APPENDIX E – DESIGN CONSIDERATIONS

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E.1 -- Executive Summary

This appendix is a summary of the conceptual design undertaken for the Mud Mountain Fish Passage Project. Two design alternatives are being developed to replace the existing Puget Sound Energy (PSE) Diversion Dam and upgrade the existing COE adult fish trap facilities: the Federally Preferred Plan and the Locally Preferred Plan.

Under the Federally Preferred Plan, the existing dam will be replaced with a concrete ogee-crest spillway with crest elevation 672.0-fmsl and apron elevation 663.3. The dam's geometry will function as a barrier to upstream fish passage up to at least 4,000-cfs and provide gravity flow water supply to the fish trap. A single 16-ft wide radial gate with sill elevation 657.0 will be located adjacent to the left bank providing headwater control to approximately 3000-cfs, and allowing for passage of bedload and debris events which may potentially accumulate in front of the fish trap supply flow intake. An additional 35-ft wide radial gate is contemplated for inclusion at the next stage of design. Under this plan, the right bank levee upstream of the dam will be raised to minimum crest elevation 679.0 from the dam to Sta 7+80.

Under the Locally Preferred Plan, the diversion dam will be replaced with a structure comprising the following components: a fixed-crest weir section, two inflatable rubber weirs, a 35-ft wide radial gate, and a 16-ft wide radial gate. The fixed-crest weir section located adjacent to the right bank abutment will consist of six 18-ft wide removable concrete panels with crest elevations 672.75-fmsl. Two identical rubber weirs will be positioned near the center of the river channel between the fixed crest section and the radial gates. Each rubber weir will have inflated crest lengths of approximately 65-ft and crest elevations 672.5. The 35-ft radial gate will be situated between the left rubber weir and the 16-ft radial gate, which in turn will be positioned adjacent to the new fish trap water supply intake and fish bypass facilities. Both gates will have sill elevations 657.0 and crest elevations 672.5. The two gates will work in tandem to maintain the normal headwater elevation 671.5, and will work in combination with the rubber weirs to pass flood flows.

For both plans, several modifications and updates are proposed for the adult fish trap facilities. To comply with juvenile fish screen criteria, a screened intake with an automated cleaning brush will be provided between the left bank and the 16-ft radial gate. The screen will be sized for a maximum combined flow of approximately 130-cfs for the trap, auxiliary attraction water, and the right bank hatchery entrance. A fish bypass flow control ramp with an adjustable crest situated downstream of the intake screens will be operated to raise and lower in conjunction with radial gate operation in response to varying river flows. The auxiliary attraction water system will be reconfigured and a new trap entrance and transport channel will extend downstream from the existing trap entrance.

E.2 -- Civil Improvements Description

2.1 REFERENCES AND DESIGN STANDARDS

2.1.1 NOAA Fisheries, "Anadromous Salmonid Passage Facility Guidelines and Criteria (DRAFT)

2.2 CIVIL CRITERIA

2.2.1 Right Bank Levee

2.2.1.1 The levee will remain stable and intact with minimum of 2-feet of freeboard up to the 100-year Recurrence - 12,000-cfs.

2.2.1.2 Vehicular access will be provided up to the 100-year Recurrence - 12,000-cfs.

2.2.2 Diversion Intake

2.2.2.1 Vehicular Access will be provided up to the 100-year Recurrence - 12,000-cfs.

2.2.3 General Supporting Facilities

2.2.3.1 Access Roads

(a) Access roads will remain stable and intact with minimum of 2-feet of freeboard up to the 100-year Recurrence - 12,000-cfs.

(b) Facility Vehicular Access will be provided up to the 100-year Recurrence - 12,000-cfs.

E.3 -- Features Common to Both Plans

3.1.1 Adult Barrier System

3.1.1.1 Toe Protection: A 10-ft deep layer of 6-ft diameter riprap will extend 10-ft downstream from the toe of the spillway apron, and then will slope up to riverbed grade at 1.5H:1V. A combination of smaller riprap and filter fabric will separate the large riprap from native materials. The riprap will extend along the entire length of the adult fish barrier components. A shallow channel will be formed in the riprap for transverse fish passage along the toe of the spillway.

3.1.1.2 Upstream Protection: A 5-ft deep layer of 2-ft diameter riprap will extend 5-ft upstream from the upstream barrier edge, and will then slope up to riverbed grade at 1.5H:1V. A combination of smaller riprap and filter fabric will separate the large riprap from native materials. The riprap will extend along the entire upstream length of the adult fish barrier components.

3.1.2 General Supporting Facilities

3.1.2.1 Right Bank Road: 35-ft wide Access Easement

3.1.2.2 Left Bank Road: 25-ft wide Access Easement

3.1.2.3 Right Bank Levee: 60-ft wide Easement

3.2 Locally Preferred Plan

3.2.1 Right Bank Levee

3.2.1.1 Crest Width: 12-ft

3.2.1.2 Side Slopes: 2H:1V

3.2.1.3 12" Riprap Layer on river-facing slope

3.2.1.4 Minimum Crest Elevation 674.0-fmsl (for first 200-ft, sloping up to Crest EL 680.0 at Sta 8+00)

3.3 Federally Preferred Plan

3.3.1 Right Bank Levee

3.3.1.1 Crest Width: 12-ft

3.3.1.2 Side Slopes: 2H:1V

3.3.1.3 12" Riprap Layer on river-facing slope

3.3.1.4 Minimum Crest Elevation 679.0-fmsl

3.3.2 Diversion Intake

3.3.2.1 Decommissioning of Diversion Intake: In the earlier versions of the FPA, the area between the existing diversion headgates and the proposed left bank retaining wall (between the trap intake and upstream bank) was to be filled to minimum elevation 678.0-fmsl with crushed rock. The headgate openings were to be plugged with concrete walls. However, the PSE water right remains in effect, so no decommisssioning of the diversion intake is contemplated.

E.4 -- Structural Improvements Description

4.1 INTRODUCTION

4.1.1 Stability analyses were performed for representative dam sections of both the Federally Preferred Alternative and the Locally Preferred Alternative. Some of the design calculations were reviewed and evaluated against FERC's criteria for stability analyses of dams. The following are some points considered in the evaluation of the stability of these sections:

- MWH relied on Technical Memorandum No. 16 prepared by Geo Engineers on May 2, 1994 as a Final Geotechnical Report and recommendations of the diversion site.

- Mr. Paul F. Anderson of the ACOE prepared a summary to the Geo Engineers Final Report on March 23, 2002. Due to some discrepancies between Geo Engineers Final report and the summary prepared by the ACOE, MWH used the original report in preparing the design criteria for stability analyses.

- The Geo Engineers Final Report is very general and lacks many values and conditions necessary for accurate structural and stability calculations.

