UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation **Project No. 14803-001**

LICENSE SURRENDER ORDER
LOWER KLAMATH PROJECT

Hatcheries Management and Operations Plan

December 2022

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project
FERC Project No. 14803

Hatcheries Management and Operations Plan

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December 2022

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1.0 Introduction

The Lower Klamath Project (FERC No. 14803) consists of four hydroelectric developments on the Klamath River: J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate (Figure 1-1). Specifically, the reach between J.C. Boyle Dam and Iron Gate Dam is known as the Hydroelectric Reach. In September of 2016, the Renewal Corporation filed an *Application for Surrender of License for Major Project and Removal of Project Works,* FERC Project Nos. 2082-063 & 14803-001 (License Surrender). The Renewal Corporation filed the License Surrender Application as the dam removal entity for the purpose of implementing the Klamath River Hydroelectric Settlement (KHSA). In November of 2020, the Renewal Corporation filed its Definite Decommissioning Plan (DDP) as Exhibits A-1 and A-2 to its Amended License Surrender Application (ALSA). The DDP is the Renewal Corporation's comprehensive plan to physically remove the Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of adverse downstream impacts (Proposed Action). In November 2022, the Commission approved the ALSA and issued the License Surrender Order (LSO) approving facility removal and habitat restoration.

The Proposed Action includes the deconstruction of the J.C. Boyle Dam and Powerhouse (Figure 1-2), Copco No. 1 Dam and Powerhouse (Figure 1-3), Copco No. 2 Dam and Powerhouse (Figure 1-4), and Iron Gate Dam and Powerhouse (Figure 1-5), as well as associated features. Associated features vary by development, but generally include powerhouse intake structures, embankments and sidewalls, penstocks and supports, decks, piers, gatehouses, fish ladders and holding facilities, pipes and pipe cradles, spillway gates and structures, diversion control structures, aprons, sills, tailrace channels, footbridges, powerhouse equipment, distribution lines, transmission lines, switchyards, original cofferdam, portions of the Iron Gate Fish Hatchery, residential facilities, and warehouses. Facility removal will be completed within an approximately 20-month period.

This Hatcheries Management and Operations Plan is the DDP fish propagation component the Renewal Corporation will implement as part of the Proposed Action. The Renewal Corporation prepared 16 Management Plans to implement the DDP, and the Commission reviewed and approved these plans as conditions of its License Surrender Order. These Management Plans were developed in consultation with federal, state, and county governments and tribes.

The LSO Ordering Paragraph (II) approves the Hatcheries Management and Operations Plan as filed on December 14, 2021 and supplemented on April 18, 2022. The Renewal Corporation now submits limited modifications to this approved plan as stated in Table 2-2. These modifications include refinement in means and methods due to further consultation with the California State Water Resources Control Board pursuant to the requirements in Ordering Paragraph (E). Table 2-2 herein shows the material modifications to the approved version of the Hatcheries Management and Operations Plan. An updated Consultation Record for the Hatcheries Management and Operations Plan is included as Appendix A.

