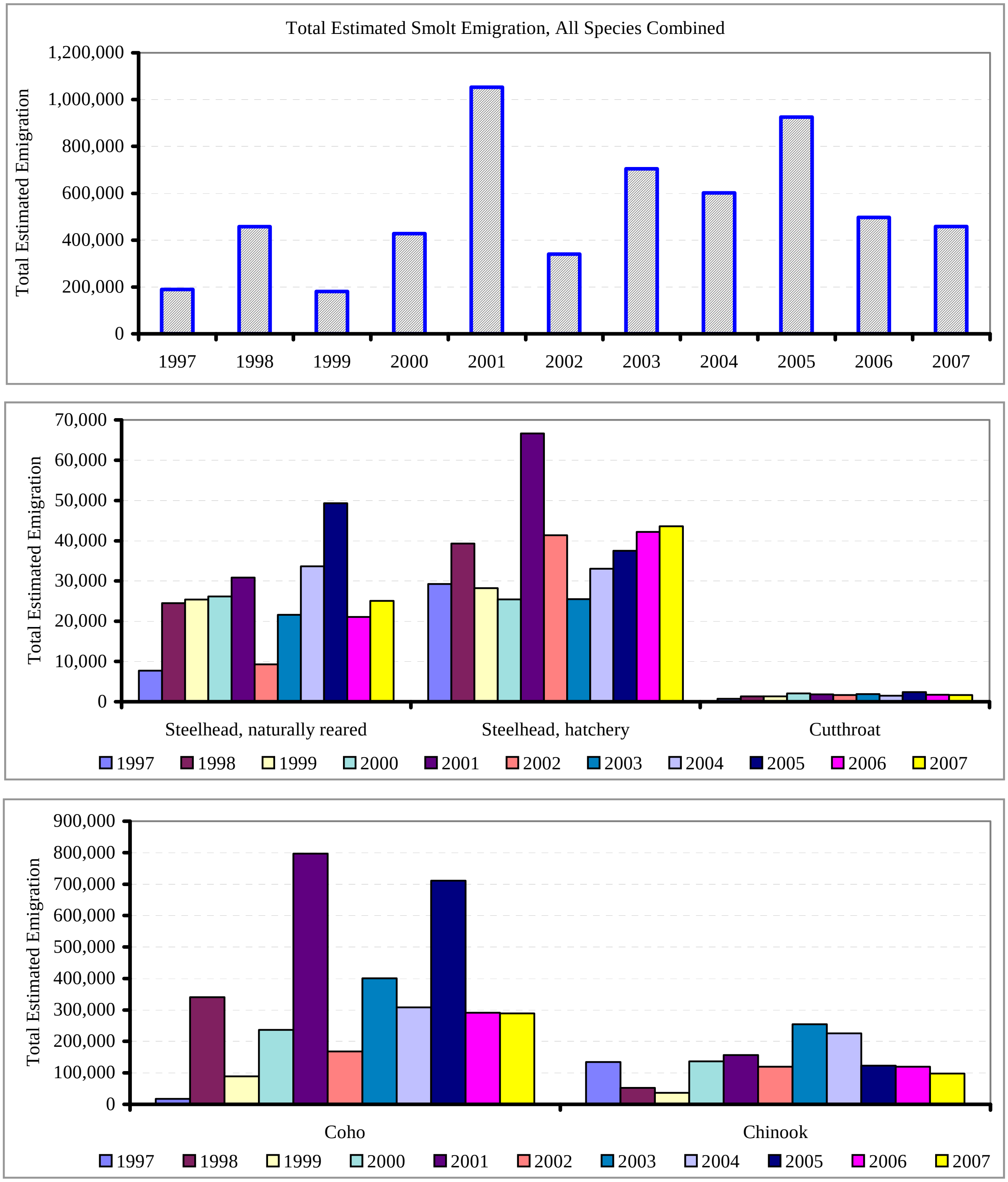


Figure 2.5-6 Estimated Abundance of Smolts Arriving at Cowlitz Falls Dam 1997-2007 (Serl and Morrill 2008)

2.5.3.4 Migration Patterns

Descriptions of the migration patterns of juvenile fish approaching Cowlitz Falls Dam and in Lake Scanewa and Riffe Lake reservoirs would assist in positioning the entrances of collection systems. Such data can be acquired by tracking fish implanted with active tags (radio or acoustic). USGS investigators have been conducting telemetry studies since 1998. They regularly conduct investigations at Cowlitz Falls Dam and report movement patterns at the face of the dam, passage locations, residence time in the forebay and the frequency of upstream excursions by radio tagged juveniles. Detailed descriptions of approach patterns in the forebay and reservoirs are largely absent. Relying on three of the more recent investigations conducted at Cowlitz Falls Dam by USGS (Perry et al. 2004, Kock et al. 2006, and Liedtke et al. 2007, 2008), key findings that may influence the design of alternatives are summarized below. Data are available for steelhead, coho, and Chinook salmon.

- Many fish do not pass Cowlitz Falls Dam upon first arrival at the dam. After juvenile fish encounter Cowlitz Falls Dam, upstream excursions were regularly observed. However, the frequency with which species exhibited this behavior varied across species and water-years.
- Milling along the face of the dam can be substantial at times, especially for steelhead and coho.
- Smolt travel time from the Lake Scanewa release site to passage at Cowlitz Falls Dam is variable. For example, in 2008 median travel time to pass Cowlitz Falls Dam ranged from10 hours for steelhead to 3.5 days for Chinook (Liedtke et al. 2008).

Migration routes to Cowlitz Falls Dam were observed in 2008 and were described in broad terms (Liedtke et al. 2008). Based on data obtained from dam-based antennas, it was reported that the majority of radio tagged fish approaching the dam were first detected in the north half of the forebay (76% of steelhead and 74% of Chinook). This distribution was evident at the face of the dam as well; underwater antennas detected 64% and 67% of each species respectively, on the north side of the dam.

2.5.4 Riffe Lake Lateral Distribution Data, 2009

In 2010 the DFPT asked the USGS to re-examine their 2009 acoustic tag data for Riffe Lake. The question was whether they had data that could describe the lateral distribution of smolts as they passed the proposed mid-reservoir site for the Riffe Lake Collector alternative. The presumption had been that the smolts would gravitate toward the old thalweg and naturally be oriented toward the south shore (envisioned FSC location). The DFPT wanted to confirm this, since such a distribution would increase the probability of smolts encountering the FSC entrance.

USGS did have a hydrophone transect deployed near that site, and they reanalyzed the data. The response variable was first detection of acoustic-tagged fish at the transect. There were 5 acoustic hydrophones; #1 deployed near the north shore, through #5 near the south. In a 27 September 2010 letter report to the DFPT, USGS attached a photograph with hydrophone locations indicated, and a bar-graph depicting the lateral distribution of three species (steelhead, coho and Chinook). Their findings indicate that about 40-50% of all species are first detected near the north-shore, and only about 15-25% near the south-shore, with another mode near the middle at hydrophone #3.

These findings draw into question the original strategy that called for the FSC to be staged near the south-shore, since smolts do not exhibit a tendency to follow the submerged thalweg on the south side of the reservoir.

2.5.5 Lewis County PUD Survival Study 2010

Recent reservoir survival estimates are consistent with those values the DFPT used in the model analyses for evaluating collection potential. In 2010, Lewis County PUD funded a USGS telemetry study to estimate survival at Cowlitz Falls Dam. As part of that work, survival estimates were reported for the reservoir and extending upstream into the Cispus and Cowlitz rivers. Radio tagged smolts were released in two locations, 21.7 and 8.9 km upstream from CFD in the Cowlitz and Cispus Rivers, respectively. Pooled survival estimates through those reaches were 96%, 99%, and 93%, for steelhead, coho and Chinook, respectively. The input values used in the biological evaluation model were 99%, 97% and 93% for those same species, respectively.

2.6 2009 Prototype Tests

2.6.1 Performance of Past Prototypes

Since 1996, a variety of entrance baffle configurations and flume/screen designs have been investigated at Cowlitz Falls Dam. Results from testing the various configurations were summarized in a document compiled for the workshop held in March 2008; "Workshop to investigate solutions for smolt collection at or near Cowlitz Falls Dam (February 8, 2008)". The workshop document resides on the Tacoma Power website. Interested readers should refer to that document, but a few key findings are summarized here. Table 2.6-1 reproduced from Liedtke et al. (2007) depicts the degree of FCE variability across the years. It has been difficult to attribute changes to specific configurations or operations, because typically a variety of conditions change across and within years, confounding the ability to draw sound conclusions. Specifically with regard to recent evaluations of the contemporary Tacoma Power fish screen system, Liedtke et al. (2007) highlights this difficulty when attempting to compare shifts in FCE between 2006 and 2007. Even so, from the collective USGS and WDFW investigations some key points are noted here:

- Steelhead, Chinook and coho do not readily pass through the Tacoma Power fish screen into the flume leading to the collection facility. A rejection zone is obvious. This continues to contribute substantially to low FCE observed at the dam. Eliminating this bottleneck would be advantageous.
- At times, fish spend considerable time moving within the space bounded by the debris barrier and the baffle entrances. This appears to be a zone of hydraulic complexity that may contribute to the observed low Entrance Efficiency (Capture Efficiency).
- In concert, rectifying these two aforementioned conditions could improve FCE substantially for most, if not all species.
- Fish passage through the induction slots has been observed at times. Any alternative staged at the dam should consider this in the design.
- Discovery Efficiency (DE) in 2006 (with the debris barrier in place) was quite high especially for Chinook (Kock et al. 2006); steelhead = 66%, coho = 51%, and Chinook = 77%. WDFW notes that previous telemetry studies revealed that using the "C" configuration, over 90% of the steelhead were detected within 1 m of the flume with the debris boom in place.

Table 2.6-1 Fish collection efficiency (FCE) estimates at Cowlitz Falls Dam from 1996 to 2007 (reproduced from Table 16 from Liedtke et al. 2007)

	Fish Collection Efficiency (%)					
Year	Steelhead		Coho salmon		Chinook salmon	
	MR	RT	MR	RT	MR	RT
1996	50%	-	15%	-	-	-
1997	45%	-	21%	-	17%	-
1998	19%[1]	55%	32%	-	18%	-
1999	41%	-	17%	68%	24%	-
2000	65%[2]	66%	45%[2]	-	24%[2]	57%

	Fish Collection Efficiency (%)					
Year	Steelhead		Coho salmon		Chinook salmon	
2001	58%	81%	42%	-	23%	-
2002	56%	-	33%	-	22%	-
2003	68%	68%	43%	-	13%	26%
2004	48%	-	42%	-	14%	-
2005	42%	-	36%	-	12%[3]	-
2006	47%	48%	26%	28%	31%	51%
2007	42%	44%	36%	64%	20%	13%
Mean FCE	*48% (13)*	*60% (14)*	*32% (10)*	*53% (22)*	*20% (6)*	*37% (21)*

Notes:

1. Poor retention of PanJet marks likely resulted in underestimate of FCE.
2. Altered baffle panel configuration.
3. Merwin trapping increased overall collection efficiency.
4. WDFW estimates were generated using mark-recapture (MR) techniques. USGS estimates were made using radio telemetry (RT) techniques. Numbers in parentheses represent one standard deviation from the mean.

2.6.2 2009 Weir Box Prototype Test

In 2009 a prototype weir box collector was fabricated and installed by Tacoma Power at the Cowlitz Falls Dam spillway. The weir box prototype was an 8-foot wide by 29-foot long by 14-foot high steel box positioned in front of the existing radial gate, spanning across both flume entrances inside Spillway Bay 2. The upstream side of the box acted as a weir, and panels could be placed on the upstream wall of the box to adjust the weir height. A fish screen was positioned horizontally in the box, creating a floor in the box at the same elevation as the floor of a flume exiting the box at either end. The solid floor of the weir box was 5.8 feet below the fish screen. Two 30-inch diameter pipes exited the weir box below the fish screen. The pipes were each perforated with thirty-six 8-inch diameter holes. The water from the pipes discharged via siphon outlets directly onto the spillway chute downstream of the radial gate. The design flow for the weir was approximately 200 cfs, with 50 cfs discharge to the bypass flumes and 150 cfs to the siphon outlets. Figure 3-1 and Figure 3 2 show the weir box prototype and associated piping.

The collection efficiency of the weir box prototype was estimated using radio tagged smolts (Liedtke et al. 2010). Over the study period, discovery efficiency at the weir box was estimated at 81% for coho, and 59% for Chinook. Entrance efficiency was 72% and 66% for the same species, respectively. Using these estimates collection efficiencies of 58% and 39% were calculated for coho and Chinook, respectively. A full weir box system would likely be comprised of 2 to 4 boxes located farther upstream than the tested prototype, thus collection potential is expected to be higher than observed during the 2009 test. The DFPT relied on these estimates as input values used in a model to determine the fish collection potential of the 60% conceptual design alternatives.

2.6.3 2010 BGS Prototype Test

In the spring and summer of 2010, Tacoma Power evaluated a prototype BGS deployed in the forebay of Cowlitz Falls Dam (HDR 2010). The goal was to determine to what extent smolts would guide along the structure toward the north shore where a collection facility may be constructed.

The structure consisted of a chain of floats from which weighted tarps were suspended to a depth of about ten feet. It was anchored at both shores, and deployed at an oblique angle with the upstream end secured to the south shore. Additionally a small gulper-type collector (about 20 cfs) was stationed at the downstream terminus of the prototype BGS. Current velocities in the forebay often were swift enough to displace the tarp from the vertical plane, compromising its guidance ability. Even so, fish reaction to the test device was instructive and encouraging.

To evaluate how smolts responded to the BGS, HDR conducted a behavior study employing miniaturized acoustic tags. They deployed a hydrophone grid in the forebay, concentrated in the area near the BGS. This system positioned fish in two-dimensional space on the horizontal plane. Steelhead, coho, and Chinook salmon (N = 341) were tagged and then released near the Day Use Park, 3.5 km upstream from the dam.

Travel times from the release site to the forebay were quite variable and ranged from 11 to 585 hours across species. Steelhead and coho were the fastest with median travel times of about 19 and 18 hours, respectively. Chinook were considerably slower with median travel times for natural origin fish (NOR) and hatchery origin fish (HOR) fish at 92 and 46 hours, respectively. Fish also spent protracted time in the forebay and exhibited milling behavior covering broad distances, often upstream from the forebay. Median elapsed times from first to last detection were 31, 43, 54, and 108 hours for steelhead, coho, NOR and HOR Chinook, respectively. Fish entering the forebay were relatively evenly distributed between the north and south halves of the reservoir with the exception of hatchery Chinook, which had a propensity to enter the forebay in the southern half of the reservoir.

Smolts appeared to exhibit a positive response to the BGS and spent relatively extended periods near the gulper entrance. The vast majority of tagged fish were detected within a 10 m radius of the gulper entrance; with 93% of the steelhead as the high, and 80% of NOR Chinook the low. Frequency distribution and time-in-zone density plots revealed that fish spent considerable time near the downstream end of the BGS and the near-field zone upstream from the gulper entrance. These observations were encouraging and a more substantial and rigid BGS structure was tested in 2011. The 2011 test results will be reviewed and applied to detailed design as appropriate.

A 100 ft long and 40 ft deep fish exclusion net was deployed approximately10 ft downstream of the BGS during the period September 6, 2011 through September 29, 2011. The intent of the net deployment was to test if a 3/32 knotless net blocking the entire water column in the forebay of Cowlitz Falls Dam, could hold up to the debris and algae growth. The test showed positive results. The net was unharmed during the deployment. No rips were created. Debris loading was limited and there was limited algae growth. The test was over a short duration leaving the question of whether a net intended to exclude Chinook and other fish from moving downstream of Cowlitz Falls dam can be deployed from July through August without ripping. As a result, the net will be deployed in 2012 for further testing.

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3.0 Design Criteria and Methodology

3.1 General

The following sections describe the criteria applied in developing the conceptual designs presented in this report and, where applicable, the methodology employed.

3.2 Fisheries and Hydraulics

Fisheries design criteria and guidelines were derived from:

- Bell. M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage and Development Evaluation Program, U.S. Army Corps of Engineers, Portland, OR.
- ENSR. 2007. Surface Bypass Program Comprehensive Review Report. Prepared for USACE Portland District. Contract No. W9127N-06-D-0004, T.O. 01.
- Goodwin, R.A.; J.M. Nestler,; J.J. Anderson; D.L. Smith; D. Tillman; T. Toney; L.J. Weber; S. Li; J.R. Cheng; and R.M. Hunter. 2006. The Numerical Fish Surrogate: Converting Observed Patterns in Fish Movement and Passage to a Mechanistic Hypothesis of Behavior for Engineering Design Support. Draft Final Technical Report ERDC/EL-06. U.S. Army Engineer Research and Development Center, Vicksburg, MS.
- Montgomery Watson Harza (MWH). 2005. Baker River Project – Upper Baker Dam Downstream Fish Passage Facilities – Guide Net Design Memorandum. Prepared for Puget Sound Energy.
- NMFS (National Marine Fisheries Service). 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.
- PacifiCorp Energy. 2007. Lewis River Fish Passage Swift Downstream Collection – Biological and Hydraulic Facility Design Criteria.
- Reese, L. 2009. Personal Communication with Lynn Reese, Hydraulic Engineer, U.S. Army Corps of Engineers, Walla Walla District. April 16, 2009. and
- Washington Group International (WGI). 2006. Upper Baker River Downstream Fish Passage Facilities – Floating Surface Collector Design Memorandum. Prepared for Puget Sound Energy.

General operational guidelines for the facilities being proposed are presented in the following table.

Table 3.2-1 Fisheries Design Criteria and Guidelines – General Operations

Component	Value	Comments	Source
Type of fish	Coho, chinook, and steelhead		
Anticipated operational period	April 15 – August 31	Fish migration period as presented in Section 2.3.2	
Possible operational period	Year-round	Additional fish presence data presented in Section 2.3.2	

Component	Value	Comments	Source
Design river flow range	15,000 cfs	Goal is to have facility operable whenever the reservoir is up and fish are migrating. 15,000 cfs Cowlitz River flow at Randle, WA is the flow at which reservoir begins to be drawn down. The design river flow of 15,000 cfs exceeds the NMFS criteria for 5% exceedence for species-specific primary and secondary fish migration periods	NMFS (2011)
Pool level range		Depends on alternative site	

Criteria and guidelines applicable to design of specific components of fish collection facilities are presented in the following tables:

Table 3.2-2 Fisheries Design Criteria and Guidelines - Exclusion/Guide Nets and BGSs

Component	Value	Comments	Source
Forebay streamlines	n.a.	Streamlines shall upwell and converge toward the fish collection entrance	MWH (2005)
Exclusion net alignment and sweeping velocity components	n.a.	Sweeping velocity toward fish collection entrance along full length of net	MWH (2005)
Exclusion net alignment and approach velocity components	≤ 0.1 fps	Allowable velocity component perpendicular to a passive exclusion screen or net (a screen where there is no appreciable sweeping flow component or an active cleaning system).	Design team recommendation, based on experience with deploying similar nets
Exclusion net alignment and approach velocity component distribution	n.a.	Positive (normal in downstream direction) along top half and downstream half of the net	MWH (2005)
Exclusion net material	Knotless mess, mesh size ≤ ¼ inch clear opening	Net will be resistant to rot and ultraviolet degradation. To improve the guidance of fish to the FSC, the net in the upper 30 to 50 feet of the water column may incorporate a knotless mess with the mesh size not to exceed 3/32 inch or an impermeable membrane.	The 3/32 inch mesh size is intended to exclude fry per NMFS (2011) Section 11.7.1
Porosity in upper 30 feet of net	< 50 %	Assuming clean net with no algae growth	MWH (2005)
BGS alignment	n.a.	Sweeping velocity toward fish collection entrance along full length of BGS.	Reese (2009)
BGS upstream end point	n.a.	No gap between end point and shore to prevent juvenile fish loss; make BGS shallower at shore instead to support adult passage.	Reese (2009)

Component	Value	Comments	Source
BGS downstream end point	n.a.	Adjacent to but not connecting to fish collection entrance. Research indicates fish sense and guide along threshold fluid strain signature at some distance from BGSs rather than directly along the physical structure and might bypass the structure entrance if that option is available.	Goodwin, et. al. (2006)
BGS areal extent and depth	Velocity under BGS ≤ 2 fps	Prevents entrainment of fish under BGS and makes structural loading reasonable; also consider depth distribution of juvenile fish.	Reese (2009)

Table 3.2-3 Fisheries Design Criteria and Guidelines - Entrances

Component	Value	Comments	Source
Fish collection entrance location	n.a.	Location of the surface bypass entrance(s) relative to smolt pathways and concentration areas in the forebay is a primary consideration for maximizing FCE. Both vertical and horizontal distribution of smolts is important in this regard. Natural features like sills and shallowing forebays are beneficial in that they shift the population up toward the surface bypass. In turn, extending the depth of the invert can increase the probability of encounter. In the horizontal plane, natural features like cul-de-sacs, lateral currents, or eddies can direct smolts toward a surface bypass. Absent these features, physical guidance devices can serve to direct fish horizontally toward a surface bypass or multiple entrances can increase the probability of fish discovery of an entrance.	ENSR (2007)
Fish collection entrance hydraulic capacity	500 cfs expandable to 750 cfs.	Hydraulic capacity agreed upon by DFPT during January 26, 2011 DFPT meeting. Additionally, it was agreed that facility would be designed in a manner that allowed the capability to expand to 1,000 cfs in the future if necessary.	Consensus of DFPT, 2011
Fish transport velocity gradient, G, from fish collection entrance through capture location	0 ≤ G ≤ 0.2 ft/s-ft from fish collection entrance to capture where no screen system	No deceleration or sharp acceleration of transport velocities that might cause fish rejection or delay. Gradient should be calculated in fish length increments, i.e. 3-4 inches.	NMFS (2011)
Fish capture velocity	8 fps	8 fps selected by DFPT members during meetings as an appropriate design value	Consensus of DFPT, 2011

Table 3.2-4 Fisheries Design Criteria and Guidelines - Screening and Capture

Component	Value	Comments	Source
Fish transport velocity gradient, G, from fish collection entrance through capture location	0 ≤ G ≤ 0.2 ft/s-ft through screen systems	No deceleration or sharp acceleration of transport velocities that might cause fish rejection or delay.	NMFS (2011)
Fish capture velocity	8 fps	8 fps selected by DFPT members during meetings as an appropriate design value	Consensus of DFPT, 2011
Minimum capture section width	3 feet		WGI (2006)
Minimum capture section depth	3 feet		WGI (2006)
Maximum screen opening	1.75 mm	Prevents fish impingement on screens	NMFS (2011)
Minimum screen open area	27 %	Prevents fish impingement on screens	NMFS (2011)
Screen cleaning	n.a.	Required for all screens	
Screen approach flow velocity component (perpendicular to screen face)	≤ 0.4 ft/s	Prevents fish impingement on screens	NMFS (2011)
Screen sweeping velocity component (parallel to screen face)	> Screen approach flow velocity component	Prevents fish delay in screen system Velocity must not decrease along the length of the screen	NMFS (2011)
Screen channel transport velocities	1 to 3 ft/s		NMFS (2011)
Maximum screen exposure time	60 seconds assuming fish movement at sweeping velocity component speed	Prevents fish delay and impingement by fatigue	NMFS (2011)
Screen bypass entrance velocity	> 110 % of maximum screen transport velocity	Promotes fish entering bypass system	NMFS (2011)
Bypass transport velocity	6 to 12 ft/s	Prevents fish holding in bypass system	NMFS (2011)
Flow depth over any bypass control weir	> 1 feet	Exceeds capture velocity over weir	NMFS (2011)

Table 3.2-5 Fisheries Design Criteria and Guidelines - Separation, Holding, and Transport

Component	Value	Comments	Source
Size separation	Adult, fingerling, and fry separation	Site specific	Per recommendation of Tacoma Power
Number of fish	# to be provided	Maximum day with reserve	Tacoma Power
Holding fish size	7.5 fish per lb for steelhead 21 fish per lb for coho 24 fish per lb for spring Chinook sub-yearlings	Based on observations at CFFF	Per WDFW comments on the 60% CDR, based on observations of fish collected at CFFF
Minimum flow rate in holding ponds	0.5 gpm/lb of fish	Corrected for fish length	Bell (1991)
Minimum holding density	1.5 lbs of fish/ft^3	Corrected for fish length	Bell (1991)
Fish hopper transport time	15 minutes	Maximum time to transport fish hopper from holding to truck if applicable	

Hydraulic design generally followed the calculation procedures, criteria, and standards established in:

- USACE. 1994. Hydraulic Design of Flood Control Channels Change 1 ENG 4794-R. EM 1110-2-1601;
- USACE. 1980. Hydraulic Design of Reservoir Outlet Works. EM 1110-2-1602; and
- USACE. 1990. Hydraulic Design of Spillways. EM 1110-2-1603.

3.3 Structural and Geotechnical

3.3.1 Structural

The following criteria and standards are proposed for the design and construction of the fish passage facilities. These will be updated with additional details as the design progresses and decisions are made by Tacoma Power in regard to operating, maintenance, and the expected life of the facilities.

3.3.1.1 Applicable Codes and Standards

The following codes, standards and specifications will generally be used, checked or consulted during the design process. The applicable version of each document is the latest edition in force unless noted otherwise. References to specific codes and standards will also be included in the applicable technical specifications of the contract documents.

The structural design, engineering, materials, equipment, and construction will conform to the following codes and standards:

- ACI 350R, American Concrete Institute, code requirements for Environmental Engineering Concrete Structures

- Aluminum Design Manual by Aluminum Association
- American Institute of Steel Construction (AISC-ASD) (2005). “Steel Construction Manual–Allowable Stress Design,” Thirteenth Edition.
- American Society of Civil Engineers (ASCE) (1993). “Strength Design for Reinforced-Concrete Hydraulic Structures”
- American Society of Civil Engineers (ASCE) (2005). “Minimum Design Loads for Buildings and Other Structures”
- USACE (1994) “Design of Hydraulic Steel Structures”, Engineering Manual EM1110-2-2105.
- American Waterworks Association (AWWA) (2004). “Steel Pipe: A Guide for Design and Installation (AWWA Manual M11),” Fourth Edition.
- International Building Code (IBC) (2003).

The structural design, engineering, construction, materials and equipment will also comply with all local, municipal and state regulations.

3.3.1.2 Material Properties

The following identifies the material properties to be used during design:

- Structural Steel - Supports, Guides, Wide Flange Sections: ASTM A 992
- Other shapes and plates: ASTM A36 or as indicated on the Drawings
- Structural Tubes: ASTM A500 Grade B or as indicated on the Drawings
- Structural Pipe: ASTM A53 Grade B or API 5LX42
- Bolts: ASTM A325 hot-dip galvanized, anchors-ASTM A36, A307 or Stainless Steel
- Anchor Bolt Grout: Two component epoxy, ASTM C-881
- Grating: Hot dip galvanized steel, Aluminum or Fiberglass.
- Access Stairs: Hot dip galvanized steel, Aluminum or Fiberglass.
- Bulkheads: Painted Steel.
- Handrails: Hot dip galvanized steel, Aluminum or Fiberglass.

3.3.1.3 Loads

The major loads considered in the design are identified in the following sections. These loads will be grouped into loading combinations as required and dictated by applicable codes.

Dead Load (DL)

The structural system of all features shall be designed and constructed to safely support all dead loads, permanent or temporary, including but not limited to self weight, metal buildings, fixed mechanical and electrical equipment, stairs, walkways and railings.

Live Load (LL)

Live loads during construction and operation will consist of the following loads:

- Human loads applied by operators and occasional visitors.
- Temporarily stored equipment on structures.

- External Hydrostatic Loads. A triangular distribution of static water pressure is assumed acting normal against the upstream faces of the screen walls, skin plates of the screen panels, fish ladder walls and other bulkheads.
- Hydrodynamic Loads. The hydrodynamic effect of the reservoir against structures will be considered. The inertia of the reservoir water includes an increased or decreased pressure on the structure concurrently with structure inertia forces assuming structures are fixed in place. The hydrodynamic forces will be computed by means of Westergaard's formula using the parabolic approximation.
- Buoyancy Loads. Structures shall be designed to resist upward hydrostatic pressure with a factor of safety of 1.5. Buoyancy pressure exists within the body of the structure and the buoyancy pressure distribution will be assumed to be unaffected by earthquake motions.
- Earthquake Loads. The earthquake loads will be selected based on IBC related maps and tables. The seismic load assessment will consider the site geology, proximity to major faults, regional seismic history, and seismic risk. The earthquake loads will be transmitted to structures from point of attachments to the rigid elements such as the dam or rock base. The actual inertial acceleration of the equipment will depend on the acceleration of the attachment element, the mass and drag of the given structure. Pseudo-static seismic coefficients acting horizontally and vertically will be determined and used based upon the seismic information provided by the geotechnical report. Dynamic analysis of structures and its components then may be performed to determine the actual period, modes of deformation under seismic event in both directions, and the percentage of mass participation for each mode.
- Impact Loads. Structure shall be designed to resist impact loads due to logs and other debris as appropriate. The design log shall be 2-foot diameter, 40-foot long, with unit weight of 60 pound per cubic feet at 4 fps. Reduced loads due to impacts at an angle may be considered.
- Snow Loads. The Cowlitz Falls Dam is located in Lewis County, Washington and design snow loads will be in compliance with requirements of the County's Building Department. It is assumed that snow load would accumulate on pervious grating surfaces the same as impervious surfaces. In other words, no reduction will be assumed for pervious surfaces.
- Wind Loads. Wind loads will be included for the design of exposed structures, and mechanical equipment mounted on top of structures. For structures, wind loads will be computed per the IBC using a basic wind speed of 100 miles per hour. A wind Importance Factor, Iw, of 1.15 will be used (Non-Hurricane Prone Regions). Wind loads will be compared to seismically induced forces and used if critical.
- Current Loads. Current loads on the structures will be calculated based on current flow velocities estimated at different events and for various dam operation scenarios. Also, current forces will be calculated in the event of PMF or spill.
- Ice Loads. Ice loads from the surface of the reservoir will be calculated and combined with other operation and non-operation loads.
- Temperature Loads. Temperature loads will be assumed based on the job site location. Temperature changes for expansion and contraction will be considered based on the construction schedule.

3.3.1.4 Load Combinations

The above listed loads will be combined and applied to the structure as required for different stages of construction, operation and maintenance. Each project component will have its own load combinations. These will be detailed at a later design stage.

3.3.2 Geotechnical

Geotechnical investigations of the alternative sites will be conducted as necessary, and geotechnical criteria determined on a site specific basis.

3.4 Mechanical and Electrical

3.4.1 Mechanical

References and Design Standards

Standards will primarily comply with the latest edition of the following publications:

- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Welding Society (AWS)
- National Fire Protection Association International (NFPA)

Design guidance is provided from the following publications:

- USACE Engineer Manual: EM 1110-2-2701, "Vertical Lift Gates"
- USACE Engineer Manual: EM 1110-2-3102, "General Principals of Pumping Station Design and Layout"
- USACE Engineer Manual: EM 1110-2-3105, "Mechanical and Electrical Design of Pumping Stations"
- USACE Engineer Manual: EM 1110-2-3200, "Wire Rope Selection Criteria for Gate Operating Devices"
- Hydraulic Institute Standard ANSI/HI 9.6.4-2000, "Vibration and Balancing"
- Hydraulic Institute Standard ANSI/HI 9.8-1998, "Pump Intake Design"

3.4.2 Electrical and Instrumentation

All power requirements will be closely coordinated with LCPUD.