- There is no reference whatsoever to seismic loading, lateral earth pressures, or allowable bearing pressures due to a seismic event in Geo Engineer's report. MWH relied on past experience and design expertise in filling data and information gaps within the Geo Engineers report. The assumptions made by MWH were reviewed by, discussed with, and agreed upon by the ACOE. Notes were added to the Design Criteria sheets to further clarify MWH assumptions made in preparing the stability analyses calculations and results.

- The seismic coefficients for the Operating Base Earthquake [OBE] and the Maximum Credible Earthquake [MCE] used in these analyses are based upon what was reported by Mr. James Ryan (ACOE) to be listed in Design Memorandum 25, "Earthquake Analysis of MMD", September 1983.

- Engineering Regulation [ER] 1110-2-1806, "Earthquake Design and Evaluation for Civil Works Projects", July 31, 1995, ER Para 5.h.(2) requires site specific studies be conducted for all Zone 3 / 4 projects for OBE and MDE [MDE = MCE for critical projects]. The existing MMD geological, seismological and geotechnical studies do not cover this requirement. In addition, EM Para 5-2.c. stipulates a dynamic internal stress analysis be performed for gated spillway monoliths. However, Mr. James Ryan (ACOE) indicated in an E-mail forwarded to MWH on June 3, 2003 that the radial gate shown under the Federally Preferred Alternative is designed for debris control and flow routing instead of impoundment / flow passage, which may allow this requirement to be relaxed, pending consultation with higher headquarters of the ACOE.

4.1.2 For this level of study (35%), stability analyses calculations were performed for what are believed to be the most critical load conditions:

- Normal Operating

- Normal Operating w/OBE

- Normal Operating w/MCE

- Probable Maximum Flood [PMF] Discharge

4.1.3 Results from the stability analyses calculations are summarized in Sections E3.3, E3.4 and E3.5.

4.1.4 Calculations for the seven loading conditions shown at the end of EM Table 4-1 are not justifiable without further geotechnical information, Site Specific Seismicity Study, and at this level of design.

4.1.5 Three different uplift pressures were calculated for each section. The uplift pressures allowing seepage are substantially less than what was reported by the Geo Engineers Final Report. However, the results listed in the results summary tables within this section are based upon the "general" value of the uplift pressure (600 psf) listed in the report.

4.2 References and Design Standards

4.2.1 Engineering Manual [EM] 1110-2-2200, "Gravity Dam Design," June 95

4.2.2 Engineering Regulation [ER] 1110-2-1806, "Earthquake Design and Evaluation for Civil Works Projects," 31 Jul 95.

4.2.3 Earthquake Analysis of MMD", as reported by USACE Structural Engineer, Jim Ryan, in E-mail Dated Wednesday, May 28, 2003

4.2.4 Technical Memorandum No. 16 (Final Geotechnical Design Report) by Geo Engineers Dated May 2, 1994

4.2.5 NOAA Fisheries, "Anadromous Salmonid Passage Facility Guidelines and Criteria (DRAFT)

4.3 Structural Criteria

4.3.1 Water Elevations

Flow (cfs)	Locally Preferred Alternative	Federally Preferred Alternative
4000 cfs (Normal)		
Head Water EL	671.50	672.77
Tail Water EL	662.15	663.49
Differential Head (ft)	9.35	9.28
24800 cfs (PMF)		
Head Water EL	672.13	679.11
Tail Water EL	669.98	670.63
Differential Head (ft)	2.15	8.48
12000 cfs (100-year)		
Head Water EL	671.50	675.43
Tail Water EL	666.16	666.91

Differential Head (ft)	5.34	8.52

4.3.2 Soil

Upstream Soil Friction Angle		35-deg
Upstream Soil Unit Weight (Dry)		125-pcf
Upstream Soil Unit Weight (Submerged)		62.5-pcf
Ka		0.271
Downstream Soil Friction Angle		35-deg
Downstream Soil Unit Weight		125-pcf
Downstream Soil Unit Weight (Submerged)		62.5-pcf
Kp		3.69
Allowable Bearing Pressure	Normal Loading	6-ksf
Allowable Bearing Pressure	Seismic Loading	8.0-ksf
Friction Angle (No Factor of Safety)	Soil To Concrete	39-deg
Friction Factor (No Factor of Safety)	Soil To Concrete	0.80
Friction Angle	Soil To Concrete	26-deg
Friction Factor	Soil To Concrete	0.49
Shear Strength (Cohesion Resistance at Base)		0-psi

4.3.3 Earthquake

Seismic Zone		3
Operating Basis Earthquake Peak Acceleration (OBE)	Horizontal	0.24g
Operating Basis Earthquake Peak Acceleration (OBE)	Vertical	0.00g
Maximum Credible Earthquake Peak Acceleration (MCE)	Horizontal	0.35g
Maximum Credible Earthquake Peak Acceleration (MCE)	Vertical	0.00g

Required Factors of Safeties
From Corps of Engineers EM 1110-2-200 (30 Jun 95)
Table 4-1 (Stability Stress Criteria)

Load Condition	COE	Resultant Location at Base	Min. Sliding FS	Foundation Bearing Pressure
Normal	Usual	Middle 1/3	2	<= Allowable
Flood	Unusual	Middle 1/2	1.7	<= Allowable
Earthquake	Extreme	Within Base	1.3	<= 1.33 *Allowable

Notes
Sliding FS Include Shear Friction

4.3.4 Structural Design

Water unit Weight	0.0625-k/cf
Concrete Unit Weight	0.15-k/cf
Concrete Compressive Strength (Lean	3000-psi

Concrete)	
Reinforced Concrete Compressive Strength	4000-psi
Active Lateral Soil Pressure	18*-Hpsf
Passive Lateral Soil Pressure on Downstream Cutoff Walls	500*-Hpsf
Passive Lateral Soil Pressure on Downstream Cutoff Walls	333*-Hpsf
Uplift Pressure	600*-L psf
Wind Pressure	0-psf
Ice Load	0-psf
Thickness of Ice	0-feet
Active Lateral Seismic Soil Pressure	Varies See Section Calcs *H psf
Lateral Hydrodynamic Pressure	Calculate using Westergaard's Formula

4.3.5 Seepage

Permeability range (at B-3)	.01 to .034-cm/sec
Average Lowest Permeability	.01 to .1-cm/sec

4.3.6 Diversion Intake

4.3.6.1 Vehicular Access will be provided up to the 100-year Recurrence - 12,000-cfs.

4.3.6.2 PSE Diversion Water Right: 2,000-cfs

4.3.6.3 Maximum wood debris size: 12-in diameter x 40-long

4.3.6.4 Typical debris: Sticks, leaves, branches and ice

4.3.6.5 Debris exclusion: Configure facility to minimize accumulations and promote flushing

4.3.6.6 Sediment at PSE Diversion: 100,000 to 1,000,000 tons/year (500,000 average)

4.3.6.7 Winter Flooding: 1,000 to 2,500-mg/l suspended solids.

4.3.6.8 Bedload Movement: Flows in excess of 8,000-cfs results in gravel and cobble movement. Historically bedload in the range of 3.5 to 10-in in diameter has accumulated at the PSE diversion.