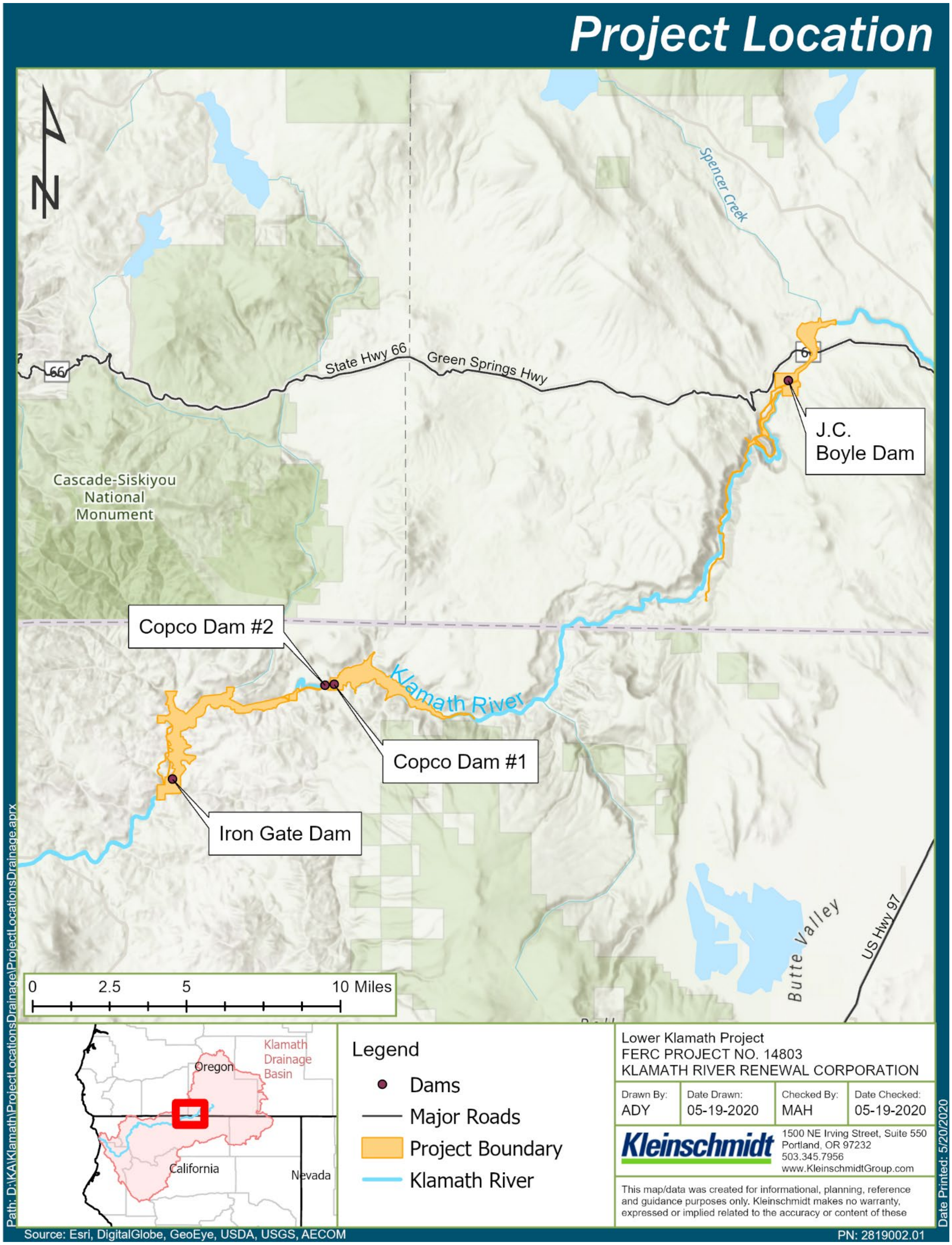

Figure 1-1. Lower Klamath Project Location

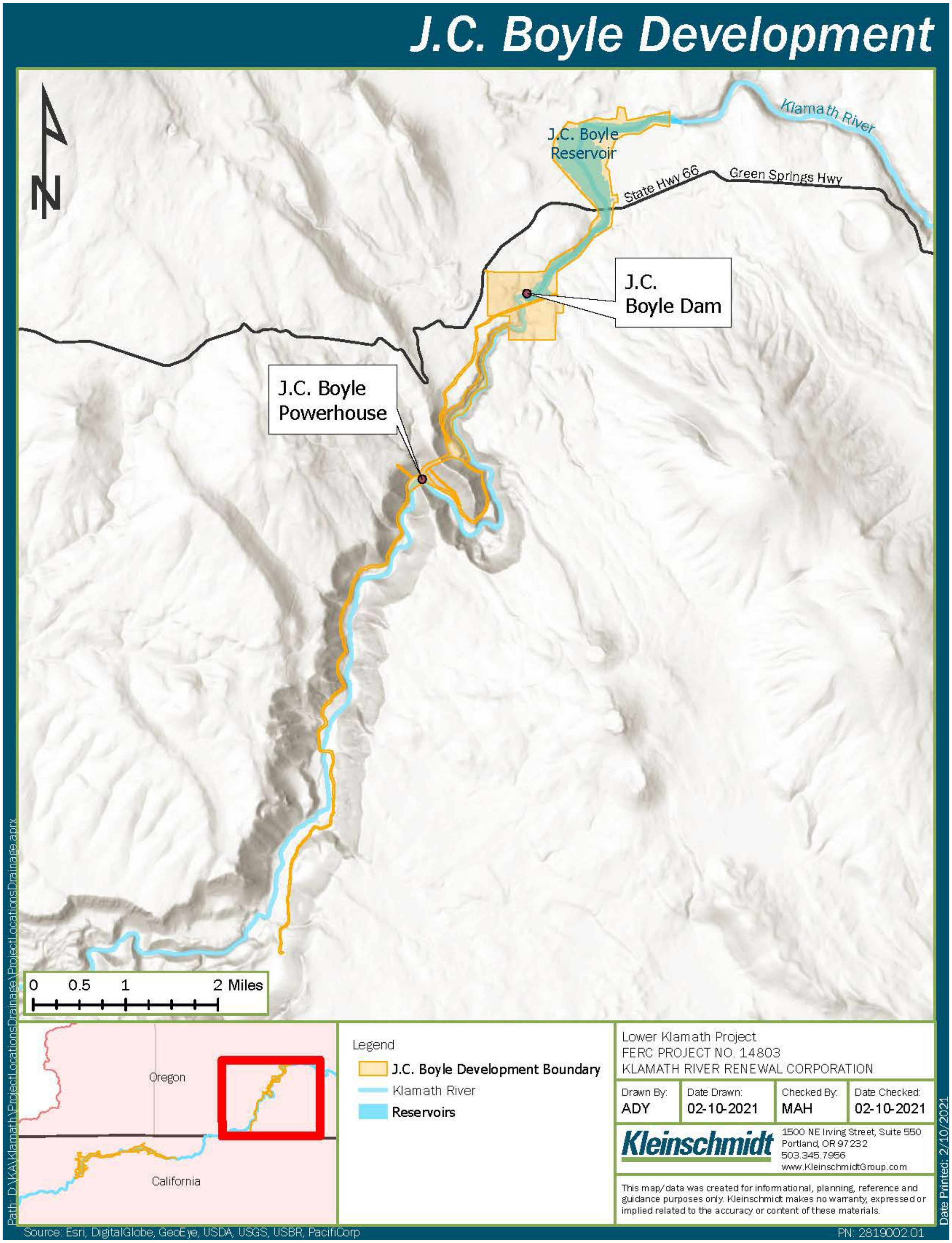

Figure 1-2. J.C. Boyle Development Facility Details

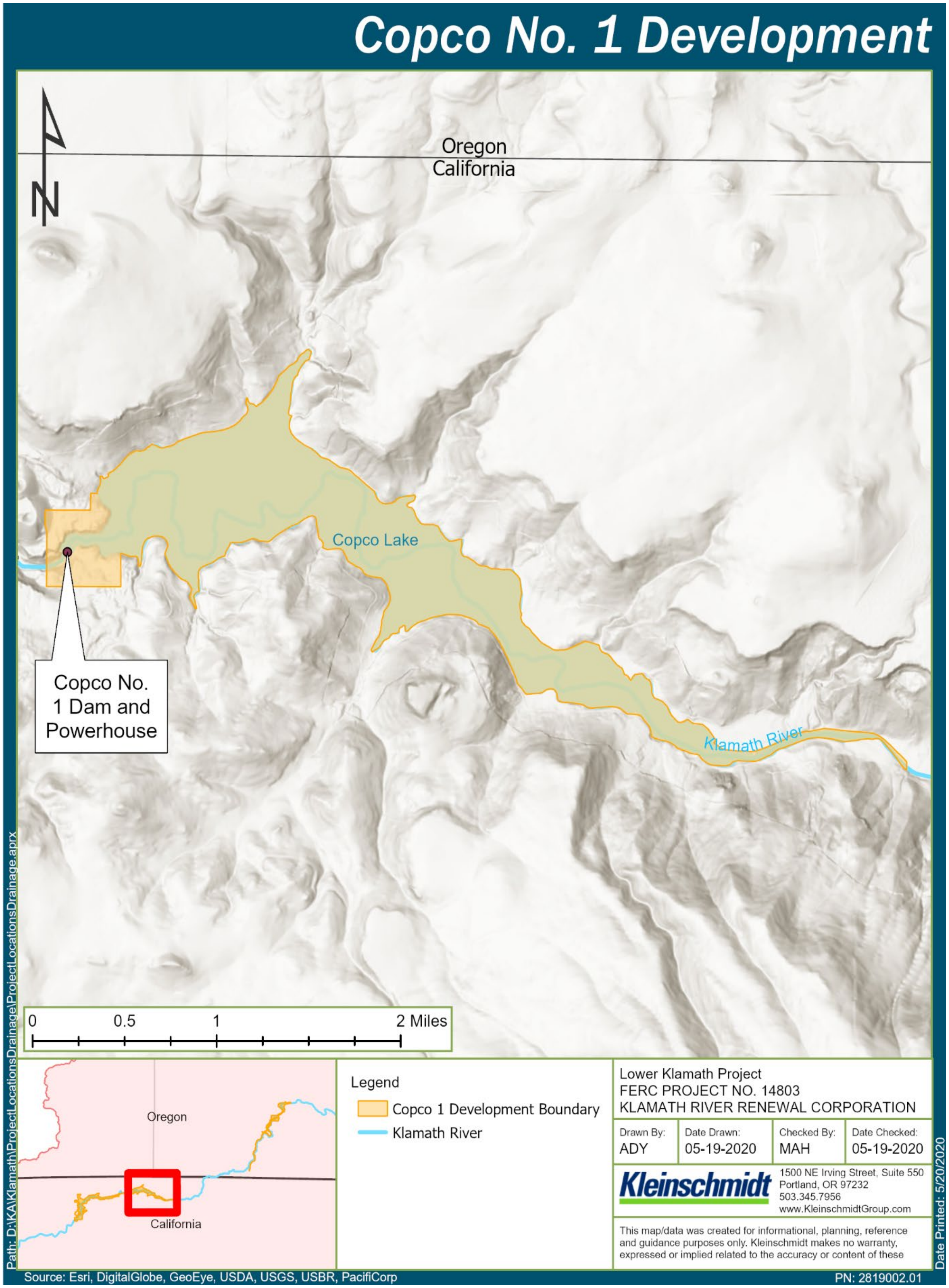

Figure 1-3. Copco No.1 Development Facility Details

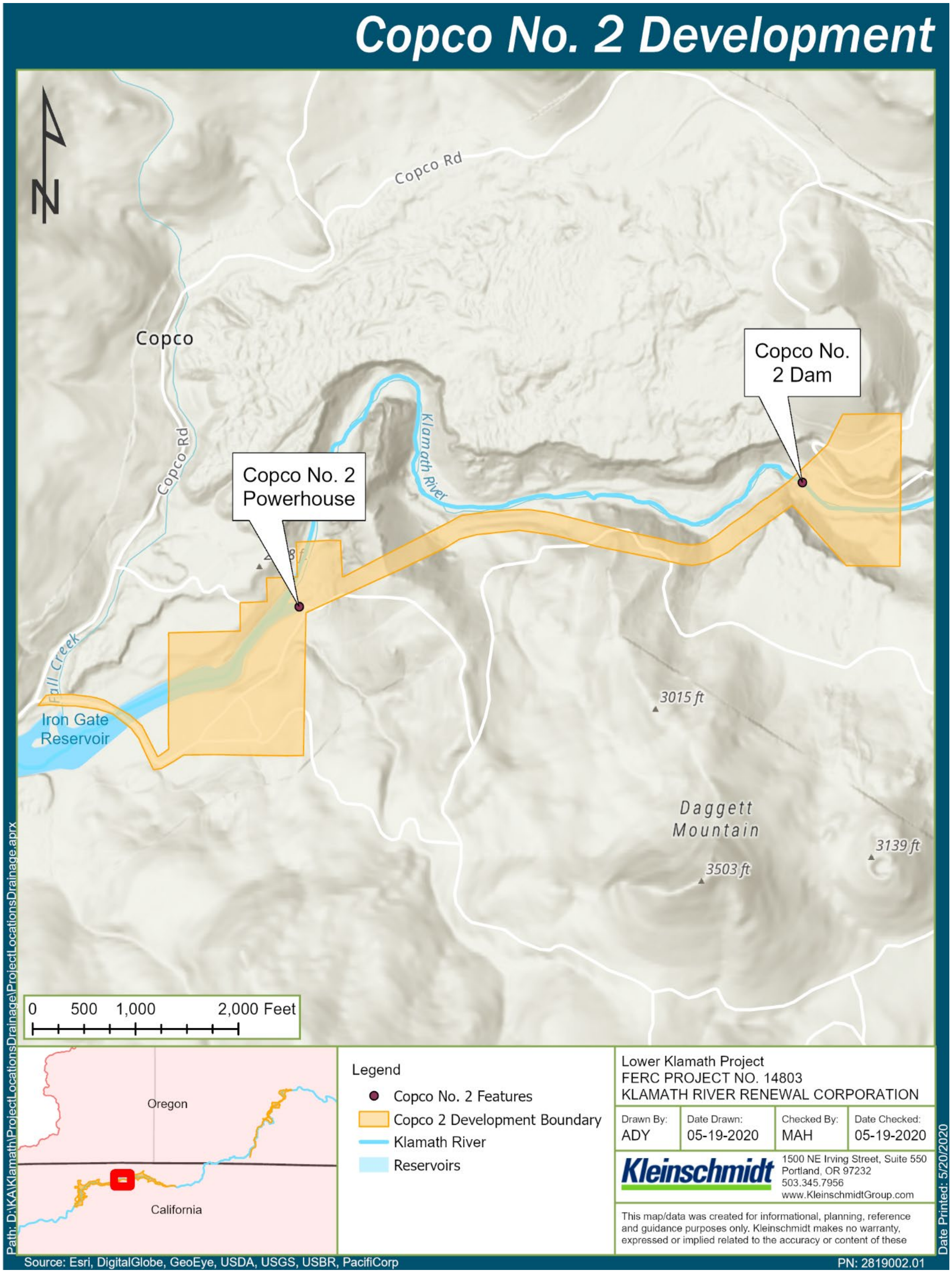

Figure 1-4. Copco No.2 Development Facility Details

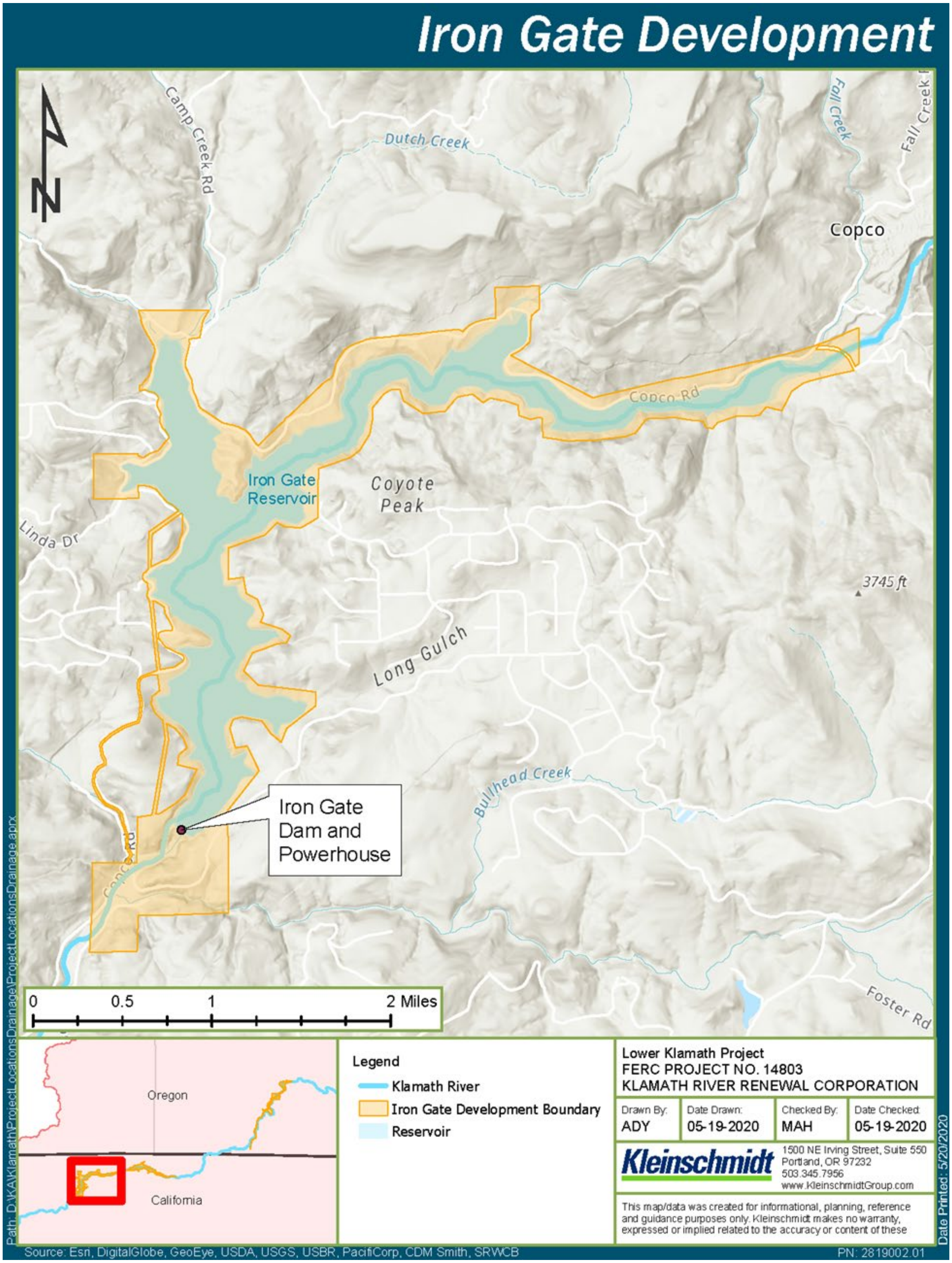

Figure 1-5. Iron Gate Development Facility Details

2.0 Regulatory Context

The Hatcheries Management and Operations Plan is one of 16 Management Plans implementing the DDP.

Table 2-1. Lower Klamath River Management Plans

1. Aquatic Resources Management Plan	9. Remaining Facilities Plan
2. Construction Management Plan	10. Reservoir Area Management Plan
3. Erosion and Sediment Control Plan	11. Reservoir Drawdown and Diversion Plan
4. Hatcheries Management and Operations Plan	12. Sediment Deposit Remediation Plan
5. Health and Safety Plan	13. Terrestrial and Wildlife Management Plan
6. Historic Properties Management Plan	14. Waste Disposal and Hazardous Materials Management Plan
7. Interim Hydropower Operations Plan	15. Water Quality Monitoring and Management Plan
8. Recreation Facilities Plan	16. Water Supply Management Plan

2.1 Purpose of the Hatcheries Management and Operations Plan

The purpose of the Hatcheries Management and Operations Plan is to provide capacity for fish propagation during dam removal and for re-population of new habitat when dam removal is complete. At the recommendation of the National Marine Fisheries Service and the California Department of Fish and Wildlife, the Renewal Corporation will move hatchery operations to Fall Creek Fish Hatchery, replacing operations at Iron Gate Fish Hatchery. In addition to the information contained in this Hatcheries Management and Operations Plan, hatchery operations will be conducted in general accordance with regulatory authorizations, including but not limited to the National Marine Fisheries Service's Biological Opinion for the Proposed Action and the Hatchery and Genetic Management Plan for Iron Gate Hatchery Coho Salmon or as amended. The Hatcheries Management and Operations Plan describes the Renewal Corporation's plans to construct, modify, operate, maintain, and facilitate transfer of ownership of the Fall Creek Fish Hatchery (FCFH), while retiring Iron Gate Fish Hatchery (IGFH). This Hatcheries Management and Operations Plan also includes annual fish production goals, identification of water supplies needed to operate the hatcheries, and the required minimum amount of flow below diversions.

2.2 Specific Regulatory Interests

The Renewal Corporation considered the following regulatory interests in the development of the Hatcheries Management and Operations Plan:

- California State Water Resources Control Board, Clean Water Act, 401 Water Quality Certificate

- California Department of Fish and Wildlife Memorandum of Understanding
- Endangered Species Act Section 7 Biological Assessment (ESA Section 7)
- Oregon Memorandum of Understanding
- Federal Energy Regulatory Commission Final Environmental Impact Statement
- Federal Energy Regulatory Commission License Surrender Order

IGFH was built and is operated in compliance with the original license for the Klamath Hydroelectric Project.

Under the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program addresses water pollution by regulating point sources that discharge pollutants to waters of the United States including stormwater and effluent discharges from municipal, industrial, and agricultural sources. Construction of modifications to FCFH will occur under an NPDES Construction General Permit obtained by the Renewal Corporation, and operations of FCFH will be conducted under a separate NPDES wastewater discharge permit obtained by CDFW.

2.3 Modifications to the Approved Plan

The Renewal Corporation has modified the December 2021 version of this plan in the following material respects to comply with the November 17, 2022, License Surrender Order.

Table 2-2. Modifications to the Approved Plan

SECTION	MODIFICATIONS
Section 2.5	• Added a statement indicating CDFW will submit an annual water usage report to the SWRCB.
Section 3.2	• Added clarification that PacifiCorp will construct the Fall Creek Fish Hatchery and will continue to own the lands and the new facilities. CDFW will lease such lands and facilities from PacifiCorp for a period of eight years following removal of Iron Gate Dam.
Section 3.2.1.1	• Added details regarding compliance with Fall Creek Fish Hatchery water rights.
Section 3.2.2.9.5	• Added a description of the minimum flows in the bypassed reaches of the Fall Creek Powerhouse tailrace and Fall Creek.
Section 4.0	• Added a requirement that the Fall Creek Fish Hatchery construction contractor maintain a 20-foot buffer around delineated wetlands.

2.4 Regulatory Approval

The Renewal Corporation will implement the Hatcheries Management and Operations Plan as approved by the Commission in the License Surrender Order. The Renewal Corporation will obtain and report to the Commission any required approvals from other agencies.

2.5 Reporting

The Renewal Corporation will prepare and submit to the Commission by April 15 of each year an annual report that will include information pertaining to implementation of the Hatcheries Management and Operations Plan including the amount of water diverted, bypass flows, and reporting requirements under the NPDES wastewater permit.

CDFW will prepare and submit to the SWRCB an annual report of water usage under its licensed appropriative water right (A025896), and a Statement of Diversion and Use under applicable riparian water rights, which are described in detail in Section 3.2.1.1

3.0 Fish Hatchery Facilities

Table 3-1 states the fish production levels for IGFH and FCFH for the purpose of License Surrender. These are consistent with the levels required by the Commission in Article 49 in the 1963 amendment to the Project license, authorizing IGH.

Table 3-1. Comparison of Hatchery Production Goals

SPECIES/LIFE STAGE	1960'S MITIGATION GOAL (AT IGFH)	PRODUCTION GOAL POST-DAM REMOVAL	RELEASE DATES
Coho Yearlings	75,000	75,000 at FCFH	March 15 – May 1
Chinook Yearlings	900,000	115,000 at FCFH	Oct 15 – Nov 20
Chinook Smolts	5,100,000	3,250,000 at FCFH	March 1 – June 15
Steelhead	200,000	0	NA

Recent developments tied to facility biological-programming investigations, the availability of appropriate water supplies and sources (including quantity, quality), and discussions involving key Project stakeholders have resulted in updates to the previous production levels and facility operations. Updated Project plans to construct, modify, operate, and maintain FCFH are identified in Sections 3.1 and 3.2.

3.1 Iron Gate Fish Hatchery

By the end of the drawdown year, the Renewal Corporation will retire IGFH and will transfer control of the following IGFH facilities to the State of California:

- A fish hatchery with a warehouse, hatchery building, four fish-rearing ponds, visitor information center, and four employee residences.

CDFW will perform all maintenance of the facilities listed above, as the warehouse, hatchery building, visitor information center, and four employee residences will be used for storage, office space, and housing to support regional and statewide CDFW aquaculture operations. A bulleted summary of the operations and maintenance activities at the Iron Gate facility post-dam removal is provided below:

- Warehouse
  - CDFW will use the existing warehouse to store tools, materials, spare parts, and other implements necessary to support hatchery operations at FCFH.
- Hatchery Building
  - CDFW will use the existing Hatchery Building to serve as office space for administration of FCFH operations, records, procurements, communications, and human resources.
- Visitor Information Center
  - CDFW will maintain the Visitor Information Center at Iron Gate for public outreach purposes and will update the facility pending funding.
- Four Employee Residences
  - CDFW will use the existing four employee residences to provide housing for FCFH staff and maintain rapid response times and site security.

CDFW will relocate all aquaculture production (adult holding, spawning, egg incubation, fish production) to the updated FCFH facility. This will effectively remove all potential Iron Gate water use for aquaculture production and all aquaculture-related effluent concerns.

Any remaining facilities at the IGFH will be the discretion of CDFW. Their use, demolition, or retention are not part of this Hatcheries Management and Operations Plan. Potential water quality impacts associated with this Hatcheries Management and Operations Plan will now occur exclusively at the FCFH. Thus, the balance of this Hatcheries Management and Operations Plan addresses facility improvements and aquaculture operations at the FCFH.

3.2 Fall Creek Fish Hatchery

PacifiCorp will construct upgraded facilities at FCFH, and CDFW will operate the hatchery. PacifiCorp will continue to own the land and the upgraded facilities at FCFH. Pursuant to the Klamath Hydroelectric Settlement Agreement, CDFW will lease such lands and facilities from PacifiCorp for a period of eight years following removal of Iron Gate Dam. The Renewal Corporation and CDFW have worked collaboratively on updated designs for the FCFH. The FCFH design is 100% complete. The following sections specific to FCFH are taken from the October 2020 Fall Creek Fish Hatchery – Design Documentation Report Issued for Construction (IFC) Design Submittal (Appendix B). The appendices of this Report, which include the design calculations are not included in Appendix B but can be provided upon request.

3.2.1 FCFH Background

PacifiCorp will modify the FCFH site to upgrade existing facilities and construct new facilities for coho (*Oncorhynchus kisutch*) and fall-run Chinook salmon (*O. tshawytscha*) production. The NMFS and CDFW have determined the priorities for fish production at FCFH under the

Hatcheries Management and Operations Plan. State and federally listed species in the Klamath River, Southern Oregon Northern California Coast (SONCC) Coho Distinct Population Segment (DPS) production is the highest priority for NMFS and CDFW, followed by Chinook salmon, which support tribal, sport, and commercial fisheries. NMFS and CDFW support discontinuation of steelhead production.

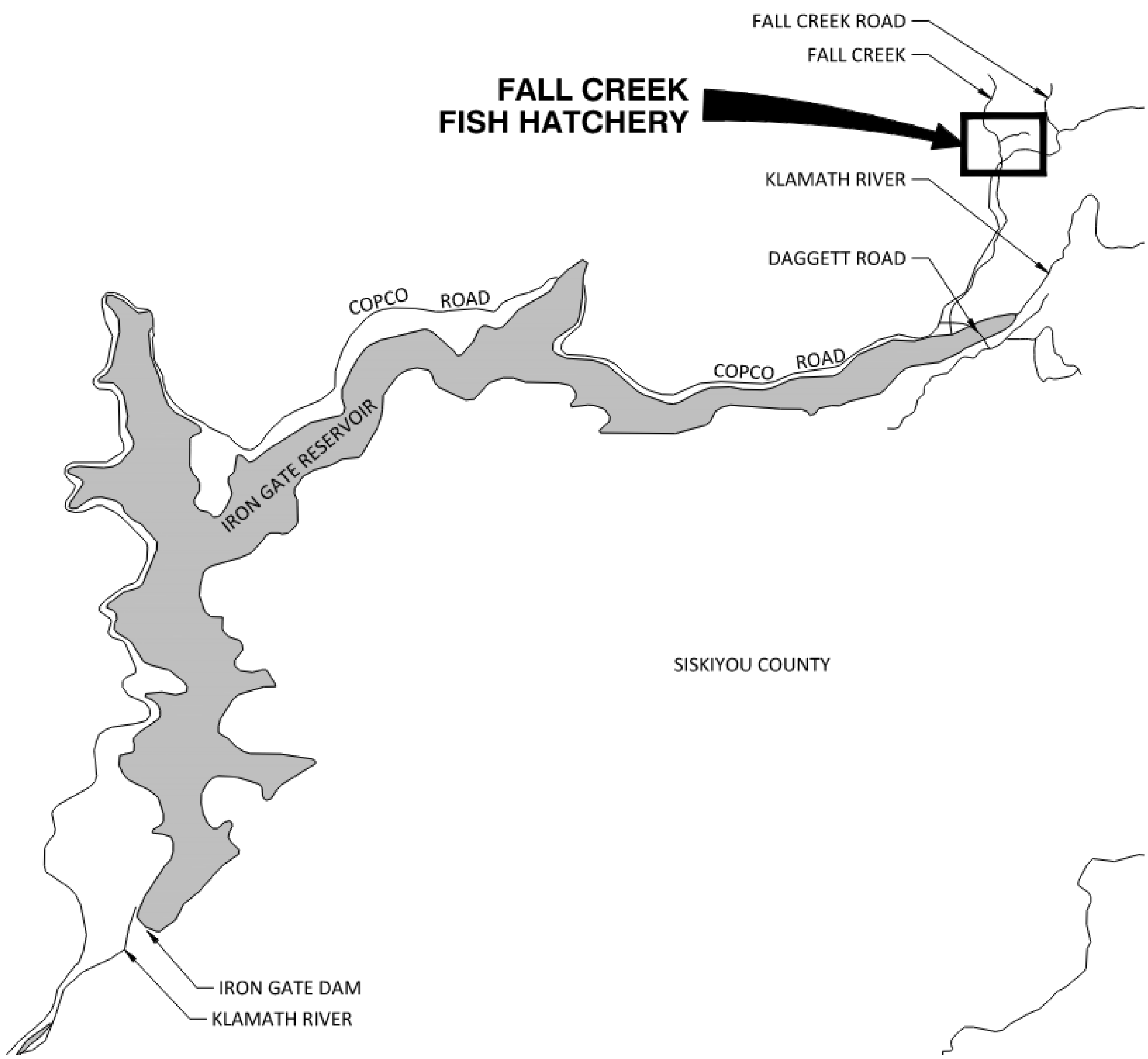

Figure 3-1. Fall Creek Fish Hatchery Vicinity & Site Map

Some historic functional facilities remain at FCFH, but substantial infrastructure improvements are required to achieve the Hatcheries Management and Operations Plan fish production goals. FCFH improvements will occur within the existing facility footprint to minimize environmental and cultural resource disturbances. FCFH will be in operation prior to the drawdown of Iron Gate Reservoir. Post-removal dam conditions will allow anadromous fish to ascend Fall Creek and be trapped for future brood purposes. The water supply and maximum available flow for the Project are set at 10 cubic feet per second (cfs). This water usage is non-consumptive, and water must be returned to Fall Creek, with final designs addressing NPDES wastewater permit considerations. The Hatcheries Management and Operations Plan requires CDFW to employ

Best Management Practices to minimize pollutants and therapeutants being discharged to Fall Creek during hatchery operations.

Hatchery production at FCFH will occur until License Surrender is effective. The Renewal Corporation expects that CDFW will continue to operate FCFH for 8 years following Iron Gate Dam removal, pursuant to the Klamath Hydroelectric Settlement Agreement.