Considerations include:

- Electrical supply: 120/240 volt ac
- Electrical grounding
- Controls: self-contained controls, pendant or radio controlled
- Control cabinets: size and location
- Miscellaneous instrumentation and annunciation

3.4.2.1 Power Supply

- Governing codes and standards will primarily comply with the latest edition of the National Electrical Code (NEC). NEC Article 553, "Floating Buildings" applies to this facility.
- The electrical systems will be in compliance with NEMA, ANSI, IEEE, and UL standards. In general, the design emphasizes safety reliability, maintainability, and economics while utilizing heavy-duty industrial type equipment.

3.4.2.2 Standby Power

- Standby power will be provided for critical circuits necessary to maintain the facilities in operating condition.
- 24 hr fuel supply will be provided.
- Standby power will maintain the monitoring and alarms systems.

4.0 Alternative Selection

This chapter presents a brief history of the considered alternatives and describes the evaluation of the fish capture strategies and system components for the alternatives that were advanced to 90% and final conceptual design. Refer to earlier versions of this report for details on the evaluation of other considered alternatives.

4.1 Downstream Collector Goal

The fish passage survival goal for the downstream collector is expressed in the Settlement Agreement (SA), License Article 1, as follows:

Article 1a)2): "proposed facilities and measures most likely to achieve the goal of 95% Fish Passage Survival ("FPS"), as defined in the August 2000 Settlement Agreement, to be funded by the Licensee to contribute to effective downstream passage and collection at or near Cowlitz Falls and/or to be constructed by the Licensee downstream of Cowlitz Falls Dam at Riffe Lake;"

Article 1c): "The Licensee shall implement, or support implementation of, additional downstream passage facility improvements and file additional reports at 18 month intervals in accordance with the preceding paragraph until the Licensee has employed the best available technology and achieved at least 75% FPS for all species"

Throughout the remainder of the document the preceding sections (Article 1a)2) and Article 1c)) shall be referred to as the "SA FPS Goal". Consistent with the SA FPS Goal, development and evaluation of juvenile fish passage collection systems will target a goal of 95% FPS.

4.2 Alternatives not Selected for Completion

In March of 2008 Tacoma Power convened a 2-day Fisheries Technical Committee (FTC) workshop attended by invited representatives of the consulting engineering community, Tacoma Power, LCPUD and other utilities, federal and state resource agencies, the U.S. Army Corps of Engineers, federal congressional staffs, and various non-Governmental organizations to brainstorm and identify specific fish collection solutions that may improve downstream fish passage. A total of thirty-eight alternatives were proposed for consideration during the brainstorming session. The brainstorming session is summarized in a report (Giorgi and Sweeney 2008a).

Following the workshop, Tacoma Power convened a Downstream Fish Passage Team (DFPT) comprised of consulting engineers and a consulting biologist, Tacoma Power and LCPUD staff, and state and federal resource agency staff. The DFPT advanced the five most promising alternatives identified at the FTC workshop to 30% and 60% conceptual design and presented them in reports dated November 24, 2008 and April 30, 2009 (AECOM et al, 2008 and 2009). The five concepts developed to 60% design level were:

- A Floating Surface Collector (FSC) in Lake Scanewa;
- Enhancement of the Existing Collector at Cowlitz Falls Dam;
- A Surface Flow Outlet (SFO) at Cowlitz Falls Dam;
- A FSC in Riffe Lake; and
- A FSC in at Mossyrock Dam.

These alternatives are described in detail in the 60% Conceptual Design Report, which is available by request with Tacoma Power.

After the 60% Conceptual Design Report was issued, seventeen alternatives that were either single structures or combinations of the five alternatives listed above were analyzed and evaluated for both potential biological effectiveness and physical operation. The results of this analysis yielded three structures as the most promising alternatives. These were the SFO located in the emergency spillway bay, the FSC in Lake Scanewa, and the FSC in Riffe Lake. In the biological evaluation, the SFO and FSC in Lake Scanewa were rated exactly the same. The combinations that resulted in the highest estimated FPS were a surface collector near Cowlitz Falls Dam, including improvements to the existing Cowlitz Falls collection system (weir boxes), coupled with the Riffe Lake FSC. The Riffe Lake FSC, as conceived in the 60% Conceptual Design Report, was determined by the Downstream Team members to be a highly challenging to technically infeasible alternative. As a result, new Riffe Lake collection alternatives will be explored during Adaptive Management Planning.

During the evaluation of alternatives, the FERC ruled that the fish facilities located at the dam cannot interfere with its operation and must be able to be removed within two hours. An SFO in the emergency spillway could not pass the design flood nor could it be removed in the required amount of time specified by the FERC. Therefore, the SFO was moved upstream and placed in its own concrete box along the north shoreline. Another favored alternative, the FSC in Lake Scanewa, was evaluated, and it was determined that it did not have to float since the lake only fluctuated two feet, from 860.0 to 862.0. Therefore, it was to be constructed of concrete and placed on the north shore. Because of these changes, these two alternatives became very similar. The only difference was in the way that they would capture fish. Two alternative configurations of a collector on the north shore of Lake Scanewa were presented in the 90% Conceptual Design Report: the "Partial Flow Capture Facility" and the "Full Flow Capture Facility". The primary difference between the alternatives was the volume of the attraction flow that would be used for capture; i.e. whether some of the attraction flow would be screened upstream of the capture module. The design of these alternatives, plus a weir box located in the spillway at Cowlitz Falls Dam, were advanced to the 90% conceptual design level, and are fully described in the 90% Conceptual Design Report, which is available by request with Tacoma Power.

The Recommended Alternative is the Partial Flow Capture Facility located on the north shore of Lake Scanewa, supplemented by collection using weir boxes in the Cowlitz Falls spillway. The evaluation of the modules that comprise the preferred alternative and the rationale for their selection is described in sub-section 4.3 through 4.6. Consultation with the DFPT continued after the 90% CDR was issued, and three potential arrangements of the Recommended Alternative were developed. These are presented in Section 5. Section 6 describes the next steps in the design and construction process, and lays out a plan for adaptive management of facility development to meet the SA FPS Goal.

4.3 General Approach and Definitions

The two collector alternatives presented in the 90% CDR have several interchangeable modules, but only one key difference in collection strategy: whether to convey the full attraction flow through the capture module or whether to screen a portion of the attraction flow before capture. These two capture strategies are termed Partial Flow Capture and Full Flow Capture. The desired capture strategy must first be evaluated and selected, and then the optimum set of components to implement that strategy can be evaluated and assembled. The capture strategies and the system components are defined below. Drawings in Section 5 illustrate each of the defined components in the context of the Recommended Alternative.

4.3.1 Capture Strategy

Full Flow Capture - The entire collection flow entering the facility passes through the Capture Module. The flow is then screened to reduce the flow volume before fish are passed downstream in a bypass pipe.

Partial Flow Capture - Part of the collection flow is removed through screens before the remainder of the fish-bearing flow is passed through the Capture Module.

4.3.2 System Components

Behavioral Guidance Structure (BGS) – A BGS is one feature used in reservoirs where there is no clear flow pattern or other natural or project feature that has been shown to cause fish to concentrate in a location where they can be collected. A BGS presents an artificial bank line and hydrodynamic signature in the reservoir, which may help to guide fish toward a collection location.

Exclusionary Net – The BGS is not a full-depth feature, as flow must still pass through the BGS plane to reach the turbines and spillways. Fish can pass under the BGS and summer migrating spring Chinook, which travel deeper in the water column, may be more likely to do so. Conceptual design efforts to date have included a full exclusionary net, assuming this will be necessary to intercept Chinook during the summer months. The net may be integral to the BGS or positioned adjacent to (downstream of) the BGS.

Capture Module – The flow is accelerated to capture velocity over a distance and at a rate dependent on the type of Capture Module employed. Fish are captured once they pass through a channel where the combination of flow velocities and distance over which the velocities exceed the swimming capability of the fish. For the Full Flow Capture strategy, the Capture Module is at the entrance of the collection facility. For the Partial Flow Capture strategy, the Capture Module is located downstream from the Pump Wall Structure, but upstream from the Dewatering Screen.

Dewatering Screens – The Dewatering Screens are located downstream from the Capture Module and serve to reduce the fish-bearing flow to the magnitude that can be accommodated in the Fish Bypass Pipe. The flow through the screens is pump-driven. The pumps and the screens accommodate the entire Capture Module flow minus the Fish Bypass Pipe flow.

Fish Bypass Pipe – The Fish Bypass Pipe conveys fish in a reduced volume of flow to the existing fish handling facility (CFFF).

Screened Flow Conveyance – This conveyance carries pumped flow from the Dewatering Screen either to the vicinity of the turbine intakes or through a diffuser to another location in the reservoir. The optimal location for the discharge of this flow will be determined through Computational Fluid Dynamic (CFD) or physical hydraulic modeling during final design.

The following sections describe the evaluation and selection of the Capture Strategy and the related system components. The pros and cons are reviewed and the logic applied to select the recommended component is presented. The evaluation and selection process was performed by the Downstream Fish Passage Team (DFPT) during its meeting on February 25, 2011.

4.4 Capture Strategy Evaluation

The pros and cons associated with the Full Flow Capture and Partial Flow Capture strategies are presented in the following table.

Table 4.4-1 Capture Strategy Evaluation

Strategy	Pros	Cons
Full Flow Capture	• Provides the largest possible flow cross section at capture to reduce potential for rejection due to fish sensing physical confinement. • Utilizes all of the attraction flow for capture.	• Does not allow adaptive management of operation to adjust flow volume entering the facility relative to changing ambient reservoir conditions. • Less conducive to adaptive management of collection flow capacity. Increasing flow capacity would require changing the geometry of the Capture Module as well as expanding the Dewatering Screens and the Screened Flow Conveyance components.
Partial Flow Capture	• Allows adaptive management of operation by adjusting Pump Wall Structure operations so entrance velocity tracks ambient reservoir velocity without requiring adjustment of downstream Capture Module geometry. • Allows adaptive management of collection flow capacity. Increasing flow capacity would only require changes to the Pump Wall Structure; all downstream structures remain unchanged. • The discharge from the Pump Wall Structure will be diffused over the length of the structure and flow into the reservoir. This discharge may have a positive effect on flow patterns and fish movement. The effect of this discharge must be evaluated with a CFD or physical model.	• Reduces the flow cross section at capture with an associated increase in the potential for rejection due to fish sensing physical confinement. • There is no known prototype or collection facility currently in operation that is similar to the Pump Wall Structure. • The discharge from the Pump Wall Structure will be diffused over the length of the structure and will flow into the reservoir. This discharge may have a deleterious effect on flow patterns and fish movement. The effect of this discharge must be evaluated with a CFD or physical model.

The Partial Flow Capture Facility was chosen because it has better overall adaptive management potential, making it a better choice for the Cowlitz facility, which is:

- In a reservoir that has more river-like and highly variable ambient flow velocities than similar surface collector applications such as Upper Baker and Round Butte; and
- Subject to a license requirement that places high value on the potential need to change in order to meet the biological performance standard.

The potential for fish rejection at the Capture Module location could be managed by selection of the type of capture module and use of a large enough capture flow and cross section. A capture velocity and length similar to those successfully used for the Upper Baker project (8 fps over 20 ft), and a larger capture flow (250 cfs compared to about 75 cfs at Baker) are proposed for the Cowlitz facility.

These decisions concerning the capture strategy and the size of the capture flow and cross section led to evaluation and selection of the best components to be employed in the Partial Flow Capture system, as described in the following section.

4.5 System Component Evaluation

Design considerations for each system component and/or the pros and cons associated with the options for each of the components are presented in the following table.

Table 4.5-1 System Component Evaluation

Component	Option	Pros	Cons
BGS		The final arrangement will be developed through prototype testing and CFD or physical hydraulic modeling as described in Section 5.4.	
Exclusionary Nets		The feasibility will be determined and final arrangement will be developed through prototype testing and CFD or physical hydraulic modeling as described in Section 6.0	
Pump Wall Structure		This component is an inherent part of the selected Partial Flow Capture strategy. There is some risk associated with the proposed discharge design of the Pump Wall Structure in that it may substantially modify the ambient forebay flow field and change fish movement within the forebay that is presently suggested by recent studies. CFD or physical hydraulic modeling must be undertaken to ascertain the hydraulic effects of the diffused pump discharge on circulation in the reservoir before committing to the proposed handling of the discharge from this component.	
Capture Module	Slot	• There are successful precedents in operation such as the Bonneville 2nd Powerhouse Corner Collector; however the flows are significantly higher than that proposed for the Scanewa Collector.	• Abrupt acceleration may cause fish rejection. • A smaller slot with significantly less flow (20 cfs) may cause rejection.
	Weir	• Successful precedents at Snake River Removable Spillway Weirs and various ice/trash sluices.	• Abrupt acceleration may cause fish rejection.
	Gradual Acceleration	• Gradual acceleration similar to the successful Baker FSC system may be less likely to cause fish rejection.	• Longer footprint and more structure required.
Dewatering Screen Module	One-sided Screen	• Simpler discharge access to the forebay if a wall discharge diffuser is employed as a Screened Flow Conveyance.	• Longer dewatering screen module will result in a longer overall structure.
	V-screen	• Shorter dewatering Screen will result in shorter overall structure.	• More difficult discharge access to forebay if a wall discharge diffuser is employed as a Screened Flow Conveyance.
Fish Bypass Pipe		The only alternative being considered is to use the existing dam penetration	

Component	Option	Pros	Cons
		location. This dictates the design flow of the Fish Bypass Pipe. The system is in place, and it appears - to safely bypass fish with 15 to 20 cfs based on results observed in 2010 and 2011. However, the proposed closed-pipe bypass is more susceptible to clogging by debris, relative to a more desirable open flume. In the present design, there is no access to the pipe upstream of the dam, or from the dam to the flume. This may complicate operation and maintenance. Debris monitoring will be addressed in the final design via use of a flume, debris inspection ports, or cameras, or similar measures.	
Screened Flow Conveyance	Pipe to Turbines / Diffuser	The screened flow conveyance method will be determined during detailed design, based on CFD or physical hydraulic modeling as described in Section 6. The pipe exit and/or diffuser detail and location will need to be carefully developed to avoid negative impacts on the turbine performance, to avoid the potential for false attraction of adult fish, and to avoid negative flow patterns within the reservoir that could detract from the fishes' ability to find the fish collection entrance at all design flows.	

The components for which there are multiple options under consideration are the Capture Module, the Dewatering Screen Module and Screened Flow Conveyance. The following sections provide rationale considered in making a recommendation for each of these components.

<u>Capture Module</u>

The Partial Flow Capture strategy is designed such that fish will already be inside the facility when they reach the capture module; therefore, preventing fish rejection is a more important design consideration than fish attraction to the facility. The Weir resemblance to a lake outlet and the Slot resemblance to successful facilities such as the Bonneville 2nd Powerhouse Corner Collector are irrelevant for fish already inside the facility unless conditions approaching the capture module cause behavioral rejection by smolts. Slowly accelerating fish to capture velocity has been employed in many fish screening systems of small cross sections. The Gradual Acceleration Capture Module features gradual acceleration; therefore it may be less likely to evoke rejection by fish already inside the facility and have the best chance of success.

<u>Dewatering Screen Module</u>

The V-screen type Dewatering Screen Module's shorter length is an overriding advantage given the length requirements of the Pump Wall Structure and Gradual Acceleration Capture Module components located upstream from it, and the overall site constraints. The greater lateral footprint can be addressed during detailed design.

<u>Screened Flow Conveyance</u>

The options of piping the screened flow to diffusers close to the turbines or discharging into the reservoir each have pros and cons. The best solution will become clearer during final design and CFD or physical hydraulic modeling.

In summary, the recommended baseline concept to be carried to final design is a Partial Flow Capture Facility incorporating a BGS, a Pump Wall Structure (depending on arrangement), a Gradual Acceleration Capture Module, V-Screens for dewatering, and the existing dam penetration for the Fish Bypass Pipe. Appropriate handling of the screened flow will be determined after CFD or physical hydraulic modeling data are available. If feasible, Exclusionary Nets will be deployed to improve the collection efficiency for Chinook. If in-situ testing demonstrates that Exclusionary Nets are infeasible, then other measures will be considered via the Adaptive

Management Plan. Modifications to the arrangement of the Recommended Alternative will be explored during the next phases of design.

4.6 Collection Flow Evaluation

The previous sections describe the evaluation of the system components and provide a general description of the basic design of the Recommended Alternative. The collection flow capacity is the last design parameter that must be established for the final conceptual design. The collection flow is described in terms of the Pump Wall capacity and the design flow of the Dewatering Screens. In this section, the DFPT provides rationale for selecting the pump flow(s).

The DFPT proposes that the Scanewa collector be comprised of two pump systems; a 250 cfs system associated with the Dewatering Screen and a 250 cfs Pump Wall Structure with the pump capacity expandable to 500 cfs, if required. This recommendation is based on the desire to maximize the potential to collect fish at the desired location, and to retain options on how to collect fish if the target numbers of fish do not enter the new primary collector. The DFPT believes that installation of an initial, robust system will offer an excellent chance of meeting the SA FPS Goal. However, if it does not, an adaptive management approach is planned that will allow the FTC to analyze the data from the first season of operation, and make informed decisions on how to improve the collection efficiency. Section 6 describes the purpose and objectives of the adaptive management plan.

Design

- The Recommended Alternative will be built in the Cowlitz Falls Dam forebay near the dam where pronounced, directed river currents are prevalent. Both the design and the setting of the Recommended Alternative emulate run-of-river Surface Flow Outlet (SFO) applications (ENSR et. al. 2007), not a gulper/barrier net collector deployed in a placid reservoir setting. Thus, parameters associated with SFOs are more relevant to establishing design flow requirements than the reservoir-net-floating surface collector systems used in high-head reservoirs, such as Upper Baker.
- The combination of variable flow entrance and Pump Wall Structure, with a downstream Capture Module and Dewatering Screen is not similar to any existing smolt collection facilities, but is similar to facilities used to exclude smolts from water diversions. The final commitment to this design concept will require hydraulic modeling studies, employing a CFD or physical model, to describe the interaction of entrance flow, Pump Wall Structure, and Dewatering Screen discharge with the forebay flow patterns to confirm that it is possible to develop a system that provides flow conditions which may be conducive to fish collection.

Scale

- In the 2007 Surface Bypass Program Comprehensive Review Report, prepared for the USACE (ENSR et. al. 2007), the authors reviewed the design and performance of virtually all surface collectors extant at that time in the Pacific Northwest. That document provides a foundation on which to evaluate factors affecting collection efficiency potential.
- The scale of the proposed Scanewa collector flow is comparable to other surface collector/bypass systems operating in the Pacific Northwest. To compare SFO flow across a broad range of SFO types, the SFO Compendium (ENSR et. al. 2007) used a flow index calculated as the ratio of SFO collection flow to powerhouse hydraulic capacity.
- Of the SFOs that were in use at the time of the SFO Compendium was published, the flow index ranged from 1.1% to 7.9%. The flow index for the top five performing collectors reviewed in the SFO Compendium (ENSR, et. al. 2007) ranged from 1.1% to 5.4%. These include the Bonneville sluiceway (1.1%), Rocky Reach Corner Collector (2.7%), Bonneville Second Powerhouse Corner Collector (3.5%), Wells bypass (5.0%), and Lower Granite RSW (5.4%).

- As a basis of comparison, for the proposed Scanewa collector at 500 cfs collection flow, the flow index is 4.8 % and at 750 cfs it is 7.2%.
  - The proposed 500-750 cfs Scanewa collector flow index slightly exceeds the most successful SFO systems operating today. This calculation is based on powerhouse capacity. In many cases, there is no spill structure in the immediate vicinity of the powerhouse, unlike at Cowlitz Falls Dam where spill occurs within the collection area. If we consider the 15,000 cfs design flow, the flow index noted here would be reduced by 50%.
  - There may be a risk associated with increasing flow collection flow rates; higher flows draw more debris-laden water into the facility, particularly in the spring. Debris impacts on collected fish have rarely been documented at the CFFF under current operations, with a debris barrier in place.

Behavior

- The SFO Compendium did not identify a flow index as being critical to influence collection efficiency as long as the flow was sufficiently large to attract fish into the collector and the authors did not provide general guidelines as to how much flow was needed to be successful because each collector and the environment in which the collector was placed was unique. The authors did stress, "Location of the SFO entrance(s) relative to smolt pathways and concentration areas in the forebay is a primary consideration for maximizing Fish Collection Efficiency (FCE)." Location was the key factor influencing performance (collection efficiency) regardless of collector design, including flow rates or entrance configuration/entrance velocity. Structures like a BGS may enhance this condition.
- Absent such advantageous migratory patterns, collection systems that incorporate multiple entrances spaced across a dam also provided high collection/passage efficiency (e.g., Wells Dam bypass, the most effective SFO ever designed).
- Recent observations at Cowlitz Falls support the premise that location is a key factor in successful fish collection. In 2010 HDR evaluated the performance of a prototype BGS. Their results indicated that:
  - A large proportion of the acoustic-tagged smolts of all species concentrated near the BGS, and importantly the compact zone near the test facility entrance; and
  - A noticeable fraction of the fish passed the dam via that route. HDR estimated that 8-10% of tagged smolts, including the problematic Chinook, entered and passed the dam via the rudimentary, very low-flow (18 cfs and 0.17 % flow index), shallow invert test facility. The comparable estimate made by USGS utilizing radio telemetry was 2% for steelhead, 5% for coho and 9% for Chinook.

Hydraulic Signature

- Intake flow rate is poorly correlated with smolt attraction to a collector entrance. This observation is supported by hydraulic model studies, which have repeatedly shown that the hydraulic influence associated with collector intake flow is quite compact and restricted to a small zone near the entrance, on the order of tens of feet. The SFO Compendium (ENSR, et. al. 2007) presented entrance centerline velocity profiles for eight different SFOs based on physical or CFD model information. The discernible increase in flow velocity above the ambient reservoir velocity approaching these intakes projected from about 10 ft upstream from the plane of the entrance for the original Cowlitz Falls Dam H-baffle configuration 250 cfs collection flow, 30 ft for The Dalles Sluice 767 cfs collection flow, 40 ft for the Bonneville Second Powerhouse Corner Collector's (B2CC's) 5,300 cfs flow, and 50 ft for the Ice Harbor RSW 8,400 cfs flow, see Figure 4.6-1.

•

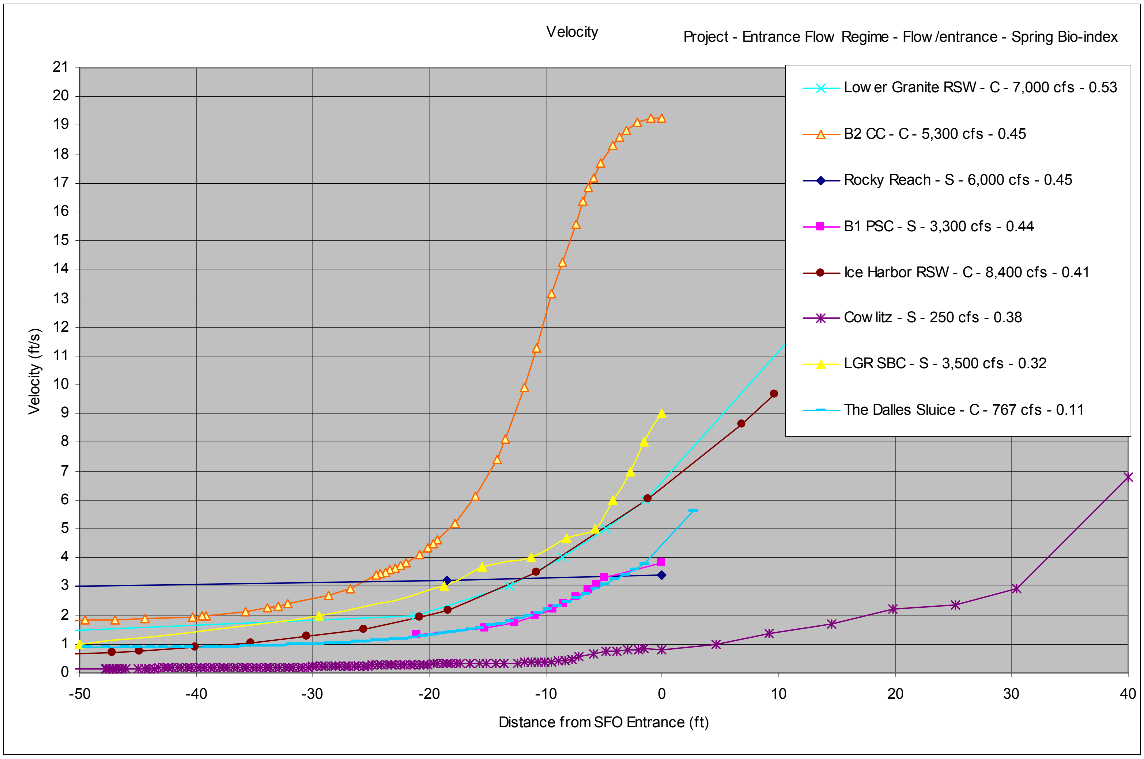


Figure 4.6-1 Velocity Profiles at SFO Entrances (from ENSR, et. al. 2007)

- The change in hydraulic signature is only expected to increase slightly as flows increase from 500 to 750 cfs, or even 1,000 cfs. Based on a comparison to the data presented above, this might expand the zone of influence from on the order of 17 ft, to 20 ft or 22 ft upstream from the plane of the entrance. Thus, the strategy of increasing flows at the Scanewa collector offers minimal potential for improving attraction of smolts to the entrance, unless the proportion of fish arriving near the collector entrance are not collected at high rates.

The information presented in Figure 4.6-1 also demonstrates that the entrance velocity is not necessarily of primary importance given that the biological performance of the B2CC, Rocky Reach, and the RSWs are all similar.

Based on this collective information, we recommend a 500 cfs collection flow (250 cfs V-screen and 250 cfs Pump Wall) that is expandable to 750 cfs (250 cfs V-screen and 500 cfs Pump Wall Structure) as the preferred design flow. Further expansion in flow capacity to 1,000 cfs by addition of another Pump Wall Structure upstream from that proposed is not precluded by this recommendation. The screens are currently designed to meet NMFS criteria up to 500 cfs. If flows greater than 500 cfs work better for collection, then additional screens and pumps will be installed to meet fry criteria.

5.0 Recommended Alternative

5.1 Partial Flow Capture Facility

The Recommended Alternative is fully endorsed by the FTC and based on a number of factors including: site conditions, biological performance, technical considerations, and economics; The alternative is a surface collector located on the north bank of the reservoir, a short distance upstream of the dam. The Partial Flow Capture Facility concept presented in the 90% CDR forms the basis of the Recommended Alternative. Based on input received during consultations with the DFPT, three potential arrangements of this alternative will be further analyzed prior to final design. The primary difference between the arrangements is the location of the entrance. Hydraulic modeling will be performed in the first half of 2012 to obtain additional data intended to aid in the selection of the preferred arrangement to carry forward to final design and construction. The three arrangements are:

Case 1 – Partial Flow Capture Facility w/ Upstream Entrance

Case 2 – Partial Flow Capture Facility w/ Upstream Entrance and Auxiliary Downstream Entrance

Case 3 – Partial Flow Capture Facility w/ Downstream Entrance

All three arrangements of the selected alternative rely on the ability to attract fish with surface flow. As such, it is desirable to avoid surface spill when the fish facilities are operating. If spill is required, it would be desirable to use the deep sluice gates rather than the current flap and spill gate operation.

In addition to the Recommended Alternative, a new weir box prototype will be tested and if determined to be beneficial, weir boxes will be installed in front of the spillway bays 2 and 3. Further discussion regarding the weir boxes is included in Objective 1 of the Adaptive Management Plan (Section 6).

A primary purpose of the conceptual design is to ensure that the alternative is technically feasible and to communicate the design intent to all stakeholders. The descriptions and associated drawings that follow are intended to provide a full-system functional description for each of the three potential arrangements of the Recommended Alternative. Salient data included in the descriptions are: flow amounts and locations; target velocities, depths, and key hydraulic features; and general facility features, dimensions, and site work requirements. The conceptual and final design will meet NMFS fish passage criteria as describe in NMFS (2011).

During final design, the system layout and hydraulics will be optimized and detailed design of the system components will be completed.

5.1.1 Case 1: Partial Flow Capture Facility with Upstream Entrance

Case 1 consists of a 500 cfs upstream entrance with possible future stepwise expansion to 1,000 cfs located approximately 250 feet upstream of the dam on river right. This arrangement is depicted on Figures 6.3-1 to 6.3-3, and the design features are briefly described below. Facility design will allow for expansion to 1,000 cfs in the future, as described in the Adaptive Management Plan (Section 6).

5.1.1.1 Project Features

The key project features include:

- Debris boom upstream, with active debris removal and management program
- 10 foot deep BGS
- Exclusionary net (for deployment in mid-July)
- Approach transition
- 500 cfs entrance (stepwise expansion to 1,000 cfs) The first expansion would be addition of pumps to existing structure to achieve 750, if test show improved fish collection the screen structure would be expanded to meet NMFS screen criteria (NMFS 2011), If performance warrants, additional flow expansion pumps would be added to facility to provide 1,000 cfs, if test show improved fish collection, the screen structure would be expanded to meet NMFS screen criteria. The Adaptive Management Plan (described is section 6.2) will detail the stepwise process.
- 250 cfs Pump Wall to partially dewater upstream entrance flow before the Capture Module (stepwise expansion first to 500, and if warranted to750 cfs)
- 250 cfs Capture Module
- 250 cfs V-Screen Facility (230 cfs dewatering screen and 20 cfs fish bypass flow)
- Screened flow conveyance pipe with deep water diffuser
- 20 cfs Fish Bypass pipe connecting to the existing fish bypass pipe through the dam
- Use existing CFFF for fish sorting, sampling, and transport
- Debris removal access road and pad for crane, and truck loading
- Two Weir Boxes with bypass to CFFF

5.1.1.2 Fish Attraction Flows

The fish attraction flows are as follows:

- Base configuration:
  - 500 cfs right bank Partial Flow Capture Facility
  - Weir box flow at spillway
- Expansion capabilities:
  - Partial flow collector expandable to 1,000 cfs by expanding the pump wall structure upstream and adding additional screen area and pumps

5.1.1.3 System Description

The key project components, presented in the direction that they would be encountered by fish passing through system, are described below:

- Entrance:
  - 15.8 feet wide by 15.8 feet deep at upstream end of pump wall
  - Velocity target 2.0 fps at entrance

  - 10 foot deep BGS guides fish to Approach Transition just upstream of entrance
  - Approach Transition built to accommodate possible future expansion of pump wall and entrance to 750 cfs entrance flow at 2.0 fps (entrance could be expanded upstream to 22.7 feet wide by 15.8 feet deep), Expansion to 1,000 cfs would require building additional pump wall structure and reorienting entrance.
- Pump Wall:
  - Feature uses criteria screens (V_a<0.4 fps) to dewater flow to 250 cfs before the Capture Module
  - No deceleration of flow through pump wall feature
  - Screened flow is returned to forebay through diffusers (<1 fps)
- Capture Module:
  - Gradual velocity increase from Pump Wall to Capture Module with maximum change in velocity per foot of 0.2 fps
  - 8 fps capture velocity attained using 20 foot long adjustable floor with 15 foot long transition ramps
  - Adjustable floor needed to accommodate 2 foot reservoir fluctuation
  - 7 foot wide x 4.5 foot deep flow over adjustable floor section
  - No deceleration of flow until after fish capture
- V-Screens:
  - Captured fish enter criteria screening downstream of capture with criteria V-screens (V_a<0.4 fps)
  - 230 cfs total dewatering in V-screen structure
  - 20 cfs fish bypass flow at end of V-screens passes over adjustable ramp gate and transitions to existing 2-foot diameter pipe through the dam to the CFFF

5.1.1.4 Design Issues Requiring Further Development

The following items have been identified as needing additional consideration during anticipated hydraulic model studies and final design.