4.3.7 COE Fish Trap

4.3.7.1 General

(a) Provide Vehicular Access up to the 100-year Recurrence - 12,000-cfs.

(b) Exclude bedload and debris from water supply intake facilities and fishway entrance.

(c) High Tailwater Design Elevation: 663.3-fmsl

(d) Low Tailwater Design Elevation: 658.6-fmsl

(e) Normal Headwater Design Elevation 671.5-fmsl

4.3.7.2 Trap Ladder

(a) Minimum Ladder Pool Length: 8.0-ft

(b) Minimum Ladder Pool Width: 6.0-ft

(c) Minimum Ladder Pool Depth: 5.0-ft

(d) Minimum Ladder Pool Energy Dissipation Volume: 546-cf

(e) Minimum Turning Pool Length: 16.0-ft

(f) Mitered or Chamfered Corners at Turning Pool Bends

(g) Minimum Ladder Freeboard: 3.0-ft

4.3.7.3 Trap Entrance

(a) Minimum Fish Trap Entrance Width: 4-ft

(b) Minimum Fish Trap Entrance Pool Depth: 6-ft

(c) Minimum Transport Channel Width: 4.0-ft

(d) Minimum Transport Channel Depth: 5.0-ft

4.3.7.4 Water Supply System

(a) Maximum Profile Bar Screen Slot Width: 1.75-mm.

(b) Maximum Diffuser Bar Grating Clear Spacing: 1-in

(c) Diffuser Bar Grating: Flat Bars

4.3.8 General Supporting Facilities

4.3.8.1 Control Building

(a) Facility Vehicular Access will be provided up to the 100-year Recurrence - 12,000-cfs.

4.4 Features Common to Both Plans

4.4.1 Radial Gate Section Geometry

Top of Gate Elevation	672.5
Upstream Apron EL	657

Downstream Apron EL	657
Design Static Head	4-feet
River Bed EL (Upstream)	657
River Bed EL (Downstream)	654
Bott EL of Cutoff Walls (Upstream)	647
Bott EL of Cutoff Walls (Downstream)	640
Overall Cross Section Width	66.25-feet

4.5 Locally Preferred Plan

4.5.1 Rubber Dam Section Geometry

Rubber Weir Crest Elevation	672.5
Upstream Apron EL	663
Downstream Apron EL	663
River Bed EL (Upstream)	663
River Bed EL (Downstream)	656
Bott EL of Cutoff Walls (Upstream)	645
Bott EL of Cutoff Walls (Downstream)	645
Overall Cross Section Width	61-feet
Length of Section (L)	50-feet

4.5.2 Rubber Dam Section Results

Results from the stability analyses calculations for the Rubber Dam Section are summarized in the table below:

	Toe Max Stress ksf	Heel Max Stress ksf	Total Sliding Force K	Slide Resisting Force k	Friction Only Factor of Safety Against Sliding	Shear Friction Factor of Safety Against Sliding	Factor of Safety Against Flotation	
Normal	0.92	0.25	25	87	3.50	3.50	1.98	
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			2	2	1.2	
	OK	OK			OK	OK	OK	
Flood	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	See Note (2)
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			1.7	1.7	1.2	
	N.A.	N.A.			OK	OK	OK	
Seismic (OBE)	0.86	0.31	28	87	3.07	3.07	1.98	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	
Seismic (MCE)	0.83	0.34	30	87	2.89	2.89	1.98	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	

4.5.3 Radial Gate Section Results (Locally Preferred)

Results from the stability analyses calculations for the Radial Gate Section are summarized in the table below:

	Toe Max Stress ksf	Heel Max Stress ksf	Total Sliding Force k	Slide Resisting Force k	Friction Only Factor of Safety Against Sliding	Shear Friction Factor of Safety Against Sliding	Factor of Safety Against Flotation	
Normal	0.95	-0.07	315	964	3.07	3.07	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			2	2	1.2	
	OK	Tension			OK	OK	OK	
Flood	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	See Note (3)
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			1.7	1.7	1.2	
	N.A.	N.A.			OK	OK	OK	
Seismic (OBE)	0.15	0.72	511	964	1.89	1.89	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	
Seismic (MCE)	0.25	0.62	602	964	1.60	1.60	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	

4.5.4 Fixed Crest Section Results

Results from the stability analyses calculations for the Fixed Crest Section are summarized in the table below:

	Toe Max Stress ksf	Heel Max Stress ksf	Total Sliding Force k	Slide Resisting Force k	Friction Only Factor of Safety Against Sliding	Shear Friction Factor of Safety Against Sliding	Factor of Safety Against Flotation
Normal	0.77	0.65	25	82	3.29	3.29	2.18
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			2	2	1.2
	OK	OK			OK	OK	OK
Flood	1.20	0.79	27	104	3.92	3.92	2.66
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			1.7	1.7	1.2
	OK	OK			OK	OK	OK
Seismic (OBE)	0.83	0.59	28	82	2.94	2.94	2.18
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2
	OK	OK			OK	OK	OK
Seismic (MCE)	0.85	0.56	29	82	2.79	2.79	2.18
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2
	OK	OK			OK	OK	OK

4.6 Federally Preferred Plan

4.6.1 Ogee Section Geometry

Ogee Crest Elevation	672.5
Downstream Apron EL	663.3
Bott. of Apron EL	658
Design Static Head	4-feet
River Bed EL (Upstream)	669
River Bed EL (Downstream)	656.5
Bott EL of Cutoff Walls (Upstream)	647
Bott EL of Cutoff Walls (Downstream)	647
Number of Galleries	0
Drain Efficiency	0%
Assumed Length of Overflow Section (L)	300-feet

4.6.2 Ogee Section Results

Results from the stability analyses calculations for the Ogee Section are summarized in the table below:

	Toe Max Stress ksf	Heel Max Stress ksf	Total Sliding Force k	Slide Resisting Force k	Friction Only Factor of Safety Against Sliding (FERC)	Shear Friction Factor of Safety Against Sliding	Factor of Safety Against Flotation (FERC)	
Normal	0.93	0.44	23	59	2.55	2.55	2.15	
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			2	2	1.2	
	OK	OK			OK	OK	OK	
Flood	1.28	0.72	37	68	1.84	1.84	2.66	
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			1.7	1.7	1.2	
	OK	OK			OK	OK	OK	
Seismic (OBE)	1.18	0.20	38	53	1.38	1.38	2.15	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	
Seismic (MCE)	1.52	-0.14	46	53	1.16	1.16	2.15	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	Tension			NO GOOD	NO GOOD	OK	See Note (5)