3.2.1.1 Fall Creek Hatchery Water Rights

CDFW holds a licensed appropriative water right (A025896) on Fall Creek for a maximum diversion of 10 cfs, which allows diversion between March 15 and December 15 annually. The water right has a priority date of 1979. The water is to be used for aquaculture and it is non-consumptive, so all diverted water (minus evaporation) is released back into Fall Creek downstream of FCFH. Between December 16 and March 14, CDFW uses water from Fall Creek under riparian water rights. This usage is also non-consumptive, and all diverted water (minus evaporation) is released back into Fall Creek downstream of FCFH.

3.2.2 FCFH Fish Production Goals and Biological Design Criteria

Table 3-2 summarizes the goals for fish production at FCFH (data compiled from CDFW information).

Table 3-2. Fall Creek Hatchery – Fish Production Goals

SPECIES (JUVENILE LIFE HISTORY)	ADULT RETURN*	INCUBATION START DATE	INCUBATION START NUMBER	TARGET RELEASE DATES	RELEASE NUMBER	RELEASE SIZE
Coho (Yearling)	Oct. – Dec.	Oct. – Mar.	120,000	Mar. 15 – May 1	75,000	10 fpp
Chinook (Smolts)	Oct. – Dec.	Oct. – Mar.	4.5M**	Pre-Mar. 31	1,250,000	520 fpp
Chinook (Smolts)	Oct. – Dec.	Oct. – Mar.	-	May 1 – June 15	1,750,000	90-100 fpp
Chinook (Yearling)	Oct. – Dec.	Oct. – Mar.	-	Oct. 15 – Nov. 20	250,000	10 fpp

*Adult trapping period from Iron Gate Fish Hatchery data
** Estimated Total Green Egg Requirement at Spawning
fpp = fish per pound

Biological information used in the design criteria are based on a biological program (bioprogram) schedule developed to meet fish production goals. This bioprogram schedule is provided in Figure 3-2 (also provided in Appendix C for ease of viewing); biological design criteria addressed below will be discussed in reference to Figure 3-2.

9-Mar-20

PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE

Fall Creek Hatchery - Coho Yearling / Chinook Sub-Yearling & Yearling Program

				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
CHINOOK PRODUCTION																												
Egg Take - Green to Eyed Egg Period																												
On Station Incubation - Eyed Eggs xfr in Nov 15 at 400 CTU																												
Chinook Brood Year Rearing in TBD (~12x4x50 Vats Pond-Rls.)									Mark and Xfr by May 31																
~ 250k Chinook Yearlings																Xfr out Nov									
Coho BY-A Early Rearing in Vats & Small Raceways								Xfr to Large Ponds																	
Coho BY-A in Production Raceways/Vats																				Xfr out Mid-April					
Coho BY-B in Early Rearing Vats & Small Raceways								Xfr to Large Ponds												Xfr to Large Ponds					
Coho BY-B in Production Raceways/Vats																									
			(F)	49.0	46.0	43.0	43.0	43.0	46.0	50.0	54.0	54.0	54.5	54.5	50.0	49.0	46.0	43.0	43.0	43.0	46.0	50.0	54.0	54.0	54.5	54.5	50.0	49.0
FC Sub-Yearling Chinook	3,250,000	(Start Inv)						3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000	250,000			3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.05	mm/ctu/day						4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16	11.67			4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16
Fish Length Inches EOM - Assumes 1200 fpp & .376 g/f @ ponding				L				1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521	6.980		L	1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521
Fish Weight Grams EOM (Piper Tables; Assumes C3000)				g/f				0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65	45.27		g/f	0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65
Fish Per Pound EOM				fpp				1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #	10 #		fpp	1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #
Biomass In Pounds EOM				biom				2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751	24,951		biom	2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.				6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608	11,915		cu.ft.	6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608
Flow Required EOM (gpm)	1.5	FI		680	680	680	680	1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122	2,383			1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122
Assume ~4.5M green; 4,136 green eggs/tray; 1,088 trays = 136 1/2 stacks								680	1.25M Rls End Mar		1.75M Rls End May (post-mark 150/lb)				Incub:	680	680	680	680	680	1.25M Rls End Mar		1.75M Rls End May					680
CDFW Growth Reduction; Days Feed/Month																23 days	15 days	7 days	7 days	7 days	15 days							
									78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400	76,200	76,000	75,800	75,600	75,400	75,000						
FC Yearling Coho	80,000	(Start Inv)													Ration:	75%	50%	25%	25%	25%	50%	Ap. 15 Rls						
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.045	mm/ctu/day						4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77	5.25	1.92	1.92	1.92	5.25	4.50						
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				L				1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759	5.966	6.041	6.117	6.193	6.400	6.577						
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			Brood Year A	g/f				0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2	33.5	35.3	37.5	37.8	41.8	45.4						
Fish Per Pound EOM				fpp				1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #						
Biomass In Pounds EOM				biom				57	129	294	635	1,190	1,986	3,087	4,183	5,087	5,628	5,915	6,267	6,300	6,948	7,500						
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.				150	255	443	739	1,129	1,584	2,125	2,595	2,944	3,145	3,263	3,415	3,391	3,619	3,801						
Flow Required EOM (gpm)	1.5	FI		40	40	40	40	30	51	89	148	226	317	425	519	589	629	653	683	678	724	760						40
CDFW Growth Reduction; Days Feed/Month					15 days	7 days	7 days	7 days	15 days																			23 days
					76,200	76,000	75,800	75,600	75,400	75,000											78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400
FC Yearling Coho	80,000	(Start Inv)		Ration:	50%	25%	25%	25%	50%	Ap. 15 Rls																		
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.045	mm/ctu/day			5.25	1.92	1.92	1.92	5.25	4.50										4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				L	5.966	6.041	6.117	6.193	6.400	6.577									L	1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			Brood Year B	g/f	33.5	35.3	37.5	37.8	41.8	45.4									g/f	0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2
Fish Per Pound EOM				fpp	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #									fpp	1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #
Biomass In Pounds EOM				biom	5,628	5,915	6,267	6,300	6,948	7,500									biom	57	129	294	635	1,190	1,986	3,087	4,183	5,087
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.	3,145	3,263	3,415	3,391	3,619	3,801									cu.ft.	150	255	443	739	1,129	1,584	2,125	2,595	2,944
Flow Required EOM (gpm)	1.5	FI		gpm	629	653	683	678	724	760						40	40	40	40	30	51	89	148	226	317	425	519	589
			GPM	720	1,349	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430	3,732	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430
			CFS	1.6	3.0	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6
			Tot. Adult Flow	10.0	10.0	10.0									10.0	10.0	10.0	10.0									10.0	10.0
				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT

Figure 3-2. Biological Program Schedule – Fall Creek Fish Hatchery

3.2.2.1 Fish Development Cycle

The colored bars across the top section of Figure 3-2 depict the timing of adult spawning and resulting egg incubation, juvenile fish rearing, and a general approach to fish transfer based on marking and release (first-feeding vessels and grow-out vessels). The adult holding/spawning process is assumed to mirror current adult holding and spawning at the IGFH and occurs from October through December. CDFW will initiate egg/alevin incubation at the onset of adult spawning and this process generally runs through March. Egg incubation activities are assumed to be flexible in the initial years of the program, as CDFW will source eggs from one or more egg production stations and/or from the most appropriate natural anadromous brood sources. Early rearing will begin as first-feeding fry are ponded, and this period will generally extend until the marking/tagging is completed. CDFW will determine marking/tagging dates and numbers based on input from NMFS and other stakeholders. The Renewal Corporation designed and sited early-rearing tanks/vessels with consideration for fish collection through the marking trailer, as well as differentiating between marked/tagged and non-marked/tagged groups. Final grow-out rearing will provide adequate rearing space and collection/release methods for fish at release.

3.2.2.2 Biological Variables

The Renewal Corporation and CDFW used water temperature, species-specific condition factor/growth rates, fish weight/length targets, and density and flow indices to prepare the preliminary operations schedule.

3.2.2.3 Water Temperature

Water temperature is a primary determining factor in the development and growth rate of fish. Figure 3-2 (row 2 for each cohort group) provides mean water temperature data that are used to estimate the rate of fish growth, which is also tied to feed rate. CDFW's prior experience rearing Chinook salmon at the Fall Creek facility demonstrates that rearing conditions are favorable for the production of high-quality juvenile salmon. CDFW-provided mean monthly water temperature data for Fall Creek is presented below in Figure 3-3.

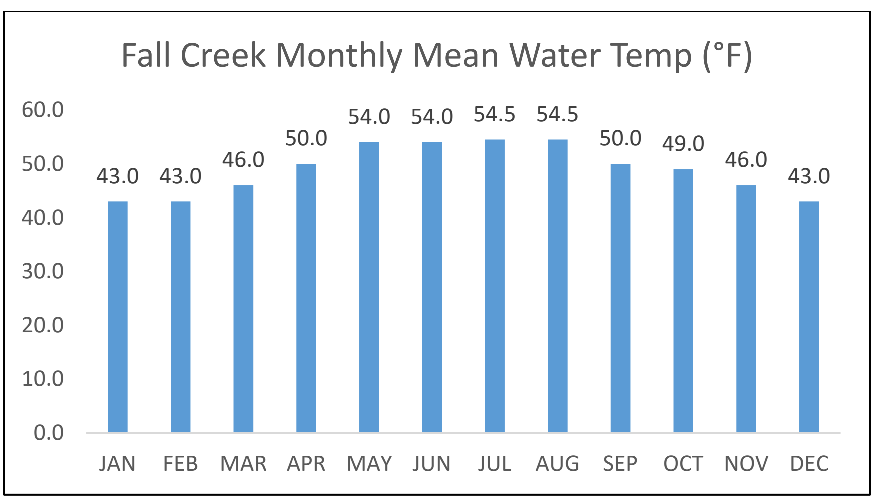

Figure 3-3. Mean Monthly Fall Creek Rearing Temperature Data (Data from L. Radford, CDFW)

3.2.2.4 Expected Growth Rates

The projected monthly growth rate shown in Figure 3-2 (row 3 for each cohort group) is 0.045 and 0.05 millimeters per centigrade temperature unit per day (mm/ctu/day) for coho and Chinook, respectively. Growth rates are applied to mean water temperatures to develop an estimate of total growth (millimeters per month), which is tied directly to feed rate. Within an ideal water temperature range for salmonids, and in the absence of feed modulation, fish will grow faster at higher water temperatures than at lower temperatures (increased daily/monthly growth in millimeters at elevated water temperature range). Therefore, CDFW will rely on the ambient Fall Creek water temperature profile to estimate growth rates.

3.2.2.5 Fish Weight and Length

Row 4 of each cohort group shown in Figure 3-2 depicts the cumulative fish length in inches, which is determined by adding the growth per month to the fish length at the end of the preceding month. The mean weight of individual fish in grams is shown in the row below the length (row 5); mean weights are obtained from Piper et al. (1982) Length-Weight Tables for the specific condition factor of fish in culture (coho C3500, Chinook C3000; Cx10^{-7}).

3.2.2.6 Density Index

Density index (DI) is a function of pounds of fish per cubic foot of rearing volume per inch of fish length (lbs fish/cf volume/length [inch]). CDFW will rear fish at a maximum DI of 0.3 for the coho and Chinook programs at Fall Creek; 0.3 is a conservative DI that is reflective of similar conservation/recovery programs for anadromous Pacific salmon juveniles throughout the Pacific Northwest.

CDFW will use DI to calculate the total rearing volume required. Figure 3-2 (row 8) shows the rearing volume required at the end of each month as fish size increases from left to right. The total volume is then divided by the volume of individual rearing tanks/vessels to determine the total number of rearing units required.

3.2.2.7 Flow Index

Flow index (FI) is a function of pounds of fish divided by fish length in inches times flow in gallons per minute (gpm). Flow index is an indication of how much oxygen is available for fish metabolism and is adjusted based on the elevation of the project site and water temperature, both of which affect the amount of dissolved oxygen in the water at saturation. CDFW will rear fish at a maximum FI of 1.50 for the coho and Chinook programs at Fall Creek; 1.50 is a conservative FI that is reflective of similar conservation/recovery programs for anadromous Pacific salmon juveniles throughout the Pacific Northwest (at similar elevations and water temperature profiles).

3.2.2.8 Egg Take and Fish Survival

Current rearing production program scenarios plan for a total of 75,000 coho salmon and approximately 3.25 million Chinook salmon at various release dates. Mean survival rate estimates provided by CDFW for the IGFH program suggest a green egg to ponding (first-feeding) survival rate of approximately 73 percent. Based on the 73 percent survival estimates, approximately 120,000 green eggs will be required for the coho program and approximately 4.5 million green eggs will be required for the Chinook program. Improved incubation water quality at Fall Creek (vs. poorer Iron Gate water quality) and reduced tray loading densities will increase survival rates as the program develops rearing techniques that favor increased survival.

3.2.2.9 Incubation and Rearing Facilities

This section provides a summary of the incubation and rearing flows, as well as rearing volumes depicted in Figure 3-2.

3.2.2.9.1 Incubation

CDFW hatchery operators will use incubation systems currently at IGFH for egg/alevin incubation at FCFH. One hundred thirty incubation stacks are available for future rearing needs. The existing incubation units are vertical stack incubators with a double-stack arrangement, with 15 useable trays per stack (full-stack, with the top tray used as sediment tray). Water flow requirements are modeled at 5 gpm, per manufacturer's recommendations, which is an industry standard, regardless of eight-tray or 16-tray configuration.

To avoid any need for auxiliary pumping, CDFW selected an eight-tray (half-stack) configuration for all incubation systems at FCFH. Additionally, reducing the tray loading densities for the Chinook program will likely result in increased survival. The current design assumes approximately 50 to 55 ounces of Chinook eggs per tray rather than approximately 100 ounces/tray currently used at IGFH.

Incubation requirements based on new loading densities for Chinook are approximately 136 half-stack incubators (1,088 trays) requiring approximately 680 gpm. Chinook incubator units are proposed as eight-tray loading, with an extra incubation tray on top of the unit acting as a sediment tray (a ninth tray without screening is used to settle sediment). Incubation requirements for the coho program are unchanged from the original planning efforts and require six half-stack incubators (approximately 40 trays required) using approximately 30 gpm of water. Coho incubator units have the flexibility (tray space) to accommodate a seven-tray loading configuration with the eighth tray (top) used as a sediment tray.

3.2.2.9.2 Early Rearing

First-feeding and early-rearing vessel requirements are based on fish size estimates from the bioprogram for the period of ponding through the marking stage of rearing. Maximum bioprogram requirements for rearing space and water flow resulted in approximately 3,850 cubic feet of rearing space and approximately 760 gpm for coho and approximately 20,200 cubic feet and 4,050 gpm for Chinook. Allowing for the maximum space and flow required at peak production for each species, the estimated rearing space required for early-rearing through marking phases are identified below:

- Coho Early-Rearing: Total rearing required at mark size of about 150 fish per pound (fpp) – 650 ft3
- Chinook Early-Rearing: Total rearing required at mark size of about 150 fpp – 16,000 ft^3

Total early-rearing space provided for coho is approximately 825 ft^3 of fiberglass vat rearing and an additional 1,200 ft^3 available in renovated concrete raceways; the renovation of the concrete raceways provides a total of eight individual rearing containers that can be used to maximize the population compartmentalization of the listed coho stock. Total early-rearing space provided for Chinook is approximately 19,200 ft^3 and provides maximum compartmentalization for cohort groups of between 204,000 (16 rearing units) and 408,000 (eight rearing units) fish, depending on mean fish size.

The maximum production/flows for coho occur at mid-April release, and the maximum biomass/flows for Chinook occur at late-May release, as shown in Figure 3-2 (row 9 for each cohort). Coho brood cohorts (first-feeding fry and smolt program) will overlap from early-ponding through smolt release; coho production for the second cohort is assumed to require approximately 650 ft^3 of rearing space (the four fiberglass vats) and 90 gpm from first-feeding through late-April transfer to larger production ponds (post-smolt release).

3.2.2.9.3 Juvenile Rearing

Grow-out vessel requirements based on Figure 3-2 (row 8 for each cohort) result in a maximum grow-out rearing need of 3,800 ft^3 of coho rearing space (April release) and approximately 20,200 ft^3 of Chinook rearing space (May release) based upon the bioprogram. Total rearing volume provided in the facility design is 4,190 ft^3 for coho and 20,340 ft^3 for Chinook. Raceway drains for both coho and Chinook units have been designed to allow for volitional emigration of fish directly to Fall Creek; volitional water supply routing is described in Sections 3.2.3.3 and 3.2.3.5.

3.2.2.9.4 Adult Holding

The Renewal Corporation designed adult holding and spawning ponds using CDFW recommendations, and the designs are consistent with NOAA guidelines for anadromous adults. The Renewal Corporation retained existing raceway series currently on-site (south of Copco Road) in the FCFH design and will renovate them to provide sufficient space to hold the requested 100 coho and 200 Chinook pre-spawn adults. One of the four existing raceways will act as a primary trapping and handling pond, with two ponds renovated to act as longer-term holding for pre-spawn coho and Chinook adults. The remaining pond will be used as a settling pond and is described later in the report. CDFW hatchery operators will route all non-cleaning (effluent) flow, which will be a maximum of 10 cfs, to the adult ponds to be used for adult holding and fish ladder attraction flows when required, which is assumed between September and December.

PacifiCorp will renovate three adult holding ponds with screen and stoplog keyways (and adequate quiescent zones; effluent collection) to allow for the potential short-term rearing of juvenile Chinook that would have otherwise been released early because of space limitations in the Chinook rearing raceway complex. Flow to the holding ponds will be second-pass, untreated water from the coho and Chinook rearing facilities. However, the second-pass water will be of sufficient quality and oxygen levels for surplus juvenile Chinook because of the conservative density and flow indices used in the bioprogram. Assuming three raceways with approximately 2,500 ft^3 of vacant space per unit (12.5 feet wide by 50 feet long by 4-foot-depth useable space; 7,500 ft^3 total), serial reuse flows from the upper production units, and using a 0.3 density index, the maximum permissible weight of 3.175-inch fish (about 104 fpp) would be approximately 7,100 pounds (about 740,000 fish at 104 fpp). Drains have been designed to provide volitional emigration of fish to Fall Creek; volitional water supply routing from this series is described in Section 3.2.4.8.