- Pump wall discharge: will discharge affect forebay flow patterns?
  - Address this concern with a CFD model and conceptual design iterations during final design phase
- Screened flow conveyance discharge: where/how to diffuse near turbines?
  - Address with CFD model and conceptual design iterations during the final design phase.
  - Initial concept shown is to diffuse the screened flow deep in the low area of the reservoir near the turbine intakes to avoid confusing flow patterns in forebay
- Transition from Pump Wall to the Capture Module needs to be optimized to not exceed 0.2 fps per foot velocity gradient
- Exclusionary net: can it be held in place and maintained at desired mid-July flows during Chinook migration season?
  - Address concern with prototype net tests being planned by Tacoma Power

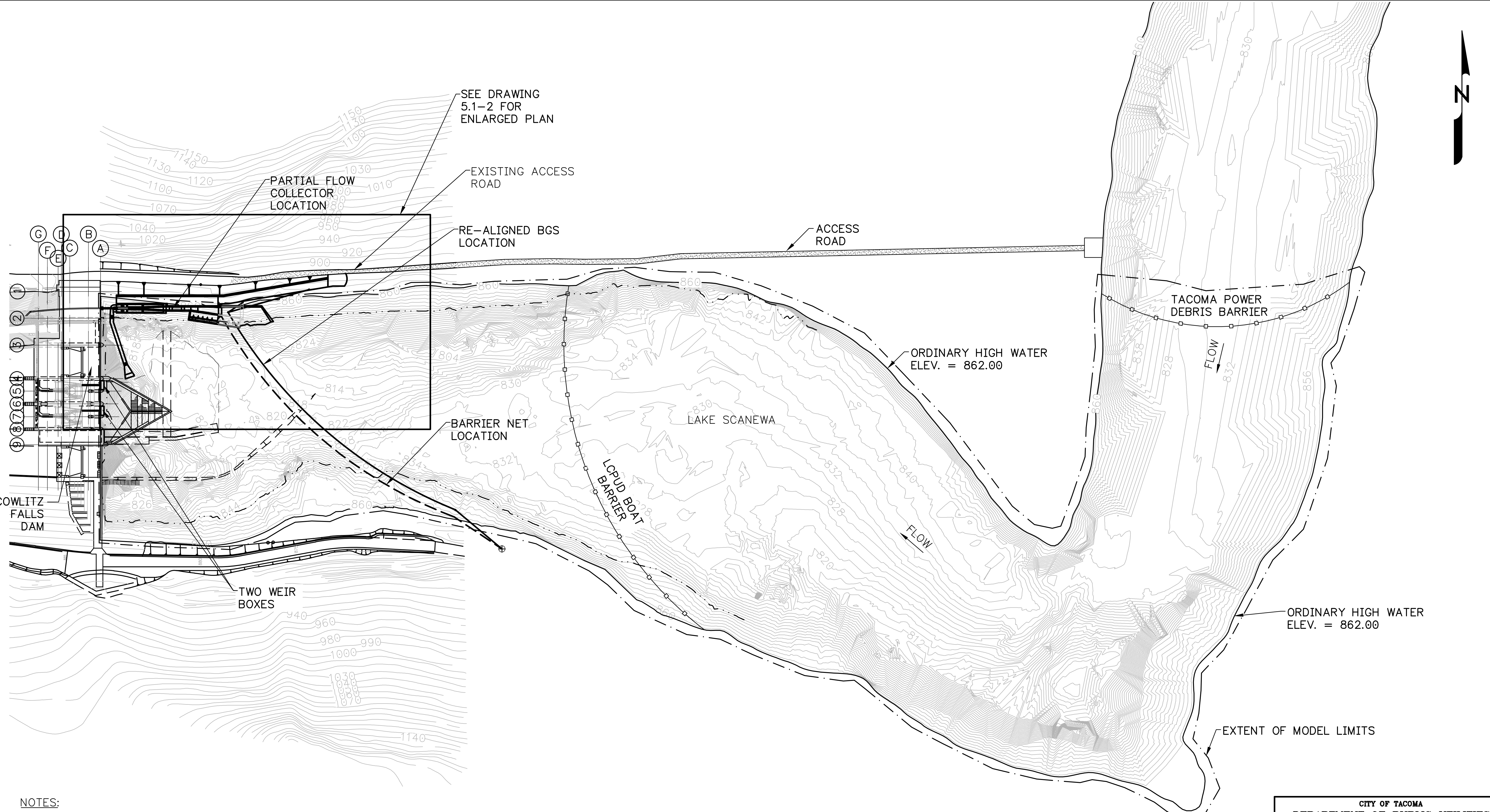
5.1.1.5 Key Issues Related to this Design

- Will fish guide along the BGS towards the collector entrance?
- If fish pass the entrance, will they go back upstream to find it, enter the weir boxes, or miss the entrances?

How effective will an exclusionary net be given the debris and velocity/flood concerns

5.1.1.6 Operational Considerations

- This system relies on the ability to attract fish with surface flow. As such, it is desirable to avoid surface spill when the fish facilities are operating. If spill is required, it would be desirable to use the deep sluice gates rather than the current flap and spill gate operation.
- The operating rules for Cowlitz Falls Dam require that the pool be drawn down about 10 feet for flood control as flows reach 23,000 cfs; at this point the fish facilities would not be operable.
- Prior to the 23,000 cfs drawdown trigger flow, the project currently releases excess flow through the Spillway 1 and 4 flap gates, then opens Spillway 4. This operation results in competing surface flows, which may attract fish away from the new Case 1 fish attraction entrances. The original BPA fish facilities anticipated use of the deep sluice gates to convey the first spills over project capacity; however, LCPUD has found these gates to be unreliable and unsafe to throttle flow. It is recommended that discussions continue with LCPUD to improve and/or redesign the low level sluice gates to allow for a reliable, throttled release of the first spill up to the drawdown trigger, in order to help maximize the performance of this Case 1 alternative.



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM TACOMA POWER. VERTICAL DATUM: NAD 83/91, COWLITZ FALLS PROJECT DATUM.

DATA AVAILABLE UPON REQUEST.

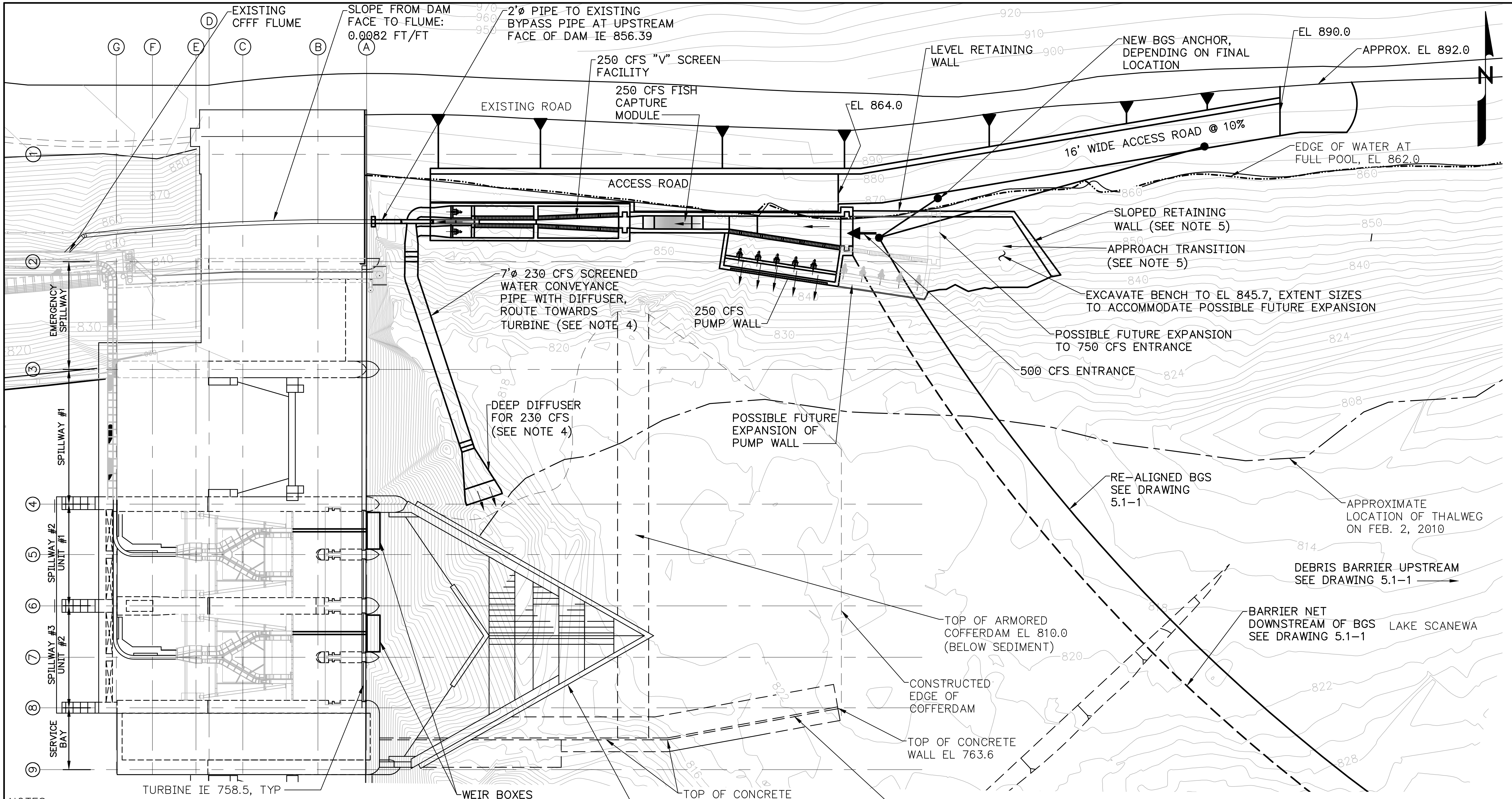
0 100 200
SCALE: 1" = 200'
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 1 PARTIAL FLOW CAPTURE FACILITY W/UPSTREAM ENTRANCE
LOCATION PLAN

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 DATE	1" = 200' SCALE
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-1	



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM BATHYMETRY SURVEY TAKEN ON FEBRUARY 2, 2010 BY TACOMA POWER.
2. ARMORED DOWNSTREAM FACE OF COFFERDAM SLOPES AT 1.25H:1V.
3. ARMORED UPSTREAM FACE OF COFFERDAM SLOPES AT ~2H:1V.
4. SCREENED WATER CONVEYANCE PIPE LOCATION IS PRELIMINARY. SIZE, ROUTING AND DIFFUSER DESIGN WILL BE RESEARCHED FURTHER DURING MODELING AND FINAL DESIGN.
5. ENTRANCE TRANSITION SHOWN IS CONCEPTUAL. ADDITIONAL DESIGN DEVELOPMENT IS RECOMMENDED BASED ON COWLITZ FALLS DAM MODEL RESULTS.

0 10 50
SCALE: 1" = 50'

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

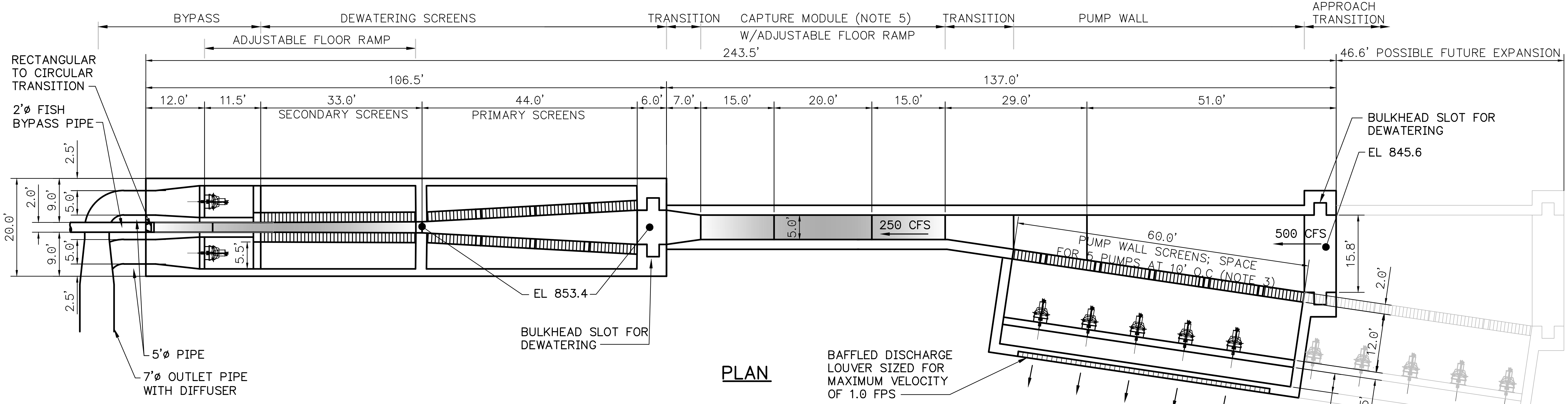
CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 1 PARTIAL FLOW CAPTURE FACILITY W/UPSTREAM ENTRANCE GENERAL PLAN

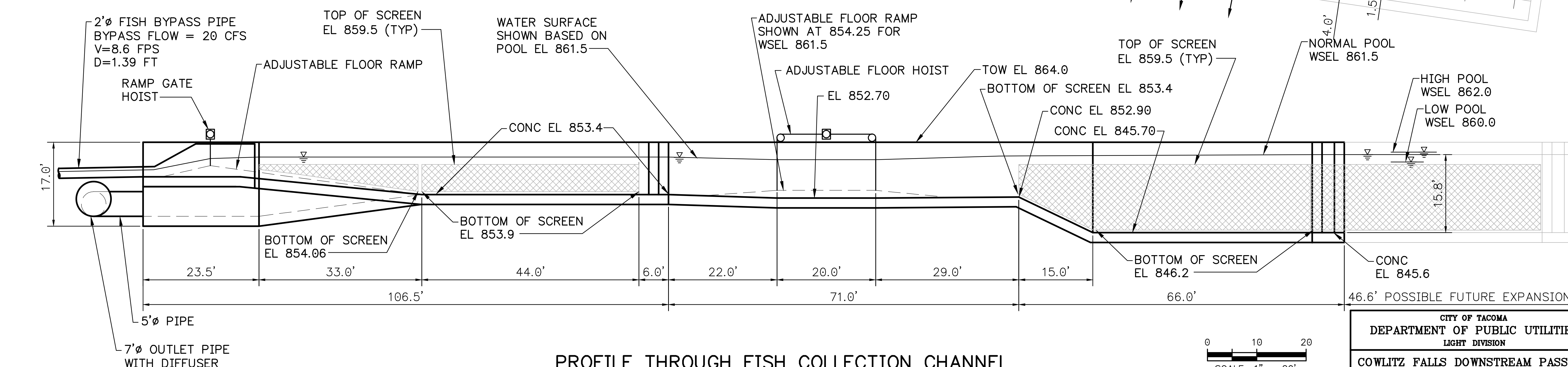
REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 50' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-2	

500 (EXPANDABLE TO 750) CFS FISH BYPASS CHANNEL HYDRAULIC DATA AT POOL EL 861.5

W (FT)	2.0 DIA	2.0	2.0	7.0	5.0	5.0	7.0	15.8	22.7
Q (CFS)	20	20	80	250	250	250	250	500	750
V (FPS)	8.6	6.9	5.3	4.7	8.0	8.0	4.3	2.0	2.0
D (FT)	1.39	1.46	7.6	7.6	6.25	6.25	8.3	15.8	15.8
F	1.35	1.0	0.34	0.30	0.56	0.56	0.26	0.09	0.09



PLAN



PROFILE THROUGH FISH COLLECTION CHANNEL

NOTES
1. RESERVOIR DESIGN EL 860.0 TO 862.0.
2. 2'ø BYPASS PIPE IE AT DAM FACE = 856.39. SLOPE FROM FACE TO FLUME = 0.0082.
3. INITIAL CONFIGURATION WILL HAVE 5–50 CFS PUMPS OPERATING TO ACHIEVE 250 CFS. SPACE WILL BE PROVIDED FOR A POSSIBLE FUTURE STRUCTURE EXPANSION UPSTREAM TO ACHIEVE 500 CFS TOTAL.
4. WATER SURFACE ELEVATIONS (WSEL) SHOWN ON PROFILE ARE APPROXIMATE AND DO NOT TAKE HEADLOSS INTO ACCOUNT. CONCRETE ELEVATIONS ARE BASED ON WSELs AND FLOW DEPTHS. FINAL HYDRAULICS AND CONCRETE INVERTS WILL BE ADJUSTED DURING FINAL DESIGN.
5. MAXIMUM VELOCITY GRADIENT OF 0.2 FT/S/FT TO BE MAINTAINED THROUGHOUT CAPTURE MODULE OVER THE EXPECTED FISH CAPTURE FLOW RANGE AND THE DESIGN RESERVOIR WATER SURFACE ELEVATION RANGE OF 860' TO 862'. DIMENSIONS SHOWN ON DRAWING MEET THIS REQUIREMENT AT 861.5' POOL ELEVATION. DETAILS OF THIS DESIGN ELEMENT NEED TO BE WORKED OUT IN FINAL DESIGN AND MODELING.

0 10 20
SCALE: 1" = 20'

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DOWNSTREAM PASSAGE
CASE 1 PARTIAL FLOW CAPTURE FACILITY W/UPSTREAM ENTRANCE
PLAN, PROFILE & VELOCITIES

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	DATE: 12/15/11	SCALE: 1" = 20'
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1–3	

5.1.2 Case 2: Partial Flow Capture Facility w/ Upstream Entrance and Auxiliary Downstream Entrance

Case 2 consists of a 500 cfs upstream main entrance (with possible stepwise expansion to 750 cfs) located approximately 275 feet upstream of the dam, and the structural components necessary to commission an up to 250 cfs auxiliary downstream entrance located at the dam face immediately to the north of the emergency spillway bay both located on river right, with flow to be determined through the Adaptive Management Plan and design process. This case focuses on making the collector operation as flexible as practical. Commissioning would likely include expansion of pumping capacity and associated screens to operate the auxiliary entrance. Case 2 is also presented herein with two different design concepts to achieve the 125 cfs flow from the auxiliary entrance. These concepts are meant to present two likely methods, but do not preclude more effective designs that may be developed during future design stages. This arrangement is depicted on Figures 6.1-4 to 6.1-8, and the design features are briefly described below

5.1.2.1 Project Features

The key project features include:

- Debris boom upstream, with active debris removal and management program
- 10 foot deep BGS
- Exclusionary net (for mid-July deployment)
- Approach transition
- Upstream Main entrance:
  - 500 cfs Entrance (stepwise expansion to 750 cfs) The first expansion would be addition of pumps to existing structure to achieve 750 cfs, if test shows improved fish collection the screen structure would be expanded to meet NMFS screen criteria (NMFS 2011),
  - Variable flow Pump Wall to partially dewater upstream entrance flow before the Capture Module flow depends on amount of dewatering of auxiliary downstream entrance flow)
  - Variable flow Capture Module up to 250 cfs (flow depends on amount of dewatering of auxiliary downstream entrance flow)
  - 250 cfs V-Screen Facility (230 cfs dewatering screen and 20 cfs fish bypass flow)
  - Screened flow Conveyance with Diffuser
  - 20 cfs Fish Bypass pipe connecting to the existing fish bypass pipe through the dam
- Auxiliary Downstream entrance:
  - An up to 250 cfs entrance with entrance flow parallel to the dam face (perpendicular to river flow direction) The flow for this entrance will be determined by the design process and Adaptive Management Plan development.
  - 90 degree bend with adjustable/removable turning vane(s)
  - Up to 250 cfs Capture Module
  - Possible dewatering screens after the Capture Module to reduce the flow before confluence with the upstream flow (see Figure 5.1-8)
  - Confluence with flow from upstream flow path resulting in 250 cfs total flow to enter the Dewatering V-Screen
- Debris removal access road and pad for crane, truck loading
- Use existing CFFF for fish sorting, sampling, and transport
- Two Weir Boxes with bypass to CFFF

•

5.1.2.2 Fish Attraction Flows

The fish attraction flows are as follows:

- Base Configuration:
  - 500 cfs right bank upstream main entrance (constant fish attraction flow regardless of auxiliary entrance).
  - 0-250 cfs right bank auxiliary downstream entrance:
    - Auxiliary downstream entrance flow can vary between 0 cfs (not operating) and 250 cfs (full flow), or an intermediate flow if the Capture Module can function and fish are attracted to the entrance.
    - Auxiliary downstream entrance flow will combine with the upstream entrance flow just upstream of the V-Screen facility. The auxiliary downstream entrance flow may be partially dewatered before combining with the upstream entrance flow (see Figure 5.1-8).
    - Weir box flow at spillway
- Expansion capabilities:
  - Partial flow collector upstream entrance expandable to 750 cfs by expanding the pump wall structure upstream and adding additional screen area and pumps.
  - Commission auxiliary entrance

5.1.2.3 Upstream Entrance System Description

The key project components, presented in the direction that they would be encountered by fish passing through system, are described below:

- Entrance:
  - 15.8 feet wide by 15.8 feet deep at upstream end of pump wall
  - Velocity target 2.0 fps at entrance
  - 10 foot deep BGS guides fish to Approach Transition just upstream of entrance
  - Approach Transition built to accommodate possible future expansion of pump wall and entrance to 750 cfs entrance flow at 2.0 fps (entrance could be expanded upstream to 22.7 feet wide by 15.8 feet deep)
- Pump Wall:
  - Dewatering facility uses criteria screens (V_a<0.4 fps) to dewater upstream entrance flow before entering the Capture Module. Two options are presented to convey the 125 cfs flow from the auxiliary entrance: one without dewatering (see Dwg 5.1-7), and one with a dewatering screen that would reduce the conveyance flow to 20 cfs prior to the confluence with flow upstream of the V-screen (see Dwg 5.1-8). It would also be possible to have a smaller dewatering screen. The final layout for this feature will be developed during final design and designs for 250 cfs auxiliary flow will be similar to those for 125 cfs.
    - If the auxiliary downstream entrance is also in operation, then the Pump Wall will need to dewater more of the upstream entrance flow, resulting in a total flow entering the V-Screens of 250 cfs (e.g. if auxiliary flow is up to 250 cfs without dewatering, then the Pump Wall needs to dewater upstream flow to up to 250 cfs so the combined flow entering the V-Screens is still 250 cfs).

- Total required dewatering through the Pump Wall will depend on if/and how much dewatering is done of the auxiliary flow before combining with the upstream entrance flow. This detail will need to be decided during final design.
- No deceleration of flow through pump wall feature
- Screened flow is returned to forebay through diffusers (<1 fps)

- Capture Module:
  - Gradual velocity increase from Pump Wall to Capture Module with maximum change in velocity per foot of 0.2 fps
  - 8 fps capture velocity maintained over 20 foot long adjustable floor with transition ramps (ramp lengths to be determined during final design)
  - Adjustable floor needs to accommodate both flow variation (if auxiliary entrance is operating) and 2 foot reservoir fluctuation
  - Drawing 6.1-6 shows a 5 foot wide Capture Module with an adjustable floor
    - Depending on modeling results and final design modifications, a section with an adjustable floor and an adjustable wall may be necessary to perform over the expected range of water surface fluctuation and variation in the Capture Module flow
  - No deceleration of flow until after fish capture
- V-Screens:
  - Captured fish enter criteria screening downstream of capture with criteria V-screens (V_a<0.4 fps)
  - 230 cfs total dewatering in V-screen structure
  - 20 cfs fish bypass flow at end of V-screens passes over adjustable ramp gate and transitions to existing 2-foot diameter pipe through the dam to the CFFF

5.1.2.4 Auxiliary Entrance System Description

The key project components, presented in the direction that they would be encountered by fish passing through system, are described below:

- Entrance:
  - 7.9 foot wide by 7.9 foot deep entrance at the dam adjacent to emergency spillway intended to capture fish that did not enter the upstream main entrance
  - Velocity target 2.0 fps at entrance
  - Entrance structure must not occlude emergency spillway during emergency spill events; maintenance of emergency spillway capacity to be confirmed during final design
- Capture Module:
  - Gradual velocity increase from entrance to Capture Module with maximum change in velocity per foot of 0.2 fps
  - 8 fps capture velocity attained using 20 foot long adjustable floor with ramps (ramp lengths to be determined during final design)
  - Adjustable floor needs to accommodate 2 foot reservoir fluctuation.
  - 4 foot wide x 3.9 foot deep flow over adjustable floor section at up to 250 cfs. Some variation in flow between 0 and 250 cfs can be explored with adjustable floor and depth of flow adjustment.
  - No deceleration of flow until after fish capture

- Optional Dewatering Screens (See Figure 5.1-8):
  - Criteria screens could be included with this design to dewater flow after the Capture Module from the up to 250 cfs entrance flow to ~20 cfs, or some value in between before combining with the upstream entrance flow
  - Single wall screens are shown, but a V-screen design could also be developed to shorten the screen length
  - Combining dewatering pumps and flow chambers with the V-screen dewatering could be explored as a simplification and cost saving measure, but balancing of screens and adjusting to variable flow rates and different flow paths may make this idea more difficult to operate at varying flows. This can be further developed during final design.
- Flow Combination:
  - Captured fish from upstream and downstream capture modules come together just upstream of V-Screen structure
  - Downstream flow combines with upstream flow for a total of 250 cfs flow to enter the V-screen structure

5.1.2.5 Design Issues Requiring Further Development

The following items have been identified as needing additional consideration during anticipated hydraulic model studies and final design.

- Flow split between upstream and downstream flow paths: how to optimize?
  - Develop detailed model with hydraulic and energy grade lines for the auxiliary entrance and for the upstream entrance, with different flow splits. Consider the effects of partial dewatering of upstream flow (e.g. if flow is not dewatered before the confluence then the upstream Capture Module will need to operate over a range of flows from 125 cfs to 250 cfs). In the drawings an adjustable floor is shown with depths resulting from these flows. An adjustable wall was also considered and could be used along with a flap gate that opens into flow as the auxiliary flow increases from 0 to 125 cfs. This could reduce the turbulence at the transition. How these flows combine, and the exact details of this confluence will be very important in the final design.
  - An iterative design optimization process is anticipated with the final design team and the hydraulic modeling effort to optimize this design alternative. Goals of this process will include:
    - Define flows over which capture modules can function effectively
    - Develop flow return design details
    - Special attention will need to be given to the flow patterns upstream of the V-Screens so that any turbulence and water surface anomalies caused by the combining flows have adequately dissipated before the screens
    - Consider the use of a physical model as a tool to address detailed design of this flow zone
- Pump wall discharge: will discharge affect forebay flow patterns?
  - Address this concern with a CFD model and conceptual design iterations during the final design phase
- Screened flow conveyance discharge: where/how to diffuse near turbines?
  - Address with CFD model and conceptual design iterations during the final design phase
  - Initial concept shown is to diffuse the screened flow in the low area of the reservoir near the turbine intakes to avoid confusing flow patterns in forebay

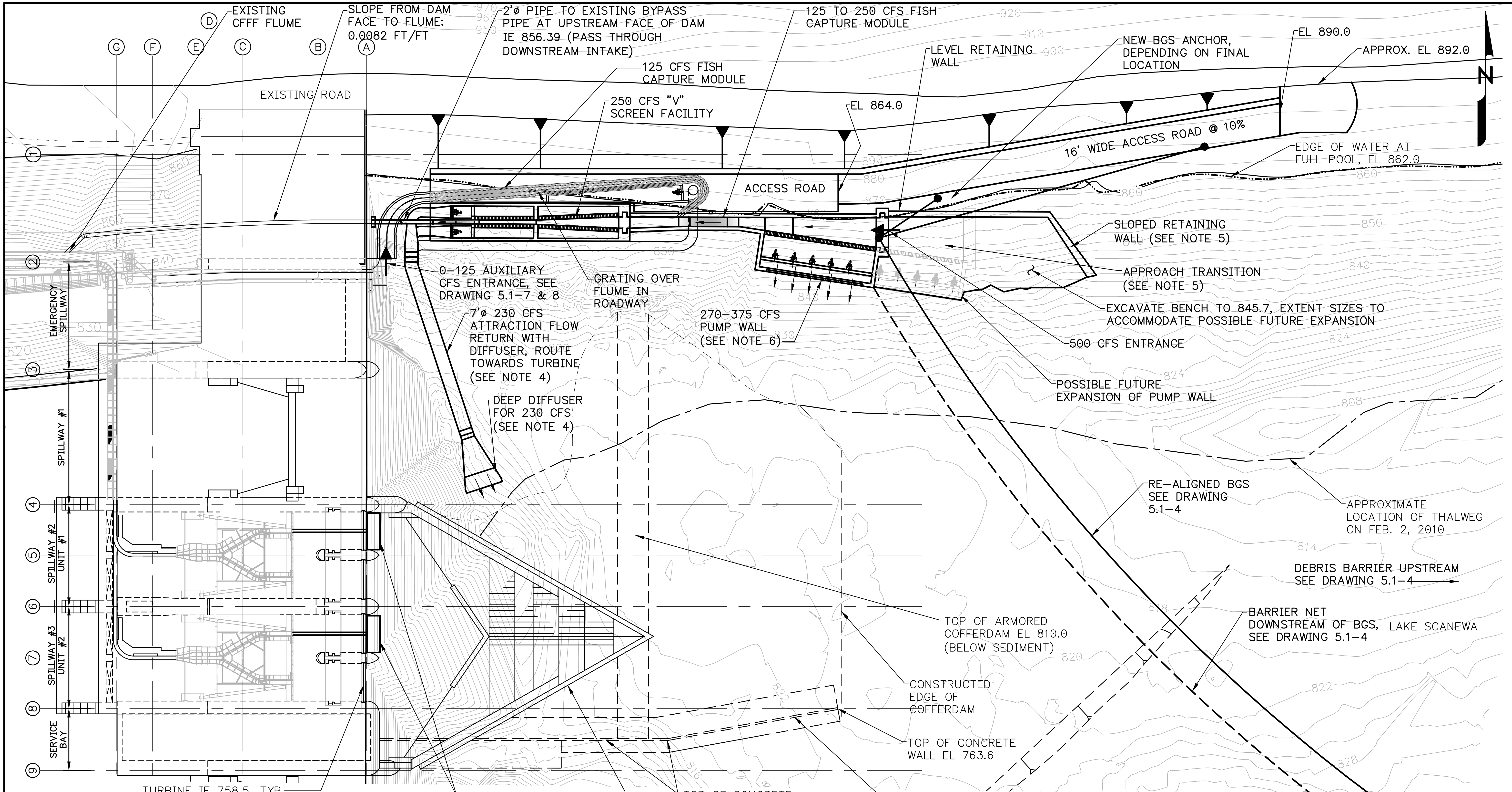
- Exclusionary net: can it be held in place and maintained at desired mid-July flows during Chinook migration season?
  - Address concern with prototype net tests being planned by Tacoma Power

5.1.2.6 Key Issues Related to this Design

- Will fish guide along the BGS towards the collector entrance?
- If fish pass the entrance, do they appear to be susceptible to either going back upstream to find the primary entrance, frequent the area of the non-operational auxiliary entrance, or enter the weir boxes?
- How effective will an exclusionary net be given the debris and velocity/flood concerns?
- Debris concerns near downstream entrance, and upstream
  - Consider secondary log boom

5.1.2.7 Operational Considerations

- This system relies on the ability to attract fish with surface flow. As such, it is desirable to avoid surface spill when the fish facilities are operating. If spill is required, it would be desirable to use the deep sluice gates rather than the current flap and spill gate operation.
- The operating rules for Cowlitz Falls Dam require that the pool be drawn down about 10 feet for flood control as flows reach 23,000 cfs; at this point the fish facilities would not be operable.
- Prior to the 23,000 cfs drawdown trigger flow, the project currently releases excess flow through the Spillway 1 and 4 flap gates, then opens Spillway 4. This operation results in competing surface flows, which may attract fish away from the new Case 1 fish attraction entrances. The original BPA fish facilities anticipated use of the deep sluice gates to convey the first spills over project capacity; however, LCPUD has found these gates to be unreliable and unsafe to throttle flow. It is recommended that discussions continue with LCPUD to improve and/or redesign the low level sluice gates to allow for a reliable, throttled release of the first spill up to the drawdown trigger, in order to help maximize the performance of this Case 2 alternative.