4.6.3 Radial Gate Section Results (Federally Preferred)

Results from the stability analyses calculations for the Radial Gate Section are summarized in the table below:

	Toe Max Stress ksf	Heel Max Stress ksf	Total Sliding Force k	Slide Resisting Force k	Friction Only Factor of Safety Against Sliding	Shear Friction Factor of Safety Against Sliding	Factor of Safety Against Flotation	
Normal	0.95	-0.07	315	964	3.07	3.07	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			2	2	1.2	
	OK	Tension			OK	OK	OK	
Flood	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	See Note (3)
Max Allowable Foundation Pressures & Min. Req'd FS	6	6			1.7	1.7	1.2	
	N.A.	N.A.			OK	OK	OK	
Seismic (OBE)	0.15	0.72	511	964	1.89	1.89	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	
Seismic (MCE)	0.25	0.62	602	964	1.60	1.60	1.73	
Max Allowable Foundation Pressures & Min. Req'd FS	8	8			1.3	1.3	1.2	
	OK	OK			OK	OK	OK	

4.7 General Notes

Note (1) **EM 1110-2-2200 (30 Jun 95)** Corps of Engineers

Table 4-1 (Stability Stress Criteria)

Load Condition	COE	Resultant Location at Base	Min. Sliding FS	Foundation Bearing Pressure
Normal	Usual	Middle 1/3	2.0	<= Allowable
Flood	Unusual	Middle 1/2	1.7	<= Allowable
Earthquake	Extreme	Within Base	1.3	<= 1.33 *Allowable

Notes

Sliding FS Include Shear Friction

Note (2) The Rubber Dam is to be deflated at flood event (No calculations performed)

Note (3) Radial Gates are to be opened to release flood water (No calculations performed)

Note (4) Uplift Pressures used in calculations are based on Geo Engineers report. The estimated uplift pressure with seepage is substantially less

Note (5) Factors of Saftey are higher than noted considering uplift with Seepage

E.5 -- Mechanical Improvements Description

5.1 References and Design Standards

5.1.1 COE, "Hydraulic Design Criteria Sheets – Tainter Gates in Open Channels"

5.1.2 Chander K. Sehgal, "Design Guidelines for Spillway Gates", March 1996

5.1.3 V.T. Chow, "Open Channel Hydraulics"

5.1.4 COE, Engineer Manual EM 1110-2-2701 "Vertical Lift. Gates"

5.1.5 NOAA Fisheries, "Anadromous Salmonid Passage Facility Guidelines and Criteria (DRAFT)

5.2 Mechanical Criteria

5.2.1 Adult Barrier System

5.2.1.1 Exclude upstream fish passage through the 5-percent Exceedance – 3,400-cfs

5.2.1.2 Normal Headwater Design Elevation 671.5-fmsl

5.2.1.3 High Tailwater Design Elevation 663.3-fmsl

5.2.1.4 0.8-ft minimum radial gate opening height

5.2.2 Diversion Intake

5.2.2.1 PSE Diversion Water Right: 2,000-cfs

5.2.3 COE Fish Trap System

5.2.3.1 General

(a) Provide Unimpeded Operation up to the 5-Percent Exceedance – 3,400-cfs.

(b) Maximum River Flow for Trap Operation: 4,000-cfs

(c) Minimum River Flow for Trap Operation: 180-cfs

(d) High Tailwater Design Elevation: 663.3-fmsl

(e) Low Tailwater Design Elevation: 658.6-fmsl

(f) Normal Headwater Design Elevation 671.5-fmsl

5.2.3.2 Trap Ladder

(a) Maximum Ladder Flow: 35-cfs

(b) Maximum Head Across Weirs: 1.0-ft

(c) Minimum Depth Over Weir Crests: 1.0-ft

(d) Minimum Ladder Freeboard: 3.0-ft

5.2.3.3 Trap Entrance

(a) Minimum Fish Trap Entrance Head: 1.0-ft

(b) Maximum Fish Trap Entrance Head: 1.5-ft

(c) Fish Trap Entrance Flow Type: Streaming, not plunging.

(d) Minimum Transport Channel Velocity: 1.5-fps

5.2.3.4 Water Supply System

(a) Maximum Total Fish Screen Flow: 130-cfs

(b) Maximum Fish Screen Approach Velocity (defined as velocity vector normal to screen): 0.4-fps

(c) Minimum Fish Screen Sweeping Velocity: 2 x Approach Velocity

(d) Fish Screen Sweeping Velocity: Shall not decrease along length of screens.

(e) Maximum Spatial Sweeping Velocity Differential: 0.2-fps/ft

(f) Maximum Auxiliary Water Supply (AWS) Flow: 70-cfs

(g) Maximum AWS Diffuser Velocity (Horizontal Grating): 0.5-fps

(h) Provide Uniform flow distribution across the AWS Diffuser Grating.

(i) Maximum Ladder Supply Flow: 35-cfs

(j) Maximum Hatchery Supply Flow (Locally Preferred Plan only): 25-cfs

5.2.3.5 Fish Screen Bypass System

(a) Independent Flow-Control Capability

(b) Minimum Bypass Entrance Flow Velocity: 110% of maximum true velocity upstream of bypass entrance

(c) Minimum Byass Entrance Width: 1.5-ft

(d) Minimum Design Bypass Flow: 5% total diverted flow

(e) Minimum Bypass Depth: 0.8-ft

(f) Minimum Bypass Velocity: 2-fps

(g) Maximum Bypass Outfall Impact Velocity: 25-fps

5.2.4 General Supporting Facilities

5.2.4.1 Electrical motors and other equipment vulnerable to submergence will have a minimum of 2-feet of freeboard up to the 100-year Recurrence - 12,000-cfs.

5.3 Features Common to Both Plans

5.3.1 16-ft Radial Gate

5.3.1.1 Width: 16-ft

5.3.1.2 Trunnion Elevation: 671.0-fmsl

5.3.1.3 Radius: 20.5-ft

5.3.1.4 Crest Elevation (Gate Closed): 672.5

5.3.1.5 Flap Gate: 13-ft W x 6-ft H

5.3.2 COE Fish Trap System

5.3.2.1 Ladder & Trap

(a) Entrance Control Gate: Motor Actuated Telescoping Weir Gate, Minimum Crest EL 654.1, Maximum Crest EL 660.0

(b) Holding Pool Brail: Existing holding pool brail will be refurbished with new, stainless steel bar grating.