3.2.2.9.5 Peak Water Demand

Water budget for an entire calendar year projects a peak water demand for the Fall Creek Fish Hatchery to be 9.3 cfs for May of each year immediately prior to Chinook sub-yearling releases and when juvenile coho are in early rearing containers. The projected annual water budget by month to support fish production at Fall Creek Hatchery is provided below in Table 3-3.

Table 3-3. Fall Creek FH Water Requirements – Full Production

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Total Juv. CFS	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1
Total Ladder CFS	-	-	-	-	-	-	-	-	10.0	10.0	10.0	10.0

The worst-case scenario for minimum flow in the FCFH bypassed reach would occur when the hatchery is drawing its full water right of 10 cfs, the City of Yreka is drawing its full water right of 15 cfs, and the Fall Creek Powerhouse is shut down unexpectedly. In this scenario, 27 cfs would be diverted from Dam B to Dam A, and 25 cfs total would be diverted into FCFH and the City of Yreka intake, leaving a minimum of 2 cfs in the tailrace channel downstream of Dam A. Fall Creek has a historic minimum flow of 32 cfs, so the minimum flow in Fall Creek upstream of the confluence with the tailrace would be 5 cfs, and the minimum flow in Fall Creek between the confluence with the tailrace and the FCFH outflow would be 7 cfs. Since FCFH is non-consumptive, the minimum flow downstream of the FCFH outflow would be 17 cfs under this scenario, which complies with the City of Yreka water right requirement to maintain a minimum flow of 15 cfs or greater in Fall Creek at the compliance gage downstream of Daggett Road.

3.2.3 FCFH Project Description

3.2.3.1 General Description

The following subsections describe the proposed modifications of FCFH to meet the fish production goals and are taken from the October 2020 Fall Creek Fish Hatchery – Design Documentation Report IFC Final Design Submittal.

The general site layout is depicted in Figure 3-5, with the major components of the layout summarized in Table 3-4, as well as in the following sections.

3.2.3.2 FCFH Water Supply Intake Structure and Meter Vault

PacifiCorp will construct the hatchery water intake structure along the southeast bank of Fall Creek directly adjacent to Dam A and opposite the City of Yreka intake structure (see Figure 3-4). The new concrete intake will divert flows up to 10 cfs from Fall Creek. CDFW hatchery operators will base actual diversion flow on need and will follow the schedule presented in Table 3-3. During construction of the intake, the contractor will maintain flow to the City of Yreka intake structure to avoid any interruption in flow diverted to the City of Yreka's water system. A buried 24-inch-diameter pipe will supply the site and will divide flows into four buried water supply pipes to deliver flow to the various hatchery facilities. The Renewal Corporation included a debris screening system in the design of the entrance to the new intake structure to prevent large sediment, detritus, and other debris from entering the intake chamber. The automated screen-cleaning system will operate at regular intervals or based on an acceptable head differential across the screen. Behind each screen will be stop log guide slots for isolation of the pipeline, or closure of one of the screen slots for general maintenance.

The Renewal Corporation has designed the 24-inch-diameter supply line to be set in the concrete wall at a sufficient depth to preclude significant air entrainment at the pipe entrance. After the flow split, magnetic flow meters will monitor the four hatchery facility supply pipelines and will transmit flow rates to a programmable logic controller (PLC) located in the electrical room connected to the Chinook Incubation Building (see Section 3.2.3.4). The intake also includes a sediment sluiceway outside of the intake chamber, for bypassing sediment and bedload that may accumulate at the toe of the intake screens.

Table 3-4. Fall Creek Fish Hatchery Major Facilities Schedule

FACILITY	SPECIES	REQUIRED CAPACITY / VOLUME	REARING VOLUME PROVIDED	FLOW REQUIRE-MENT	TOTAL DIMENSIONS (REARING DIMENSIONS)	COMMENTS
Intake Structure	-	-	-	10 ft^3/s	8' (W) x 8.9' (L) x 8.5' (H)	Concrete Structure
Meter Vault	-	-	-	-	13' (W) x 15' (L) x 6.4' (H)	Concrete In-Ground Vault
Coho Building	Coho	-	-	-	53' (W) x 65' (L)	Pre-engineered Metal Building
Incubators	Coho	48 trays	48 trays	40 gpm	25" (W) x 25" (L) x 34.5" (H) (per stack)	Existing, from IGFH
Incubation Working Vessel	Coho	150 ft^3	150 ft^3	30 gpm	(2) 2' (W) x 15' (L) x 3' (H)	Existing, from IGFH
First-Feeding Vessel	Coho	750 ft^3	825 ft^3	150 gpm	(2) 4' (W) x 16' (L) x 3' (H), Existing (3' W x 15' L x 2.5' Depth) Existing	Existing, from IGFH
					(2) 6' (W) x 21' (L) x 4' (H), New (5' W x 20' L x 3' Depth) New	Fiberglass Vat
Rearing Ponds	Coho	3,850 ft^3	5,400 ft^3	764 gpm	(2) 11' (W) x 40' (L) x 3.8' (H), Existing (11' W x ~38' L x 3' Depth) Existing	Existing Concrete Raceway
					(2) 12.0' (W) x 34.8' (L) x 5' (H), New (12.0' W x 30' L x 4' Depth) New	Concrete Raceway
Chinook Incubation Building	Chinook	-	-	-	50' (W) x 60' (L)	Pre-engineered Metal Building
Incubators	Chinook	1,088 trays	1,088 trays	680 gpm	25" (W) x 25" (L) x 34.5" (H) (per stack)	Existing, from IGFH
Incubation Working Vessel	Chinook	290 ft^3	290 ft^3	60 gpm	(4) 2.5' (W) x 14.5' (L) x 2.5' (H)	Existing, from IGFH

FACILITY	SPECIES	REQUIRED CAPACITY / VOLUME	REARING VOLUME PROVIDED	FLOW REQUIRE-MENT	TOTAL DIMENSIONS (REARING DIMENSIONS)	COMMENTS
Chinook Rearing Ponds	Chinook	20,200 ft^3	23,040 ft^3	4,040 gpm	(8) 12’ (W) x 64.8’ (L) x 5’ (H) (12’ x 60’ L x 4’ Depth)	Concrete Raceway
Trapping/Sorting Pond	Coho/ Chinook	3,350 ft^3	3,350 ft^3	200 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway (1495 gpm provided)
Chinook Adult Holding Pond	Chinook	1,800 ft^3	3,350 ft^3	400 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway (1495 gpm provided)
Coho Adult Holding Pond	Coho	600 ft^3	3,350 ft^3	200 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway 1495 gpm provided
Spawning Building	Coho/ Chinook	-	-	-	25’ (W) x 35’ (L)	Pre-engineered Metal Building
Settling Pond	-	3,200 ft^3	3,200 ft^3	-	(2) 12.6’ (W) x 31.8’ (L) x 5’ (H)	Concrete Pond (2 Bays)
Fish Ladder	Coho/ Chinook	-	-	10 ft^3/s	2.5’ (W) x 24.6’ (L)	Denil Type (Concrete)
Fish Barrier (Dam A)	Coho/ Chinook	-	-	-	29’ (W) x 16’ (L)	Velocity Apron (Concrete)
Fish Barrier (Dam B)	Coho/ Chinook	-	-	-	11.5’ (W) x 20’ (L)	Velocity Apron (Concrete)
Fish Barrier (Fishway)	Coho/ Chinook	-	-	-	17.3’ (W) x 8’ (L) x 4.5’ (H)	Picket Panels on Concrete Sill

Figure 3-4. Intake Structure Location and City of Yreka Intake (Source: McMillen Jacobs)

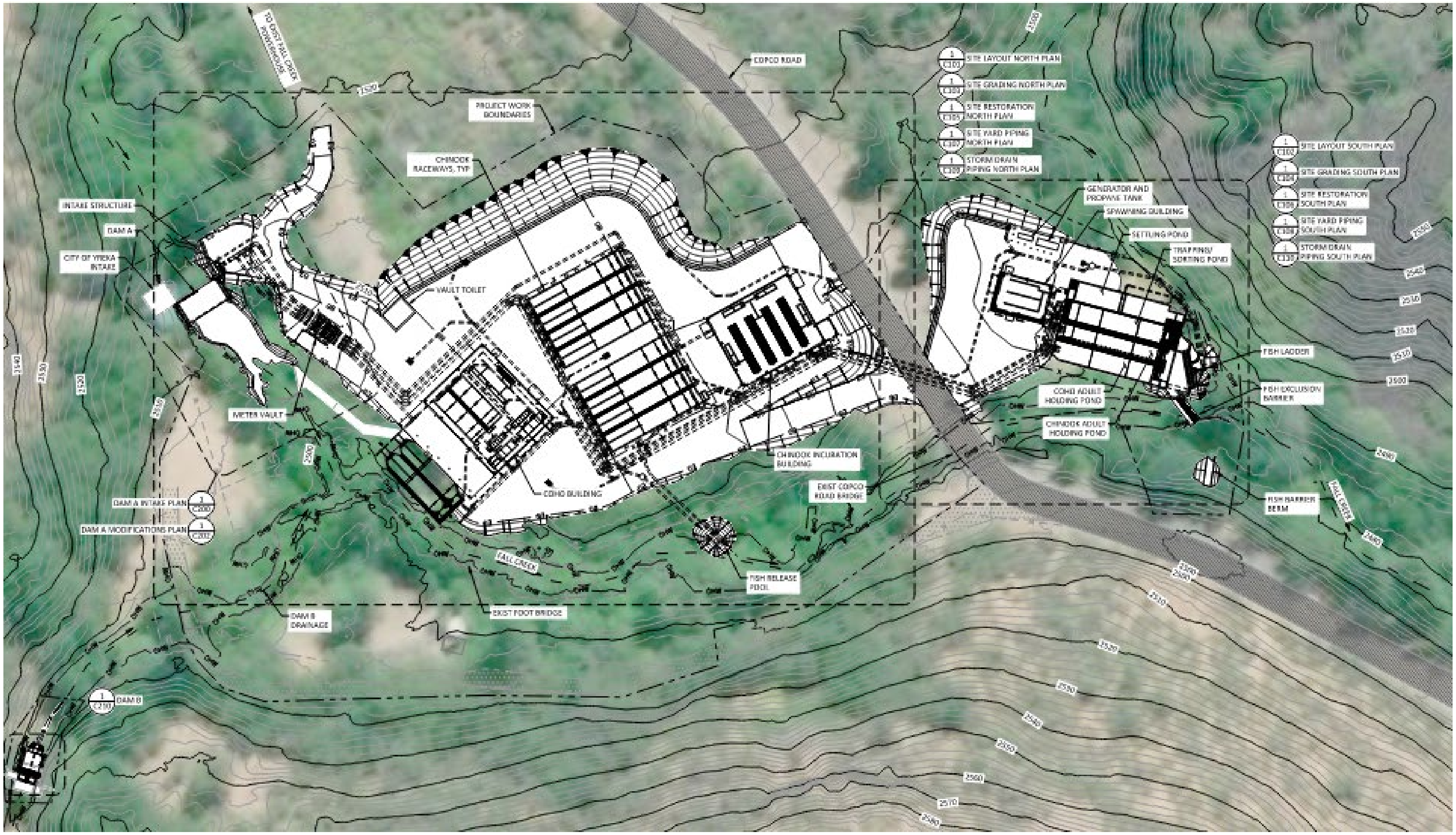

Figure 3-5. General Site Layout

3.2.3.3 Coho Building

The Coho Building will be located at the north end of the Project site at pad elevation 2503.0 (North American Vertical Datum [NAVD] 88), and will house all coho incubation, grow-out, and rearing infrastructure coho production facilities. The Coho Building will be a pre-engineered metal building with interior dimensions of 53 feet wide by 65 feet long.

The design plans include using existing incubation stacks and trays from IGFH (see Figure 3-6), which are configured in a row of six half-stacks (i.e., eight trays per stack) along the southwest wall. This will accommodate the 120,000 coho green eggs discussed in the bioprogram description at 2,500 eggs per tray. CDFW hatchery operators will provide a water flow rate of 5 gpm to each of the incubation stacks via a head tank located above the stacks. The intent of a head tank design is to protect against any potential flow interruption. Water will flow downward through the stacks to a floor drain that discharges to a production drain system, with flows diverted to one of two systems (adult ponds as online flow; effluent ponds as effluent flow). The design plans also include two working vessels (egg picking, enumeration) from IGFH to supplement the incubation stacks (see Figure 3-6).

Figure 3-6. Existing IGFH Incubators (Left) and Working Vessels (Right) (Source: McMillen Jacobs)

The design plans include four first-feeding vessels for initial ponding of the coho fry, consisting of two existing vats from IGFH and two new fiberglass aquaculture vats, providing a total of 825 ft^3 of ponding volume. First-feeding vessels include screen guides, such that a quiescent zone can be maintained at the downstream end of the vessel. These vessels will operate in a flow-through condition with a 150-gpm (total) renewal rate, and online overflows will pass through a standpipe in the quiescent zone that flows into the drain system and is then routed to the adult holding ponds; effluent will flow to the effluent pond (or holding tanks if designed) via an effluent standpipe adjacent to the vats in the floor, which will discharge to the effluent drain system.

The design plans include grow-out and rearing space in part in the existing upper raceway bank (see Figure 3-7). There are two existing concrete raceways (approximately 11 feet wide by 40 feet long by 3.8 feet deep) adjacent to Fall Creek that will be just outside of the Coho Building. These will be rehabilitated with a surficial mortar layer and resurfaced with an epoxy liner for use in coho grow-out and rearing. This raceway bank will be covered with a roof above and predator netting and fencing provided along the sides of the site. PacifiCorp will remove the existing flume that feeds these raceways and will replace the flume with pipe manifolds that provide a maximum of 210 gpm to each of the existing raceways. The design plans further subdivide the raceways with two 20-foot-long pony walls, equipped with dam boards and fish screen slots. This will provide approximately 1,300 ft^3 of early rearing volume for use prior to fish tagging/marking. After fish have been tagged/marked, the dam boards and fish screens can be removed, allowing the full 2,500 ft^3 of rearing space to be used.

Figure 3-7. Existing Upper Raceway Bank (Source: McMillen Jacobs)

At the downstream end of the existing raceways, PacifiCorp will install dam boards and fish screens upstream of the outlet works. Additionally, a set of dam boards will be installed in the existing concrete outlet flume, and pond overflow will be directed into a production drainpipe that will convey flow to the adult holding ponds. When fish are to be released from these raceways, CDFW hatchery operators will close a gate on the production drainpipe and lower dam boards in the existing concrete flume to allow fish to pass over the dam boards and directly into Fall Creek.

The design plans include further rearing space in two new concrete raceways 12 feet wide by 35 feet long by 5 feet deep, located approximately 20 feet from the existing raceways inside the Coho Building. A roadway will pass under the roof structure between the existing and the new raceways. For tagging and marking, CDFW hatchery operators will position the trailer between the existing and new raceways and open the roll-up doors on the Coho Building. Operators will distribute newly tagged/marked fish among the four raceways as required by rearing volume.

Overflow from the new concrete raceways will discharge to an approximately 2-foot-wide exit channel that will direct flows to a production drainpipe in the concrete wall. In addition, there will be a 2-foot by 2-foot box in the exit channel behind a set of dam boards leading to the volitional fish release pipe. If operators desire that fish be volitionally released from these ponds, the gate on the production drainpipe can be closed and dam boards can be removed at the volitional fish release box. Fish will volitionally go over the dam boards and enter a 10-inch-diameter fish release pipe that will convey them to the existing concrete flume on the discharge end of the existing coho rearing raceways, and ultimately out to Fall Creek.

Finally, because production periods will overlap and all coho infrastructure, with the exception of the existing upper raceways, will be housed in the same building, biosecurity will be maintained by curtain systems between the respective areas of the Coho Building (e.g., incubation, first-feeding, rearing/grow-out).

3.2.3.4 Chinook Incubation Building

The Chinook Incubation Building will be located immediately north of Copco Road at pad elevation 2503.0 (NAVD 88) and will house only the Chinook egg incubation operations. The Chinook Incubation Building will be a pre-engineered metal building with interior dimensions of 50 feet wide by 60 feet long.

The design plans include existing incubation stacks and trays from IGFH configured in eight rows of 17 half-stacks, for a total of 136 stacks or 1,088 trays. Incubation trays will accommodate the 4.5 million Chinook green eggs discussed in the bioprogram at an approximate loading density of 4,150 eggs per tray. Rows of incubation stacks maintain a 7.5-foot buffer on other rows to mitigate any cross-contamination from splashing. CDFW hatchery operators will route a flow of 5 gpm to each of the incubation half-stacks via head tank above, as in the Coho Building, and water will flow to the drain system in the floor.

Four incubation working vessels will be reused from IGFH and will be positioned around the inside perimeter of the building for hatchery operations.

3.2.3.5 Chinook Raceways

The design plans include eight concrete raceways in two raceway banks north of the Chinook Incubation Building at pad elevation 2503.0 (NAVD 88), with the pond invert set 3 feet below the pad elevation (2500.0 NAVD 88). PacifiCorp will construct raceways with 26-foot-long pony walls and fish screen guide slots and stop log slots at intervals along the length of the structure, such that ponding volumes can be incremented based on fish development. The eight raceways provide a total rearing volume of 23,040 ft^3. Bioprogram requirements for tagging and marking assume Chinook will be marked at 150 fpp with a required rearing volume of 16,045 ft^3. CDFW staff have indicated that Chinook sub-yearling cohort releases will begin immediately after marking has been completed. If required, the total rearing volume available (23,040 ft^3) provides adequate rearing flexibility for CDFW staff to rear fish up to approximately 104 fpp before approaching the recommended 0.3 density index maximum.