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM BATHYMETRY SURVEY TAKEN ON FEBRUARY 2, 2010 BY TACOMA POWER.
2. ARMORED DOWNSTREAM FACE OF COFFERDAM SLOPES AT 1.25H:1V.
3. ARMORED UPSTREAM FACE OF COFFERDAM SLOPES AT ~2H:1V.
4. SCREENED WATER CONVEYANCE PIPE LOCATION IS PRELIMINARY. SIZE, ROUTING AND DIFFUSER DESIGN WILL BE RESEARCHED FURTHER DURING MODELING AND FINAL DESIGN.
5. ENTRANCE TRANSITION SHOWN IS CONCEPTUAL. ADDITIONAL DESIGN DEVELOPMENT IS RECOMMENDED BASED ON COWLITZ FALLS DAM MODEL RESULTS.
6. PUMP WALL FINAL SIZE WILL DEPEND ON AMOUNT OF AUXILIARY DOWNSTREAM ENTRANCE FLOW DEWATERED.

0 10 50
SCALE: 1" = 50'

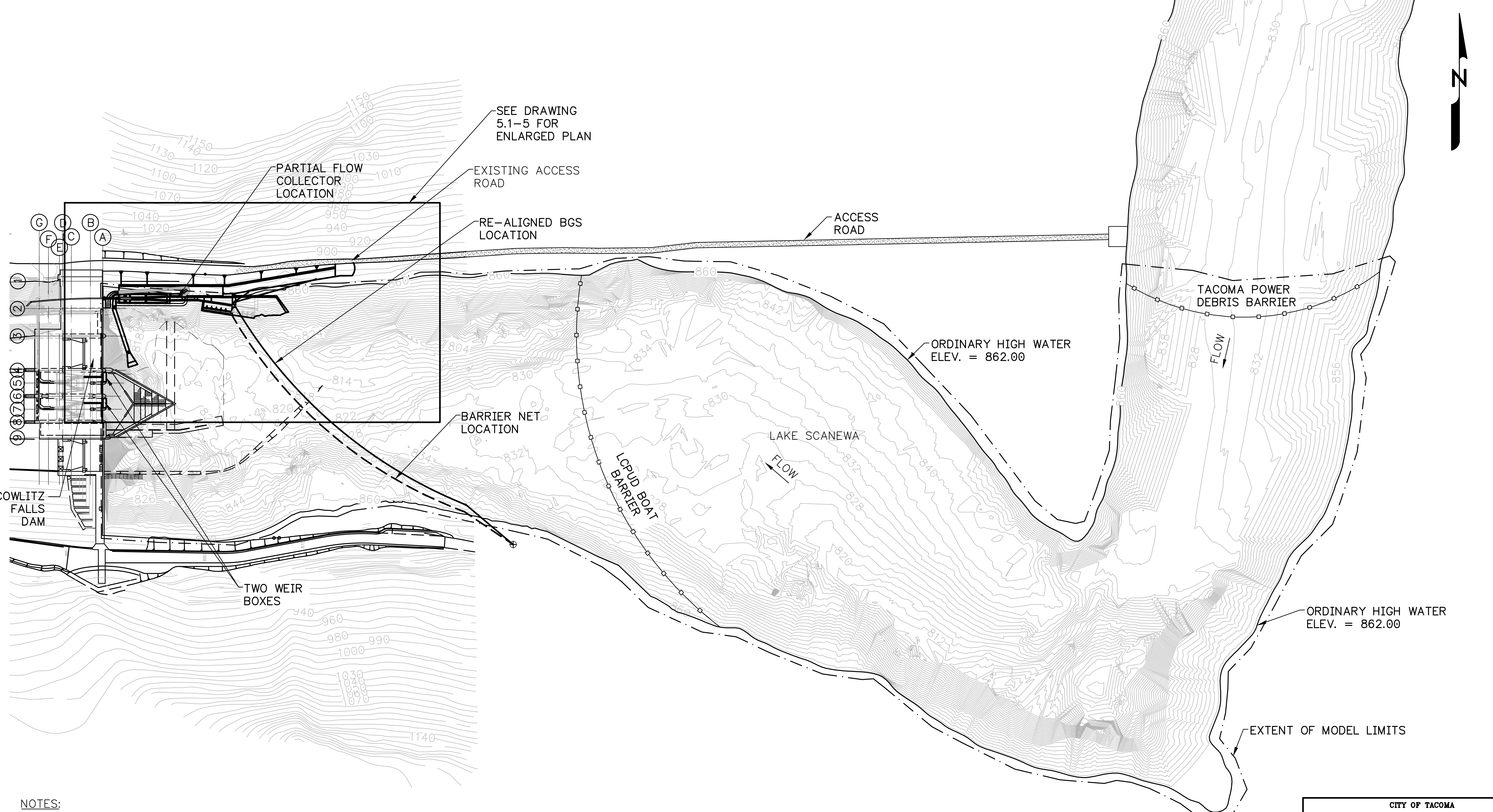
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 2 CASE 1 W/AUXILIARY DOWNSTREAM ENTRANCE GENERAL PLAN

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/12/11 (DATE)	1" = 50' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-5	



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM TACOMA POWER. VERTICAL DATUM: NAD 83/91, COWLITZ FALLS PROJECT DATUM.

   DATA AVAILABLE UPON REQUEST.

0 100 200
SCALE: 1" = 200'
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

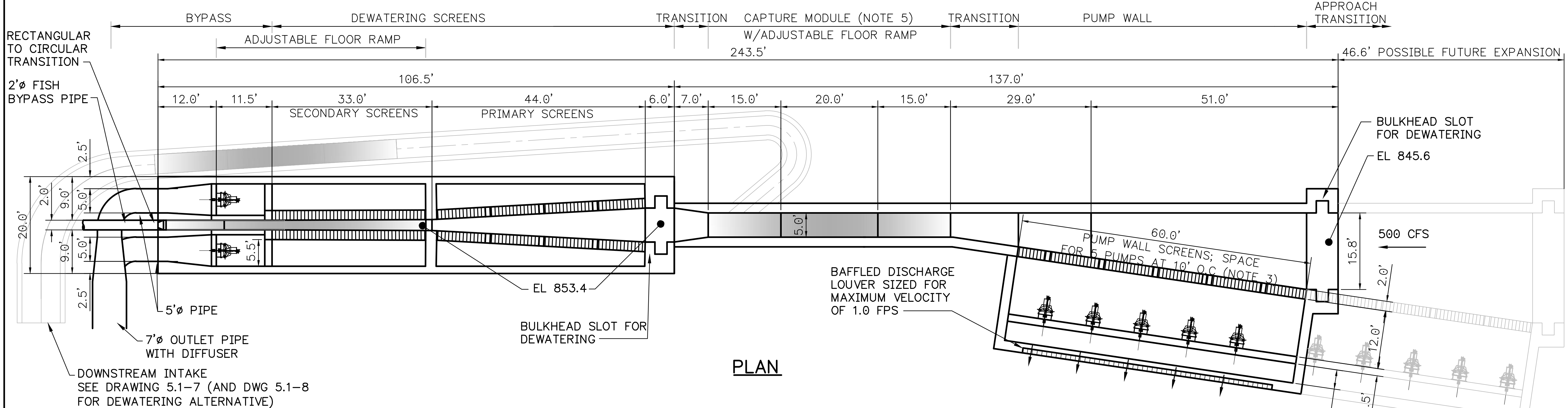
CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 2 CASE 1 W/AUXILIARY DOWNSTREAM ENTRANCE LOCATION PLAN

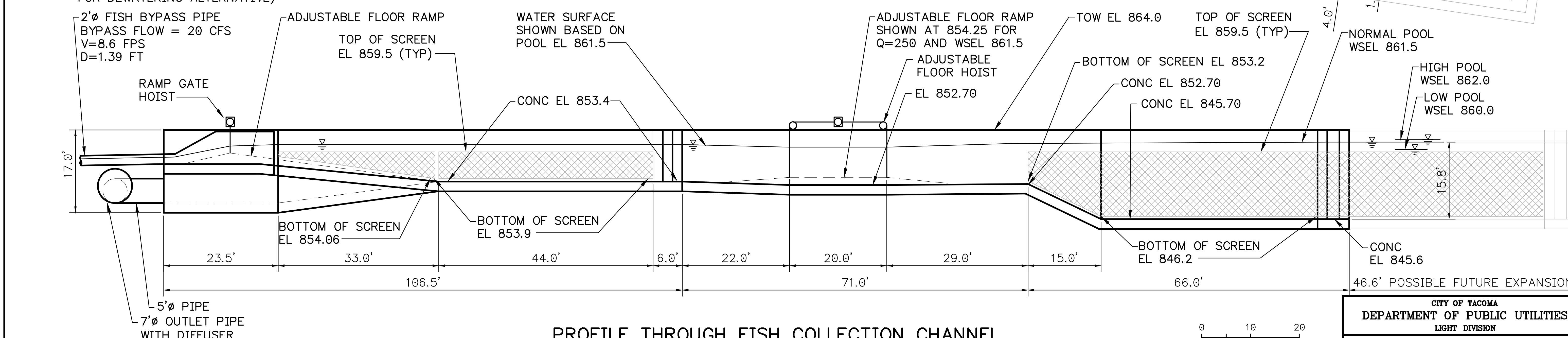
REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 200' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1–4	

500 (EXPANDABLE TO 750) CFS FISH BYPASS CHANNEL HYDRAULIC DATA AT POOL EL 861.5

W (FT)	2.0 DIA	2.0	2.0	7.0	5.0	5.0	7.0	15.8	22.7
Q (CFS)	20	20	80	250	125 (250)	125 (250)	125 (250)	500	750
V (FPS)	8.6	6.9	5.3	4.7	8.0	8.0	2.0 (4.3)	2.0	2.0
D (FT)	1.39	1.46	7.6	7.6	3.1 (6.3)	3.1 (6.3)	8.8 (8.3)	15.8	15.8
F	1.35	1.0	0.34	0.30	0.80 (0.56)	0.80 (0.56)	0.12 (0.26)	0.09	0.09



PLAN



PROFILE THROUGH FISH COLLECTION CHANNEL

NOTES

1. RESERVOIR DESIGN EL 860.0 TO 862.0.
2. 2'ø BYPASS PIPE IE AT DAM FACE = 856.39. SLOPE FROM FACE TO FLUME = 0.0082.
3. INITIAL CONFIGURATION WILL HAVE 5–75 CFS PUMPS OPERATING TO ACHIEVE MAX 375 CFS. SPACE WILL BE PROVIDED FOR AN ADDITIONAL 5–50 CFS PUMPS TO ACHIEVE A TOTAL MAX OF 650 CFS DEWATERING.
4. WATER SURFACE ELEVATIONS (WSEL) SHOWN ON PROFILE ARE APPROXIMATE AND DO NOT TAKE HEADLOSS INTO ACCOUNT. CONCRETE ELEVATIONS ARE BASED ON WSELs AND FLOW DEPTHS. FINAL HYDRAULICS AND CONCRETE INVERTS WILL BE ADJUSTED DURING FINAL DESIGN.
5. MAXIMUM VELOCITY GRADIENT OF 0.2 FT/S/FT TO BE MAINTAINED THROUGHOUT CAPTURE MODULE OVER THE EXPECTED FISH CAPTURE FLOW RANGE AND THE DESIGN RESERVOIR WATER SURFACE ELEVATION RANGE OF 860' TO 862'. DIMENSIONS SHOWN ON DRAWING MEET THIS REQUIREMENT AT 861.5' POOL ELEVATION. DETAILS OF THIS DESIGN ELEMENT NEED TO BE WORKED OUT IN FINAL DESIGN AND MODELING.

0 10 20
SCALE: 1" = 20'

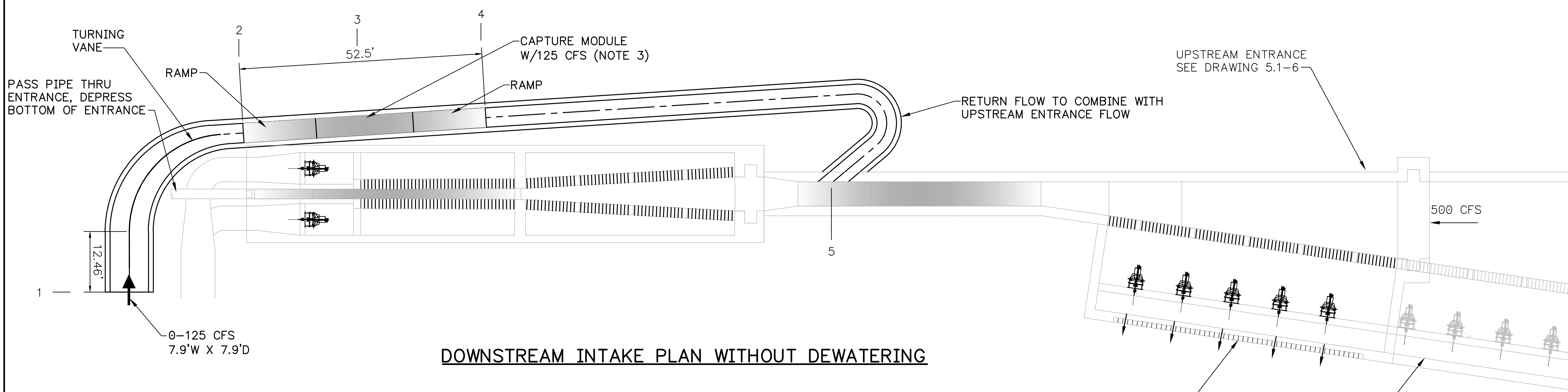
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

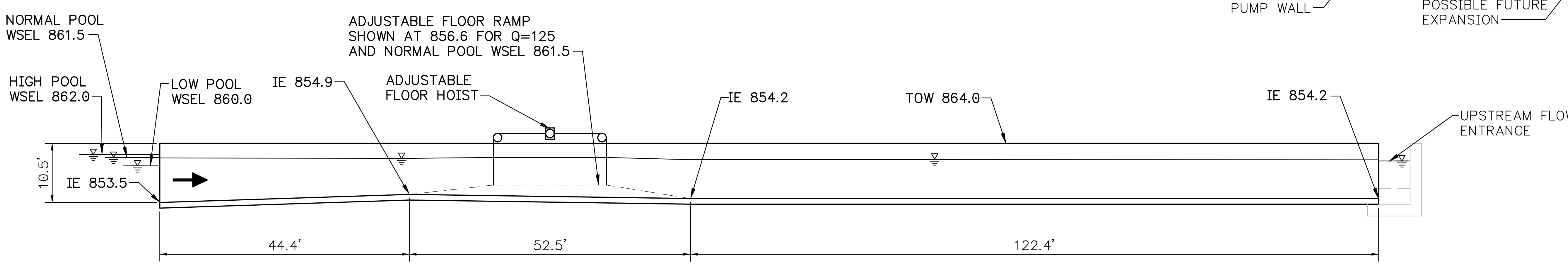
CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 2 EXTENDED CASE 1
W/AUX DOWNSTREAM ENT
PLAN, PROFILE & VELOCITIES

REVIEWED	DESIGNED	FIELD BOOK
APPROVED — SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 20' (SCALE)
APPROVED — APPROVING ENGINEER	DRAWING NO. 5.1–6	



DOWNSTREAM INTAKE PLAN WITHOUT DEWATERING



PROFILE

500 (EXPANDABLE TO 750) CFS FISH BYPASS CHANNEL HYDRAULIC DATA AT POOL EL 861.5

LOCATION	1	2	3	4	5
W (FT)	7.9	4.0	4.0	4.0	4.0
Q (CFS)	125	125	125	125	125
V (FPS)	2.0	5.0	8.0	4.5	4.5
D (FT)	7.9	6.3	3.9	6.9	6.9
F	0.13	0.35	0.71	0.3	0.3

NOTES

1. RESERVOIR DESIGN EL 860.0 TO 862.0.
2. WATER SURFACE ELEVATIONS (WSEL) SHOWN ON PROFILE ARE APPROXIMATE AND DO NOT TAKE HEADLOSS INTO ACCOUNT. CONCRETE ELEVATIONS ARE BASED ON WSELS AND FLOW DEPTHS. FINAL HYDRAULICS AND CONCRETE INVERTS WILL BE ADJUSTED DURING FINAL DESIGN.
3. MAXIMUM VELOCITY GRADIENT OF 0.2 FT/S/FT TO BE MAINTAINED THROUGHOUT CAPTURE MODULE OVER THE EXPECTED FISH CAPTURE FLOW RANGE AND THE DESIGN RESERVOIR WATER SURFACE ELEVATION RANGE OF 860' TO 862'. DIMENSIONS SHOWN ON DRAWING MEET THIS REQUIREMENT AT 861.5' POOL ELEVATION. DETAILS OF THIS DESIGN ELEMENT NEED TO BE WORKED OUT IN FINAL DESIGN AND MODELING.

0 10 20
SCALE: 1" = 20'

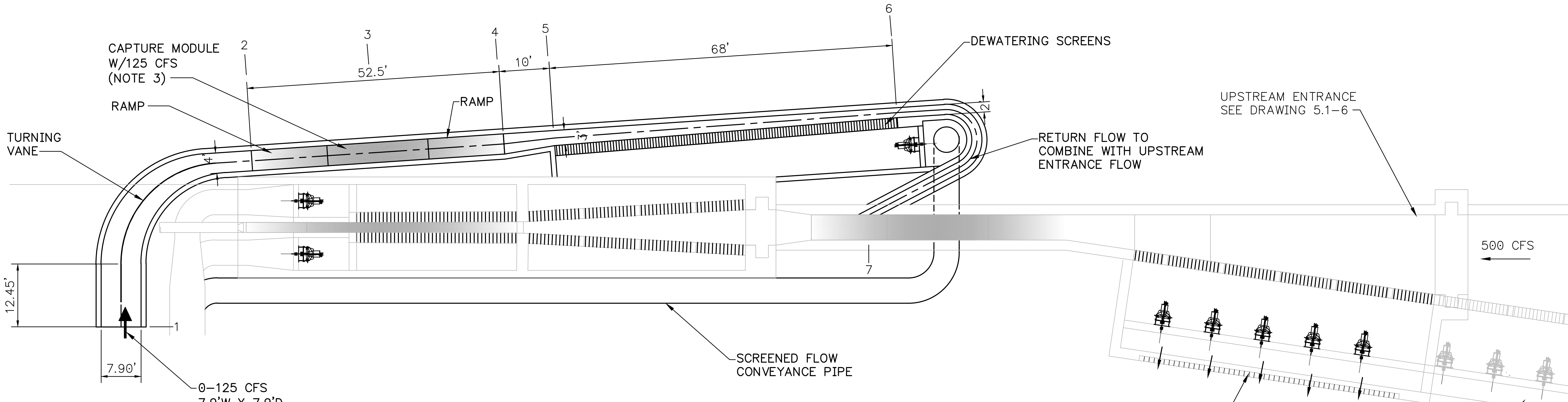
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

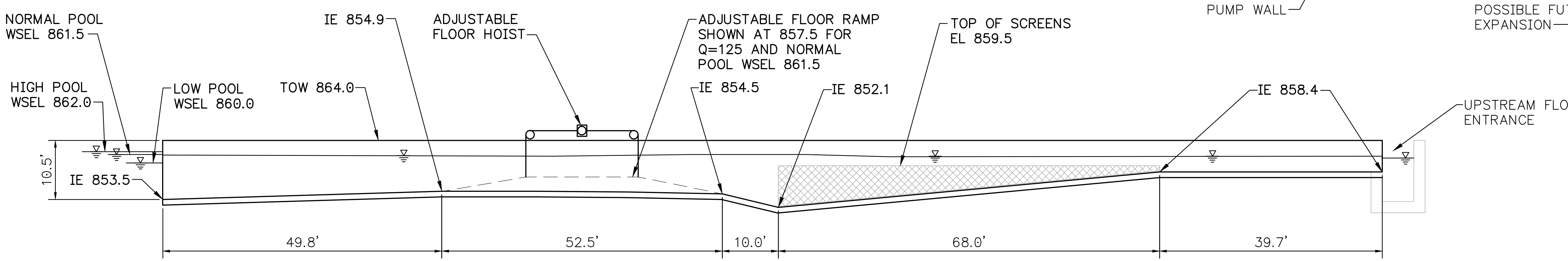
CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 2 CASE 1 W/AUXILIARY
DOWNSTREAM ENTRANCE
PLAN, PROFILE & VELOCITIES

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 20' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-7	



DOWNSTREAM INTAKE PLAN WITH DEWATERING



PROFILE

500 (EXPANDABLE TO 750) CFS FISH BYPASS CHANNEL HYDRAULIC DATA AT POOL EL 861.5

LOCATION	1	2	3	4	5	6	7
W (FT)	7.9	4.0	4.0	4.0	3.0	2.0	2.0
Q (CFS)	125	125	125	125	125	20	20
V (FPS)	2.0	5.0	8.0	4.5	4.5	3.3	3.3
D (FT)	7.9	6.3	3.9	6.9	9.3	3.0	3.0
F	0.13	0.35	0.71	0.30	0.26	0.34	0.34

NOTES
1. RESERVOIR DESIGN EL 860.0 TO 862.0.

2. WATER SURFACE ELEVATIONS (WSEL) SHOWN ON PROFILE ARE APPROXIMATE AND DO NOT TAKE HEADLOSS INTO ACCOUNT. CONCRETE ELEVATIONS ARE BASED ON WSELS AND FLOW DEPTHS. FINAL HYDRAULICS AND CONCRETE INVERTS WILL BE ADJUSTED DURING FINAL DESIGN.

3. MAXIMUM VELOCITY GRADIENT OF 0.2 FT/S/FT TO BE MAINTAINED THROUGHOUT CAPTURE MODULE OVER THE EXPECTED FISH CAPTURE FLOW RANGE AND THE DESIGN RESERVOIR WATER SURFACE ELEVATION RANGE OF 860' TO 862'. DIMENSIONS SHOWN ON DRAWING MEET THIS REQUIREMENT AT 861.5' POOL ELEVATION. DETAILS OF THIS DESIGN ELEMENT NEED TO BE WORKED OUT IN FINAL DESIGN AND MODELING.

0 10 20
SCALE: 1" = 20'

0 1"
BAR MEASURES ONE INCH
ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 2 CASE 1 W/AUXILIARY
D/S ENT & DEWATERING
PLAN, PROFILE & VELOCITIES

REVIEWED
APPROVED
SUPERVISING ENGINEER
APPROVED
APPROVING ENGINEER
DESIGNED
FIELD BOOK
12/15/11
DATE
1" = 20'
SCALE
DRAWING NO.
5.1-8

5.1.3 Case 3: Partial Flow Capture Facility with Downstream Entrance

Case 3 consists of a 500 cfs downstream entrance (with possible future expansion to 750 cfs) located at the dam face, immediately to the north of the emergency spillway bay on river right. This arrangement is depicted on Figures 5.1-9 to 5.1-11, and the design features are briefly described below.

5.1.3.1 Project Features

The key project features include:

- Debris boom upstream, with active debris removal and management program
- 500 cfs Entrance (expandable to 750 cfs) with adjustable/removable turning vanes.
- 375 cfs Primary Dewatering V Screens (expandable to 625 cfs)
- 125 cfs Capture Module
- 105 cfs Secondary Dewatering V-Screens
- Screened flow conveyance pipe with deep water diffuser
- 20 cfs Fish Bypass pipe (connect to the existing fish bypass pipe through the dam, or install a new pipe depending on final design configuration)
- Use existing CFFF for fish sorting, sampling, and transport
- Debris removal access road and pad for crane, truck loading
- Two Weir Boxes with bypass to CFFF

5.1.3.2 Fish Attraction Flows

The fish attraction flows are as follows:

- Base configuration:
  - 500 cfs right bank Partial Flow Capture Facility
  - Weir box flow at spillway
- Expansion capabilities:
  - Partial flow collector expandable to 750 cfs by adding additional screen area and pumps

5.1.3.3 System Description

The key project components, presented in the direction that they would be encountered by fish passing through system, are described below:

- Entrance and Transition:
  - 15.8 feet wide by 15.8 feet deep at upstream end of pump wall
  - Velocity target 2.0 fps at 500 cfs (3 fps at 750 cfs expansion)
  - Transition to V-Screen entrance with 90 degree bend with adjustable/removable turning vanes
- Primary V-Screens:
  - The first two screen panels are blank panels (reserved for possible future expansion to 750 cfs)
  - Flow accelerates to 3 fps before dewatering starts
  - Flow is dewatered to 125 cfs with a velocity of 3.4 fps before the Capture Module
- Capture Module:

- Gradual velocity increase from end of Primary Screens to capture velocity of 8 fps with maximum change in velocity per foot of 0.2 fps
- 8 fps capture velocity attained using 20 foot long adjustable floor with ramps (ramp length to be determined in final design)
- Adjustable floor needs to accommodate 2 foot reservoir fluctuation
- 5 foot wide x 3.1 foot deep flow over adjustable floor section
- No deceleration of flow until after fish capture

- Secondary V-Screens:
  - Gradual velocity increase from end of Primary Screens to capture velocity of 8 fps with maximum change in velocity per foot of 0.2 fps.
  - 8 fps capture velocity attained using 20 ft long adjustable floor with ramps (ramp length to be determined in final design)
  - Adjustable floor needs to accommodate 2 foot reservoir fluctuation
  - 5 foot wide x 3.1 foot deep flow over adjustable floor section.
    - No deceleration of flow until after fish capture

5.1.3.4 Design Issues Requiring Further Development

The following items have been identified as needing additional consideration during anticipated hydraulic model studies and final design.

- Flow patterns leading up to entrance and in 90 degree bend (with turning vanes)
  - Address with hydraulic model and conceptual design iterations during final design phase
  - Examine effect of expansion to 750 cfs and 3 fps at the entrance and 90 degree bend
- Screened flow conveyance discharge: where/how to diffuse near turbines?
  - Address with CFD model and conceptual design iterations during the final design phase.
  - Initial concept shown is to diffuse the screened flow deep in the low area of the reservoir near the turbine intakes to avoid confusing flow patterns in forebay

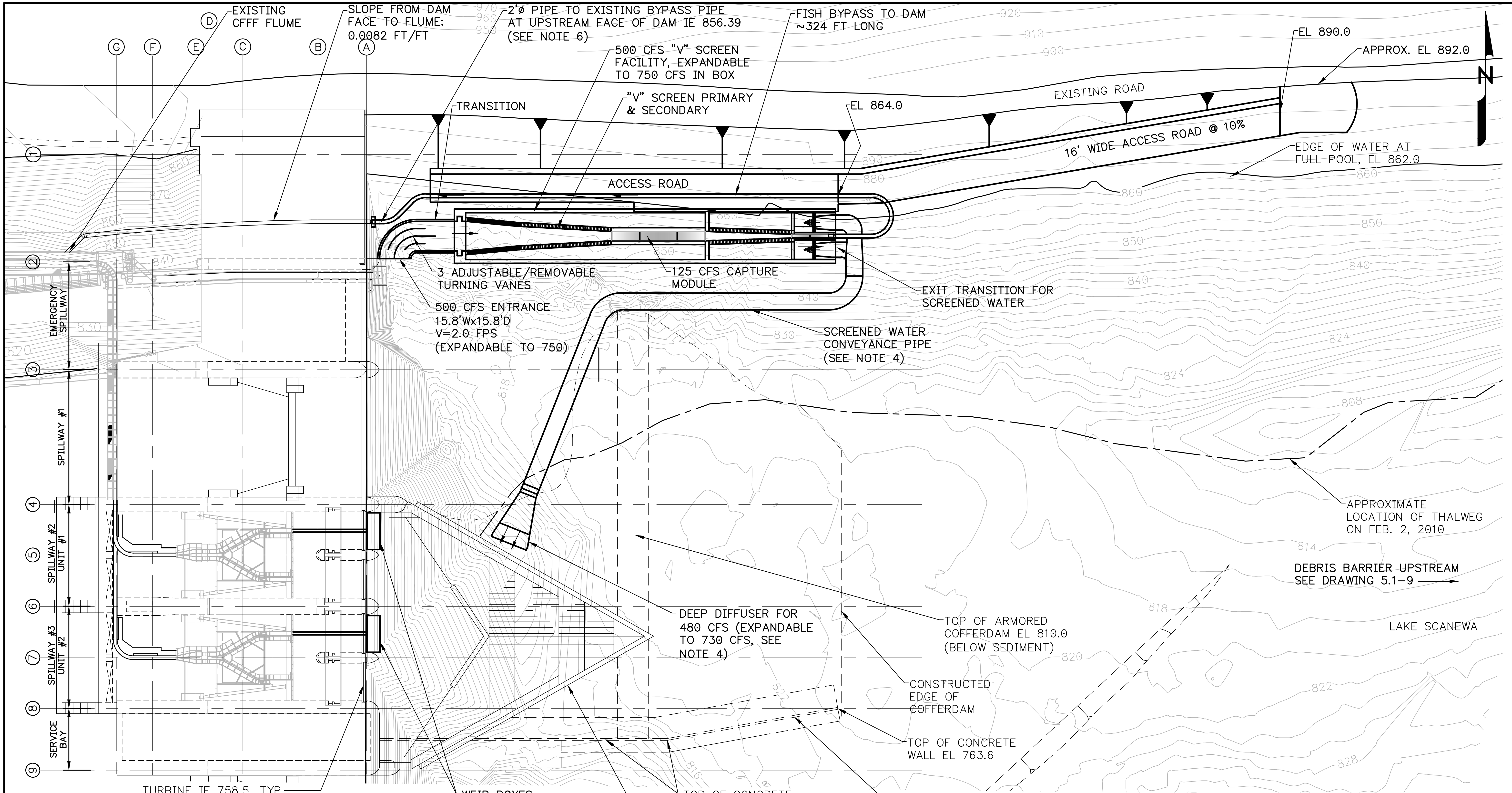
5.1.3.5 Key Issues Related to this Design

- Will fish find entrance relative to turbine and weir box flows?
- No BGS is provided to help guide fish to the north side. Will fish find the corner entrance?
- Avoid standing waves and draw-downs in the screen facilities (Baker example), desire uniform flow conditions
  - Address with hydraulic model and conceptual design iterations during final design phase

5.1.3.6 Operational Considerations

- This system relies on the ability to attract fish with surface flow. As such, it is desirable to avoid surface spill when the fish facilities are operating. If spill is required, it would be desirable to use the deep sluice gates rather than the current flap and spill gate operation.
- The operating rules for Cowlitz Falls Dam require that the pool be drawn down about 10 feet for flood control as flows reach 23,000 cfs; at this point the fish facilities would not be operable.