(c) Fish Return Flume: Stainless steel flume, 18-in wide x 24-in tall x ~50-ft long

(d) Fish Return Flume Control Gate: 18-in wide x 24-in slide gate

(e) Fish Hopper: Existing fish hopper will be refurbished with new, stainless steel bar grating.

5.3.2.2 Water Supply System

(a) Fish Screens: Vertically oriented wedge-wire screen panels, 11-ft wide x 7-ft high, stainless steel, and heavy-duty "Profile-Bar" construction with 1.75-mm slot openings. At maximum 130-cfs screen flow, maximum average approach velocity is 0.37-fps.

(b) Fish Screen Cleaner: Trolley mounted brush system traveling on rails, 10-minute cycle @ maximum 2-fps.

(c) Fish Screen Flow Balancing System: Adjustable vane type baffles adjusted to maintain uniform flow through all the screen panels.

(d) Control Gates: Existing gates will be replaced with new fabricated slide gates, various sizes, 10-ft seating head, 0-ft unseating head, motor- operated.

(e) Diffuser Grating: Replace existing diffuser grating with stainless steel, flat bar grating with 1-in maximum clear space.

5.3.2.3 Fish Screen Bypass System

(a) Fish Bypass Ramp Gate: Motor actuated vertical-lift gate. Hydraulic operator with 7-ft stroke.

(b) Fish Bypass Ramp: Stainless steel flume with hinged attachment to gate, measuring: 9-ft wall height at upstream (crest) end, 6.5-ft wall height at downstream end, 2.5-ft wide, 54-ft long. Flume is supported on downstream end by two wheels on 50-lb crane rail for horizontal movement.

(c) Minimum Operating Crest EL: 662.0-fmsl

(d) Maximum Operating Crest EL: 669.0-fmsl.

(e) Design HWEL: 671.5-fmsl

(f) Minimum Bypass Flow: ~20-cfs

(g) Maximum Bypass Flow: ~400-cfs

5.3.2.4 Sediment Control System

(a) Fish Bypass Sediment Sluice Gate: 12-in Dia

(b) Fish Bypass Sediment Sluice Pipe: 12-in Dia Steel Pipe

(c) Water Supply Forebay Sediment Sluice Gate: 36-in dia sluice gate

(d) Water Supply Forebay Sediment Sluice Pipe: 36-in dia Steel Pipe

(e) Water Supply Forebay Sediment Control Pump:

(f) Fish Bypass Ramp Gate Well Sediment Sluice Gate: 8-in dia sluice gate

(g) Fish Bypass Ramp Gate Well Sediment Sluice Pipe: 8-in dia Steel Pipe

(h) Sediment Control Valves: 4-in Sediment Control Valves with Motor Actuators.

(i) Sediment Control Manifolds: 8-in x 4-in, length varies, 3/8-in holes @ 6-in oc.

(j) Sediment Control Pipe: 4-in and 6-in DIP

5.4 Locally Preferred Plan

5.4.1 Rubber Weirs (2-Identical)

5.4.1.1 Crest Length: 64-ft

5.4.1.2 Crest Elevation (inflated): 672.5-fmsl

5.4.1.3 Base Length: 50-ft

5.4.1.4 Base Elevation: 663.0-fmsl

5.4.1.5 Inflated Height: 9.5-ft

5.4.2 35-ft Radial Gate

5.4.2.1 Width: 35-ft

5.4.2.2 Trunnion Elevation: 671.0-fmsl

5.4.2.3 Radius: 20.5-ft

5.4.2.4 Crest Elevation (Gate Closed): 672.5

5.4.3 General Supporting Facilities

5.4.3.1 Electrical motors and other equipment vulnerable to submergence will have a minimum of 2-feet of freeboard up to the 100-year Recurrence - 12,000-cfs.

5.4.4 Facilities Operation

5.4.4.1 Operations Table

	Flow (cfs)									
		Fish Trap								
	TOTAL RIVER	Ladder	AWS	Hatchery Supply	TOTAL	Bypass Ramp Gate	16' Radial Gate	35' Radial Gate	Rubber Weirs	Fixed Crest Panels
From	180	35	70	25	130	50	0	0	0	0
To	550	35	70	25	130	420	0	0	0	0
From	550	35	70	25	130	20	400	0	0	0
To	1080	35	70	25	130	20	0	930	0	0
From	1080	35	70	25	130	20	0	930	0	0
To	4020	35	70	25	130	20	0	3850	0	0
From	4020	0	0	0	0	20	0	4000	0	0
To	7300	0	0	0	0	0	0	7300	0	0
From	7300	0	0	0	0	0	0	7300	0	0
To	10290	0	0	0	0	0	2920	7370	0	0
From	10290	0	0	0	0	0	2920	7370	0	0
To	18750	0	0	0	0	18750				0

	HWEL	*TWEL*	*dWSEL*	*Description*
From	671.5	658.6	12.9	Trap open, bypass ramp gate adjusted to maintain HWEL 671.5, both gates closed, rubber weirs inflated.
To	671.5	659.6	11.9	
From	671.5	659.6	11.9	Trap open, minimum bypass flow, 16' gate operated (open min 0.8') to maintain HWEL 671.5, AWS flow initially trimmed to 50-cfs, 35' gate closed, rubber weirs fully inflated.
To	671.5	662.6	8.9	
From	671.5	662.6	8.9	Trap open, minimum bypass flow, both gates operated (min 0.8' open) in tandem to maintain HWEL 671.5, rubber weirs inflated.
To	671.5	664.4	7.1	
From	671.5	664.4	7.1	Trap closed, up to max bypass flow, both gates fully open, rubber weirs operated in tandem to maintain HWEL 671.5 until deflated, eventually HWEL rises until spill over fixed crest panels.
To	672.5	670.5	2.0	

5.5 FEDERALLY PREFERRED PLAN

5.5.1 Facilities Operation

5.5.1.1 Operations Table

	Flow Ranges (cfs)							
		Fish Trap						
	TOTAL RIVER	Ladder	AWS	Hatchery Supply	TOTAL	Fish Bypass Ramp Gate	16' Radial Gate	303' Ogee Crest
From	180	35	70	25	130	50	0	0
To	550	35	70	25	130	400	0	0
From	550	35	50	25	130	20	400	0
To	2750	35	70	25	130	20	2600	0
From	2750	35	70	25	130	20	2600	0
To	12000	0	0	0	0		12000	

	HWEL	*TWEL*	*dWSEL*	*Description*
From	671.5	658.6	12.9	Trap open, bypass ramp gate adjusted to maintain HWEL 671.5, gate closed.
To	671.5	659.6	11.9	
From	671.5	659.6	11.9	Trap open, minimum bypass flow, gate operated (open min 0.8') to maintain HWEL 671.5, AWS flow initially trimmed to 50-cfs.
To	671.5	662.6	8.9	
From	671.5	659.6	11.9	Trap initially open then closing around 6,000-cfs, maximum bypass flow, gate fully open, HWEL rises and eventually spill over ogee.
To	678.3	670.5	7.8	