CDFW hatchery operators will operate Chinook rearing raceways in a flow-through condition, with manifolds at the upstream end of the pond supplying a maximum of 500 gpm to each of the ponds, and dam board overflows draining to a sloped concrete exit channel that connects the two raceway banks. The design plans include two open concrete boxes at the southwest end of the exit channel containing the production drainpipe and the volitional fish release pipe, respectively. During normal operations, dam boards will be in place to isolate the volitional fish release pipe, such that all water is directed to the production drainpipe and on to the adult holding ponds.

During volitional fish release, the adult holding ponds may be used for raising fish on second-pass water, and therefore, flow through the Chinook raceways will need to be divided between the production drain system and the volitional fish release pipe. At volitional fish release, CDFW hatchery operators will remove fish screens in each of the raceways and install a fish screen in front of the production drain box. The operators will adjust dam boards in front of both pipe boxes for the desired distribution between the two pipes, while maintaining a pool in the exit channel for fish that volitionally leave the raceways. Fish will be contained in the exit channel until they volitionally pass over the dam boards into the volitional fish release pipe. The volitional fish release pipe will convey fish entrained flows in an open channel condition to a constructed plunge pool adjacent to Fall Creek, approximately 150 feet upstream of the existing Copco Road bridge.

The design plans include predator netting and security fencing to protect the Chinook rearing raceways. Predator netting is connected to an exterior security fence with a metal frame structure that will allow personnel to stand and move around in the enclosure for access to the ponds. The security fence will generally be maintained 1 foot from edge of concrete, such that feed vehicles could drive close to the ponds, as needed. The security fence includes man gates and double-leaf gates between the raceway banks such that vehicles could access the 12-foot-wide center aisle between the raceway banks. At tagging/marking, it is anticipated that the tagging/marking trailer will pull into the center aisle for best access to the raceways.

3.2.3.6 Adult Holding Ponds

The existing lower concrete pond bank consists of four ponds approximately 12.5 feet wide by 70 feet long, with a concrete outlet structure at the downstream end (see Figure 3-8). PacifiCorp will refurbish three of these ponds for use as adult holding ponds: one for trapping and sorting, one for coho holding, and one for Chinook holding. Existing pond concrete walls are in poor structural condition and will require demolition and reconstruction. Reconstructed walls include walkways between each of the ponds and neoprene jump panels above the pond walls.

Based on estimates of holding 200 Chinook and 100 coho at any given time and estimated adult weights (Chinook – 12 lbs, coho – 8 lbs), NMFS guidance (2011) dictates a minimum of 1,800 ft^3 of pond volume for Chinook and 600 ft^3 of storage for coho. Each individual pond has approximately 3,350 ft^3 of storage, which provides ample capacity for adult holding. Because of the available capacity in the reconstituted ponds, these ponds may additionally be used for raising fish on second-pass water at the option of CDFW. Therefore, CDFW hatchery operators will retrofit the ponds with fish screen slots for partitioning, as needed operationally.

The adult holding ponds will be fed by a supply pipe from the intake structure but will also be fed by the fish production drain system, such that at any given time (aside from nominal losses to cleaning) the adult ponds will be fed with the full water right of 10 cfs. In the coho and Chinook holding ponds, during normal operations, the water supply will flow over a set of dam boards at the downstream end and through a floor diffuser into the fish ladder. The design plans include a finger weir at the downstream end of the trapping-and-sorting pond where pond outflow will be routed. This will then serve as the trap at the end of the fish ladder. As fish go over the weir, they will remain in the trapping-and-sorting pond until CDFW hatchery operators transfer them into their respective holding ponds. The trapping-and-sorting pond includes a fish crowder to aid in sorting and transfer of the respective species.

The design plans include fish screen keyways in the adult holding ponds that will allow for culture and effluent collection for a limited number of Chinook juveniles during the periods when adult coho and Chinook are not present. Acknowledging that the water source will be serial reuse from upper facility fish rearing systems (coho and Chinook production raceways), the conservative density and flow indices used in the program should provide second-pass water of sufficient quality and oxygen levels to support serial reuse for a limited number of surplus juvenile Chinook. If juvenile fish are to be raised in these ponds, the coho and Chinook holding pond outflow can be isolated from the fish ladder with a set of dam boards to full height. A fish release pipe with another set of dam boards in the exit channel provides the option of volitional release from these ponds. The fish release pipe will convey fish to the pool at the toe of the fish ladder. Furthermore, the adult holding ponds will be connected by dam boards that may be removed such that fish can be directed into any of the three ponds.

Figure 3-8. Existing Lower Raceway Bank Ponds (Source: McMillen Jacobs)

The design plans include an enclosure consisting of perimeter fencing surrounding the lower raceway bank to provide site security and deter mammalian and avian predation.

3.2.3.7 Spawning Building

Immediately north of the adult holding ponds at pad elevation 2491.5 (NAVD 88) will be the Spawning Building. The Spawning Building will be a pre-engineered metal building with interior dimensions of 25 feet wide by 35 feet long and will house equipment relocated from IGFH. A roll-up working door is located on the southeastern wall of the building, providing direct access to the head of the sorting/trapping raceway. Within the sorting/trapping raceway, CDFW hatchery operators will use the fish lifting basket and hoist from IGFH to transfer fish from the raceway to an electro-anesthesia tank for fish sedation or euthanasia. CDFW hatchery operators will temporarily place a mobile sorting table immediately outside of the roll-up door to sort and transfer sedated fish into the Spawning Building through removable troughs.

The design plans include a new holding table and air spawning table within the Spawning Building for egg retrieval. PacifiCorp will relocate the IGFH egg rinsing table and water hardening table for egg processing prior to incubation. The design plans include a conveyor belt for transferring fish carcasses to a collection bin located outdoors. Additional return pipes are provided along the southeastern wall of the building for returning fish to either the trapping/sorting pond or the Chinook holding pond.

Excess space is provided within this structure for storage of hatchery supplies, as needed. Additional workspace is provided for any collaborator activities.

3.2.3.8 Settling Pond

The final pond in the existing lower concrete raceway bank (easternmost pond) serves as a settling pond to settle out any biosolids or other solid waste from cleaning of the upstream facilities discharged to a waste drain. The effluent treatment is discussed in greater detail in Section 3.2.4.3. PacifiCorp will refurbish this pond and parse it into two distinct bays such that solids can be dried and removed as necessary over the life of the facility, while the waste drain system remains in operation.

The settling pond is located in the same perimeter exclosure as the adult holding ponds and should deter waterfowl from landing on the pond and stirring up the settled solids; overhead predator netting and/or wires may be added in the future if this becomes a problem. Adequate space is provided to allow a septic pump truck to access the pond from the adjacent pad when solids are to be vacuumed out of the pond.

The design plans include an overflow structure at the downstream end of each of the settling pond bays that will divert flow-through water into the fish ladder (see below) for mixing with the adult holding pond flows and release to Fall Creek.

3.2.3.9 Fish Ladder

The fishway is a baffled chute, which is a type of roughened chute designed to meet the NMFS criteria. The baffled chute type is a Denil fishway that is 2.5 feet wide by approximately 25 feet long. The entrance to the fishway will be located just downstream of the picket barrier at the upstream terminus to maximize fish passage efficiency. The fishway will ascend to the constructed concrete outlet structure at the lower raceway bank and will terminate at the finger weir at the downstream end of the trapping and sorting pond to convey fish into the pond for sorting. The fish ladder will consist of 15 standard baffles in total and will be of the Denil-type, as described in the NMFS (2011) guidelines (see Figure 3-9). At the top of the Denil ladder will be a pool for fish to turn into the constructed outlet structure. This turning/resting pool is sized to provide adequate energy dissipation characteristics and will be equipped with a dam board weir for fish to enter the constructed outlet structure.

The uppermost pool in the constructed outlet structure will be fed by the flow over the finger weir, and by flow from the coho and Chinook holding ponds through a floor diffuser. The finger weir is sized according to recommendations from the U.S. Army Corps of Engineers Fisheries Handbook (Bell 1991) and maintains approximately 3.5 inches above the fingers of the finger weir.

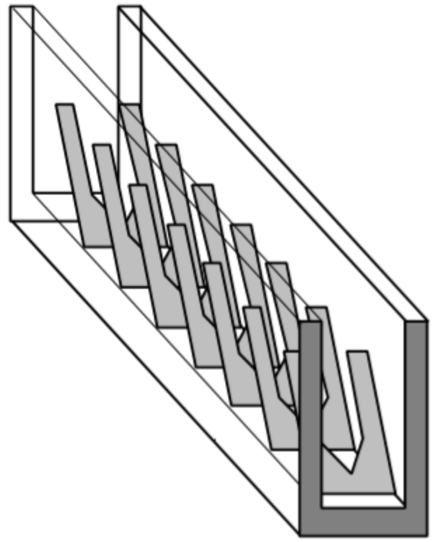

Figure 3-9. Perspective of Denil-Type Fish Ladder with Single-Plane Baffles

3.2.3.10 Fishway Picket Fish Barrier

PacifiCorp will construct a removable fish exclusion picket barrier with the fish ladder that will guide fish to the fish ladder entrance pool and ultimately up to the trap. The fish barrier consists of a set of aluminum pickets with 1-inch-maximum clear spacing installed on a permanent concrete sill and removed each year at the beginning and end of the trapping season. The sill has side walls and a 6-inch-tall curb across the bottom that the picket panels will seal against, forming a continuous barrier across the stream. The sill and removable pickets are oriented at an angle of approximately 30 degrees to the stream transect, such that an anadromous fish moving upstream will encounter the barrier and be directed toward the stream's east bank, where the fish ladder entrance pool is situated. The typical fish ladder flow of 10 cfs will act as an attraction flow to the anadromous fish. The NMFS (2011) recommendations for attraction flow in smaller streams are typically greater than 10 percent of the design high flow during the fish passage season. In this case, 10 cfs is approximately 20 percent of the design high flow and will provide effective attraction flow. The orientation of the picket barrier will also aid in reducing approach velocities at the barrier.

The picket framing will consist of ultra-high molecular weight (UHMW) stringer bars with penetrations for the aluminum pickets to slide in. UHMW stringer bars will be overlapped at installation to tie the individual picket panels together. These picket panels will rest at the bottom against the concrete sill, with a 6-inch-tall curb to prevent fish from passing underneath the panels. The picket panels will then be connected to a stand secured to the concrete sill. A small walkway will be cantilevered from the framing/stringer bars above the high-water level, such that access may be maintained to the whole length of the barrier without entering the stream (see Figure 3-10).

When debris or bedload accumulates on the pickets, the pickets will need to be manually cleaned to ensure that less than 0.3 feet of additional headloss on the clean picket condition is maintained (per NMFS 2011). CDFW hatchery operators will perform this by raising and lowering individual pickets through the stringer bars to allow the accumulated debris or bedload to be washed downstream. This will be performed from the small access way and will only need to be performed during the trapping season, as the pickets will be removed from the creek at all other times.

Figure 3-10. Temporary Picket Barrier for Adult Fish Trap (Source: McMillen Jacobs)

3.2.3.11 Dam A Velocity Barrier

Immediately downstream of existing Dam A, a 16-foot-long by 29-foot-wide sloped concrete apron will be constructed from the downstream face of Dam A. The apron is at 16H:1V (about 6.3 percent), resulting in high velocities and shallow flow depths. The combined high-velocity apron and the jump required to pass upstream of Dam A will effectively bar passage to both juvenile and adult anadromous fish for the anticipated creek flow range expected during juvenile fish release, adult migration, and up to larger flood events. This barrier follows design guidance from NMFS (2011).

3.2.3.12 Dam B Velocity Barrier

Immediately downstream of existing Dam B, a 16-foot-long by 11.5-foot-wide sloped concrete apron will serve as a similar velocity barrier to preclude fish from approaching the Dam B reservoir and exclude juvenile fish passage upstream. PacifiCorp will construct the Dam B concrete apron primarily above grade to prevent significant downstream modifications to the stream corridor inside of the ordinary high-water mark (OHWM). This will result in some demolition of the existing pier and sill for construction of the concrete apron. The existing sill where the stop logs are located is approximately 1-foot 10-inches and new aluminum stop logs will be fabricated to fit the existing stop log slots.

Because of the limited height of Dam B, the stop logs will have insufficient height above the new concrete apron to meet the NMFS (2011) weir conditions for a standard velocity barrier. Therefore, the stop logs will be fitted with a newly fabricated nappe extension piece that will push the nappe overflow approximately 3.0 feet downstream of the aluminum stop logs, making for more difficult jump conditions for upstream migrating fish. This method has proven effective for similar conditions excluding anadromous salmonids in McMillen Jacobs Associates previous project experience.

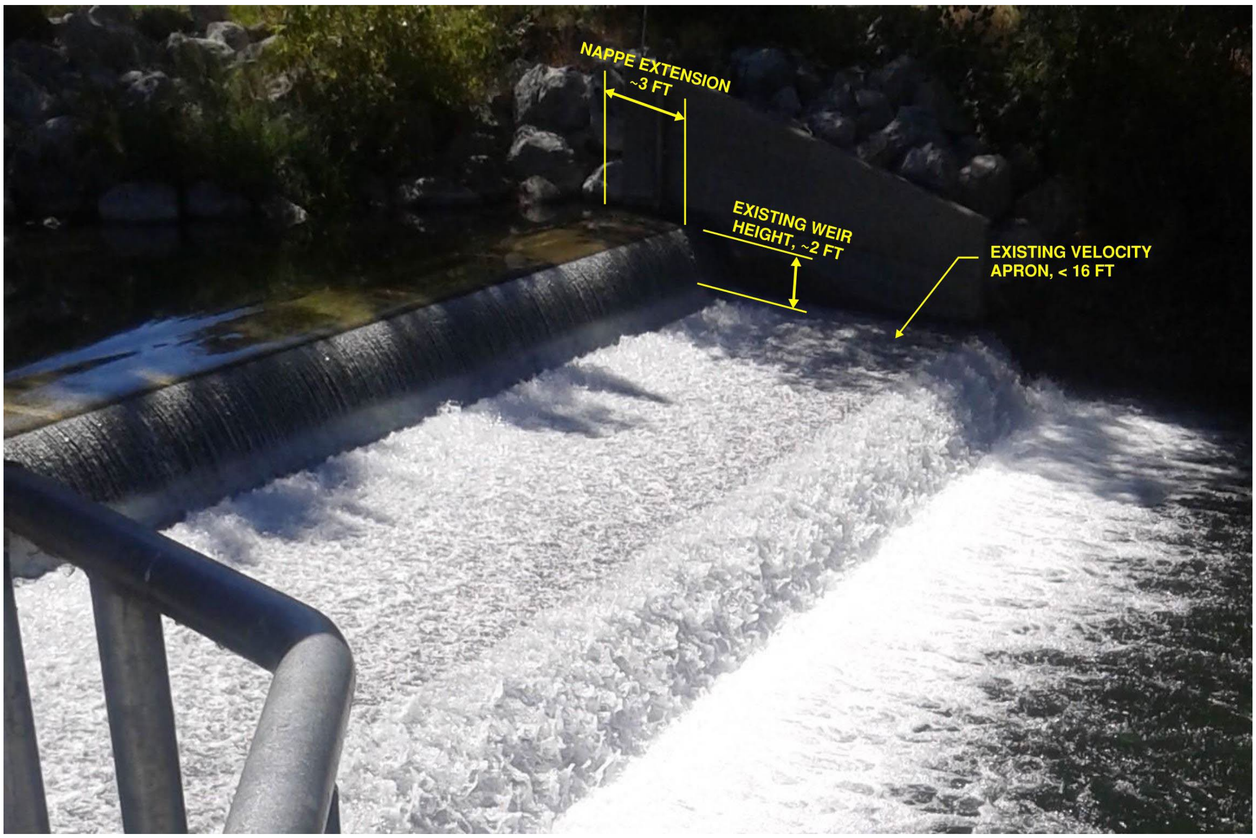

Figure 3-11. Nappe Extension Retrofit (Source; McMillen Jacobs)

In all other regards, the barrier follows design guidance from NMFS (2011). A sluicing gate and pipe will pass underneath the velocity barrier to allow flushing of accumulated sediment upstream of Dam B.

3.2.3.13 In-Water Work

In-water work activities associated with the FCFH include the construction of the intake, Dam A & Dam B Fish Barriers, Fish Picket Barrier, and Fish Ladder. Per CA 401 WQC Condition 8 – Public Drinking Water Supplies and Condition 10 – Construction General Permit Compliance and Water Quality Monitoring and Protection Plans, the Renewal Corporation developed a

Water Quality Monitoring and Protection Plan (WQMPP). The WQMPP outlines measures to control erosion, stream sedimentation, dust, and soil mass movement.

3.2.4 FCFH Operations

3.2.4.1 General Description

The following subsections describe the general operations of the FCFH and are taken from the October 2020 Fall Creek Fish Hatchery – Design Documentation Report Final Design Submittal (Appendix B).

3.2.4.2 Water Distribution and Collection Systems

The intake located at Dam A for the Project is intended to operate autonomously, with self-cleaning screens set to initiate a cleaning cycle based on pre-set head differential or time interval. A trough will collect debris removed from the screens, which will require occasional removal by hatchery personnel. The isolation valves on each of the four supply pipelines are intended to be normally open, with all flow being controlled in the downstream distribution systems.

Supply piping will generally be operated by valves located at each of the raceways, vessels, or working spaces. Flows through each of the supply pipelines will be monitored by the flow meters located in a below-grade vault, with flow rate estimates transmitted to the PLC. CDFW hatchery operators will oversee the programming of the PLC to alert hatchery personnel if the water right is exceeded. There has been a 0.5 cfs contingency built within the FCFH bioprogram (Appendix C) to ensure that the water right is not exceeded while hatchery production goals are achieved.