- Prior to the 23,000 cfs drawdown trigger flow, the project currently releases excess flow through the Spillway 1 and 4 flap gates, then opens Spillway 4. This operation results in competing surface flows, which may attract fish away from the new Case 1 fish attraction entrances. The original BPA fish facilities anticipated use of the deep sluice gates to convey the first spills over project capacity; however, LCPUD has found these gates to be unreliable and unsafe to throttle flow. It is recommended that discussions continue with LCPUD to improve and/or redesign the low level sluice gates to allow for a reliable, throttled release of the first spill up to the drawdown trigger, in order to help maximize the performance of this Case 3 alternative.



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM BATHYMETRY SURVEY TAKEN ON FEBRUARY 2, 2010 BY TACOMA POWER.
2. ARMORED DOWNSTREAM FACE OF COFFERDAM SLOPES AT 1.25H:1V.
3. ARMORED UPSTREAM FACE OF COFFERDAM SLOPES AT ~2H:1V.
4. SCREENED WATER CONVEYANCE PIPE LOCATION IS PRELIMINARY. SIZE, ROUTING AND DIFFUSER DESIGN WILL BE RESEARCHED FURTHER DURING MODELING AND FINAL DESIGN.
5. ENTRANCE TRANSITION SHOWN IS CONCEPTUAL. ADDITIONAL DESIGN DEVELOPMENT IS RECOMMENDED BASED ON COWLITZ FALLS DAM MODEL RESULTS.
6. LENGTH OF FISH WILL MAKE USE OF EXISTING 2'ø PIPE THROUGH DAM INFEASIBLE AT LOW POOL ELEVATION. NEW DAM PENETRATION AND POSSIBLE RE-PLUMBING OF CFFF WILL BE REQUIRED.

SCALE: 1" = 50'

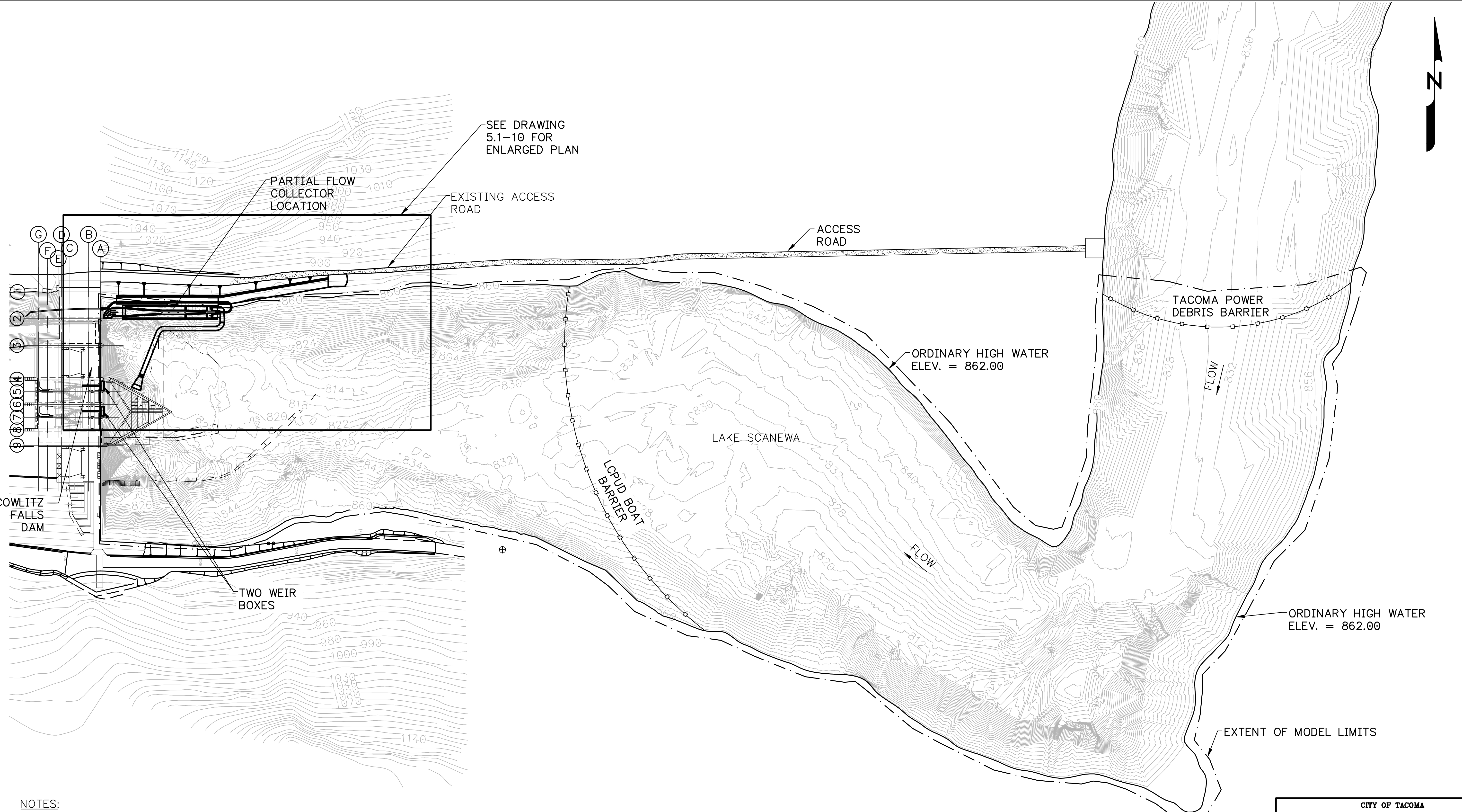
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 3 PARTIAL FLOW CAPTURE FACILITY W/DOWNSTREAM ENTRANCE
GENERAL PLAN

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 50' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-10	



NOTES:

1. BATHYMETRIC DATA UPSTREAM OF COWLITZ FALLS DAM FROM TACOMA POWER. VERTICAL DATUM: NAD 83/91, COWLITZ FALLS PROJECT DATUM.

DATA AVAILABLE UPON REQUEST.

0 100 200
SCALE: 1" = 200'
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

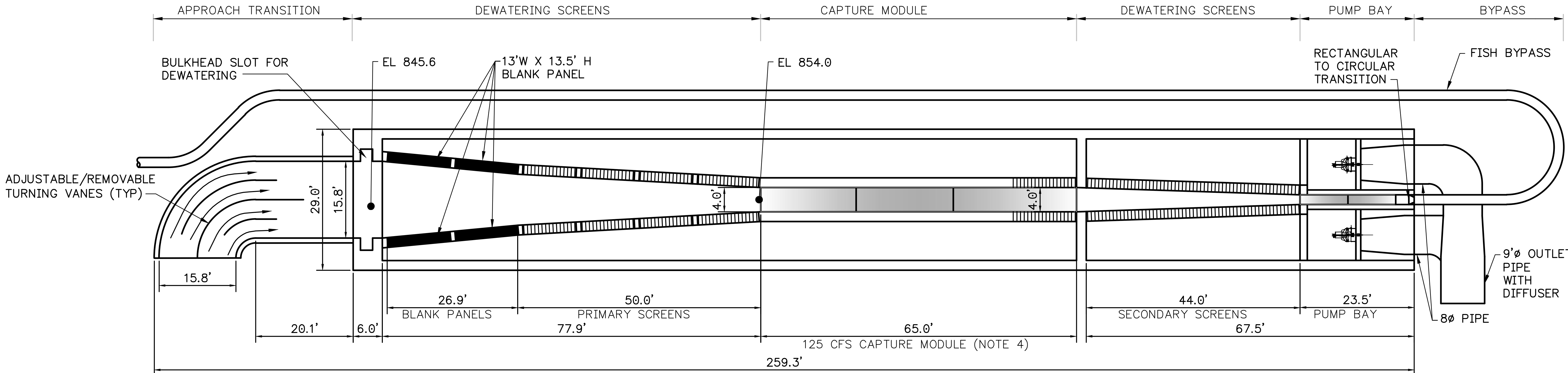
CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 3 PARTIAL FLOW CAPTURE FACILITY W/DOWNSTREAM ENTRANCE
LOCATION PLAN

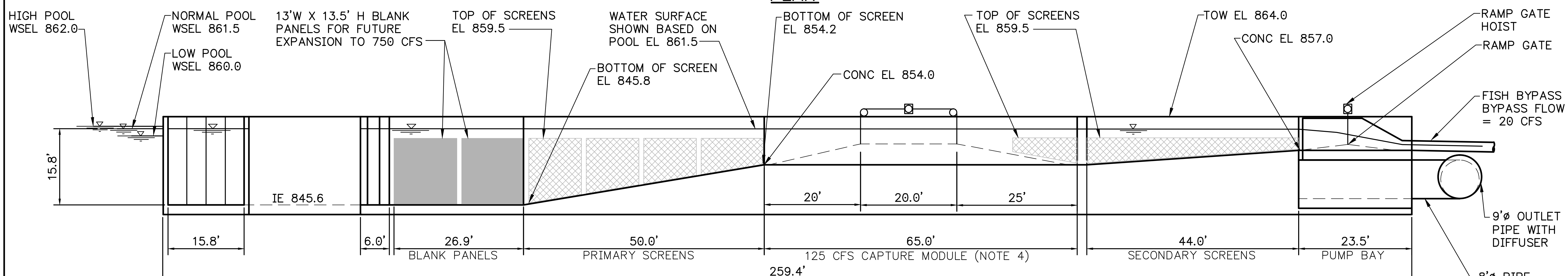
REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/15/11 (DATE)	1" = 200' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1–9	

500 (EXPANDABLE TO 750) CFS FISH BYPASS CHANNEL HYDRAULIC DATA AT POOL EL 861.5

W (FT)	15.8	(15.8)	15.8	(15.8)	10.5	4.0	4.0	4.0	4.0	2.0	2.0
Q (CFS)	500	(750)	500	(750)	500	125	125	125	96	20	20
V (FPS)	2.0	(3.0)	2.0	(3.0)	3.0	4.3	8.0	8.0	3.3	3.4	6.9
D (FT)	15.8	(15.8)	15.8	(15.8)	15.8	7.3	3.9	3.9	7.3	2.9	1.46
F	0.09	(0.13)	0.09	(0.13)	0.13	0.28	0.71	0.71	0.21	0.34	1.0



PLAN



PROFILE THROUGH 500 CFS FISH COLLECTION CHANNEL

NOTES
1. RESERVOIR DESIGN EL 860.0 TO 862.0.

2. 2'ø BYPASS PIPE IE AT DAM FACE = 856.39. SLOPE FROM FACE TO FLUME = 0.0082.

3. WATER SURFACE ELEVATIONS (WSEL) SHOWN ON PROFILE ARE APPROXIMATE AND DO NOT TAKE HEADLOSS INTO ACCOUNT. CONCRETE ELEVATIONS ARE BASED ON WSELS AND FLOW DEPTHS. FINAL HYDRAULICS AND CONCRETE INVERTS WILL BE ADJUSTED DURING FINAL DESIGN.

4. MAXIMUM VELOCITY GRADIENT OF 0.2 FT/S/FT TO BE MAINTAINED THROUGHOUT CAPTURE MODULE OVER THE EXPECTED FISH CAPTURE FLOW RANGE AND THE DESIGN RESERVOIR WATER SURFACE ELEVATION RANGE OF 860' TO 862'. DIMENSIONS SHOWN ON DRAWING MEET THIS REQUIREMENT AT 861.5' POOL ELEVATION. DETAILS OF THIS DESIGN ELEMENT NEED TO BE WORKED OUT IN FINAL DESIGN AND MODELING.

0 10 20
SCALE: 1" = 20'

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA.

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ DOWNSTREAM FISH PASSAGE
CASE 3 PARTIAL FLOW CAPTURE FACILITY W/DOWNSTREAM ENTRANCE
PLAN, PROFILE & VELOCITIES

REVIEWED	DESIGNED	FIELD BOOK
APPROVED / SUPERVISING ENGINEER	12/21/11 (DATE)	1" = 20' (SCALE)
APPROVED / APPROVING ENGINEER	DRAWING NO. 5.1-11	

5.2 Weir Box

5.2.1 System Overview

The weir box(es) is anticipated to be located on the face of the dam in the trash rack gate slots (also see Objective 1 of the Adaptive Management Plan described in Section 6 of this document). Two weir boxes, each 20 feet wide are proposed to be installed at the entrance to Spillway Bays 2 and 3 provided the prototype proves to be effective. Each weir box in envisioned to be a steel box containing a floor fish screen at mid-height, a steel bottom below the screen, an opening in the back to discharge flow, a fish flume, and a flow deflector in the turbine intake.

A flume is anticipated to extend from the weir box to the existing flume in the radial gates. Flow will pass over the weir on the upstream face of the box to create a surface flow attraction. Water in the box will be drawn through the floor screen to the gate slot.

Based upon the currently conceived prototype concept, the sections below details the weir box components. The final design may vary upon discussion with LCPUD and FERC. After testing the prototype, significant changes may occur to improve performance.

5.2.2 Physical and Functional Description

The weir box is designed to be approximately 20 feet wide to fit in the space between the piers, and 8 feet deep and maximum height of 13 feet. The box will have an adjustable weir crest on the upstream edge that will allow for stop logs to be added or removed, controlling flow into the box. See Figure 5.2-1. The box will have fish screens located horizontally across the box as well as along the rear panel. Each box will have a flume connecting back to the existing flume in the radial gate. The flume walls and floor could also have fish screens.

Each weir box installation consists of the box itself and a set of baffle panels consisting of three existing 16 foot x 22 foot solid panels. There will be two vertical guides in each forebay, one for the trash rack and one adjacent upstream for the trash rack cleaner. For this weir box, the three baffle panels will be installed as is currently done in the trash rack slot on top of the trash rack, and the weir box will be installed in the same slot on top of the baffle panels. This will allow the trash rack cleaners to be functional after removal of the weir box.

According to the FERC's recent communication, it is necessary to remove the fish weir boxes and baffle panel sets in approximately 3 hours. In order to meet the removal requirement, the following arrangement and removal procedure is proposed. See Drawings 5.2-1.

1. A bridge crane will be installed above each weir box. It will lift each weir box from the installed position up to a storage position above the piers and forward of the slot.
2. The telescoping weir concept will be utilized to gang the three baffle panels together so they could be raised with one lift.
3. Slots will be added to the pier wall to accommodate the "telescoping weir" baffle panels. Each panel will require its own slot.
   A storage/dogging mechanism for the panels and weir box will be located on top of the piers on either side of the forebay entrance.
4. A bypass flume extending from the weir box to the existing flume entrance will be installed on the top, front of the radial gate.
5. A crane will be installed under the deck to raise the flume section to a stored position under the spillway deck.

These features are described in additional detail below.

A bridge crane will be installed on the pier noses on either side of the forebay entrances. It will have a twin hoist, so that the fish collection boxes and baffle panels in each bay will be lifted from both ends. The bridge crane will be supported on cantilevered frames attached to the top of the spillway piers. The length of bridge movement will be sufficient to raise the weir box and move it to its storage location at the upstream end of the pier.

An additional slot will be added upstream and adjacent to the trash rack cleaner slot. Its bottom will be under water about 24 feet and will support the upstream baffle panel in the down position. The slot for the trash rack cleaner is approximately 10 inches wide, which is not wide enough to hold a baffle panel. The trash rack cleaner slot or baffle will have to be modified to accept the middle baffle panel. Modifications to the trash rack cleaner might also be necessary. The downstream slot will require no modifications. Another set of guides will be located above the deck level to store the fish collection box after it has been lifted out of the water and released by the hoist.

In order to remove the three baffle panels quickly, they will be modified so that they can all be raised together in a single lift. To accomplish this, interlocking tabs will be added so that the three panels operate as a single three-leaf gate. The panels in adjacent slots will form a single gate when lowered into operating position. When in the raised position, all panels will be at the same elevation reducing the required hook clearance over the deck.

The trash rack cleaner should still be operable by lowering it down the new, wider center slot. The weir box and baffle panels will need to be removed before lowering the cleaner into place.

Tacoma Power plans to perform prototype weir box testing in 2012.

5.2.3 Operational Description

5.2.3.1 Normal Operations

There will be two weir boxes each with an effective spillway crest width of 18 feet. The flow is limited by the amount of water that can be drawn down the gate slot using the flow deflectors tested in 2009. It is estimated that up to 280 cfs can be drawn through two 20-foot weir boxes with two flow deflectors in both slots in a spillway bay. However, this is at full turbine flow. At a reduced turbine flow the amount drawn down the gate slot could be substantially less, which may require investigation of additional methods to increasing flow through the weir boxes.

5.2.3.2 Installation and Removal Operations

The procedure for installing the panels and weir box will be as follows.

1. Place the lifting beam on the crane hook.
2. Move the bridge crane downstream over the downstream baffle panel and connect the lifting beam to the top of the downstream panel.
3. Raise the panels slightly and remove the dogging device.
4. Lower the baffles into the slots until the upstream baffle rests on the bottom of its slot.
5. Continue lowering until the downstream baffle rests on top of the trash rack.
6. Remove the lifting beam and raise it.
7. Move the bridge crane upstream over the weir box and connect the lifting beam to the top of the weir box.
8. Lift the weir box and un-dog it.
9. Lower the weir box into the upstream panel slot until it rests on top of the upstream panel.
10. Un-dog the bypass flume from its storage position under the bridge deck and move it forward over the baffle panels and lower it into position using the gantry crane. See Figure 2.

The procedure for removal of the bypass flume, baffle panels, and weir box will be the reverse of the installation procedure. In addition, this procedure could be performed concurrently at two of the forebay entrances.

The weir box and baffle panels could be removed in one hour in the manner stated above. However, it would probably require mobilizing multiple crews to remove both weir box/baffle systems within an hour.

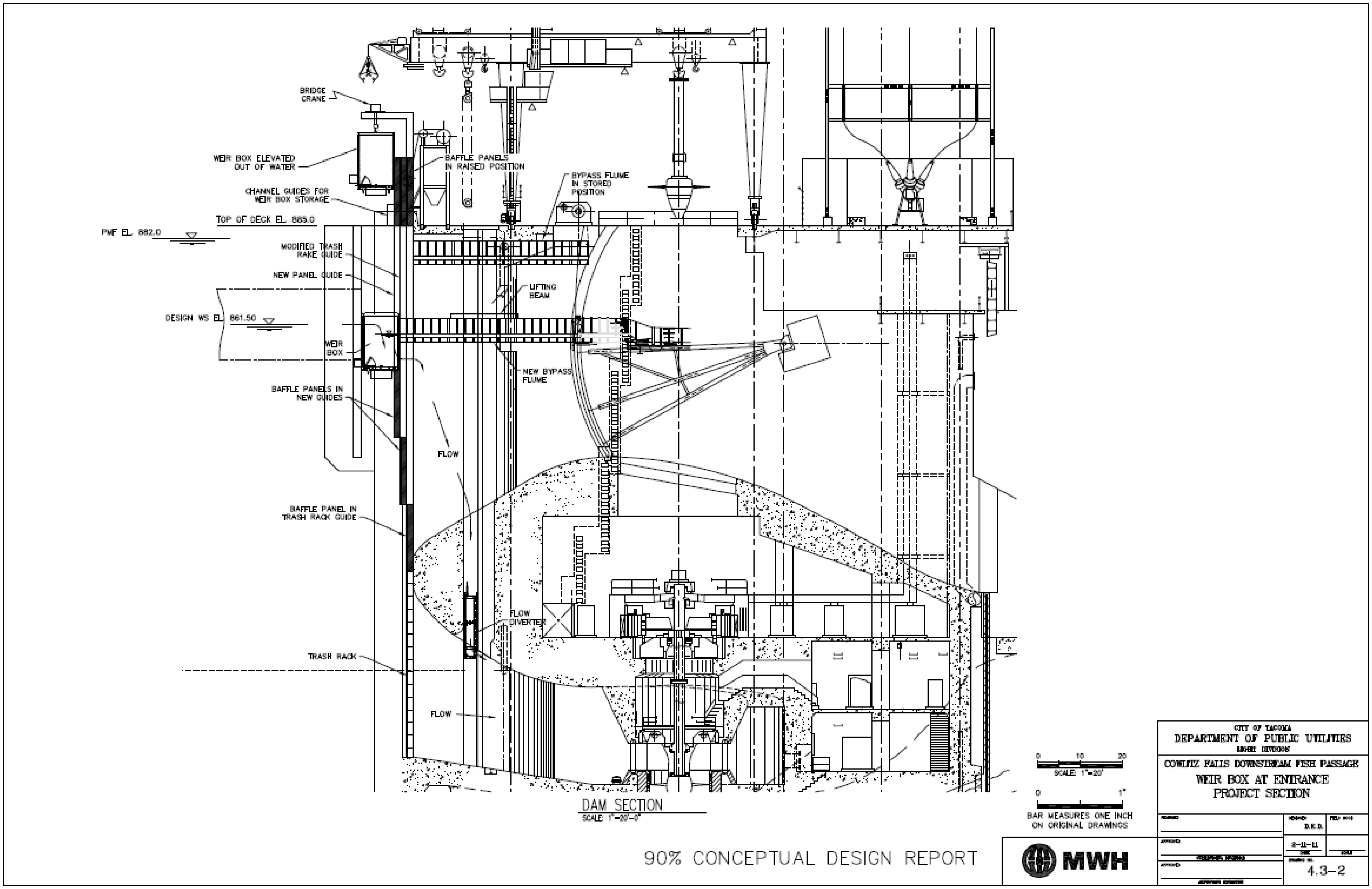


Figure 5.2-2 Weir Box at Entrance Project Section

6.0 Next Steps

6.1 Initial Facility Design Studies

6.1.1 Prototype Studies

The following studies are recommended to provide data to support or refute performance assumptions about the facility components that are critical to the success of the Recommended Alternative.

2011 BGS Prototype Study – In order to meet the SA FPS Goal a sufficient number of fish must reach the collector entrance. The 2010 BGS prototype study indicated that fish may guide along a BGS, but did not provide enough information to quantify fish guidance. Studies of an improved BGS Prototype took place during the 2011 fish passage season. Radio-telemetry was used to determine if the BGS can successfully concentrate fish in sufficient numbers for the Recommended Alternative to potentially meet the performance goals. Study results and recommendations with a full accounting of study strengths and weakness, will be used by a design team to inform final design.

2011 and 2012 Exclusionary Net Evaluations – Successful collection of spring Chinook by the Recommended Alternative will depend on the ability of the BGS to concentrate spring Chinook near the collector entrance, and the feasibility of maintaining exclusionary netting in place during the critical migration period. Velocity data were gathered in the reservoir near the cross section of the potential net alignment in 2010. These data were evaluated and extrapolated to the design flow for the migration period to determine feasibility of maintaining an exclusionary net. In addition, a section of full-depth net was installed in the Cowlitz Falls Dam forebay in 2011 to estimate loading and debris accumulation characteristics, and to assess whether the net and its anchor system can accommodate the fluctuations in forebay depth resulting from the highly variable sediment deposition patterns. The 2011 pilot test occurred over a 4 week period in late summer. The installation timing and location for the 2011 exclusionary net test was selected so that it did not interfere with or confound results from the BGS telemetry studies. Exclusionary net testing will be repeated in 2012 during the entire spring Chinook migration period.

Seasonal Collector Downstream of Cowlitz Falls Dam - The Recommended Alternative will not be operational until 2016; as a result, Tacoma Power will explore the efficacy of a cheap, quick and effective temporary seasonal collector design suggested by WDFW and located downstream of Cowlitz Falls Project. The collector is intended to collect Chinook outmigrants during July, August and September. WDFW has provided a conceptual design for this seasonal collector for use as an interim adaptive management measure, and potentially, for use throughout the license term. If Tacoma Power and the resource agencies reach consensus regarding implementation of this interim measure, Tacoma Power will proceed with implementation. The target operation date will be the 2013 low flow season. The discontinuation or improvement of this collector will be determined through the adaptive management process.

6.1.2 Hydraulic Model Studies

The guiding principles for juvenile collection are described by the SA FPS Goal. Three arrangements of the Recommended Alternative have been presented and hydraulic models will be constructed and used to gain a better understanding of the hydraulic performance of each arrangement. Computational Fluid Dynamics (CFD) and/or Physical Hydraulic Model Studies of the Cowlitz Falls forebay and the collector itself will provide information needed for detailed design. Examples of the types of data that could be obtained through these studies and their application to design include:

- Document existing reservoir flow patterns over the full range of fish passage design flows and normal turbine operating patterns during the fish collection season. Compare general flow patterns with 2010 and 2011 fish location data to infer likely fish movement in the hydraulic field of the forebay. This information can be used by the design team to optimize the collector layout and location.

- Estimate hydrodynamic loads on the debris boom, and refine its location and alignment.
- Estimate hydrodynamic loads on the BGS and refine its location and alignment
- Document the BGS effects on the flow patterns below the BGS;
- Estimate hydrodynamic loads on the Exclusionary Nets and refine their location and alignment;
- Evaluate streamlines approaching the collector entrance, and refine its location, alignment, and/or geometry to provide smooth and uniform streamlines into the Pump Wall Structure;
- Evaluate flow characteristics in proximity to the Pump Wall Structure, and establish its orientation, features and discharge location(s);
- Evaluate flow characteristics in proximity of the Screened Flow Conveyance (diffusers, directional hoods, partial, or full flow piping) and establish their configuration and discharge location(s);
- For piped Screened Flow Conveyance, provide data for pipe outlet, multi-port, and/or diffuser designs to avoid negative impacts on turbine performance, reservoir flow patterns, and minimize false attraction to the discharge points;
- Evaluate flow merge characteristics for auxiliary entrance configuration; and
- Evaluate flow vane requirements for auxiliary entrance configuration.

The fisheries and hydraulic engineering design details developed through the modeling are required to complete the detailed design of the facility to the 30% level; therefore the modeling tasks should commence as soon as possible following selection of the final Recommended Alternative.

The upstream model limits should be an adequate distance beyond the bend in the river upstream from the project forebay to address the debris boom issues. The downstream model limits should include the turbine intakes, so that effects of the Screened Flow Conveyance on the distribution of flow entering the turbines can be assessed.

Throughout the hydraulic model studies, emphasis will be placed on developing flow patterns that, based on past experience with other fish collection systems, may be conducive to successful fish collection. However, it must be understood that ultimately, the only guarantee that the flow field is conducive to fish collection will be through monitoring and evaluation of actual fish movement in the field.

6.2 Adaptive Management Plan

To achieve the SA FPS Goal, the following steps must be followed:

1. Design, build, and operate a state-of-the-art collection system with the goal of achieving the SA FPS Goal.
2. Determine the FPS of the system to evaluate compliance with the SA FPS Goal.
3. Modify or augment the system, if required to meet the SA FPS Goal.

The first step deals with initial collector design issues, whereas the second two following steps involve establishing an Adaptive Management Plan (AMP) with specific Monitoring and Evaluation (M&E) criteria to inform the selection of specific adaptive management actions to improve the system, if needed. The FTC is in the final stages of completing the first step and committing to a course of action. This section describes the proposed adaptive management process. The AMP will be developed by a sub-committee appointed by the FTC.

There are two objectives for the Adaptive Management Plan (AMP). The first objective is focused on implementing actions to improve FPS before the Lake Scanewa Collector is fully designed and constructed. The second objective is focused on identifying the post-operational process to improve the overall Upper Cowlitz smolt collection system if the Recommended Alternative does not achieve the SA FPS Goal.

Objective 1

The AMP will consider actions that can be taken prior to building the permanent fish collector on the north shore of Lake Scanewa adjacent to the Cowlitz Falls Dam. The installation of a cheap, quick and effective temporary seasonal collector downstream of Cowlitz Fall Dam will be explored. A prototype weir box is being designed, and if approved by FERC for deployment, will be tested in 2012 in spillway bay 3. If the prototype weir box is found effective the prototype will be refined and deployed in spillway bays 2 and 3. An additional element to maximizing effectiveness of the weir boxes is to determine if modification of the debris deflector or its attachment to the dam can be implemented that will allow better access to the area in front of spillways 2 and 3 by smolts in the forebay, which will require agreement by LCPUD and FERC to implement modifications. Additional studies and deployment strategy will be described by the AMP and other concepts such as spillway collectors will also be contemplated.

The AMP will also consider or describe processes that will be used to: 1) consider the efficacy of a recommended collection device intended for use prior to installation of the Lake Scanewa collector, 2) advocate studies to measure biological and physical performance for the intermediate collection methodologies, 3) describe how study results will be used to determine if the intermediate collectors should be continued, improved or abandoned. The AMP may also describe additional pre-construction tests or studies, as described in the remainder of this section.

The AMP will continue investigations into collection facilities downstream of Cowlitz Falls Dam. A collector located in Riffe Lake was one of the five alternatives included in the 60% Conceptual Design Report and has been recommended in previous evaluations of juvenile salmonid collection methods at or near Cowlitz Falls Dam. Past biological modeling results suggest that a collector in Riffe Lake may be necessary to achieve the SA FPS Goal. To date only a collector located in mid-Riffe Lake has been considered; however, other locations may also support effective collection of outmigrating juvenile salmonids. As part of Objective 1, a seasonal (summer/fall) collector in the riverine section of Riffe Lake is being considered.

Objective 1 should also include an evaluation regarding additional alternatives for collecting juvenile outmigrants below Cowlitz Falls Dam. The goal of this evaluation would be to identity the most effective structure and location for collecting outmigrating juvenile salmonids downstream of Cowlitz Falls Dam, in the event that the Lake Scanewa Collector does not achieve the SA FPS Goal. Initiation of conceptual design including biological testing will begin immediately following completion of the final design of the Lake Scanewa Collector. Final Design of a collector downstream of Cowlitz Falls Dam will be completed by 2018 with intent to initiate construction expeditiously as informed by the AMP. -

Objective 2

The AMP will describe an iterative and logical process by which the facility performance will be assessed, and its configuration and/or operations modified, if required to meet the SA FPS Goal. The AMP will describe the process that will be used to gather and share information and will specify how the data that are collected will be used to initiate and guide adaptive management actions.

The AMP will describe initial and subsequent hypotheses to be tested and methods used to accept or reject those hypotheses. The plan will contemplate potential causes for the facility not achieving the SA FPS Goal and describe facility changes that would be made if those conditions are encountered. The plan will also prescribe a process used to alter monitoring and evaluation (M&E) studies, if unanticipated conditions are encountered that challenge the relevance of the prescribed M&E studies (i.e. high water/ low water years, mechanical failures, lack of fish availability). The required elements of the AMP are described in more detail below:

Assessment of likely shortcomings and remedies – Although the design of the selected alternative will be based on the best available information and to the extent possible, on site specific information about fish behavior, the AMP must recognize the potential that the facility, as initially constructed, will not meet the component performance goals necessary to achieve the SA FPS Goal. The AMP will identify the components of the system that are likely to be critical to the facility's success and will anticipate potential shortcomings and associated remedies for those components. This assessment will be based on past experience at this and similar facilities. If the assessment indicates that prototype tests and/or analyses beyond those specified in Section 6-1 should be conducted prior to construction, the AMP will detail the additional pre-construction tests.

Potential Modifications - The type and extent of potential modifications to the facility will be documented in the AMP; examples of potential modifications may include: changing collection flow rate, moving the BGS, expanding facility by adding screen and pumps to the primary entrance, or opening an auxiliary entrance at the corner of the dam (Case 2). The list will be complete to the extent possible, but may not be able to reflect newly tested technologies and thus should not limit future options. Information on potential modifications should be incorporated into the completion of the detailed design of the facility to the 30% level, so that the detailed design can, to the extent practical, incorporate sufficient flexibility to accommodate the specified modifications.