E.6 -- Electrical / Control Improvements Description

6.1 References and Design Standards

6.1.1 Governing codes and standards will primarily comply with the latest edition of the National Electrical Code.

6.1.2 The electrical systems for either alternative 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.

6.2 Electrical / Control Criteria

6.2.1 Equipment and design will be for Seismic Zone 3.

6.2.2 Switchboards – 480 VAC, 3PH, 65 KAIC

6.2.3 Panel boards -

6.2.3.1 480 VAC, 3PH, 65 KAIC

6.2.3.2 120/208, 3PH, 22 KAIC

6.2.4 Local Control Panels and Controls:

6.2.4.1 Enclosures

(a) Outdoor, Corrosive, and Wet Areas – Nema 4X

(b) Indoor – Nema 12

6.2.4.2 Control

(a) Programmable logic controller (PLC) based.

(b) Actuators will communicate with the PLC via digital network loops.

(c) Gages and sensors will interface digitally or with 4-20 mA analog signals.

(d) A local personal computer (PC) with supervisory control and data acquisition (SCADA) will serve as a human machine interface with the PLC.

(e) Alarm will be generated and annunciated from the PLC.

6.2.5 Electric Motors

6.2.5.1 1-HP or greater

(a) 460 VAC, 3 phase

(b) Totally enclosed fan cooled (TEFC)

(c) Premium Efficient, 1.15 Service Factor, Class F insulation

(d) Nema rated across the line starters up to 25 HP

(e) Reduced voltage solid state starters (RVSS) or variable frequency drives for motors over 25 Hp.

6.2.5.2 Fractional Horsepower

(a) 120 VAC, 1 phase

(b) Totally enclosed fan cooled (TEFC)

(c) Standard Efficient, 1.15 Service Factor, Class F insulation

6.2.5.3 Variable Speed

(a) 18- pulse drive

(b) 460 VAC, 3 phase

(c) Totally enclosed fan cooled (TEFC)

(d) Inverter grade, 1.5 Service Factor, Class F insulation

6.2.6 Raceway

6.2.6.1 Exposed conduit – rigid galvanized steel, ¾-inch minimum

6.2.6.2 Encased – Schedule 40 PVC

6.2.6.3 Flexible – Liquidtite with integral ground

6.2.6.4 Grounding – full length copper grounding conductors sized per NEC Article 250

6.2.6.5 Conductors – Wire fill per NEC Appendix C10.

6.2.6.6 Fittings – Zinc plated malleable or gray iron for galvanized conduit, PVC for PVC conduit.

6.2.7 Wire and Cable

6.2.7.1 600 V rated with Class B Type XHHW cross-linked polyethylene insulation conforming to UL 44.

6.2.7.2 Conductors - Stranded copper , 12 AWG minimum for power and 14 AWG minimum for control.

6.2.8 Grounding

6.2.8.1 Comply with NEC Article 250 and local codes

6.2.8.2 Materials: Bare annealed copper conductors suitable for direct burial, Conductors will be #4 typically. Ground rods will be ¾ inch diameter and 10 feet long.

6.2.8.3 Installation: Raceways will include grounding conductors. Concealed connections will be exothermic welded and exposed will be bolted pressure type. Copper bonding jumpers will insure continuous metallic grounding across non-conductive structural features.

6.2.9 Level Sensors: Non-submerged sonic type transducers transmitting a 4 to 20 mA current signal.

6.2.10 Proximity sensors: Mechanical type limit switches, inductive type proximity switches, analog feedback for automatic electric and hydraulically driven gates.

6.3 Features Common to Both Plans

6.3.1 Motor Control Center and Power Service: The power service will be fed off the existing power grid on the left bank. A new transformer to feed the 480VAC 3 PH service is anticipated. The conservatively sized 400 amp service will feed the motor control center housed in the control and equipment building. The motor control center will include surge suppression, power monitoring, manual transfer capability for feed from a portable generator, a 100 amp lighting panel, in addition to the various motor drives and disconnects for equipment. The layouts of the motor control center are depicted on plates: 20 and 39 for the Locally and Federally preferred alternatives respectively. The oneline diagrams of the motor control center and associated equipment are depicted on Plates 21 and 40 for the Locally and Federally preferred alternatives respectively.

6.3.2 Control and Communications: The PLC will be housed in a panel, in the same room, opposite the motor control center. A communications panel will house communications terminations and telemetry equipment. A dedicated phone line and modem (back door) connected to PLC communications port independent of HMI such that PLC sends communications failure alarm via the backdoor will be provided. Backdoor line shall provide access to PLC for maintenance and communications with portable laptop computer from any remote telephone.Provide PLC Fail relay with normally closed contact connected to backdoor line such that relay closes upon PLC fail and sends alarm via back door. Backdoor line shall provide access to PLC for maintenance and communications with portable laptop computer from any remote telephone. A personal computer will provide a human machine interface (HMI) with the PLC to allow setpoint changes, monitoring of alarms and facility status, and trending of key parameters such as water levels, gate position, and equipment operation. Personal computer shall be human machine interface (HMI) device only; no control logic shall reside in personal computer. The PLC program shall hold all set points and commands in place as of last command prior to communications failure or personal computer shutdown. Provide pass word protection scheme for HMI to allow access at appropriate level of authority to only view status (Clerk), adjust set points (Operator), and adjust equations and modify PLC program (Engineer). Flow diagrams of the various equipment and sensors are depicted on Plates 22 and 41 for the Locally and Federally preferred alternatives respectively.

Persopnal computer shall be human machine interface (HMI) device only; no control logic shall reside in personal computer. The PLC program shall hold all set points and commands in place as of the last command prior to communications failure or personal computer shutdown.

Provide a dedicated phone line and modem (back door) connected to PLC communications port independent of HMI such that PLC sends communications failure alarm via the backdoor. Back door line shall provide access to PLC for mainenance and ocmmunications with portale laptop computer from any remote telephone. Provide PLC Fil relay with normally closed contact connected to backdoor line such that relay closes upon PLC fail and sends alarm via back door.

Provide password protection scheme for HMI to allow access at appropriate level of authority to only view status (Clerk), adjust set points (Operator), and adjust equations and modify PLC program (Engineer).