CDFW hatchery operators will adjust flow to individual rearing raceways or vessels by operating the supply manifold valve and estimating flow at the overflow discharge. The production drain piping system will convey the rearing raceway and vessel drain flows to the adult holding ponds. There are no control valves on the drain piping system. The design plans include clean-outs on all pipelines throughout the facility to allow hatchery staff to flush the pipelines, as needed, if flow disturbances are observed.

Under typical operations, water will return to Fall Creek after being routed through the drain piping system, through the adult holding ponds, and ultimately through the fish ladder downstream of the adult holding ponds.

During times of fish release, water can also return through any of the three volitional release pipes located at the coho raceways, Chinook raceways, or the adult holding pond discharge channel. CDFW hatchery operators will place stop gates or dam boards in front of the raceway drain, diverting all flow through the fish release piping after those respective dam boards have been removed. The volitional release pipes will only be in operation when hatchery staff release fish to Fall Creek throughout the year.

3.2.4.3 Waste Management

CDFW hatchery operators will perform waste management with a vacuum system that discharges to the waste drain system. The design plans include quiescent zones near the downstream end of the raceways and rearing vessels, where biosolids will settle. Operators will use vacuums, as depicted in Figure 3-12, to suction out the solids and discharge into the waste drain system. The waste drain system will discharge the solids with a transport water flow to the settling pond.

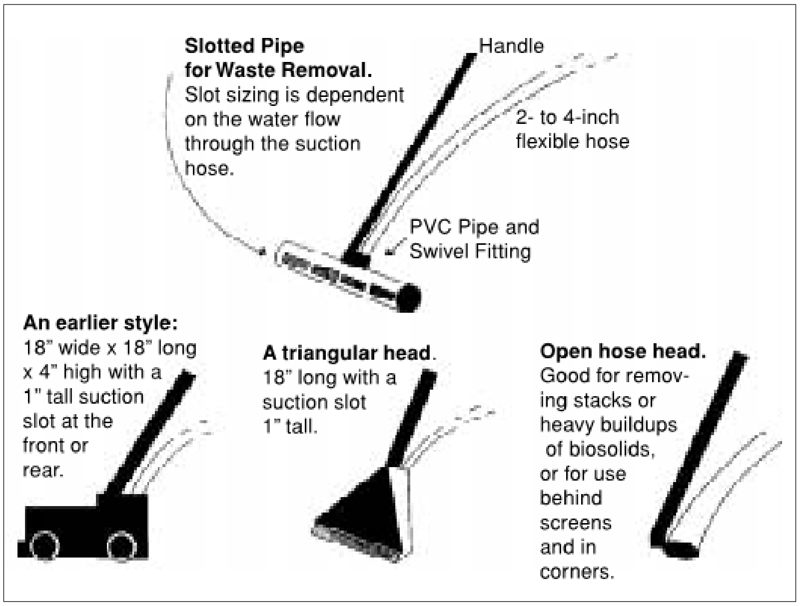

Figure 3-12. Typical Vacuum Removal of Solids (Source: Idaho DEQ, nd)

The settling pond is partitioned into two sections, with the flow from the waste drain system directed to these partitions by a valve. One of these subdivisions will collect flows from the upstream cleaning of the ponds, while the water content in the other is allowed to evaporate. Once the drying partition is sufficiently dry, CDFW hatchery operators will remove and dispose of biosolids in a manner consistent with state and federal requirements that will not adversely impact water quality. Operators will adjust the valve to direct flows to the empty partition, and the water content in the other partition will evaporate.

The downstream end of each of the settling pond bays is equipped with an overflow structure that will divert flow-through water into a pipe that discharges into the fish ladder. The fish ladder will be the primary outfall from the hatchery.

3.2.4.4 Water Quality Sampling

The plan for the water quality sampling associated with the project will consist of the following elements:

- Water quality sampling locations will be at the intake structure and at the fish ladder downstream of the settling pond discharge location;
- At this time, a Time Schedule Order (TSO) has been tentatively agreed upon between CDFW and by the RWQCB, therefore, monitoring the effluent may be required but not held to effluent limitations. The NPDES wastewater permit for the Project has yet to be finalized.

3.2.4.5 Treatment of Therapeutants

Another effluent concern for the facility will be the use of therapeutants or inorganics that could occasionally be required for fish treatment. Use of such therapeutants is not anticipated due to the high quality of the intake water, low and biologically conservative incubation and rearing densities, and the short design life of the facility. However, if fish treatment therapeutants are used, operationally hatchery staff can isolate and direct the flow to the waste drain system and use the 3,200 ft^3 of effluent holding provided by the effluent settling pond. While use would be dependent on flow rates supplied to each individual rearing unit, the effluent settling ponds provide short-term storage of up to 24,000 gallons of therapeutant-laden flow that could then be pumped to appropriate storage tanks and transferred to approved off-site disposal areas or discharged to Fall Creek after the required residence time.

3.2.4.6 Adult Holding and Spawning

3.2.4.6.1 Trapping and Sorting

Adult salmon will be guided to the base of the fish ladder by the fish exclusion picket barrier located adjacent to the holding ponds on Fall Creek. At the head of the fish ladder, adult salmon will pass over a dam board weir and enter the holding pond outflow structure, where attractant flows will guide them over a finger weir trap into the sorting/trapping pond. PacifiCorp will modify and reuse the IGFH fish crowder and lift at FCFH to allow CDFW hatchery operators to guide fish to the head of the pond and into the fish lift, where they may be hoisted into the electro-anesthesia tank for temporary sedation. Operators will raise sedated fish to a sorting table, where adult Chinook are placed in their respective ponds through a removable pipe and adult coho are processed and placed in a separate pond by hatchery personnel.

3.2.4.6.2 Spawning

During Chinook spawning operations, CDFW hatchery operators will remove the dam boards separating the Chinook holding pond from the sorting/trapping pond and install a fish screen in the upper quarter of the trapping pond. PacifiCorp will modify and reuse the IGFH fish crowder at FCFH in the Chinook pond to guide fish into the sorting pond and into the fish lift, where they may be hoisted into the electro-anesthesia tank for sedation. At the sorting table, CDFW hatchery operators will separate males and females and transfer them to the holding table within the spawning building. Operators will gather female salmon eggs on the air spawning table, where they will be fertilized, rinsed, water hardened, and prepared for incubation. If male salmon are to be used more than once during the spawn season, operators will manually return stripped males to their respective rearing containers (raceways for Chinook and spawning tubes for coho). Operators will place fish carcasses on the conveyor belt to be deposited in a collection bin outside, where they will be periodically gathered and processed by hatchery personnel.

3.2.4.7 Incubation

Incubation trays are provided in the coho and Chinook buildings for egg/alevin incubation within the hatchery. Multiple half-stack incubators (eight trays per stack) are provided in both buildings and hold eggs during incubation, with the water supply provided by a constant head tank feeding each row. Hatchery personnel will perform periodic cleaning of the trays during the incubation period, and working vessels are provided for egg picking and enumeration purposes.

3.2.4.8 Juvenile Rearing

Rearing of juvenile salmonids is anticipated to take place in the coho and Chinook raceway banks. Additionally, the design plans for the adult holding ponds include dam boards and fish screen slots to allow for juvenile rearing if elected by hatchery personnel. Each raceway contains segmented bays, with the total rearing volume configurable by insertion of removable fish screens. Waste will settle into a final screened bay, to be periodically cleaned by hatchery personnel through the waste drain system.

Each raceway bank is equipped with a volitional release piping system, returning juvenile salmon to Fall Creek at the end of the rearing season. Hatchery personnel will place stop gates or dam boards in front of the raceway drain, diverting all flow through the fish release piping after those respective dam boards have been removed.

4.0 Remaining Hatcheries Plan Conditions

FCFH water delivery systems relevant to aquaculture operations and infrastructure are exclusively gravity-flow, with no pumping required, and were designed to minimize the risks associated with flow interruption and additional capital and operating costs associated with a facility relying on a pumped water supply. Automated water intake screen cleaning systems, infrastructure alarms, and nearby staff housing are provided in the FCFH design to minimize the risks associated water flow interruption. Additionally, CDFW staff have elected to design and operate an aquaculture facility that will employ extremely conservative aquaculture rearing guidelines and use strict biosecurity measures to further safeguard cultured stocks.

In severe drought or Fall Creek Hydropower facility shutdown or load rejection events in which water flow is prevented from entering Dam A from the Fall Creek Hydropower facility, water can be diverted from Dam B to Dam A to supplement the change in flow. In addition, the design of the facility fiberglass tanks and concrete holding pond rearing vessels provide for maximum retention of water within the vessels using standpipes and stoplogs to retain the water volumes required for fish production. The current design of the FCFH facility does not include an oxygen diffuser delivery system, but a simple system can be purchased from several aquaculture suppliers that would extend the potential rearing vessels holding period in the event of an emergency. The addition of these systems would extend the holding period in emergency water supply event from days versus hours. While emergency oxygen systems could address oxygen requirements of cultured stocks in an emergency event, coho and Chinook salmon require water temperatures within a strict thermal range that is generally not warmer than 65° F for short-term holding to maintain a safe rearing environment. If both short- and long-term water quantity concerns in the Fall Creek Basin occur, discussions with both State, Federal and Tribal cooperators will occur to establish cooperator-approved actions such as emergency release of cultured fish stocks (short-term decision/action) and/or the reduction of broodstock (or resulting brood-year cohorts) to align with reduced water quantities (two of many potential actions). In all cases, cooperators and permitting agencies will be involved in discussions that involve emergency releases and/or brood-year reductions to aquaculture activities at FCFH.

The FCFH construction activities that occur above the ordinary high-water mark will occur under a NPDES Construction General Permit. Compliance with this permit will be implemented through a Storm Water Pollution Prevent Plan required as part of the permit. During FCFH construction activities, the Renewal Corporation will coordinate with the hatchery construction contractor to establish and maintain a 20-foot buffer around delineated wetlands.

The facility is being designed to use a maximum of 10 cfs and will be equipped with water flow supply/delivery monitoring systems to document water use throughout the rearing cycle. CDFW will file water rights reports with the State Water Board annually.

As detailed in Section 3.2.4.4 and consistent with NPDES wastewater permit requirements to be issued by the RWQCB, CDFW will address NPDES wastewater reporting details and documents as permit language is developed. CDFW is currently in the process of developing the NPDES wastewater permit requirements for the FCFH site.

5.0 References

Bell, M. 1991. *Fisheries Handbook of Engineering Requirements and Biological Criteria.* U.S. Dept. of the Army, Army Corps of Engineers, North Pacific Division, Fish Passage Development and Evaluation Program.

KHSA. 2016. Klamath Hydroelectric Settlement Agreement. February 18, 2010, as amended April 6, 2016 and November 30, 2016.

National Marine Fisheries Service (NMFS). 2011. Anadromous Salmonid Passage Facility Design. National Oceanic and Atmospheric Administration, NMFS, Northwest Region: Portland, OR.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service. Washington, D.C.

Appendix A

Consultation Record

Consultation Record

Hatcheries Management and Operations Plan		
Agency	**Date of Agency Plan Submittal**	**Agency Comments Received Date**
California State Water Resources Control Board	December 17, 2020 August 2, 2021 July 14, 2022	January 13, 2021 September 10, 2021 September 20, 2022
California Department of Fish and Wildlife	December 17, 2020 August 2, 2021	January 11, 2021 August 16, 2021
National Marine Fisheries Service	December 17, 2020 August 2, 2021	January 11, 2021 August 2, 2021/ September 1, 2021
California North Coast Regional Water Quality Control Board	December 17, 2020 August 2, 2021	No Comments Received No Comments Received

Appendix B

Fall Creek Fish Hatchery - Design Documentation Report; IFC Design Submittal

Klamath River Renewal Project

Fall Creek Fish Hatchery—Design Documentation Report

Final Design Submittal

FINAL
Revision No. 02

October 2020

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seals, as professional engineers/architects licensed to practice as such, are affixed on the following pages

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Revision Log

Revision No.	Date	Revision Description
0	June 1, 2020	Initial Draft - 50% Design
1	September 2, 2020	90% Design
2	October 28, 2020	Final Design

1.0 Introduction and Background

1.1 Purpose

The purpose of this report is to present the design documentation associated with development of the Fall Creek Fish Hatchery Project.

1.2 Background

1.2.1 Location

The Project is located in Siskiyou County northwest of Iron Gate Dam near Yreka, California. The Project is located at the existing Fall Creek Fish Hatchery site adjacent to Fall Creek.

1.2.2 Project Description

1.2.2.1 Fall Creek Fish Hatchery

The Klamath River Renewal Project includes the removal of four dams along the Klamath River. As part of the overall Project, the existing Iron Gate Fish Hatchery (IGFH) production will be moved to the Fall Creek Hatchery site. The Fall Creek Hatchery site will be modified to upgrade existing facilities and construct new facilities for Coho (*Oncorhynchus kisutch)* and fall-run Chinook salmon (*O. tshawytscha)* production. California-Oregon Power Company (Copco) built the Fall Creek Fish Hatchery (FCFH) in 1919 as compensation for the loss of spawning grounds due to the construction of Copco No. 1 Dam. FCFH was operated by the California Department of Fish and Wildlife (CDFW) to raise approximately 180,000 Chinook salmon yearlings in continuous operation between 1979 and 2003, when it ceased operations and hatchery production on the Klamath River was consolidated at IGFH. The National Marine Fisheries Service (NMFS) and CDFW have determined the priorities for fish production at FCFH under the proposed Fish Hatchery Plan. As a state- and federally listed species in the Klamath River, Southern Oregon Northern California Coastal (SONCC) Coho Distinct Population Segment (DPS) production is the highest priority for NMFS and CDFW, followed by Chinook salmon, which support tribal, sport, and commercial fisheries. Steelhead (*O. mykiss)* production is the lowest priority. Due to limited water availability and rearing capacities at the two facilities, and recent low hatchery steelhead returns, NMFS and CDFW have determined that steelhead production will be discontinued. Table 1-1 summarizes the NMFS/CDFW goals for fish production at FCFH (data compiled from CDFW information).

Table 1-1. Fall Creek Hatchery – Fish Production Goals

Species (Juvenile Life History)	Adult Return*	Incubation Start Date	Incubation Start Number	Target Release Dates	Release Number	Release Size
Coho (Yearling)	Oct. – Dec.	Oct. – Mar.	120,000	Mar. 15 – May 1	75,000	10 fpp
Chinook	Oct. – Dec.	Oct. – Mar.	4.5M**	Pre-Mar. 31	1,250,000	520 fpp

Species (Juvenile Life History)	Adult Return*	Incubation Start Date	Incubation Start Number	Target Release Dates	Release Number	Release Size
(Sub-Yearling)						
Chinook (Sub-Yearling)	Oct. – Dec.	Oct. – Mar.	-	May 1 – June 15	1,750,000	90-100 fpp
Chinook (Yearling)	Oct. – Dec.	Oct. – Mar.	-	Oct. 15 – Nov. 20	250,000	10 fpp

*Adult trapping period from Iron Gate Fish Hatchery data

** Estimated Total Green Egg Requirement at Spawning

fpp = fish per pound

Since ceasing operations in 2003, the FCFH raceways remain and CDFW continues to run water through the raceways. The facility has retained its water rights, but substantial infrastructure improvements will be required to achieve the fish production goals following dam removal. FCFH improvements will occur within the existing facility footprint to minimize environmental and cultural resource disturbances, and the facility must be in operation prior to the drawdown of Iron Gate Reservoir. The water rights and maximum available flow for the Project are set at 10 cubic feet per second (cfs). This water right is non-consumptive and water must be returned to Fall Creek, with final designs addressing National Pollutant Discharge Elimination System (NPDES) water quality permit considerations. The proposed Fish Hatchery Plan requires CDFW to employ Best Management Practices to minimize pollutants and therapeutants being discharged to Fall Creek during hatchery operations.

1.3 Report Organization

This DDR is a record of the design effort for the Project and specifically describes the details of the design process and work effort. The DDR consists of a summary of the design elements, criteria, methods and approach, engineering calculations, and pertinent references. The major report sections and intended purpose are presented in Table 1-2.

Table 1-2. Major Report Sections and Purpose

Section	Description	Purpose
1	Introduction and Background	Presents the authorization, scope, background, a description of the overall Project, and the report organization.
2	Design Criteria	Summarizes the basic design criteria that are used as the basis for the design of the Fall Creek Fish Hatchery.
3	Project Description	Describes the Fall Creek Fish Hatchery Project.
4	Hydraulic Design	Presents the hydraulic analysis of the piping systems, fish ladder, and fish barrier systems.
5	Civil Design	Includes information related to the civil design of the Fall Creek Fish Hatchery and associated access around the site.

Section	Description	Purpose
6	Geotechnical Design	Summarizes the geotechnical design associated with the two borings, B-13 and B-14, summarized in the Geotechnical Data Report prepared by CDM Smith and AECOM Technical Services, Inc.
7	Architectural Design	Includes information related to the architectural design of the FCFH buildings.
8	Structural Design	Includes information related to the structural design of the FCFH buildings, concrete raceways and holding ponds, fish ladder, and barrier.
9	Mechanical Design	Includes information related to the mechanical design of the FCFH facility including supply water, internal building plumbing, and HVAC design.
10	Electrical Design	Includes information related to the electrical design of the FCFH facility.
11	Instrumentation and Controls	Includes information related to the instrumentation and control components of the FCFH facility.
12	Operation	Includes a summary of the anticipated FCFH facility operation.
13	References	Documents the references used in developing the design.
Appendices		
A	Hydraulic Design Calculations	Presents the detailed calculations related to hydraulic design.
B	Civil Design Calculations	Presents the detailed calculations related to civil design.
C	Structural Design Calculations	Presents the detailed calculations related to structural design.
D	Mechanical Design Calculations	Presents the detailed calculations related to mechanical design.
E	Electrical Design Calculations	Presents the detailed calculations related to electrical design.
F	Biological Design Criteria TM	Presents the detailed calculations related to biological design.
G	Water Quality Sampling TM	Summarizes the water quality data collected at the proposed Fall Creek Fish Hatchery intake site.