Specific Monitoring and Evaluation (M&E) Criteria – Requirements for monitoring and evaluation must be clearly defined in the AMP. Specifically, the following need to be considered:

1. Performance Metrics – The AMP must define how the performance of the facility will be evaluated against the performance metrics established by the SA FPS Goal.
2. Diagnostic Tools – The AMP must provide a means of diagnosing which component/s of the facility is/are responsible for the sub-goal performance, e.g. are fish being guided to the vicinity of the collector entrance in adequate numbers, are they entering the facility, and are they staying in the facility? The application of diagnostic tools will allow decisions to be made about what component or components need to be adjusted and in what way.
3. In-Season Adjustment - The AMP should anticipate the potential for making in-season adjustments. Based on the monitoring data, it may be desirable to make adjustments to the facility operation, e.g. collection flow rate, during an operating season in an attempt to test sensitivity or make improvements in performance. If "block-testing" of different facility operations or configurations is desired, these tests should be described by the plan. In addition the plan should describe how preliminary results will be obtained, reviewed, and used to trigger in-season adjustments, if indicated.

The AMP will be developed through a collaborative effort of the Adaptive Management Team approved by the FTC, and completed at the same time as the 30% design of the facility currently scheduled to commence on June 2012. The AMP will identify issues that may preclude achievement of the SA FPS Goal and recommend facility modifications as necessary to achieve the goal.

7.0 References

Bell. M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage and Development Evaluation Program, U.S. Army Corps of Engineers, Portland, OR.

ENSR. 2007. Surface Bypass Program Comprehensive Review Report. Prepared for USACE Portland District. Contract No. W9127N-06-D-0004, T.O. 01.

Harza/ENSR. 1993. Final Report - Hydraulic Model Studies for Fish Collection Facilities - Cowlitz Falls Project. Prepared for Bonneville Power Administration and Public Utility District No. 1 of Lewis County.

HDR. 2010. Cowlitz Falls Behavioral Guidance Structure Evaluation DRAFT October 15, 2010. Prepared for Tacoma Power.

GAIA Northwest. 1993. Cowlitz Falls Project Fisheries Management Plan: Anadromous Reintroduction Program. Prepared for Bonneville Power Administration, Richland, Washington.

Giorgi, A. 2010. Cowlitz River Project Downstream Fish Passage Updated Biological Evaluation Approach and Input – May 7, 2010.

Giorgi, A. and C. Sweeney. 2008a. Report on FTC Workshop – Investigating Alternatives for Smolt Collection at or near Cowlitz Falls Dam. Prepared for Tacoma Power.

Giorgi, A. and C. Sweeney. 2008b. Cowlitz River Project Downstream Fish Passage Team - August 5, 2008 Presentation to Fisheries Technical Committee.

Goodwin, R.A.; J.M. Nestler,; J.J. Anderson; D.L. Smith; D. Tillman; T. Toney; L.J. Weber; S. Li; J.R. Cheng; and R.M. Hunter. 2006. The Numerical Fish Surrogate: Converting Observed Patterns in Fish Movement and Passage to a Mechanistic Hypothesis of Behavior for Engineering Design Support. Draft Final Technical Report ERDC/EL-06. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Harza. 1999. 1997 and 1998 Technical Study Reports, Volume II.

Harza Northwest, Inc. 1994. Cowlitz Falls Fish Passage Facilities Downstream Passage Facility Conceptual Design Report. Prepared for Bonneville Power Administration.

Harza Northwest, Inc. 1992. Cowlitz Falls Fish Passage Alternatives Preliminary Report. Prepared for Bonneville Power Administration.

Kock, T. J., T. L. Liedtke, M. A. Kritter, and D. W. Rondorf. 2006. Behavior and passage of juvenile salmonids during evaluation of a new fish screen at Cowlitz Falls Dam, 2006. Report by the U.S. Geological Survey to Tacoma Power, Tacoma, Washington.

Lewis County Public Utility District. 2009. Information for Conceptual Design Report. E-mail from Joe First to Bill Iyall.

Liedtke, T., T. Kock, B. Ekstrom, I. Royer, and D. Rondorf. 2010. Juvenile salmonid collection efforts in the upper Cowlitz River Basin: 2009 evaluations. Final report to Tacoma Power.

Liedtke, T., Kock, T., Ekstrom, B. and Rondorf, D. 2009. Behavior and passage of juvenile salmonids during evaluation of a fish screen at Cowlitz Falls Dam. Report from USGS to Tacoma Power. Tacoma, Washington.

Liedtke, T., Kock, T., Ekstrom, B. and Rondorf, D. 2008. Behavior and passage of juvenile salmonids during the evaluation of a fish screen at Cowlitz Falls Dam, Washington, 2008. Report from USGS to Tacoma Power. Tacoma, Washington.

Meridian Environmental. 2004. Use of IHA/RVA and Other Methodologies to Evaluate Flows on the Cowlitz River (Final). Prepared for Tacoma Power.

Montgomery Watson Harza (MWH). 2005. Baker River Project – Upper Baker Dam Downstream Fish Passage Facilities – Guide Net Design Memorandum. Prepared for Puget Sound Energy.

MWH/ENSR, 2005. Prototype Fish Screen at Cowlitz Falls Hydroelectric Project, Design Basis Report (Draft). Prepared for Tacoma Power.

NMFS. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

Northwest Power and Conservation Council, 2004. Lower Columbia Sub basin Plan. In *Lower Columbia Salmon Recovery and Fish and Wildlife Sub basin Plan, Volume II Sub basin Plan, Chapter E Cowlitz, Coweeman and Toutle*.

PacifiCorp Energy. 2007. Lewis River Fish Passage Swift Downstream Collection – Biological and Hydraulic Facility Design Criteria.

Perry, R. W., A. C. Braatz, M. J. Farley, and D. W. Rondorf. 2004. Migration behavior of juvenile salmonids and evaluation of a modified box entrance at Cowlitz Falls Dam, Washington, 2003. Report by the U.S. Geological Survey to the Public Utility District No. 1 of Lewis County, Chehalis, Washington.

Reese, L. 2009. Personal Communication with Lynn Reese, Hydraulic Engineer, U.S. Army Corps of Engineers, Walla Walla District. April 16, 2009.

Serl, J., and C. Morrill. 2008. Draft 2007 summary for the Cowlitz Falls anadromous fish reintroduction project. Prepared by WDFW for BPA, Richland WA.

Stockley, C . 1961. The migration of juvenile salmon past the Mayfield Dam site, Cowlitz River, 1955 and 1956. WDFW report funded by the City of Tacoma.

Tacoma Power. 2008. Workshop to Investigate Solutions for Smolt Collection at or near Cowlitz Falls Dam March 3 & 4, 2008 Background Information.

USACE. 1994. Hydraulic Design of Flood Control Channels Change 1 ENG 4794-R. EM 1110-2-1601.

USACE. 1980. Hydraulic Design of Reservoir Outlet Works. EM 1110-2-1602.

USACE. 1990. Hydraulic Design of Spillways. EM 1110-2-1603.

Washington Group International (WGI). 2006. Upper Baker River Downstream Fish Passage Facilities – Floating Surface Collector Design Memorandum. Prepared for Puget Sound Energy.

APPENDIX A – COMMENT

Mid-Riffe Lake Collector

WDFW Comment

WDFW is concerned that there is no mention of the design of the mid-Riffe Lake collector in this report. During completion of the Conceptual Design Report there was language that committed Tacoma Power to initiate and complete design of the Mid-Riffe Lake Collector once the 100% design report was completed for the Lake Scanewa Collector. WDFW is concerned that removing this language was not agreed to by all parties, including WDFW, and has therefore reinserted this language back into the 12/20/11 Draft Conceptual Design Report.

NMFS Comment

There is no mention of the design of the mid-Riffe Lake collector in this version of the report. In other versions, there was language that committed Tacoma Power to initiate and complete design of the Mid-Riffe Lake Collector once the 100% design report was completed for the Lake Scanewa Collector. NMFS is not in support of removing this language and requests that this is put back in.

American Rivers Comment

First, we do not support the removal of plans related to a mid-Riffe Lake collector. As noted in both agencies' comments, previous versions of the document included commitments to initiation and design of a collector at a certain stage in the process. This intent was conveyed at various FTC meetings as well. As such, we disagree with the removal of this critical element of downstream fish passage and recommend its inclusion in the final plan.

Tacoma Response

Page 7-1 of the 60% Design Document states the following "Additional design activities for the Riffe Lake Alternatives should be delayed so that resources can be dedicated to completing the design of the Lake Scanewa Alternatives. This recommendation is supported by the biological and technical performance evaluation as well as by resource constraints, opportunities for additional data collection and ability to learn from similar projects that are currently under development in the Pacific Northwest." Tacoma's definition of "Riffe Lake Alternatives" is a secondary downstream fish collection system in upper Riffe Lake intended to collect fish that may elude capture at the Lake Scanewa collector. The alternatives analysis will not include the Mid-Riffe Collector described in the 60% and earlier versions of the Conceptual Design Report, because Tacoma and Downstream Team members considered the alternative to range from highly challenging to technically infeasible.

The following paragraphs were added to Section 6 to address your comment.

The AMP will continue investigations into collection facilities downstream of Cowlitz Falls Dam. A collector located in Riffe Lake was one of the five alternatives included in the 60% Conceptual Design Report and has been recommended in previous evaluations of juvenile salmonid collection methods at or near Cowlitz Falls Dam. Past biological modeling results suggest that a collector in Riffe Lake may be necessary to achieve the SA FPS Goal. To date only a collector located in mid-Riffe Lake has been considered; however, other locations may also support effective collection of outmigrating juvenile salmonids. As part of Objective 1, a seasonal (summer/fall) collector in the riverine section of Riffe Lake is being considered.

Objective 1 should also include an evaluation regarding additional alternatives for collecting juvenile outmigrants below Cowlitz Falls Dam. The goal of this evaluation would be to identity the most effective structure and location for collecting outmigrating juvenile salmonids downstream of Cowlitz Falls Dam, in the event that the Lake Scanewa Collector does not achieve the SA FPS Goal. Initiation of conceptual design including biological testing will begin immediately following final design of the Lake Scanewa Collector. Final Design of a collector downstream of Cowlitz Falls Dam will be completed by 2018 with intent to initiate construction expeditiously as informed by the AMP

1,000 cfs Flow into Collector

WDFW Comment

While WDFW is agreeable to designing the primary entrance for a flow of 500 cfs with the potential to expanding to a flow of 750 cfs, WDFW is concerned that there is no reference to the potential for future expansion to 1,000 cfs. WDFW has consistently requested that the design of the Lake Scanewa Collector include the potential for expansion to a 1,000 cfs flow if necessary to achieve the Settlement Agreement Fish Passage Survival Goal (SA FPS Goal) described in the draft Final Conceptual Design Report. WDFW has provided some edits to the attached document that include references to the 1,000 cfs flow to the primary entrance. WDFW would appreciate the inclusion of these edits in the Final Conceptual Design Report.

American Rivers

Second, the amount of flow at the primary collection entrance is a critical factor in the effectiveness of the facility. It is my understanding that there was significant discussion among the Downstream Team members regarding the appropriate level of flow, resulting in a starting point of 500 cfs with the potential to expand the capacity in the future if necessary. We have concerns that the current plan allows for expansion only to 750 cfs, rather than to 1000 cfs, which we believe was the understanding of the Downstream Team members, as well as American Rivers.

Tacoma Response

Tacoma supports adding 1,000 cfs as the maximum total capacity of the facilities through a stepwise progression of improving the facility to meet fish passage goals for Case 1 and 2.. Tacoma does not support 1,000 cfs for Case 3 because it increases the size of the facility beyond practical limits.

2012 Testing of Behavioral Guidance Structure

WDFW Comment

WDFW is concerned that future studies do not include continued testing of the Behavioral Guidance Structure (BGS). Success of the BGS in guiding fish to the capture location is a critical element to the success of the Lake Scanewa Collector. While data collected by testing the BGS in 2012 may not be completed in time to contribute to the 30% design, it would be available for use as efforts move towards a final design for the Lake Scanewa Collector. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector WDFW would expect Tacoma Power to collect as much information regarding that structure as possible prior to constructing and operating this collector. WDFW needs to understand why continued evaluation of the BGS is not included in this draft Conceptual Design Report.

NMFS Comment

The future studies do not include testing of the Behavioral Guidance Structure (BGS). Success of the BGS in guiding fish to the capture location is a critical element to the success of the Lake Scanewa Collector. While data collected by testing the BGS in 2012 may not be completed in time to contribute to the 30% design, it would be available for use as efforts move towards a final design. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector, NMFS expects Tacoma to collect as much information as possible regarding the BGS prior to constructing and operating this collector. If the BGS does not work as hoped, then the alternative with the main entrance located upstream may not be the best alternative. Also, the auxiliary entrance may need to be designed with higher entrance flows than currently contemplated.

American Rivers Comment

Third, we support the calls that future studies include testing of the Behavioral Guidance Structure (BGS). As already noted, success of the BGS in guiding fish to the capture location is a critical element in the effectiveness of the Lake Scanewa Collector. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector, American Rivers recommends that Tacoma collect as much information as possible regarding the BGS prior to constructing and operating this collector.

Tacoma Response

The BGS will receive testing in 2012 for physical attributes such as cable loads, water velocity in front and behind the BGS and alignment changes with changes in flow. Tacoma does not intend to conduct additional fish behavior studies. The past two years of study have provided an indication of likely fish behaviors, but this information has limited application, because once the Lake Scanewa collector is installed flow patterns and fish behaviors are likely to change. In addition, fish behavior information collected in 2012 would have minimal, if any, impact on the fish collector design, because the data would be available after irrevocable design decisions were made unless the design scheduled is slowed down significantly. The flow rates in the auxiliary entrance is addressed in the following response.

<u>Flow into the Auxiliary Entrance</u>

WDFW Comment

Case 2 presented in the draft Conceptual Design Report include a secondary entrance near the face of Cowlitz Falls Dam. WDFW greatly appreciates Tacoma Power's response to past WDFW comments on this issue by including this additional entrance as part of the draft Final Conceptual Design Report. WDFW is however concerned that a specific flow has been associated with this additional entrance. It was WDFW's expectation that the flow to this additional entrance would determined through the upcoming physical or conceptual flow modeling. WDFW is concerned that deciding on flow to the additional entrance prior to completion of the aforementioned modeling efforts may decrease the effectiveness of this additional entrance. WDFW believes that identifying the flow that will be most effective for this additional entrance will be critical to the success of this entrance, which has taken on increased importance due to the recent addition of this entrance to the design process.

NMFS Comment

Section 5.1.2, page 5.8. Given the uncertainty of fish collection in the forebay of Cowlitz Falls, we recommend that the capacity of the downstream auxiliary entrance be increase from 125 cfs to 250 cfs for maximum operational flexibility. If possible, the entrance should be designed so that, like the main entrance, it could be expanded from 125 cfs to 250 cfs if needed. Our concern stems from our experience with the Upper Baker Gulper which operated at approximately 130 cfs but the collection efficiency was not very high.

Tacoma Response

Tacoma agrees to provide up to 250 cfs at the auxiliary entrance provided hydraulic modeling and the design team, of which WDFW and NMFS are members, are provided information that indicate a maximum flow of 250 cfs is hydraulically feasible.

<u>NMFS Fish Passage Criteria</u>

WDFW Comment

Previous drafts of this Conceptual Design Report have included references to National Marine Fisheries Service (NMFS) criteria for screens and water intake. All of those references have been deleted from this most recent draft of the Final Conceptual Design Report. WDFW is requesting that those references be reinserted into the final version of the Conceptual Design Report. These references to NMFS criteria were included in pages 11 and 12 of the previous version of the Conceptual Design Report.

NMFS Comment

Previous drafts of the CDR have included references to NMFS' criteria for Anadromous Salmonid Passage Facility Design. Please include reference to NMFS' 2011 "Anadromous Salmonid Passage Facility Design." This document is located at:

http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

American Rivers Comment

Fourth, fish passage facilities throughout the Northwest are required to meet NMFS' criteria for Anadromous Salmonid Passage Facility Design. Tacoma's Cowlitz Project is no exception. This should be made clear throughout the CDR.

Tacoma Response

Section 3.0 "Design Criteria and Methodology " reference the NMFS Anadromous Salmonid Passage Facility design document multiple times. Tacoma added reference to this document in the case studies section to emphasis the importance of meeting the NMFS criteria in the design of the facility.

WDFW Comment

During discussion regarding design of the Lake Scanewa Collector WDFW consistently asked that an option to discharge flow downstream of Cowlitz Falls Dam be considered. In review of this draft conceptual design report WDFW does not see any reference to consideration for discharge downstream of Cowlitz Falls Dam. WDFW is requesting that this discharge option be considered as part the upcoming physical or conceptual flow modeling.

Tacoma Response

Tacoma does not support moving water past Cowlitz Falls Dam and prefers pumping. Hydraulic modeling will inform any possible adverse forebay circulation patterns which will be addressed through engineered solutions such as energy dissipating structures.

Adaptive Management Plan

NMFS Comment

Section 6.2, page 6-4. Last paragraph. The DFPT has been disbanded; therefore, DFPT will not be the group developing the AMP. Maybe it is the design team or a teamlet from the FTC. The part of the sentence that reads: ". . . and completed at the same time as the 30% design of the facility currently scheduled to commence on June 2012" is confusing. Does this mean work on the AMP will start June 2012? Please clarify

American Rivers Comment

Finally, it goes without saying that an essential element of improving downstream juvenile fish collection is a comprehensive adaptive management plan. American Rivers looks forward to working with Tacoma on a plan through the FTC.

Tacoma Response

The FTC members or their appointees will be involved in the AMP. Work on the AMP will begin no later than early March 2012.

Additional Comments by NMFS

NMFS Comment

NMFS is committed to work with Tacoma and other interested FTC entities to complete the Adaptive Management Plan identified in the CDR

Tacoma Response

Tacoma looks forward to working with NMFS and other FTC members on the Adaptive Management Plan.

NMFS Comment

NMFS is committed to work with Tacoma and other interested FTC entities to complete the Adaptive Management Plan identified in the CDR.

Tacoma Response

Tacoma looks forward to working with NMFS and other FTC members on the Adaptive Management Plan.

NMFS Comment

Section 2.5.1, page 2-18. The second paragraph needs to be updated. Fall Chinook have been transported above Cowlitz Falls (started in 2010). Also, this paragraph is confusing because it leaves coho out. Coho should be added to the discussion in this paragraph

Section 2.5.2, page 2-20. In the middle of the paragraph that begins "Historically, migration timing. . ." There is a sentence that reads: "Given that the fisheries plan calls for the reintroduction of spring and fall Chinook and coho upstream from Cowlitz Falls Dam, it is possible that the historically diverse life history patterns may be re-expressed." Winter steelhead should be added to this sentence.

Section 2.5.3.1, page 2-21. In the second sentence in the second paragraph under this Section, it reads: "Steelhead in particular are a concern because adults do move downstream while mature and as kelts, and are collected. . ." The "and" before "as kelts" needs to be deleted to make this clear.

Table 3.2-1, page 3-1. Under the comments column, the Section referred to needs to be changed from Section 2.3.2 to 2.5.2.

Table 3.2-3 and Table 3.2-4, pages 3-3 and 3-4. We recommend that the design fish transport velocity gradient be limited to $0 \le G \le 0.2$ ft/s-ft as per NMFS guidelines. This should apply from the entrance through the capture point and then again, from the secondary screens to the bypass entrance. The current alternatives appear to follow this criterion. We are not sure that the ENSR criteria of $0 \le G \le 0.4$ ft/s-ft is appropriate.

Section 4.2, page 4-1. There is a link missing. Currently the draft has "INSERT LINK".

Table 5.2-2 System Component Evaluation, page 4-5. Next to the Fish Bypass Pipe it states: "The system is in place, and it appears has been shown to safely bypass fish with . . ." Please remove "has be shown." Also, this table is in Section 4 but is labelled as if it were in Section 5.

Section 4.6, page 4-7. Toward the end of the second paragraph it reads: "However, if it does not, an adaptive management approach is planned that will allow the DFPT to analyze the data from the first season of operation . . ." The DFPT has been disbanded therefore, this should be the FTC.

Section 4.6, page 4-9. The last sentence on this page reads: "If flows greater than 500 cfs work better for collection, then additional screens and pumps can be installed to meet fry criteria." Please replace "can" with "will".

Section 6.1.1, page 6-1, third paragraph. It reads: "Successful collection of spring Chinook by the Recommened Alternative will depend on the ability of the BGS to concentrate spring Chinook near the collector entrace, and/or on the feasibility of maintaining exclusionary netting in place during the critical migration period." The "and/or" needs to be replaced with "and".

Section 6.1.2, page 6-2. The last bullet in the middle of the page reads: "Evaluate flow vane requirements for downstream entrance configuration." In the rest of the document, this entrance is called the "auxiliary entrance." To avoid confusion in the document, please replace "downstream entrance" with "auxiliary entrance".

Section 6.2, page 6-2. The first step reads: "Design, build, and operate a state-of-the-art collection system with the potential of achieving the SA FPS Goal." Please replace "potential" with "goal" or "objective".

Section 6.2, page 6-2. The sentence that reads: "The DFPT is in the final stages of completing the first step and committing to a course of action." The DFPT has been disbanded. Also, it is not appropriate for the DFPT to commit to a course of action. In addition, the first step is "Design, build, and operate a state-of-the-art collection system" . . . technically the first step will not be completed until 2016. Please re-write this sentence. Perhaps DFPT could be replaced with FTC and the sentence changed to read: "The FTC is in the final stages of committing to a course of action for the first step."

Tacoma Response

Paragraphs were modified as requested

NMFS Comment

Section 5.0, page 5-1. We have several specific comments regarding the proposed alternatives but, given the preliminary nature of these designs, we will hold off on specific design comments until a more appropriate time during the design process.

Tacoma Response

Tacoma looks forward to working out the design details with NMFS and other FTC Members.

NMFS Comment

Section 6.2, page 6-3. Please provide an example of a hypotheses to tested under the AMP. NMFS wants to discuss this with Tacoma prior to this CDR being finalized.

Tacoma Response

The type of hypotheses were discussed at the February 3, 2012 FTC and mutual understand was reached as to the type of hypotheses the AMP will address.

NMFS Comment

Section 6.2, page 6-3. Last paragraph. Under potential modifications, an example identified was "opening an auxiliary entrance". So if the alternative selected has two entrances, this would be a third entrance?

Tacoma Response

The intent is to open no more than two entrances. The paragraph was altered to reflect that intent.

American Rivers
Rivers Connect Us

Debbie Young

Tacoma Power

P.O. Box 11007

Tacoma, WA 98411

Re: Comments on Conceptual Design Report (CDR), Cowlitz River Project (FERC No. 2016) Downstream Fish Passage (dated December 20, 2011).

Dear Ms. Young,

Thank you for the opportunity to review and provide comments on the draft Conceptual Design Report. At the January 3, 2012 Fisheries Technical meeting, comments were requested to be submitted by January 23, 2012. I apologize for the delay in submitting these, but hope they will be considered as the CDR is finalized. They should not result in any delay to its finalization as I am writing to express support for several key elements set forth in both the Washington Department of Fish and Wildlife and National Marine Fisheries Service's comments already submitted into the record.

We appreciate all the technical work undertaken by the "Dowstream Fish Passage Team", established to address the challenging issue of downstream juvenile fish collection at Tacoma's Cowlitz Project. Despite several years of analysis, the collection efficiencies fall far short of what is required in the Settlement Agreement, the FERC-issued license, and NMFS' Biological Opinion for the project. We, however, have concerns with several elements of the CDR and do not support the current plan for addressing juvenile fish collection absent several key modifications.

First, we do not support the removal of plans related to a mid-Riffe Lake collector. As noted in both agencies' comments, previous versions of the document included commitments to initiation and design of a collector at a certain stage in the process. This intent was conveyed at various FTC meetings as well. As such, we disagree with the removal of this critical element of downstream fish passage and recommend its inclusion in the final plan.

Second, the amount of flow at the primary collection entrance is a critical factor in the effectiveness of the facility. It is my understanding that there was significant discussion among the Downstream Team members regarding the appropriate level of flow, resulting in a starting point of 500 cfs with the potential to expand the capacity in the future if necessary. We have concerns that the current plan allows for expansion only to 750 cfs, rather than to 1000 cfs, which we believe was the understanding of the Downstream Team members, as well as American Rivers.

Third, we support the calls that future studies include testing of the Behavioral Guidance Structure (BGS). As already noted, success of the BGS in guiding fish to the capture location is a critical element in the effectiveness of the Lake Scanewa Collector. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector, American Rivers recommends that Tacoma collect as much information as possible regarding the BGS prior to constructing and operating this collector.

Fourth, fish passage facilities throughout the Northwest are required to meet NMFS' criteria for Anadromous Salmonid Passage Facility Design. Tacoma's Cowlitz Project is no exception. This should be made clear throughout the CDR.

Finally, it goes without saying that an essential element of improving downstream juvenile fish collection is a comprehensive adaptive management plan. American Rivers looks forward to working with Tacoma on a plan through the FTC.

Thank you again for the opportunity to comment. We look forward to working with you to resolve these issues and begin implementing a fish passage plan that moves the basin closer to meeting the necessary juvenile fish collection standards.

Sincerely,

Brett Swift

State of Washington
Department of Fish and Wildlife
2108 Grand Blvd. Vancouver WA 98661 (360) 906-6700

January 23, 2012

Debbie Young
Natural Resources Manager
Tacoma Power
P.O. Box 11007
Tacoma, Washington 98411

Dear Ms. Young,

Thank you for providing Washington Department of Fish and Wildlife (WDFW) with the opportunity to review the 12/20/11 Draft of the "Conceptual Design Report Cowlitz River Project (FERC No. 2016) Downstream Fish Passage" (Conceptual Design Report). The majority of our comments are included in the attached word document as track changes in the actual report that was distributed for our review. In addition, we have some overarching comments that are included in this letter.

WDFW is concerned that there is no mention of the design of the mid-Riffe Lake collector in this report. During completion of the Conceptual Design Report there was language that committed Tacoma Power to initiate and complete design of the Mid-Riffe Lake Collector once the 100% design report was completed for the Lake Scanewa Collector. WDFW is concerned that removing this language was not agreed to by all parties, including WDFW, and has therefore reinserted this language back into the 12/20/11 Draft Conceptual Design Report.

While WDFW is agreeable to designing the primary entrance for a flow of 500 cfs with the potential to expanding to a flow of 750 cfs, WDFW is concerned that there is no reference to the potential for future expansion to 1,000 cfs. WDFW has consistently requested that the design of the Lake Scanewa Collector include the potential for expansion to a 1,000 cfs flow if necessary to achieve the Settlement Agreement Fish Passage Survival Goal (SA FPS Goal) described in the draft Final Conceptual Design Report. WDFW has provided some edits to the attached document that include references to the 1,000 cfs flow to the primary entrance. WDFW would appreciate the inclusion of these edits in the Final Conceptual Design Report.

Case 2 presented in the draft Conceptual Design Report include a secondary entrance near the face of Cowlitz Falls Dam. WDFW greatly appreciates Tacoma Power's response to past WDFW comments on this issue by including this additional entrance as part of the draft Final Conceptual Design Report. WFDFW is however concerned that a specific flow has been associated with this additional entrance. It was WDFW's expectation that the flow to this additional entrance would determined through the upcoming physical or conceptual flow modeling. WDFW is concerned that deciding on flow to the additional entrance prior to completion of the aforementioned modeling efforts may decrease the effectiveness of this additional entrance. WDFW believes that identifying the flow that will be most effective for this additional entrance will be critical to the success of this entrance, which has taken on increased importance due to the recent addition of this entrance to the design process.

WDFW is concerned that future studies do not include continued testing of the Behavioral Guidance Structure (BGS). Success of the BGS in guiding fish to the capture location is a critical element to the success of the Lake Scanewa Collector. While data collected by testing the BGS in 2012 may not be completed in time to contribute to the 30% design, it would be available for use as efforts move towards a final design for the Lake Scanewa Collector. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector WDFW would expect Tacoma Power to collect as much information regarding that structure as possible prior to constructing and operating this collector. WDFW needs to understand why continued evaluation of the BGS is not included in this draft Conceptual Design Report.

During discussions regarding design of the Lake Scanewa Collector WDFW consistently asked that an option to discharge flow downstream of Cowlitz Falls Dam be considered. In review of this draft conceptual design report WDFW does not see any reference to consideration for discharge downstream of Cowlitz Falls Dam. WDFW is requesting that this discharge option be considered as part the upcoming physical or conceptual flow modeling.

Previous drafts of this Conceptual Design Report have included references to National Marine Fisheries Service (NMFS) criteria for screens and water intake. All of those references have been deleted from this most recent draft of the Final Conceptual Design Report. WDFW is requesting that those references be reinserted into the final version of the Conceptual Design Report. These references to NMFS criteria were included in pages 11 and 12 of the previous version of the Conceptual Design Report.

Finally, WDFW looks forward to working with you to develop an effective Adaptive Management Plan that helps us all implement juvenile collection facilities that achieve the SA FPS Goal described in the draft Conceptual Design Report. WDFW believes that the Adaptive Management Plan will be critical to designing, constructing and operating a collection facility that will achieve the SA FPS Goal. Effective planning and implementation of both Objective 1 (interim actions) and Objective 2 (post-operation modifications) will be critical to the long term success of this juvenile collection facility. Time is limited to complete the Adaptive Management Plan and WDFW is committed to work with Tacoma Power, and other interested FTC entities, to complete the Adaptive Management Plan within the designated time line.

Thank you again for providing WDFW with the opportunity to provide input on the draft Final Conceptual Design Report. We hope that our comments are useful. We provided these comments with the intent to be constructive and to develop a plan that will lead us all to a taking actions that will achieve the SA FPS Goal. If you have any questions or concerns regarding our comments please feel free to contact me.

Sincerely,

Patrick Frazier
Region 5 Fish Program Manager

Cc: Keith Underwood (Tacoma)
Michelle Day (NMFS)
John Serl (WDFW)
Eric Kinne (WDFW)

Here are NMFS' comments on Conceptual Design Report (CDR), Cowlitz River Project (FERC No. 2016) Downstream Fish Passage (dated 20 December 2011). Thank you for the opportunity to review and provide comments on the document.

NMFS agrees with comments submitted earlier today by Washington Department of Fish and Wildlife (January 23, 2012, e-mail from Pat Frazier, WDFW, to Debbie Young and Keith Underwood, Tacoma). We look forward to working with you and other interested FTC parties to finalized the CDR.

General comments:

There is no mention of the design of the mid-Riffe Lake collector in this version of the report. In other versions, there was language that committed Tacoma Power to initiate and complete design of the Mid-Riffe Lake Collector once the 100% design report was completed for the Lake Scanewa Collector. NMFS is not in support of removing this language and requests that this is put back in.

The future studies do not include testing of the Behavioral Guidance Structure (BGS). Success of the BGS in guiding fish to the capture location is a critical element to the success of the Lake Scanewa Collector. While data collected by testing the BGS in 2012 may not be completed in time to contribute to the 30% design, it would be available for use as efforts move towards a final design. Given the importance of the BGS to the effectiveness of the Lake Scanewa Collector, NMFS expects Tacoma to collect as much information as possible regarding the BGS prior to constructing and operating this collector. If the BGS does not work as hoped, then the alternative with the main entrance located upstream may not be the best alternative. Also, the auxiliary entrance may need to be designed with higher entrance flows than currently contemplated.