6.3.3 Fish Screen: The fish screen supplies a screened water supply, free of juvenile fish and debris, to the fish trap(s). The electrical and control associated with this feature include a cable driven brush sweep to clean the screen and level feed-back to monitor water level differential across the screen. The cable drive is driven by a variable speed, gear reduced electrical motor, which turns a drum drive to move the cable. Proximity switches located along the travel of the brush, provide feedback to control the speed and direction of the brush. The cleaner control will allow manual control of the brush movement or allow for automatic cycling of the cleaner. Automatic cleaning will be triggered from either a timing cycle or a head differential across the screen greater than the differential setpoint. Provide limit switches at each end of fish screen cleaner travel (home dock) with PLC timer to send SCREEN CLEANER FAIL alarm via PLC if fish screen cleaner jams and fails to dock within allotted time.

Provide limit swithces at each end of fish screen cleaner travel (home dock) with PLC timer to send SCREEN CLEANER FAIL alarm via PLC if fish screen cleaner jams and fails to dock within allotted time.

6.3.4 COE Fish Trap: Electrical equipment and control of the fish trap include the telescoping gate at the trap fishway entrance, hoists for the brail and hopper, and electric actuators on selected fishway water supply gates. The hoists for the brail and hopper are electric drum drives, which are manually controlled from local control stations. The fishway entrance will be automatically controlled to maintain a target water differential between the entrance pool and the tailwater. The two auxiliary water supply (AWS) gates will automatically regulate flow to the diffuser chamber to maintain a target AWS supply rate based on water differential across the gates and gate position feedback. Other supply gates are automatically closed and repositioned during sediment control events.

6.3.5 Bypass Ramp Gate: The bypass ramp gate is actuated by a hydraulic cylinder. This cylinder raises or lowers the gate to bypass flows between 20 and 400 cfs. The positioning utilizes headwater level and gate position feedback to maintain the desired bypass flow setpoint for the gate.

6.3.6 16 foot Radial Gate: The 16 foot radial gate is actuated by two hydraulic cylinders. These cylinders raise or lower the gate to bypass flows in excess of 400 cfs, which corresponds to a minimum allowable opening of 0.8 feet to prevent harming fish. The positioning utilizes headwater level and gate position feedback to maintain the desired bypass flow setpoint for the gate. The gate will also include a bedload passage mode, during which it will be opened to a preset opening for a short period of time to flush out the channel immediately upstream of the gate. The gate includes a flap gate, which has two manually controlled hydraulic cylinders to lower the gate and pass relatively small floating debris, such as sticks, leaves, and small tree limbs, while the radial portion of the gate is closed.

6.3.7 Sediment Control: The sediment control system includes a vertical turbine pump (located downstream of the fish screens), electrically actuated isolation and flush gates, and electrically actuated butterfly valves, which control the water to the sediment control manifolds. This system is intended to be operated semi-automatically. It is similar to the system, which has been successfully operated at the fish screen for the PSE diversion. A typical sediment control cycle would be initiated just after the fish trap was emptied. The cycle would include the following steps:

6.3.7.1 Raise the telescoping fishway entrance, close the fish trap supply gates, open the flush gate (located near the channel invert just upstream of the bypass ramp gate) to a preset opening, start the sediment control pump and sequentially (upstream to downstream) open the valves supplying the manifolds discharging into the channel upstream of the screens.

6.3.7.2 Close the flush gate (upstream of the screens), open the flush gate (downstream of the screens), and sequentially (upstream to downstream) open the valves supplying the manifolds discharging into the chamber downstream of the screens.

6.3.7.3 Close the flush gate (downstream of the screens), open the fish trap supply gates, lower the fishway entrance gate, and sequentially (upstream to downstream) open the valves supplying the manifolds discharging into the hopper pool, then the holding pool, on down the fishway to the entrance pool.

6.3.7.4 After the cycle is complete the pump is shut off. There are a total of 19 manifolds to sequence and a cycle will take about 20 minutes to complete.

6.3.8 General Supporting Facilities: General support equipment includes: Lighting, convenience receptacles, a welding receptacle, the hydraulic power unit, HVAC for the equipment and control building, a portable pump for (de-watering equipment as needed), and a package sewage grinder type pump station to service the equipment and control building.

6.4 Locally Preferred Plan

6.4.1 35 foot Radial Gate: The 35 foot radial gate is actuated by two hydraulic cylinders. These cylinders raise or lower the gate to bypass flows during relatively high flow events (flows in excess of 3000 cfs). Approximately 930 cfs passes under the 35-ft radial gate when it is opened 0.8 feet. Operation of this gate requires coordination with other gates and maintaining at least a 12 inch opening. The positioning utilizes headwater level and gate position feedback to maintain the desired bypass flow setpoint for the gate.

6.4.2 Rubber Weirs: Two rubber weirs are actuated by compressed air supplied by three air compressors. The weirs are raised or lowered by actuating inflating or deflating control valves on the supply manifold to each weir. Drain valves will be periodically manually opened to purge any accumulated water. Excessive pressure will trigger an automatic deflation of the weirs. The weirs are only lowered during flood events to pass bedload and minimize the headwater level. The weir re-inflation will be manually initiated after the flood event has passed. The control is based from a vendor package with weir pressure status, valve operation status, compressor run status, and alarms communicated to the PLC.

6.4.3 Right Bank (Hatchery) Fishway Entrance: Electrical equipment and control at the right bank fishway entrance include a electrically actuated AWS gate and a level transmitter in the diffusion water chamber. The AWS gates will automatically regulate flow to the diffuser chamber to maintain a target AWS supply rate based on water differential across the gates and gate position feedback.

6.5 Federally Preferred Plan

6.5.1 The Federally Preferred Plan does not have any feature unique from the Locally Preferred Plan.

E.7 -- Construction

7.1 References and Design Standards

7.1.1 Constructabilitly Review White River Diversion Dam Rebuild, The Natt McDougall Company, December 1996

7.2 Construction Criteria

7.2.1 Cofferdam elevation: Stage at 4,000-cfs plus 1 foot freeboard.

7.2.2 Maintain unimpeded operation of the right and left bank fish traps (except for relatively short shut downs for unavoidable modifications).

7.2.3 Minimize outages of the PSE diversion.

7.2.4 Limit water turbidity to that of the river.

7.2.5 Adult Barrier System

7.2.5.1 Exclude upstream fish passage through 4,000-cfs

7.2.5.2 Maintain a Normal Headwater Design Elevation 671.5-fmsl

7.2.5.3 High Tailwater Design Elevation 663.3-fmsl

7.3 Features and Issues Common to Both Plans

7.3.1 Sediment and Erosion Control: Sediment and erosion control will consist of a filter fabric silt fences on the downhill slopes of disturbed areas. A detention pond will also provide settling of excessive sediment to limit discharge to the river of water less turbid than the river. Major disturbances will be scheduled to occur during periods when the river is running with high turbidity (summer) due to glacial melt.