2.0 Design Criteria

2.1 Pertinent Data

Pertinent data for the Project include the assumed survey datum, topographic mapping, and references as described below.

2.1.1 Survey Datum

The Project data provided by the Klamath River Renewal Corporation (KRRC) were supplied in reference to the North American Vertical Datum of 1988 (NAVD88, Geoid 12B). This is the vertical datum that will be used on all drawings and in all calculations submitted as deliverable for the Project. The horizontal coordinate system is the California Coordinate System of 1983, Zone 1 North American Datum of 1983 (NAD83) in feet.

2.1.2 Topographic Mapping

Topographic data was supplied by CDM Smith and includes (1) Light Detection and Ranging (LiDAR) and sonar survey performed in 2018 by GMA Hydrology, Inc. for the entire site, and (2) a river transect and existing structure survey completed by the River Design Group.

2.2 References and Data Sources

A wide range of data sources and references was used in developing this TM. Specific data related to the conceptual design of the FCFH were obtained from the various technical analyses and memoranda prepared by CDM Smith, which include the following:

- CDM Smith. 2019. Basis of Design Report.
- CDM Smith. 2019. Geotechnical Data Report.
- CDM Smith. 2019. Klamath River Renewal Project Geotechnical Data Report.

Additional data sources, including publicly available aerial imagery, U.S. Geological Survey (USGS) maps, USGS streamflow gaging station data, soils maps, as-constructed drawings, and standard engineering reference documents, were used.

2.3 General Design Criteria and Standards

2.3.1 Standard List of Terms and Abbreviations

ACI	American Concrete Institute
ADM	Aluminum Design Manual
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers

ASTM	American Society of Testing and Materials
AWS	American Welding Society
CBC	California Building Code
CCOR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CGP	Construction General Permit
DI	density index
DO	dissolved oxygen
DPS	Distinct Population Segment
ECP	Erosion Control Plan
FCFH	Fall Creek Fish Hatchery
FI	flow index
ft^3	cubic feet
fpp	fish per pound
GBR	Geotechnical Baseline Report
gpm	gallons per minute
HDPE	high-density polyethylene
HEC-RAS	Hydrologic Engineering Center River Analysis System
HMI	Human Machine Interface
hp	horsepower
HVAC	Heating, Ventilation, and Air Conditioning
IBC	International Building Code
IEEE	Institute of Electrical and Electronic Engineers
IESNA	Illuminating Engineering Society of North America
IGFH	Iron Gate Fish Hatchery
ISA	Instrument Society of America
ksf	kips per square foot
KRRC	Klamath River Renewal Corporation
kW	kilowatts
lb/cf/in	pounds of fish per cubic foot of rearing volume per inch of fish length
lbs/ft^3	pounds of fish per cubic foot of rearing space
LED	Light-Emitting Diode
LiDAR	Light Detection and Ranging survey
mA	milliamperes (or milliamps)
MDD	maximum dry density
mg/L	milligrams per liter
ml/L	milliliter per liter
mm	millimeter
mm/ctu/day	millimeters per centigrade temperature unit per day
NAD	North American Datum

NAVD	North American Vertical Datum
nd	no date
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NHC	Northwest Hydraulic Consultants
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PLC	Programmable Logic Controller
Project	Fall Creek Hatchery Project
pcf	pounds per cubic foot
psf	pounds per square foot
PVC	polyvinyl chloride
RWQCB	Regional Water Quality Control Board
SS	Structural Fill
SONCC	Southern Oregon Northern California Coastal
SCADA	Supervisory Control and Data Acquisition
TM	Technical Memorandum
TSS	total suspended solids
UL	Underwriters Laboratories
USACE	United States Army Corps of Engineers
USACE EMs	United States Army Corps of Engineers Engineer Manuals
USBR	United States Bureau of Reclamation
US DOE	United States Department of Energy
USGS	United States Geological Survey
UV	Ultraviolet
V	Volts (alternating current, if not stated otherwise)
Vac	Volts (alternating current)
Vdc	Volts (direct current)

2.4 Biological

Key biological information used in the development of design criteria are based on a biological program (bioprogram) schedule developed in conjunction with CDFW Fisheries staff. The bioprogram schedule is included with this document as Figure 2-1; biological design criteria addressed below will be discussed in reference to Figure 2-1.

9-Mar-20

PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Fall Creek Hatchery - Coho Yearling / Chinook Sub-Yearling & Yearling Program

				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
CHINOOK PRODUCTION																												
Egg Take - Green to Eyed Egg Period																												
On Station Incubation - Eyed Eggs xfr in Nov 15 at 400 CTU																												
Chinook Brood Year Rearing in TBD (~12x4x50 Vats Pond-Rls.)												Mark and Xfr by May 31																
~ 250k Chinook Yearlings																		Xfr out Nov										
Coho BY-A Early Rearing in Vats & Small Raceways											Xfr to Large Ponds																	
Coho BY-A in Production Raceways/Vats																							Xfr out Mid-April					
Coho BY-B in Early Rearing Vats & Small Raceways											Xfr to Large Ponds												Xfr to Large Ponds					
Coho BY-B in Production Raceways/Vats																												
			(F)	49.0	46.0	43.0	43.0	43.0	46.0	50.0	54.0	54.0	54.5	54.5	50.0	49.0	46.0	43.0	43.0	43.0	46.0	50.0	54.0	54.0	54.5	54.5	50.0	49.0
FC Sub-Yearling Chinook	3,250,000	(Start Inv)						3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000	250,000			3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.05	mm/ctu/day						4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16	11.67			4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16
Fish Length Inches EOM - Assumes 1200 fpp & .376 g/f @ ponding				L				1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521	6.980		L	1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521
Fish Weight Grams EOM (Piper Tables; Assumes C3000)				g/f				0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65	45.27		g/f	0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65
Fish Per Pound EOM				fpp				1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #	10 #		fpp	1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #
Biomass In Pounds EOM				biom				2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751	24,951		biom	2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.				6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608	11,915		cu.ft.	6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608
Flow Required EOM (gpm)	1.5	FI		680	680	680	680	1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122	2,383			1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122
Assume ~4.5M green; 4,136 green eggs/tray; 1,088 trays = 136 1/2 stacks								680	1.25M Rls End Mar		1.75M Rls End May (post-mark 150/lb)				Incub:	680	680	680	680	680	1.25M Rls End Mar		1.75M Rls End May					680
CDFW Growth Reduction; Days Feed/Month																23 days	15 days	7 days	7 days	7 days	15 days							
									78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400	76,200	76,000	75,800	75,600	75,400	75,000						
FC Yearling Coho	80,000	(Start Inv)													Ration:	75%	50%	25%	25%	25%	50%	Ap. 15 Rls						
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.045	mm/ctu/day						4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77	5.25	1.92	1.92	1.92	5.25	4.50						
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				L				1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759	5.966	6.041	6.117	6.193	6.400	6.577						
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			Brood Year A	g/f				0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2	33.5	35.3	37.5	37.8	41.8	45.4						
Fish Per Pound EOM				fpp				1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #						
Biomass In Pounds EOM				biom				57	129	294	635	1,190	1,986	3,087	4,183	5,087	5,628	5,915	6,267	6,300	6,948	7,500						
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.				150	255	443	739	1,129	1,584	2,125	2,595	2,944	3,145	3,263	3,415	3,391	3,619	3,801						
Flow Required EOM (gpm)	1.5	FI		40	40	40	40	30	51	89	148	226	317	425	519	589	629	653	683	678	724	760						40
CDFW Growth Reduction; Days Feed/Month					15 days	7 days	7 days	7 days	15 days																			
					76,200	76,000	75,800	75,600	75,400	75,000																		23 days
FC Yearling Coho	80,000	(Start Inv)		Ration:	50%	25%	25%	25%	50%	Ap. 15 Rls											78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	0.045	mm/ctu/day			5.25	1.92	1.92	1.92	5.25	4.50										4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				L	5.966	6.041	6.117	6.193	6.400	6.577									L	1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			Brood Year B	g/f	33.5	35.3	37.5	37.8	41.8	45.4									g/f	0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2
Fish Per Pound EOM				fpp	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #									fpp	1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #
Biomass In Pounds EOM				biom	5,628	5,915	6,267	6,300	6,948	7,500									biom	57	129	294	635	1,190	1,986	3,087	4,183	5,087
Volume Required EOM (cu.ft.)	0.3	DI		cu.ft.	3,145	3,263	3,415	3,391	3,619	3,801									cu.ft.	150	255	443	739	1,129	1,584	2,125	2,595	2,944
Flow Required EOM (gpm)	1.5	FI		gpm	629	653	683	678	724	760						40	40	40	40	30	51	89	148	226	317	425	519	589
			GPM	720	1,349	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430	3,732	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430
			CFS	1.6	3.0	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6
			Tot. Adult Flow	10.0	10.0	10.0									10.0	10.0	10.0	10.0									10.0	10.0
				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT

Figure 2-1. Biological Program Schedule – Fall Creek Fish Hatchery

2.4.1 Fish Development Cycle

The colored bars across the top section of Figure 2-1 depict the timing of adult spawning and resulting egg incubation, juvenile fish rearing, and a general approach to fish transfer based on marking and release ("first-feeding" vessels and "grow-out" vessels). The adult holding/spawning process is assumed to mirror current adult holding and spawning at the IGFH and occurs from October through December. Egg/alevin incubation is initiated at the onset of adult spawning and generally runs through March. Egg incubation activities are assumed to be flexible in the initial years of the program as eggs may be sourced from one or more CDFW egg production stations and/or sourced from the most appropriate natural anadromous brood sources. Early rearing will begin as first-feeding fry are ponded, and this period will generally extend until the marking/tagging is completed. The ultimate marking/tagging dates and numbers will be determined after further input from CDFW. Early-rearing tanks/vessels will be designed and sited with consideration for fish collection through the marking trailer, as well as differentiating between marked/tagged and non-marked/tagged groups. Final grow-out rearing will provide adequate rearing space and collection/release methods for fish at release.

2.4.2 Biological Variables

The primary biological variables used in the preparation of the preliminary operations schedule include water temperature, species-specific condition factor/growth rates, fish weight/length targets, and density and flow indices.

2.4.2.1 Water Temperature

Water temperature is a primary determining factor in the development and growth rate of fish. Figure 2-1 (row 2 for each cohort group) provides mean water temperature data that are used to estimate the rate of fish growth, which is also tied to feed rate. Temperature profiles for the Fall Creek source water are considered ideal for the culture of Pacific salmon. CDFW's prior rearing experience at the Fall Creek facility with Chinook salmon demonstrate that rearing conditions are favorable for the production of high-quality juvenile salmon. CDFW-provided mean monthly water temperature data for Fall Creek is presented below in Figure 2-2.

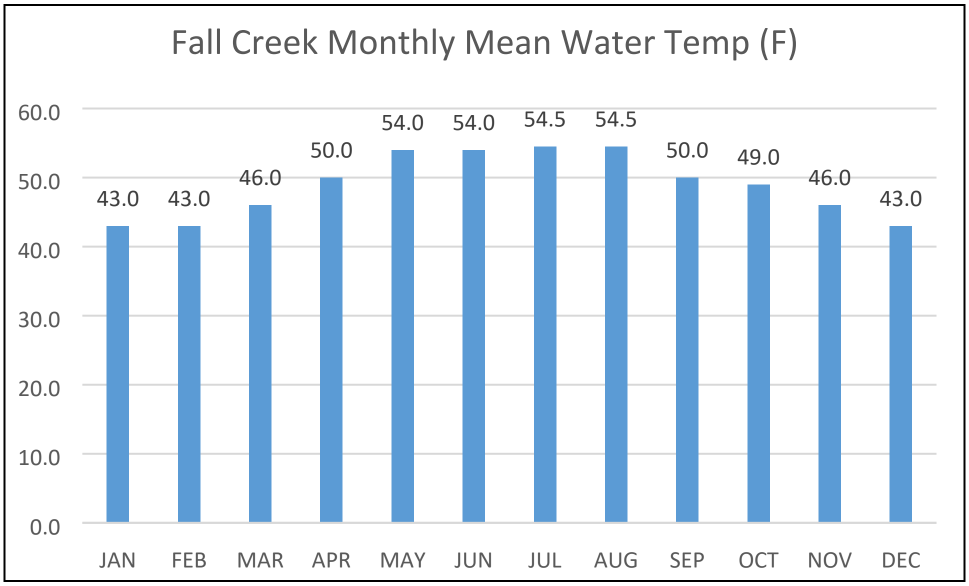

Figure 2-2. Mean Monthly Fall Creek Rearing Temperature Data (Data from L. Radford, CDFW)

2.4.2.2 Expected Growth Rates

The projected monthly growth rate shown in Figure 2-1 (row 3 for each cohort group) is 0.045 and 0.05 millimeters per centigrade temperature unit per day (mm/ctu/day) for Coho and Chinook, respectively. Growth rates are applied to mean water temperatures to develop an estimate of total growth (millimeters per month), which is tied directly to feed rate. Within an ideal water temperature range for salmonids and in the absence of feed modulation, fish will grow faster at higher water temperatures than at lower temperatures (increased daily/monthly growth in millimeters at elevated water temperature range). CDFW does not plan to use chilled water (i.e., water chiller units) for incubation and/or grow-out rearing strategies. For the new facility, CDFW will rely on ambient Fall Creek water temperature profile.

2.4.2.3 Fish Weight and Length

Row 4 of each cohort group shown in Figure 2-1 depicts the cumulative fish length in inches, which is determined by adding the growth per month to the fish length at the end of the preceding month. The mean weight of individual fish in grams is shown in the row below the length (row 5); mean weights are obtained from Piper et al. (1982) Length-Weight Tables for the specific condition factor of fish in culture (Coho C3500, Chinook C3000; $Cx10^{-7}$).

2.4.2.4 Density Index

Density index (DI) is a function of pounds of fish per cubic foot of rearing volume per inch of fish length (lbs fish/cf volume/length [inch]). CDFW staff have agreed to rear fish at a maximum DI of 0.3 for the Coho and Chinook programs at Fall Creek; 0.3 is a conservative DI that is reflective of similar conservation/recovery programs for anadromous Pacific salmon juveniles throughout the Pacific Northwest.

The DI is then used to calculate the total volume of rearing space required in terms of cubic feet. Figure 2-1 (row 8) shows the rearing volume required at the end of each month as fish size increases from left to right. The total volume is then divided by the cubic foot volume of individual rearing tanks/vessels to determine the total number of rearing units required.

2.4.2.5 Flow Index

Flow index (FI) is a function of pounds of fish divided by fish length in inches times flow in gallons per minute (gpm). Flow index is an indication of how much oxygen is available for fish metabolism and is adjusted based on the elevation of the project site and water temperature, both of which affect the amount of oxygen in the water supply at saturation. CDFW staff have agreed to rear fish at a maximum FI of 1.50 for the Coho and Chinook programs at Fall Creek; 1.50 is a conservative FI that is reflective of similar conservation/recovery programs for anadromous Pacific salmon juveniles throughout the Pacific Northwest (at similar elevations and water temperature profiles).

2.4.3 Egg Take and Fish Survival

Current rearing production program scenarios plan for a total of 75,000 Coho salmon and approximately 3.25 million Chinook salmon at various release dates. Mean survival rate estimates provided by CDFW for the IGFH program suggest a green egg to ponding (first-feeding) survival rate of approximately 73 percent. Based on the 73 percent survival estimates, approximately 120,000 green eggs will be required for the Coho program and approximately 4.5 million green eggs will be required for the Chinook program. Acknowledging improved incubation water quality at Fall Creek (vs. poorer Iron Gate water quality) and reduced tray loading densities, survival rates are anticipated to increase as the program develops rearing techniques that favor increased survival.

2.4.4 Incubation and Rearing Facilities

This section provides a brief summary of the incubation and rearing flows, as well as rearing volumes depicted in Figure 2-1.

2.4.4.1 Incubation

Incubation systems currently at IGFH will be used for egg/alevin incubation at Fall Creek. A total of 130 incubation stacks are currently available for future rearing needs. The existing incubation units are vertical stack incubators with a double-stack arrangement with 15 useable trays per stack (full-stack/with the top tray used as sediment tray). Water flow requirements are modeled at 5 gpm, per manufacturer's recommendations, which is an industry standard, regardless of eight-tray or 16-tray configuration.

Early hydraulic modeling efforts indicated that egg incubation systems (vertical stack incubators) would require auxiliary pumping if full-stack arrangements were required (16-tray configuration). In stressing the importance of gravity-flow systems to the extent possible, CDFW staff elected for an eight-tray (half-stack) configuration for all incubation systems at FCFH. Additionally, CDFW staff acknowledge that reducing the tray loading densities for the Chinook program will likely result in increased survival. The current design efforts will assume approximately 50 to 55 ounces of Chinook eggs per tray rather than the approximately 100 ounces/tray currently used at IGFH.

Incubation requirements based on new loading densities for Chinook are approximately 136 half-stack incubators (1,088 trays) requiring approximately 680 gpm. Chinook incubator units are proposed as eight-tray loading with an extra incubation tray on top of the unit acting as a sediment tray (ninth tray without screening used to settle sediment). Incubation requirements for the Coho program are unchanged from the original planning efforts and require six half-stack incubators (approximately 40 trays required) using approximately 30 gpm of water. Coho incubator units have the flexibility (tray space) to accommodate a seven-tray loading configuration with the eighth tray (top) used as a sediment tray.