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NMFS is committed to work with Tacoma and other interested FTC entities to complete the Adaptive Management Plan identified in the CDR.

Specific Comments:

Section 2.5.1, page 2-18. The second paragraph needs to be updated. Fall Chinook have been transported above Cowlitz Falls (started in 2010). Also, this paragraph is confusing because it leaves coho out. Coho should be added to the discussion in this paragraph.

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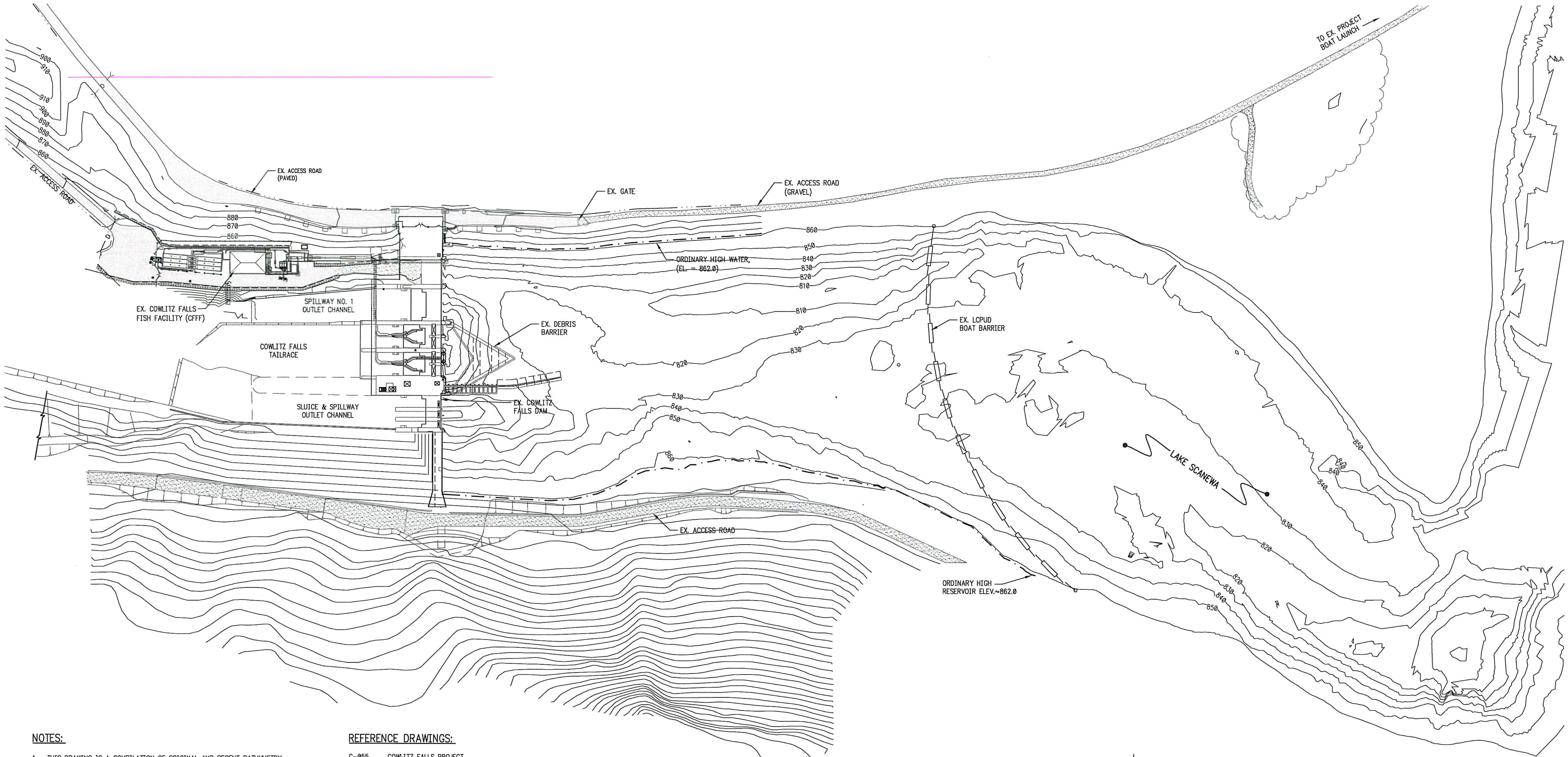
Section 6.2, page 6-3. Last paragraph. Under potential modifications, an example identified was "opening an auxiliary entrance". So if the alternative selected has two entrances, this would be a third entrance?

Section 6.2, page 6-4. Last paragraph. The DFPT has been disbanded; therefore, DFPT will not be the group developing the AMP. Maybe it is the design team or a teamlet from the FTC. The part of the sentence that reads: ". . . and completed at the same time as the 30% design of the facility currently scheduled to commence on June 2012" is confusing. Does this mean work on the AMP will start June 2012? Please clarify.



NOTES:

1. THIS DRAWING IS A COMPILATION OF ORIGINAL AND RECENT BATHYMETRY AND TOPOGRAPHIC SURVEYS. THIS DRAWING SHALL SERVE AS THE SURVEY OF RECORD AND IS THE BASIS FOR ALL SUBSEQUENT CIVIL DRAWINGS.
2. BATHYMETRY SURVEY PERFORMED ON JUNE 28, 2011 BY TACOMA POWER AND THEN UPDATED (IN VICINITY OF UPSTREAM COLLECTOR FEATURES) USING THE LATEST IN MULTI-BEAM SONAR TECHNOLOGY BY TETRA-TECH, INC. ON MARCH 28, 2014.
3. NORTH SHORE TOPOGRAPHIC SURVEY PERFORMED BY TACOMA POWER ON MAY 11, 2011, (UPSTREAM SIDE OF DAM), JANUARY 17, 2013 AND MARCH 18, 2103 (DOWNSTREAM SIDE OF DAM).
4. TOPOGRAPHIC CONTOURS SOUTH OF COWLITZ FALLS DAM AND RESERVOIR ARE BASED UPON THE ORIGINAL CONSTRUCTION DRAWINGS AND HAVE NOT BEEN VERIFIED RECENTLY. IF CONSTRUCTION EXPANDS INTO THAT AREA, THE TOPOGRAPHY SHOULD BE VERIFIED.
5. CONTROL FOR SURVEYS CONDUCTED IN 2011, 2012, 2013 AND 2014 WAS ESTABLISHED BY UTILIZING MONUMENTS SP6 AND SP11 AS PER ORIGINAL BECHTEL DRAWING C-055.
6. THE CONTRACTOR SHALL LOCATE ALL NEW FEATURES IN RELATION TO DAM GRIDLINES Ⓐ & ②.

REFERENCE DRAWINGS:

C-055	COWLITZ FALLS PROJECT INSTRUMENTATION (BECHTEL DRAWING)
1-C1.0	COWLITZ FALLS DAM NORTH SHORE COLLECTOR UPSTREAM SITEPLAN
1-C1.1	COWLITZ FALLS DAM NORTH SHORE COLLECTOR COLLECTOR SITE PLAN
1-C1.2	COWLITZ FALLS DAM NORTH SHORE COLLECTOR DOWNSTREAM SITE PLAN

LEGEND:

- 321 — EXISTING CONTOUR
- EXISTING LOG BOOM OR DEBRIS BARRIER
- EXISTING GUARDRAIL
- EXISTING ASPHALT PAVEMENT
- EXISTING GRAVEL ROAD

N

SCALE: 1"=100'

0 50 100 200

COWLITZ FALLS PROJECT DATUM MONUMENTS SP11 TO SP6 EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV. NO. 0

FIELD BOOK:

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL			

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
SURVEY OF RECORD

SUBMITTED

APPROVED

DESIGNED	DRAWN	CHECKED
KJK	JCH	
9/19/2014	1"=100"	
DATE	SCALE	

DRAWING NO. 1-C0.1

SHEET NO.

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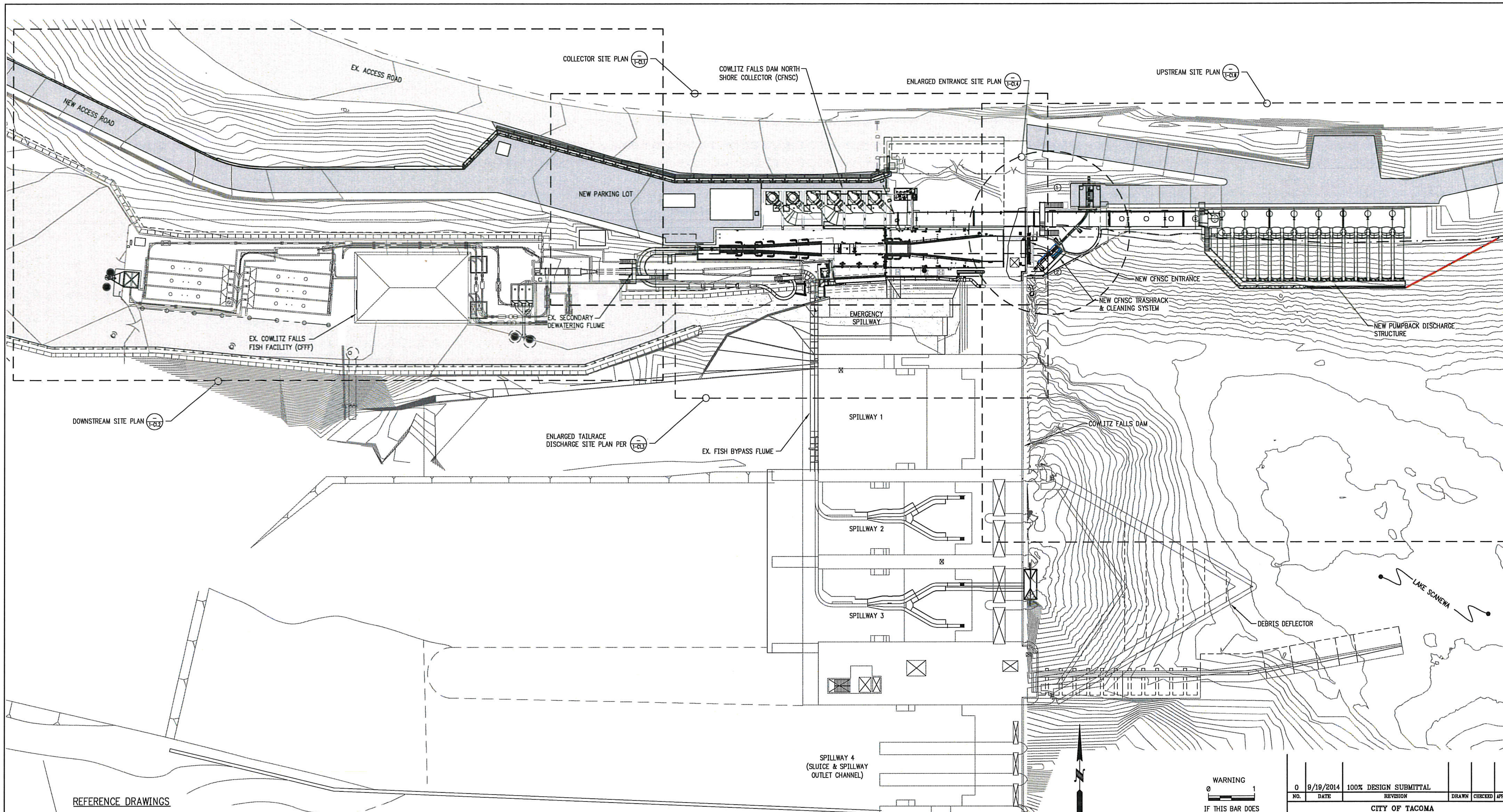

REFERENCE DRAWINGS

- 1-C1.0 NORTH SHORE COLLECTOR UPSTREAM SITE PLAN
- 1-C1.1 NORTH SHORE COLLECTOR COLLECTOR SITE PLAN
- 1-C1.2 NORTH SHORE COLLECTOR DOWNSTREAM SITE PLAN
- 1-C1.3 NORTH SHORE COLLECTOR ENLARGED TAILRACE DISCHARGE SITE PLAN
- 1-C1.4 NORTH SHORE COLLECTOR ENLARGED ENTRANCE SITE PLAN

SCALE: 1"=100'
0 50 100 200

COWLITZ FALLS PROJECT DATUM MONUMENTS SP11 TO SP6 EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL			

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

REV. NO. 0

FIELD BOOK:

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
CIVIL
OVERALL PLAN

SUBMITTED

APPROVED

DESIGNED	DRAWN	CHECKED
KJK	JCH	

DATE	SCALE
9/19/2014	1"=30'

DRAWING NO. 1-C0.2
SHEET NO.

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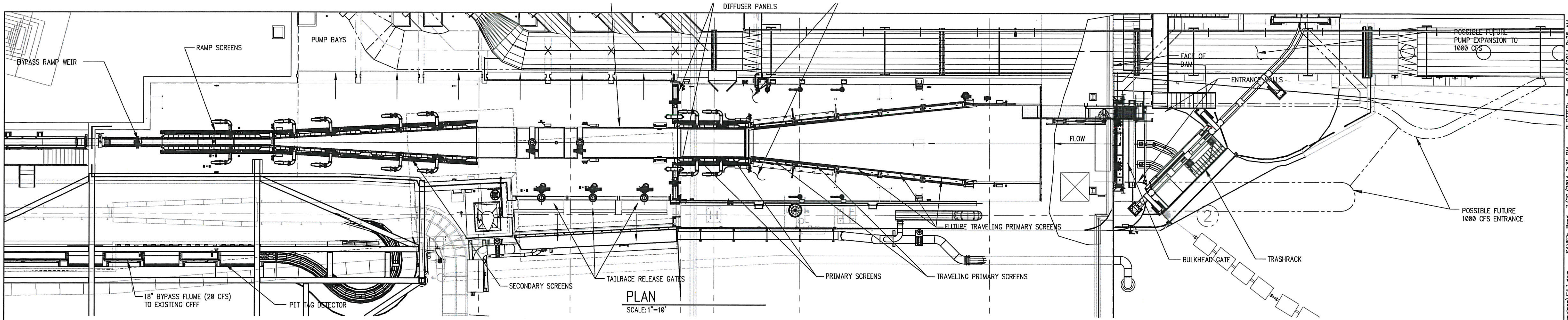

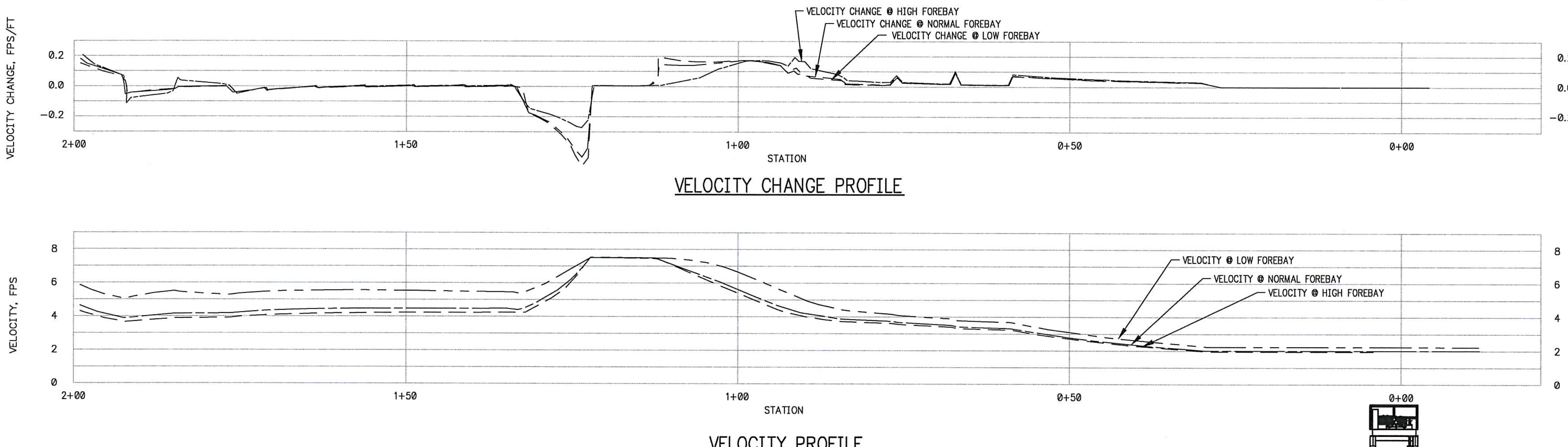

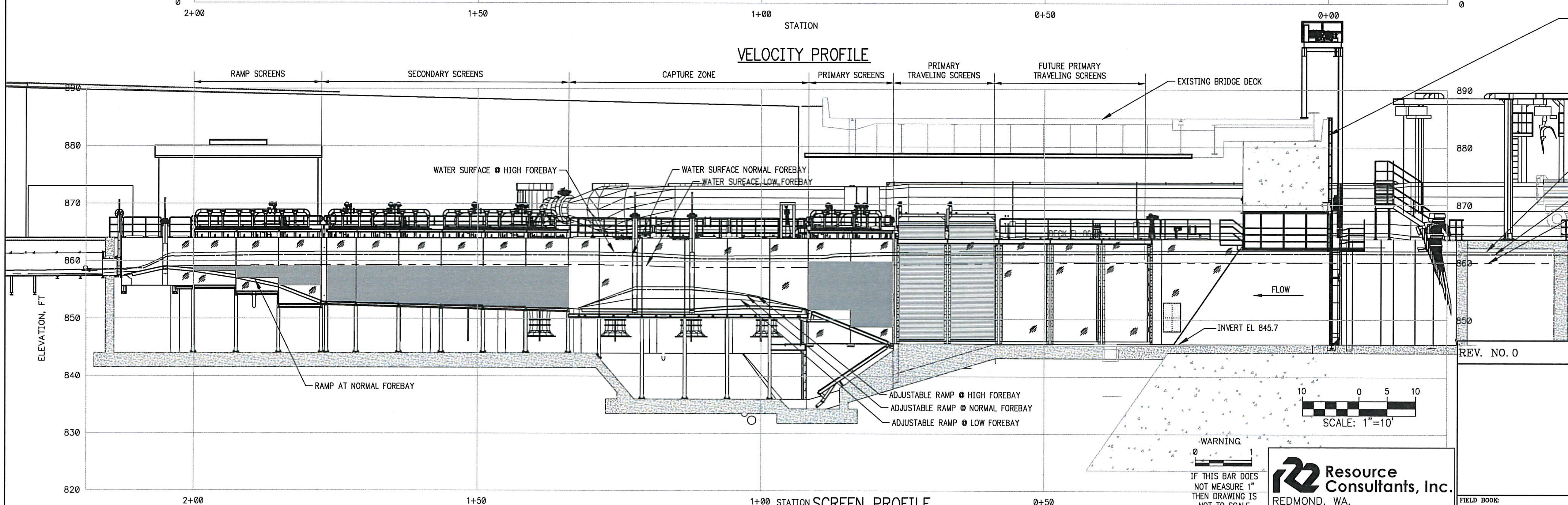

NOTES:

1. THE FLOW CONDITIONS DEPICTED ON THIS SHEET ARE 500 CFS AT THE ENTRANCE, 250 CFS THRU THE CAPTURE MODULE, AND 20 CFS OUT THE BYPASS.
2. THE APPROACH VELOCITY TO THE SCREENS IS 0.36 FPS.
3. THREE FOREBAY WATER SURFACE ELEVATION CONDITIONS ARE DEPICTED:

   LOW FOREBAY – 860.0 WS EL

   NORMAL FOREBAY – 861.5 WS EL

   HIGH FOREBAY – 862.0 WS EL
4. IN GENERAL SCREENS SHALL BE SS WEDGE WIRE WITH SPRAY BACKWASH CLEANERS.
5. THE FOUR SCREENS UPSTREAM – SHALL BE TRAVELING TYPE SCREENS.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

REV. NO. 0

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
500 CFS FLOW CONDITIONS

Resource Consultants, Inc.
REDMOND, WA.

SUBMITTED
APPROVED
FIELD BOOK:

DESIGNED	DRAWN	CHECKED
FEP	JES	

DATE	SCALE
9/19/2014	1"=10'

DRAWING NO. G4.1
SHEET NO.

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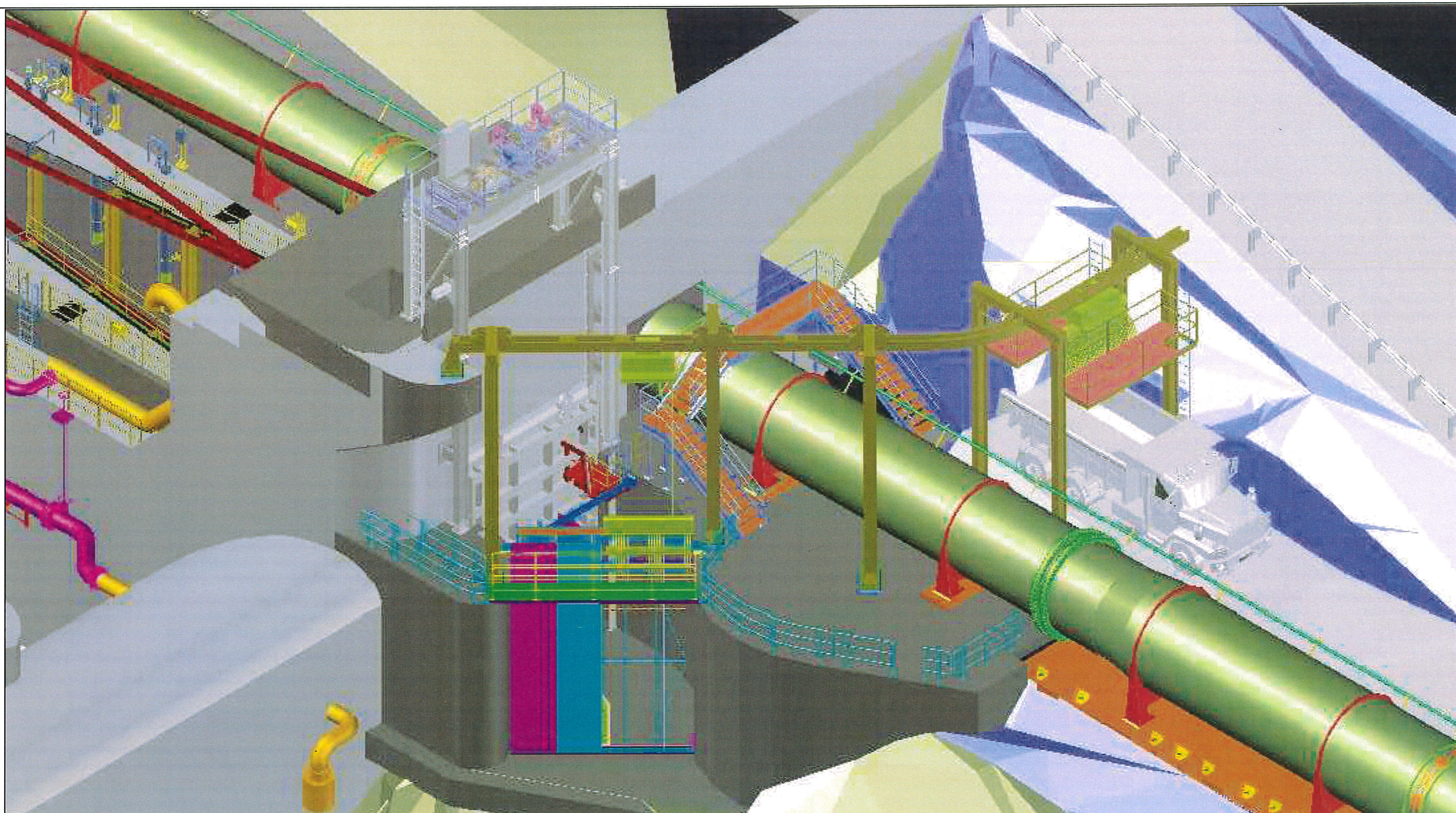


ISOMETRIC

COWLITZ FALLS PROJECT DATUM
MONUMENTS SP11 TO SP6
EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

SCALE: ¼"=1'-0"
0 2' 4' 8'

Resource Consultants, Inc.
REDMOND, WA.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV. NO. 0

FIELD BOOK:

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
ENTRANCE AREA
ISOMETRIC

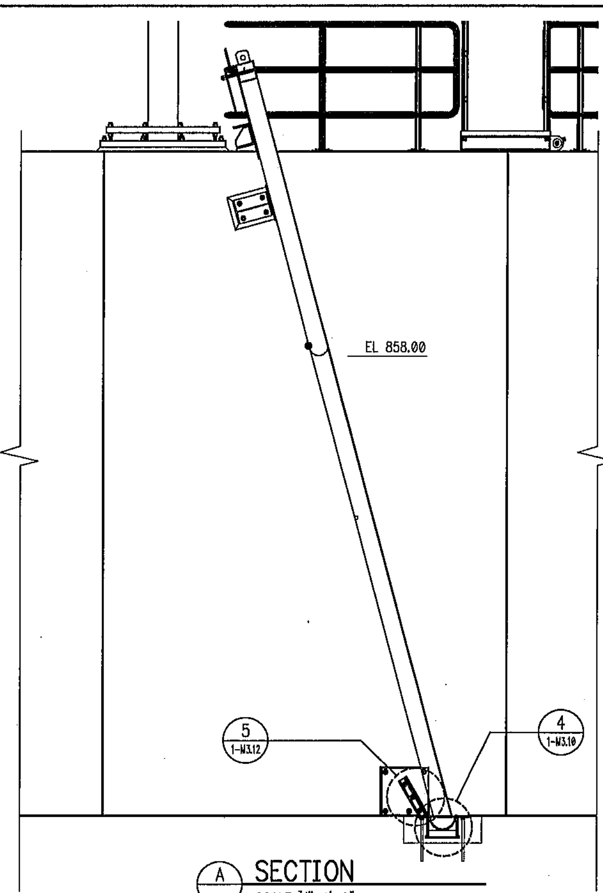
SUBMITTED

APPROVED

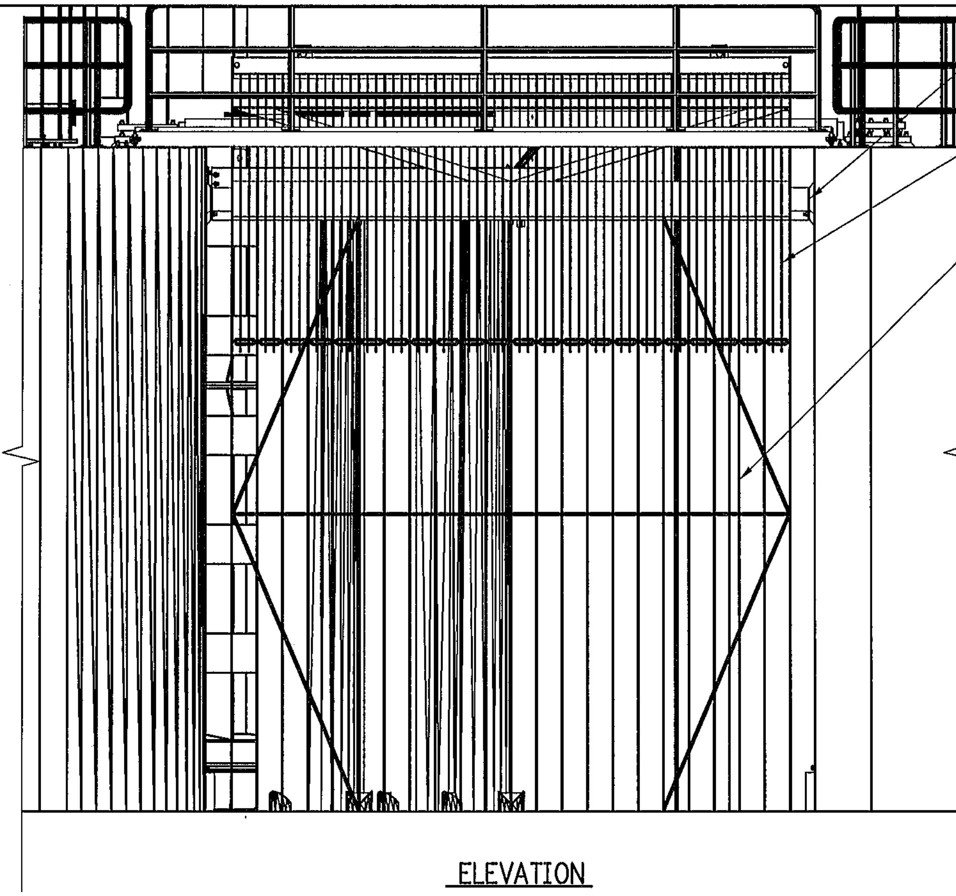
DESIGNED	DRAWN	CHECKED
FEP	JES	

DATE: 9/19/2014
SCALE: 3/8=1'-0"
DRAWING NO. 1-M3.04
SHEET NO.