7.3.2 Cofferdams: In general cofferdams will be built from the existing riverbank barrow or from material de-watered while building up the cofferdam. The cofferdams will include an impermeable membrane armored with riprap. Other features are listed as follows:

7.3.2.1 Cofferdams12-ft Minimum Crest Width

7.3.2.2 Crest Elevations: Vary above the dam depending on the alternative, 663.0-fmsl below dam

7.3.2.3 Maximum 2H:1V side-slopes

7.3.2.4 3-ft offset from toe-of-berm to top-of-excavation

7.3.2.5 Type I Cofferdam: 6-in to 4-ft riprap on riverside slope at 1.5H:1V maximum slope, 6-ft minimum thickness, geomembrane layer between riprap and core.

7.3.2.6 Type II Cofferdam: 4-in to 2-ft riprap on riverside slope at 2H:1V maximum slope, 3-ft minimum thickness, geomembrane layer between riprap and core.

7.3.2.7 Type III Cofferdam: 3-in to 1-ft riprap on riverside slope at 2H:1V maximum slope, 2-ft minimum thickness, geomembrane layer between riprap and core.

7.3.2.8 Phasing of the cofferdams is dependant on the alternative and will be discussed in the respective construction sections.

7.3.3 De-watering: De-watering is anticipated to require up to 50-foot deep wells pumping about 150 gpm on 40-ft spacing to maintain groundwater levels below the excavation. Wells would discharge into a common high density polyethylene header, leading to the sedimentation pond during initial startup and transitions. A set of sumps is also anticipated along the toe of the upstream cofferdam. These sumps would pick up seepage through the riverbed just below the cofferdams. A total of 8 pumps are anticipated, pumping a total of 400-gpm. After the water has cleared up it can be released directly to the tailwater. Further hydro-geological investigations will need to be performed to better anticipate how a functional de-watering system may be configured. The contractor would design the actual system.

7.3.4 Earthwork: The majority of the earthwork consists of excavations within the cofferdams for building features located in the river. It is likely that much of the material removed from the riverbed will be suitable as backfill. A maximum side-slope 1.5H:1V is anticipated for excavations. Access to the work areas will be limited to working from the cofferdam crests and along the barrier apron.

7.3.5 Fish Trap Operation: Uninterrupted operation of the COE Fish Trap will be a challenge requiring detailed sequencing of minor outages in order to modify the fishway entrance, add the sediment control system, improve the AWS system, and upgrade the brail. Much of this work could have relatively short duration (1 week) and be timed between fish runs. The right bank (hatchery) fishway will have fewer impacts and will be less of a problem to sequence construction. Both fishways will need to be extended while the cofferdams have isolated the normal entrance. This will be accomplished with culverts extending through the cofferdams.

7.3.6 General Supporting Facilities

7.3.6.1 Access Roads: In general the existing roads provide adequate access to both the right and left banks of the project. Only minor gravel surfacing for maintaining the surface for heavy truck traffic is anticipated. Construction access on the left bank will require significantly re-grading the river bank just upstream of the intake to install the temporary diversion channel and provide access to the area upstream of the existing PSE intake.

7.3.6.2 Laydown and Stockpile areas: Nat McDougall Company estimated a 150 foot by 300 foot area would be required on both the right and left bank of the river for staging , laydown and office space. Space for stockpiling on the order of 10,000 cubic yards of material will also be required. Currently their appears to be a short supply of laydown and stockpile areas adjacent to the project site with sufficient size to meet the construction requirements, particularly on the right (north) bank by the hatchery. Potential areas on the left (south) bank by the trap are located along the access road west of the trap.

7.3.6.3 Utilities: Power will be required on both sides of the river. The local grid extends to both sides. The capacity and type will need to be verified to determine if it is adequate to support the construction.

7.4 Locally Preferred Plan

7.4.1 Cofferdams: Construction of the cofferdams will occur in two major phases.

7.4.1.1 Phase 1 will isolate new construction on the right bank. This will allow construction of the fixed crest portion of the barrier and one of the rubber weirs. During this phase flash boards along the existing dam will need to be maintained and the PSE diversion will need to operate up to its 2,000 cfs capacity, should the river flow approach 4,000 cfs.

7.4.1.2 Phase 2 will isolate the new right bank features, the PSE diversion, and COE Fish Trap.

(a) Initially a cofferdam extending upstream of the longer term cofferdam will be required to isolate the intake to the temporary diversion. The majority of the temporary diversion can be constructed prior to placing the cofferdam, however the features in the vicinity of the intake will require isolation from the river.

(b) After the temporary diversion canal is in place the cofferdams will be extended to the upstream and downstream stoplogs of the right bank rubber weir. Next the new PSE intake slab and side walls will be constructed along with a temporary timber wall to isolate the interior of the PSE intake just upstream of the exiting COE fish trap water supply intake. Once this wall is in place the PSE diversion can be re-established along with operation of the fish trap. River flow at this point will be through the new fixed crest section of the barrier. Temporary flash boards will be required to maintain the headwater conditions and fish barrier. This flash boards will need to be readily removal in the event high flow.

(c) Prior to removing the cofferdam, stoplogs will be placed across the majority of the intake, while leaving two downstream-most bays open but temporarily isolated from the PSE diversion so water can be supplied to the trap via the new fish screen. This will allow the PSE intake to be isolated while the temporary wall is removed, the interior training wall constructed, and the temporary diversion sealed off. The headgate improvements can also be constructed at this stage.

(d) The final step will be removing the permanent stoplogs along with the temporary bay 11 and 12 stoplogs to re-establish the diversion.

7.5 Federally Preferred Plan

7.5.1 Cofferdams: Construction of the cofferdams will occur in three major phases.

7.5.1.1 Phase 1 will isolate new construction on the right bank. This will allow construction of just over half the ogee weir barrier, however the northerly most 140 will only include the slab up to the apron. During this phase flash boards along the existing dam will need to be maintained and the PSE diversion will need to operate up to its 2,000 cfs capacity, should the river flow approach 4,000 cfs.

7.5.1.2 Phase 2 will isolate the new right bank features, the PSE diversion, and COE Fish Trap. The PSE diversion will effectively be taken out of service at this point. A temporary 36-inch diameter pipe will supply the existing fish trap intake. The cofferdam will be established over the top of the new ogee weir section. Temporary flashboards will need to be established along the northerly portion of the ogee section, without the ogee crest. This will maintain the barrier while provide the ability to pass high river flow should the rate approach 4,000 cfs.

7.5.1.3 Phase 3 will re-establish a cofferdam similar to the upstream portion of Phase 1 by extending the upstream Phase 2 cofferdam to the right bank, while removing the upper-upstream and the downstream Phase 2 cofferdams. Note the top of the ogee weir apron is just about the 4000 cfs tailwater condition. After the northerly ogee section is in place the Phase 3 cofferdam can be removed.