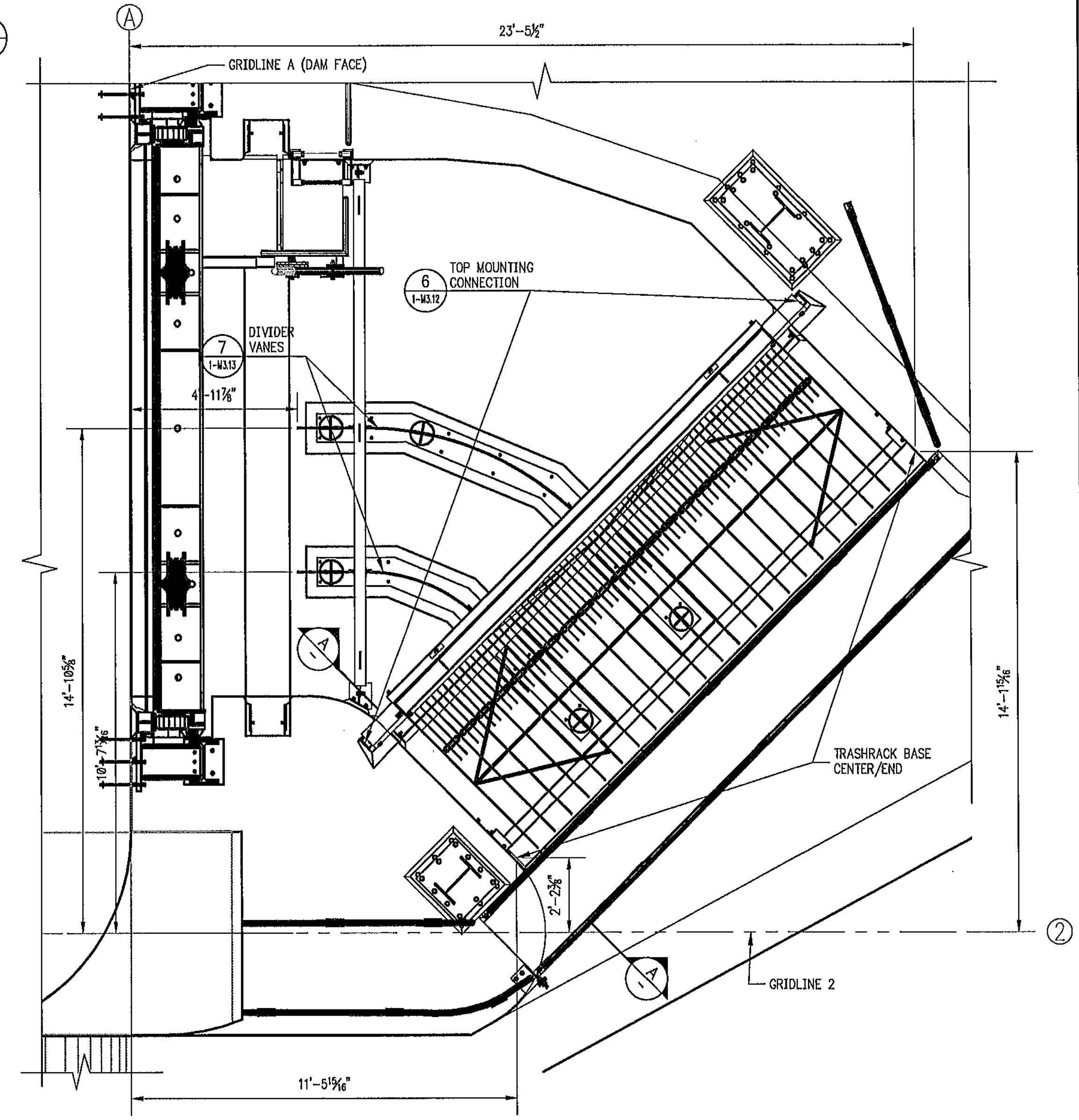
FILED IN: \\Nas\shared projects\1952 Cowlitz Falls DS Fish Capture Facility\Drawings\1-M3.04.dwg SAVED: Jim 9/18/2014 3:03 PM PLOTTED: Jim 9/18/2014 3:06 PM



A SECTION
SCALE: 3/8"=1'-0"

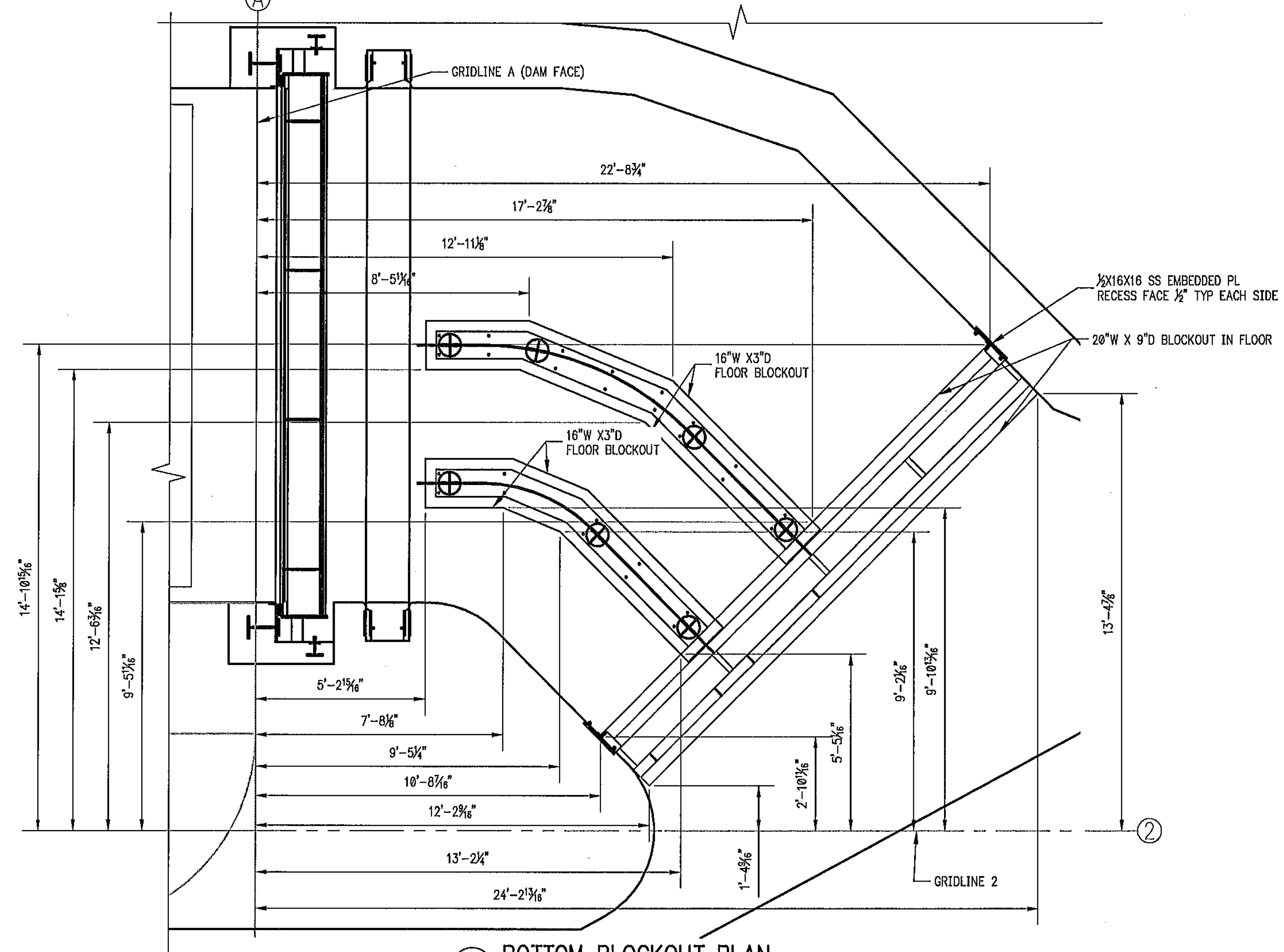


ELEVATION



OVERALL PLAN

1 TRASH RACK
1-M1.2
SCALE: 3/8"=1'-0"



1 BOTTOM BLOCKOUT PLAN
1-M1.1
SCALE: 3/8"=1'-0"

COWLITZ FALLS PROJECT DATUM
MONUMENTS SP11 TO SP6
EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

SCALE: 3/8"=1'-0"
0 6" 1' 2' 3' 4' 6'

Resource Consultants, Inc.
REDMOND, WA.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV. NO. 0

FIELD BOOK:

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
TRASHRACK
PLAN AND SECTIONS

SUBMITTED

APPROVED

DESIGNED	DRAWN	CHECKED
FEP	JES	

DATE	SCALE
9/19/2014	3/8"=1'-0"

DRAWING NO.
1-M3.07
SHEET NO.

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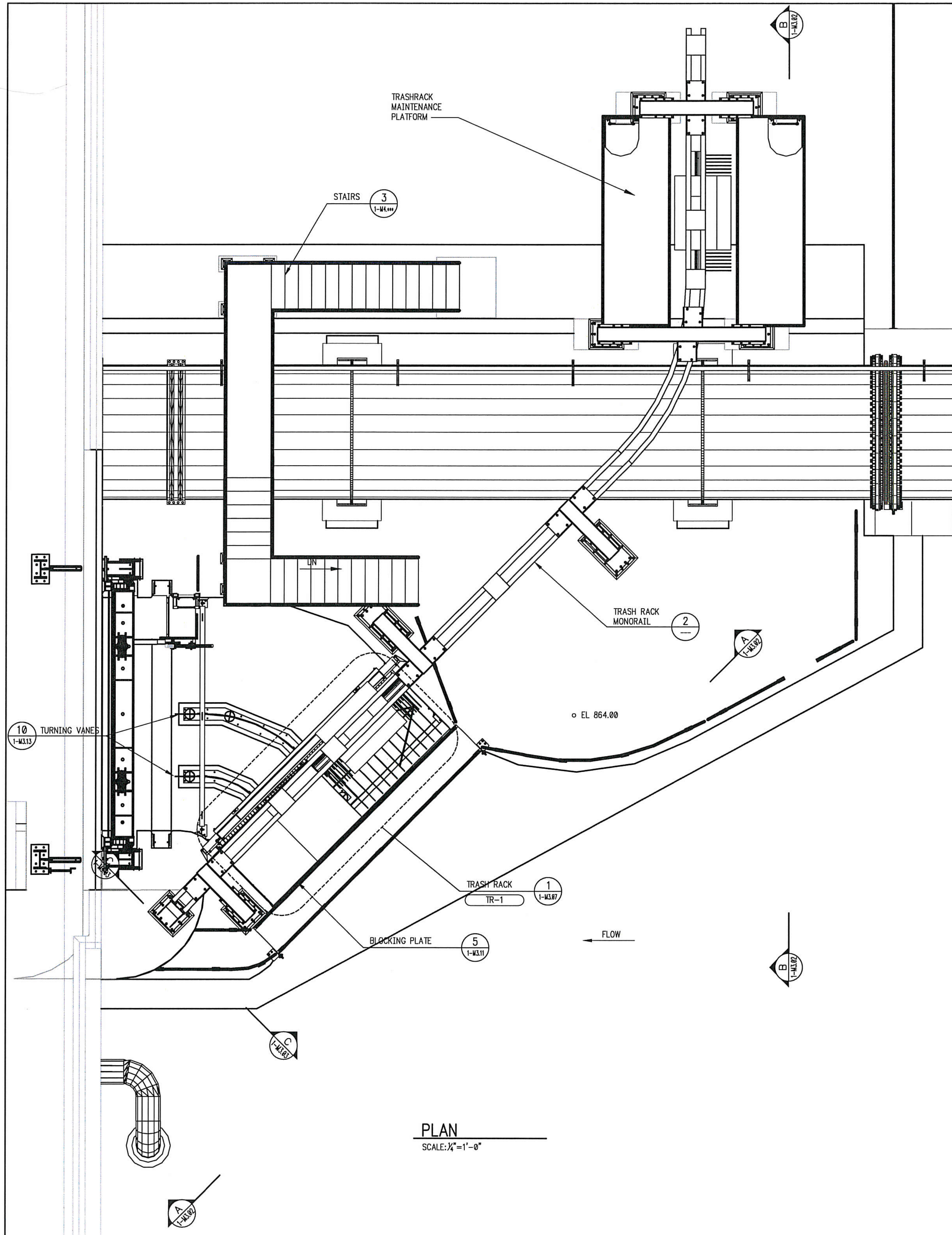
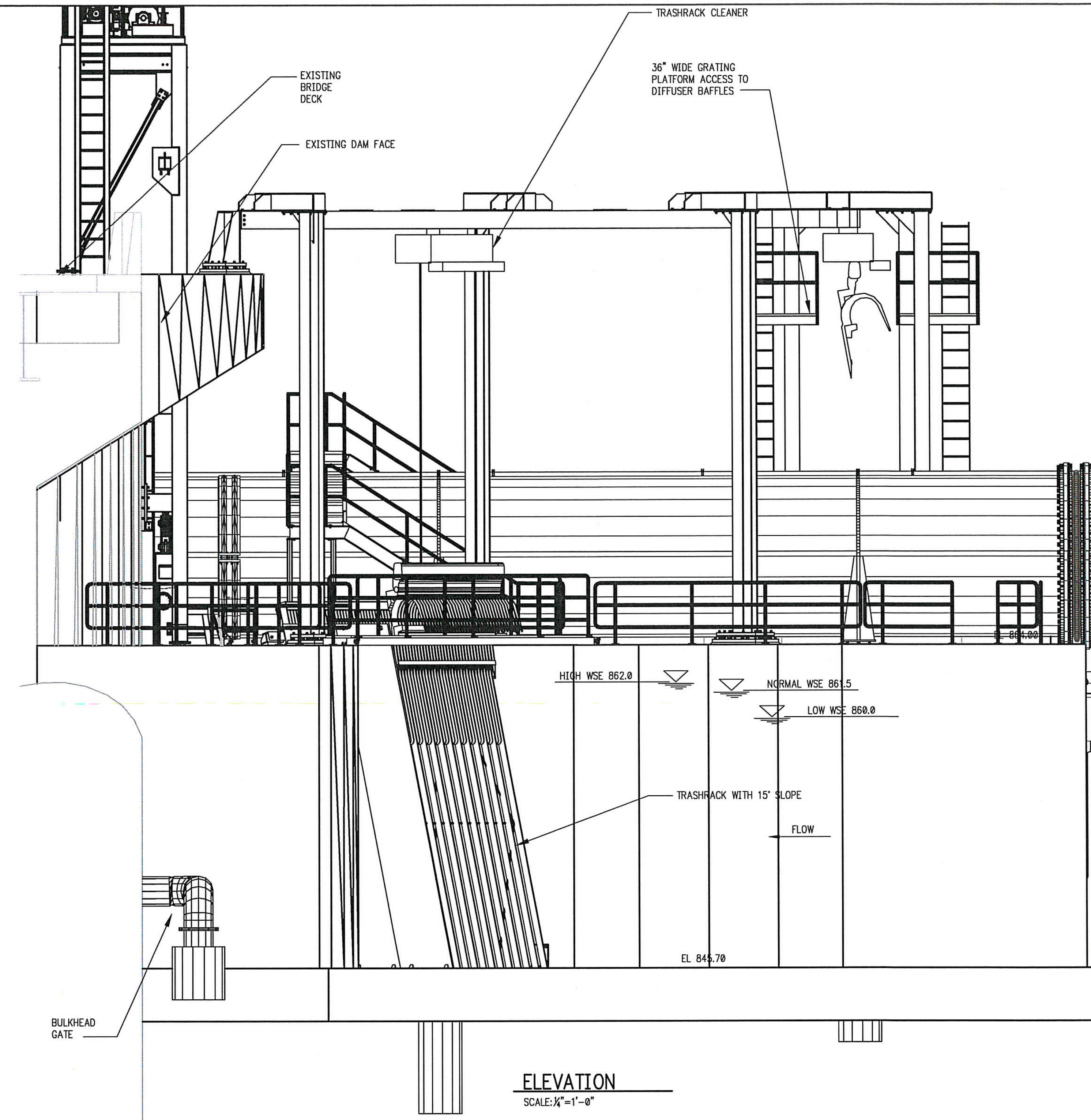


PLAN
SCALE: 1/4"=1'-0"



ELEVATION
SCALE: 1/4"=1'-0"

COWLITZ FALLS PROJECT DATUM
MONUMENTS SP11 TO SP6
EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

SCALE: 1/4"=1'-0"
0 2' 4' 8'

Resource Consultants, Inc.
REDMOND, WA.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV. NO. 0

FIELD BOOK:

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
ENTRANCE AREA
PLAN AND SECTION

SUBMITTED

APPROVED

DESIGNED	DRAWN	CHECKED
FEP	JES	

DATE	SCALE
9/19/2014	3/8=1'-0"

DRAWING NO.
1-M3.01
SHEET NO.

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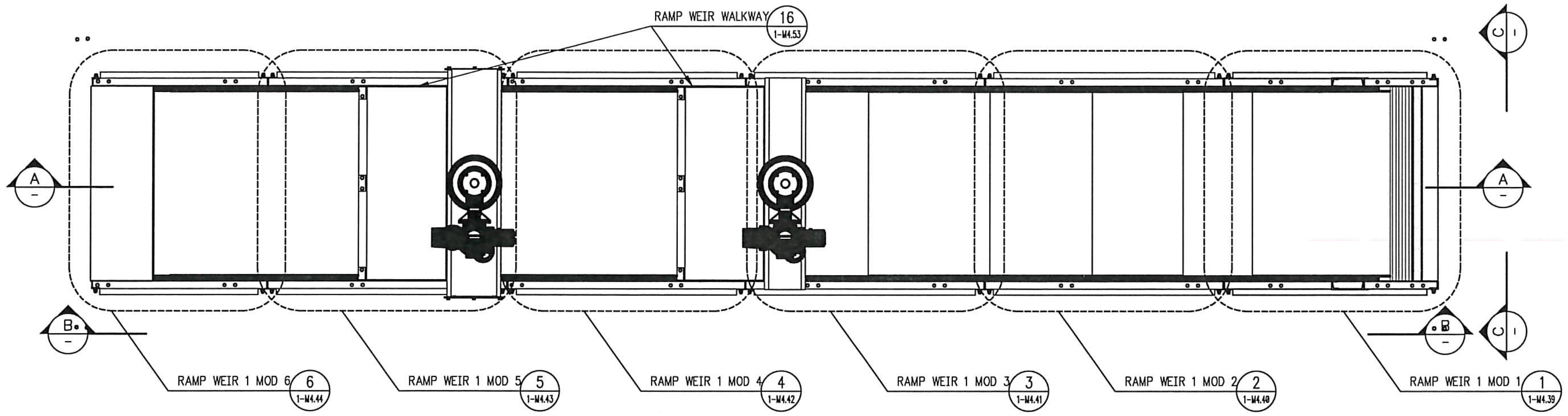
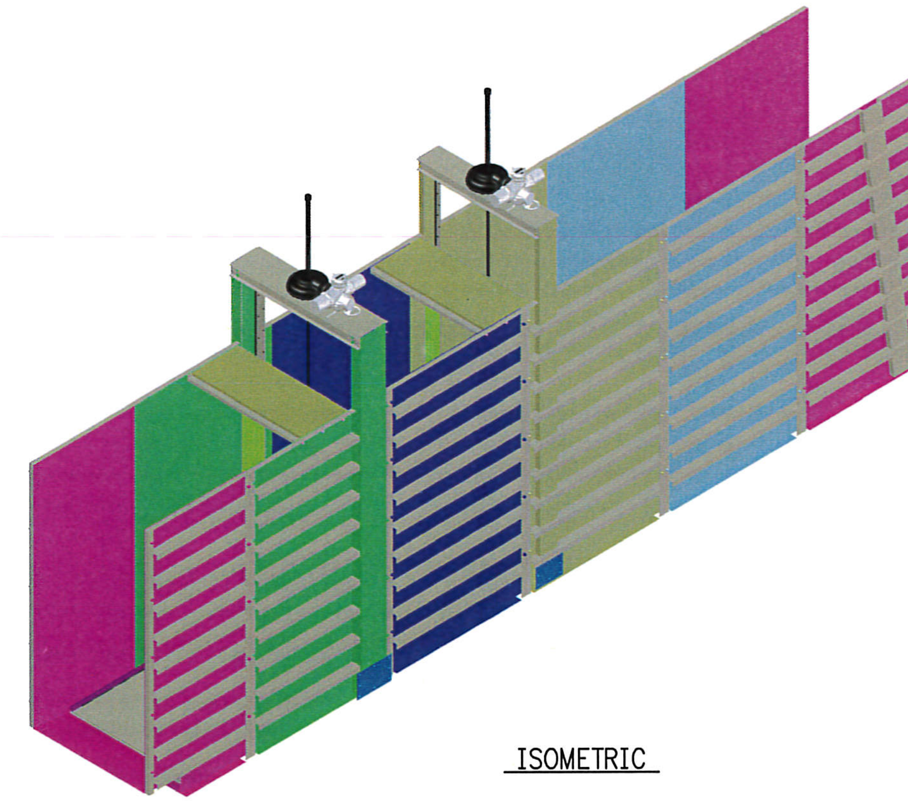


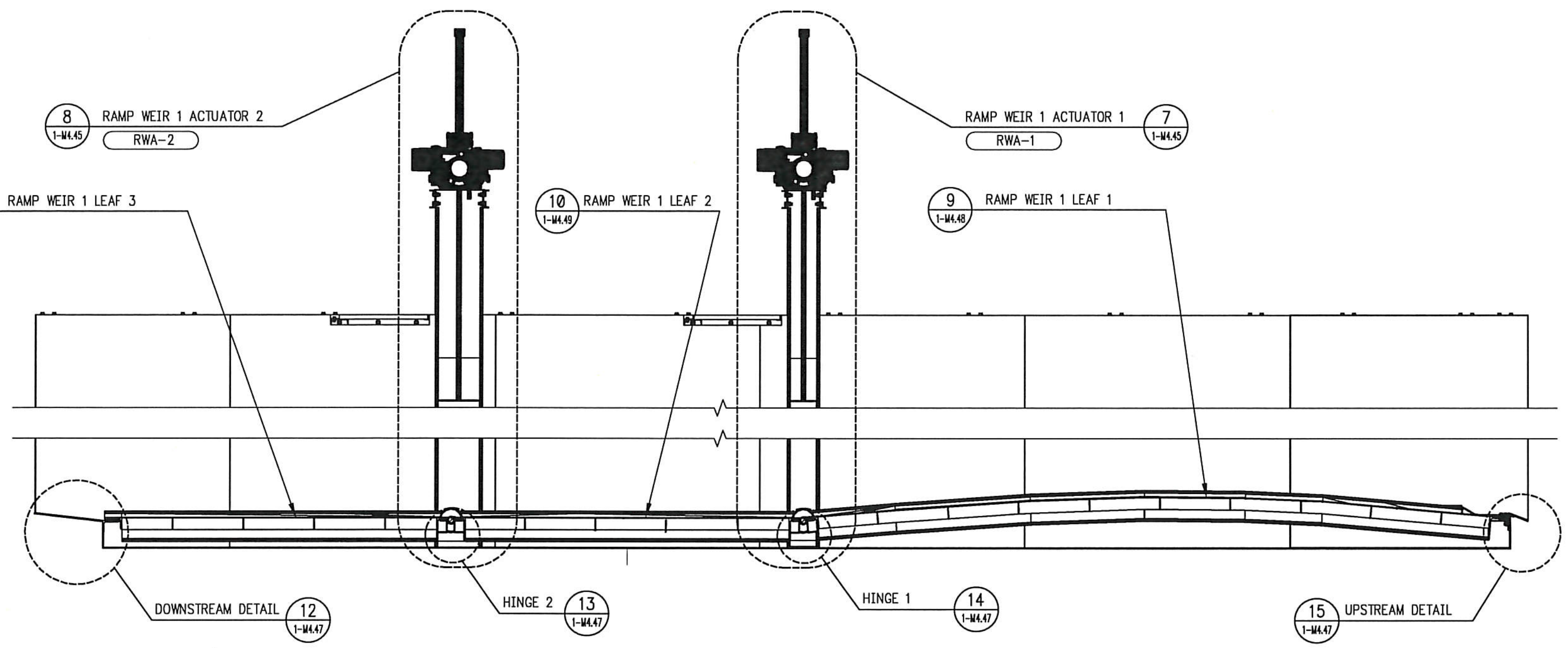
PLAN

1 (1-M4.37) CAPTURE ZONE RAMP WEIR 1

SCALE: 3/8"=1'-0"

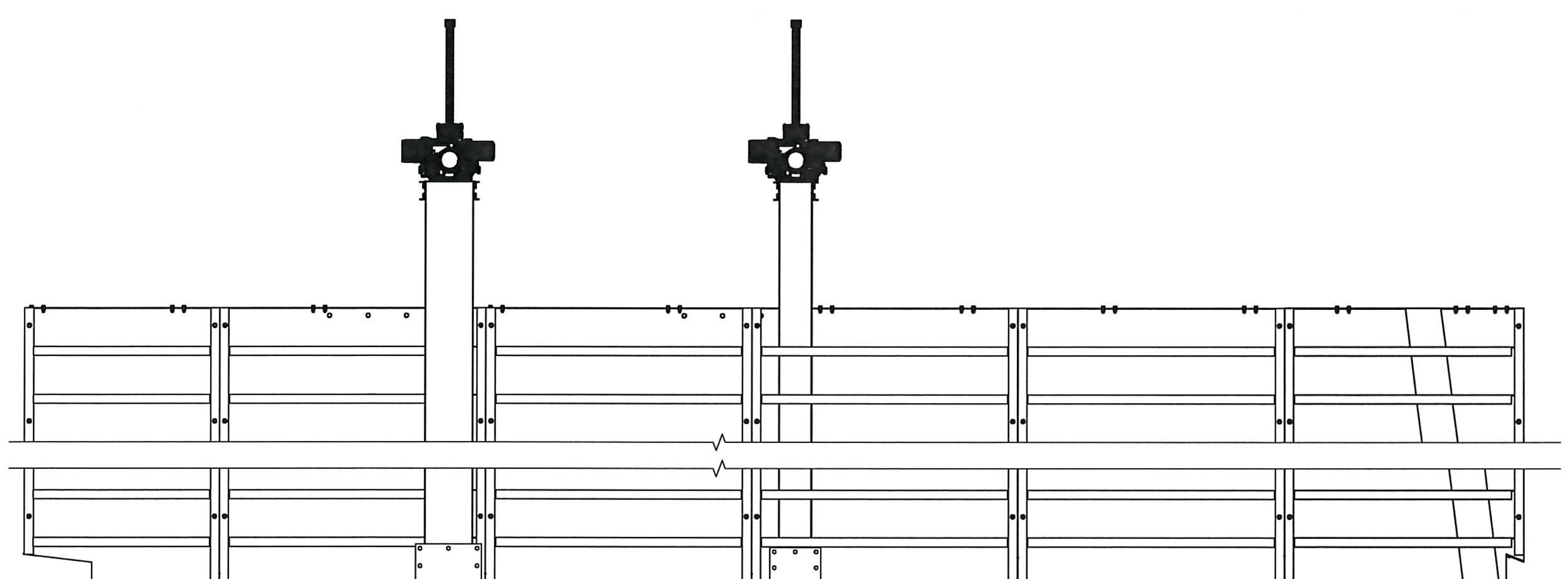


ISOMETRIC



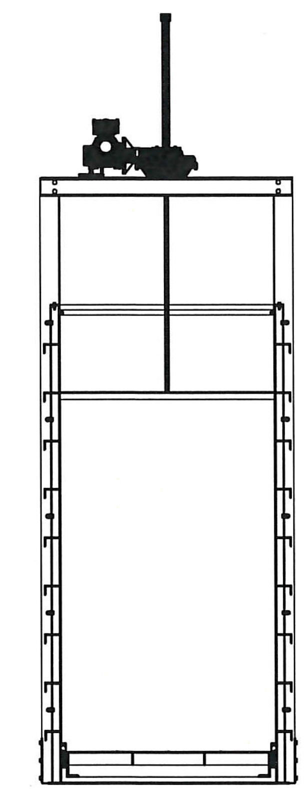
A SECTION

SCALE: 3/8"=1'-0"



B SECTION

SCALE: 3/8"=1'-0"



C SECTION

SCALE: 3/8"=1'-0"

NOTES:

1 RAMP WEIR SHALL BE FABRICATED AND INSTALLED PER SPEC 46 80 11 – RAMP WEIRS.

COWLITZ FALLS PROJECT DATUM
MONUMENTS SP11 TO SP6
EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

SCALE: 3/8"=1'-0"
0 6" 1' 2' 3' 4' 6'

Resource Consultants, Inc.
REDMOND, WA.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV. NO. 0

FIELD BOOK

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
CAPTURE ZONE RAMP WEIR
DETAILS 1

SUBMITTED	DESIGNED	DRAWN	CHECKED
	FEP	JES	
APPROVED	DATE 9/19/2014	SCALE 3/8=1'-0"	
	DRAWING NO. 1-M4.38		
	SHEET NO.		

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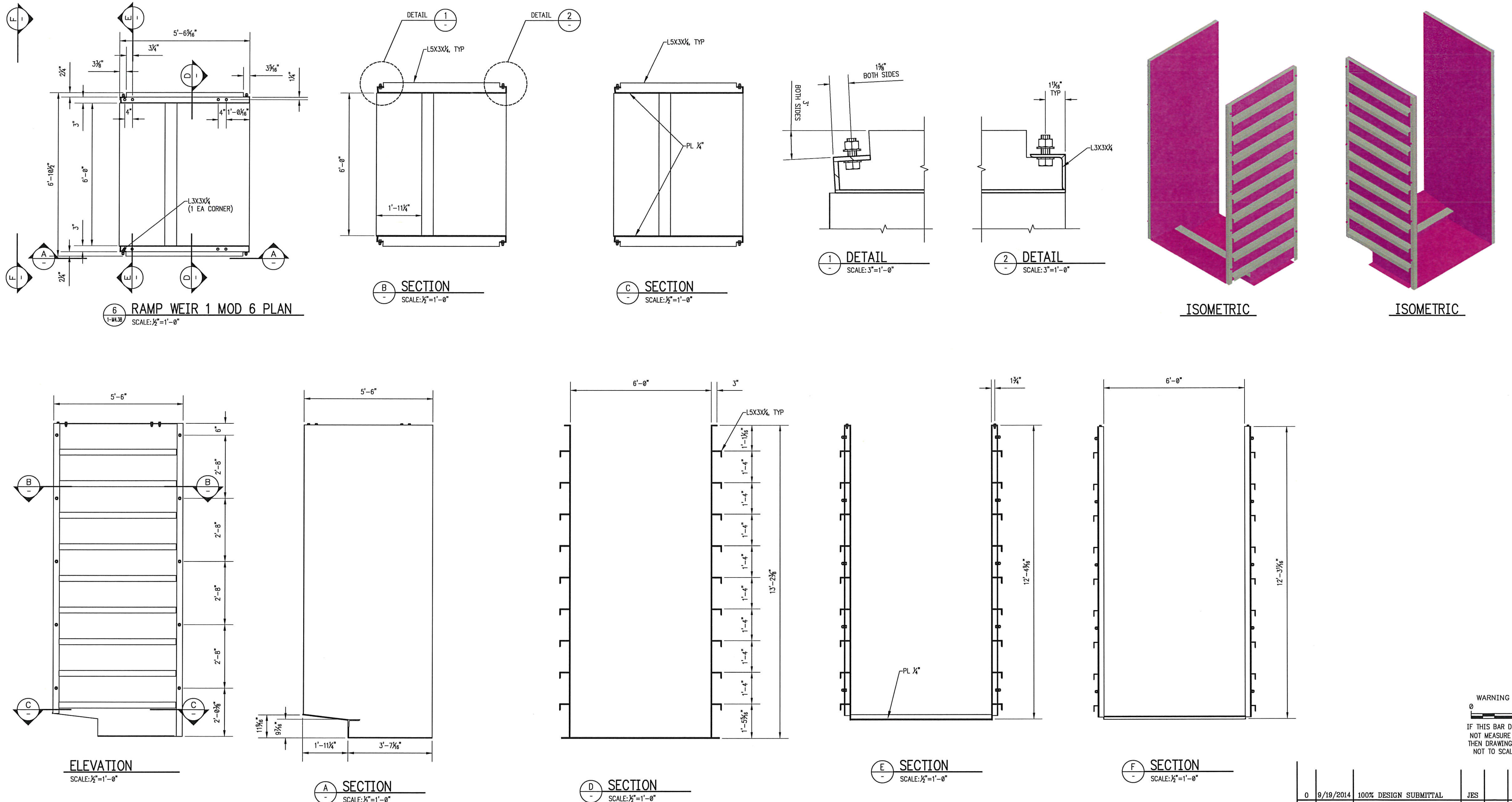

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

COWLITZ FALLS PROJECT DATUM
MONUMENTS SP11 TO SP6
EQUALS NORTH

VERTICAL DATUM
COWLITZ FALLS PROJECT DATUM
BM SP6 = 888.55

SCALE: ½"=1'-0"
0 1' 2' 4'

Resource Consultants, Inc.
REDMOND, WA.

NO.	DATE	REVISION	DRAWN	CHECKED	APPROVED
0	9/19/2014	100% DESIGN SUBMITTAL	JES		

REV. NO. 0

FIELD BOOK:

CITY OF TACOMA
DEPARTMENT OF PUBLIC UTILITIES
LIGHT DIVISION

COWLITZ FALLS DAM
NORTH SHORE COLLECTOR
CAPTURE ZONE RAMP WEIR
DETAILS 7

SUBMITTED

APPROVED

DESIGNED	DRAWN	CHECKED
FEP	JES	
9/19/2014 DATE	3/8=1'-0" SCALE	

DRAWING NO. 1-M4.44

SHEET NO.

FILED IN: \\Nas\shared projects\1952 Cowlitz Falls DS Fish Capture Facility\Drawings\1-M4.44.dwg SAVED: Brad 8/21/2014 12:20 PM PLOTTED: Jim 9/16/2014 11:07 AM