2.4.4.2 Early Rearing

First-feeding and early-rearing vessel requirements are based on fish size estimates from the bioprogram for the period of ponding through the marking stage of rearing. Maximum bioprogram requirements for rearing space and water flow resulted in approximately 3,850 cubic feet of rearing space and approximately 760 gpm for Coho and approximately 20,200 cubic feet and 4,050 gpm for Chinook. Acknowledging the maximum space and flow required at peak production for each species, the estimated rearing space required for early-rearing through marking phases are identified below:

- Coho Early-Rearing: Total rearing required at mark size of about 150 fish per pound (fpp) – 650 ft^3
- Chinook Early-Rearing: Total rearing required at mark size of about 150 fpp – 16,000 ft^3

Total early-rearing space provided for Coho is approximately 825 ft^3 of fiberglass vat rearing and an additional 1,200 ft^3 available in renovated concrete raceways; the renovation of the concrete raceways provides a total of eight individual rearing containers that can be used to maximize the population compartmentalization of the listed Coho stock. Total early-rearing space provided for Chinook is approximately 20,200 ft^3 and provides maximum compartmentalization for cohort groups of between 204,000 (16 rearing units) and 408,000 (eight rearing units) fish, depending on mean fish size.

The maximum production/flows for Coho occur at mid-April release and the maximum biomass/flows for Chinook occur at late-May release, as shown in Figure 2-1. Coho brood cohorts (first-feeding fry and smolt program) will overlap from early-ponding through smolt release; Coho production for the second cohort is assumed to require approximately 650 ft^3 of rearing space (the four fiberglass vats) and 90 gpm from first-feeding through late-April transfer to larger production ponds (post-smolt release).

2.4.4.3 Juvenile Rearing

Grow-out vessel requirements based on Figure 2-1 result in a maximum grow-out rearing need of 3,800 ft^3 of Coho rearing space (April release) and approximately 20,200 ft^3 of Chinook rearing space (May release) based upon the bioprogram. Total rearing volume provided in the facility design is 4,190 ft^3 for Coho and 23,040 ft^3 for Chinook. Raceway drains for both Coho and Chinook units have been designed to allow for volitional emigration of fish directly to Fall Creek; volitional water supply routing is described later in this document.

2.4.4.4 Adult Holding

Adult holding and spawning ponds have been designed per CDFW recommendations and align with NOAA guidelines for anadromous adults as closely as possible. The existing raceway series currently on-site (south of Copco Road) will be retained, renovated, and will provide sufficient space to hold the requested 100 Coho and 200 Chinook pre-spawn adults. One of the four existing raceways will act as a primary trapping and handling pond, with two ponds renovated to act as longer-term holding for pre-spawn Coho and Chinook adults. The remaining pond will be used as a settling pond and is described later in the report. All non-cleaning (effluent) flow, which will be a maximum of 10 cfs, will be routed to the adult ponds and used for adult holding and fish ladder attraction flows when required, which is assumed between September and December.

The three adult rearing ponds will be renovated with screen and stoplog keyways (and adequate quiescent zones; effluent collection) to allow for the potential short-term rearing of juvenile Chinook that would have otherwise been released early because of space limitations in the Chinook rearing raceway complex. Flow to the holding ponds is second-pass, untreated water from the Coho and Chinook rearing facilities. However, the second pass water should be of sufficient quality and oxygen levels for surplus juvenile Chinook because of the conservative density and flow indices used in the biological program. Assuming three raceways with approximately 2,500 ft^3 of vacant space per unit (12.5’W x 50’L x 4’D useable space; 7,500 ft^3 total), serial reuse flows from the upper production units, and using a 0.3 density index, the maximum permissible weight of 3.175-inch fish (about 104 fpp) would be approximately 7,100 pounds (about 740,000 fish at 104 fpp). Drains have been designed to provide volitional emigration of fish to Fall Creek; volitional water supply routing from this series is described later in this document.

2.4.5 Peak Water Demand

Appendix A provides a water budget for an entire calendar year with a peak water demand of 9.3 cfs projected for May of each year immediately prior to Chinook sub-yearling releases and when juvenile Coho are in early rearing containers. The projected annual water budget by month is also provided below in Table 2-1.

Table 2-1. Fall Creek FH Water Requirements – Full Production

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Juv. CFS	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1
Total Ladder CFS	-	-	-	-	-	-	-	-	10.0	10.0	10.0	10.0

2.5 Civil

2.5.1 Erosion Control Plan

The contractor will be required to obtain a Construction Storm Water General Permit from the California State Water Resources Control Board prior to construction. Construction General Permits (CGPs) are required for construction projects that result in greater than 1 acre of soil disturbance. The CGP requires temporary and post-construction Best Management Practices to prevent erosion and reduce sediment discharges from construction sites.

Prior to permit issuance by Siskiyou County, submittal of an Erosion Control Plan (ECP) to the appropriate Director at Siskiyou County is required. The ECP shall include methods for controlling runoff, erosion, and sediment movement.

2.5.2 Hatchery Effluent Discharge

The California Regional Water Quality Control Board (RWQCB) requires hatchery facilities that discharge effluent to obtain an NPDES permit to regulate the hatchery effluent discharge. It is assumed that the waste stream from FCFH will be required to meet effluent limitations included in the California Regional Water Quality Control Order No. R1-2015-0009, General NPDES CAG131015, Waste Discharge Requirements for Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters.

2.5.3 Stormwater Control

The federal Clean Water Act requires facilities that discharge stormwater runoff to obtain an NPDES permit to regulate the discharge of stormwater into surface waters such as Fall Creek. The design of the FCFH site will minimize the addition of impervious areas. The addition of impervious areas will be limited to rooftops and gravel surfacing around the site. The drainage from new impervious areas will be routed to a storm drain system that will provide treatment before discharging water to Fall Creek. The storm drain system was sized to treat a water quality storm event of 0.2 inches per hour (in/hr) per California Stormwater Quality Association recommendations and local rain data, and to withstand the 100-year rainfall event without ponding on the road surfaces.

2.5.4 Grading

According to the California Building Code adopted by the County of Siskiyou design standards, slopes shall be no steeper than 2 horizontal (H) to 1 vertical (V). Steeper slopes may be allowed if the Building Official determines they will be stable or if a geotechnical engineer certifies that the site has been investigated and that the proposed deviation will be and will remain structurally stable.

2.5.5 Site Access

Modeling to simulate site access conditions was performed using AutoTurn software and the following design vehicles:

- Standard pickup truck (2019 Ford F-450, Crew Cab).
- Marking and tagging trailer for access and egress from the Coho and Chinook rearing ponds (43.0-foot-long Newmar X-Aire 2009, on a 21.85-foot-long design truck, based on typical marking trailers used by the U.S. Fish and Wildlife Service).
- Septic pump truck for access and egress from the settling pond, storm drain hydrodynamic separators, and vault toilet (33.6-foot-long design truck).

2.6 Hydraulic

The proposed hydraulic engineering criteria are presented in the tables below. A brief description of the contents of each table is as follows:

- **Table 2-2.** Hydraulic Standards, References, and Standards of Practice
- **Table 2-3.** Governing Hydrological Criteria for Adult Salmon Facilities
- **Table 2-4.** Inlet Structure Hydraulic Criteria
- **Table 2-5.** Supply Piping Hydraulic Criteria
- **Table 2-6.** Drain Piping Hydraulic Criteria
- **Table 2-7.** Volitional Fish Release Pipe Hydraulic Criteria
- **Table 2-8.** Coho Rearing Hydraulic Criteria
- **Table 2-9.** Chinook Rearing Hydraulic Criteria
- **Table 2-10.** Adult Holding Hydraulic Criteria
- **Table 2-11.** General NPDES CAG131015 Effluent Limitations
- **Table 2-12.** Settling Pond Hydraulic Criteria
- **Table 2-13.** Fish Ladder Hydraulic Criteria
- **Table 2-14.** Fish Barrier Hydraulic Criteria

2.6.1 Applicable Codes and Standards

The following codes, standards, and specifications will serve as the general design criteria for the hydraulic design of the FCFH facilities.

Table 2-2. Hydraulic Standards, References, and Standards of Practice

Standard	Reference
ASCE, 1975	American Society of Civil Engineers (ASCE). 1975. *Pipeline Design for Water and Wastewater*. ASCE: New York, NY.
CDFW, 2004	California Department of Fish and Wildlife (CDFW). 2004. *California Salmonid Stream Habitat Restoration Manual.* March 2004.
Chow, 1959	Chow, V.T. 1959. *Open Channel Hydraulics*. McGraw-Hill Book Company: New York, NY.
Idaho DEQ, nd	Idaho Department of Environmental Quality. nd. *Idaho Waste Management Guidelines for Aquaculture Operations.*
Lindeburg, 2014	Lindeburg, M.R. 2014. *Civil Engineering Reference Manual, Fourteenth Edition.* Professional Publications, Inc.: Belmont, CA.
Miller, 1990	Miller, D.S. 1990. *Internal Flow Systems.* The Fluid Engineering Centre, BHRA: Cranfield, UK.
NMFS, 2011	National Marine Fisheries Service (NMFS). 2011. *Anadromous Salmonid Passage Facility Design*. National Oceanic and Atmospheric Administration, NMFS, Northwest Region: Portland, OR.
NOAA Atlas 14	National Oceanic and Atmospheric Administration (NOAA). 2014. *Precipitation-Frequency Atlas of the United States, Volume 6 Version 2.3: California.* NOAA, National Weather Service: Silver Spring, MD.

Standard	Reference
Rossman, 2000	Rossman, L.A. 2000. EPANET2, User's Manual. U.S. Environmental Protection Agency (USEPA), Office of Research and Development, National Risk Management Research Laboratory: Cincinnati, OH.
Tullis, 1989	Tullis, J.P. 1989. *Hydraulics of Pipelines: Pumps, Valves, Cavitation, Transients*. John Wiley & Sons, Inc.
USFWS, 2017	U.S. Fish and Wildlife Service (USFWS). 2017. *Fish Passage Engineering Design Criteria*. USFWS, Northeast Region RG, Hadley, MA.
USBR, 1987	U.S. Bureau of Reclamation (USBR). 1987. *Design of Small Dams*. U.S. Department of the Interior, USBR: Washington, D.C.

2.6.2 Fall Creek Hydrology

USGS Gage Station No. 11512000 was used to estimate the hydrology of Fall Creek near the proposed FCFH site. This gage station is located approximately two-thirds of a mile downstream from the existing lower raceway bank at the site, and therefore provides the best representation of flows at the site. The data record consists of daily average discharge, and extends from 1933 to 1959, and then from 2003 to 2005. Table 2-3 below presents the governing hydrological criteria used as the basis of the design for adult collection facilities at FCFH.

Table 2-3. Governing Hydrological Criteria for Adult Salmon Facilities

Criteria	Units	Value	Comments
Period of Anadromous Fish Present at Site	-	Oct – Dec	See Bioprogram
95% Exceedance Streamflow (Fish Passage Low Flow)	cfs	23.4	NMFS, 2011; for period when anadromous fish are present at the site
50% Exceedance Streamflow (Fish Passage Typical Flow)	cfs	30.1	NMFS, 2011; for period when anadromous fish are present at the site
5% Exceedance Streamflow (Fish Passage High Flow)	cfs	46.8	NMFS, 2011; for period when anadromous fish are present at the site
1% Exceedance Streamflow (Fish Passage High Flow)	cfs	71.9	CDFW, 2004; alternative high flow definition, for period when anadromous fish are present at the site
1% Exceedance Streamflow (Juvenile High Flow)	cfs	76.9	High flow for maximum flow month during juvenile release (March)
2-year Flood Event Streamflow	cfs	115.3	Adjusted from downstream USGS Gage 11512000
100-year Flood Event Streamflow	cfs	756.2	Adjusted from downstream USGS Gage 11512000
2-year, 24-hour Precipitation Depth	in	1.94	NOAA Atlas 14, Volume 6, Version 2
10-year, 24-hour Precipitation Depth	in	2.88	NOAA Atlas 14, Volume 6, Version 2
100-year, 24-hour Precipitation Depth	in	4.43	NOAA Atlas 14, Volume 6, Version 2

2.6.3 Fall Creek Intake Structure

A non-consumptive water diversion from Fall Creek will support hatchery operations by construction of a new intake structure at Dam A. Water demand for facility operations will vary to meet biological criteria for various life stages of fish development. Table 2-4 below summarizes the design criteria used to support the design of the intake structure at Dam A on Fall Creek.

Table 2-4. Intake Structure Hydraulic Criteria

Criteria	Units	Value	Comments
Design Flow	cfs	10	FCFH Water Right and Proposed Maximum Diversion Flow from Fall Creek to Project Site
Design Water Surface Elevation	ft	2510.4	Elevation of Dam A at crest
Trash Rack Percent Open Area	%	50	Typical, subject to screen manufacturer specifications
Maximum Allowable Trash Rack Occlusion	%	40	Assumed, conservative for an automatically cleaned screen
Pipe Entrance Loss Coefficient, K_e	-	0.7	USBR, 1987; Maximum for open pipe with downstream isolation valve
Screen Cleaning System	-	See Comment	Automatic active water spray bar system.

2.6.4 Supply Piping

The supply piping network was analyzed using EPANET2 software (Rossman, 2000) to determine the head at the design locations, and to size the water supply pipes in the network. The supply piping consisted of four main distribution networks: (1) the Coho building distribution piping, (2) the Chinook raceway distribution piping, (3) the Chinook Incubation Building distribution piping, and (4) the adult holding pond distribution piping. These constituted four separate models in the EPANET2 software. Table 2-5 below summarizes the supply piping initial hydraulic criteria used to develop the EPANET2 model. For a full discussion of the supply piping scenarios modeled (and associated conditions and coefficients, see Section 4.1).

Table 2-5. Supply Piping Hydraulic Criteria

Criteria	Units	Value	Comments
Pipe Hazen-Williams Coefficient	-	120	ASCE 1975; Small diameter of good workmanship or large diameter of ordinary workmanship. Schedule 80 PVC material.
Minor Loss Coefficient – 90° Bend	-	0.24	Tullis, 1989
Minor Loss Coefficient – 45° Bend	-	0.10	Tullis, 1989
Minor Loss Coefficient – 22.5° Bend	-	0.06	Tullis, 1989
Minor Loss Coefficient – Butterfly Valve (Open)	-	0.2	Tullis, 1989

Criteria	Units	Value	Comments
Minor Loss Coefficient – Tee (Branch Flow)	-	1.0	Miller, 1990; Approx. 60%-40% Flow Split
Minor Loss Coefficient - Tee (Line Flow)	-	0.2	Miller, 1990; Approx. 60%-40% Flow Split
Minor Loss Coefficient - Reducer	-	See Comment	Calculated based on relative pipe size according to Tullis 1989

2.6.5 Drain Piping

The online drain pipeline will convey effluent from the rearing vessels to the adult holding ponds and will ultimately be discharged into Fall Creek via the new fish ladder. All outlet pipes and trunk lines were sized to maintain open-channel flow with the exception of pipe risers into the adult holding ponds (see Section 4.2). Table 2-6 below summarizes the drain piping hydraulic criteria used to develop the drain piping hydraulic calculations.

Table 2-6. Drain Piping Hydraulic Criteria

Criteria	Units	Value	Comments
Gravity Flow – Maximum Flow Depth	%	75	Prevent pressurizing of pipe for presence of waves, etc. Generally less than 70%
Minimum Self-Cleaning Velocity	ft/s	1.5	Typical, Sewer Design
Typical Self-Cleaning Velocity	ft/s	2.0	Typical, Sewer Design
Gravity Flow Pipe Manning's Roughness Coefficient, n	-	0.013	Maximum; Plastic Pipe
Pressure Pipe Relative Roughness	in	6.0×10^{-5}	Lindeburg, 2014; Plastic Pipe
Minor Loss Coefficient – 90° Bend	-	0.24	Tullis, 1989
Minor Loss Coefficient – 45° Bend	-	0.10	Tullis, 1989
Minor Loss Coefficient – Tee (Branch Flow)	-	1.0	Miller, 1990; Approx. 60%-40% Flow Split
Minor Loss Coefficient - Tee (Line Flow)	-	0.2	Miller, 1990; Approx. 60%-40% Flow Split
Orifice Discharge Coefficient	-	0.62	Lindeburg, 2014; Sharp-Edge

2.6.6 Volitional Fish Release Pipes

The volitional fish release pipes will convey juvenile fish from the rearing raceways to various discharge points in Fall Creek. Pipe design was subject to design criteria from NMFS (2011) for fish bypass pipes. Table 2-7 below summarizes the fish release piping hydraulic design criteria.

Table 2-7. Volitional Fish Release Pipe Hydraulic Criteria

Criteria	Units	Value	Comments
Gravity Flow – Maximum Flow Depth	%	75	Prevent pressurizing of pipe for presence of waves, etc. NMFS, 2011; Section 11.9.3.2 Generally less than 70%
Gravity Flow – Minimum Flow Depth	%	40	NMFS, 2011; Section 11.9.3.9
Minimum Bend Radius R/D	-	5.0	NMFS, 2011; Section 11.9.3.4 Greater for supercritical flows; Bend radius 5 times the pipe diameter
Typical Access Port Spacing	ft	150	NMFS, 2011; Section 11.9.3.5
Maximum Pipe Velocity	ft/s	12.0	NMFS, 2011; Section 11.9.3.8
Minimum Pipe Velocity	ft/s	6.0	NMFS, 2011; Section 11.9.3.8 Generally less than 6.0 ft/s, absolute minimum of 2.0 ft/s
Minimum Pipe Diameter	in	10	NMFS, 2011; Table 11-1
Plunge Pool Maximum Impact Velocity	ft/s	25.0	NMFS, 2011; Section 11.9.4.2
Plunge Pool Minimum Depth	ft	4.0	USFWS, 2017; Reference Plate 9-2 Up to an equivalent drop height of 16', then ¼ of the equivalent drop height

2.6.7 Rearing Facilities

Based upon the biological design criteria summarized above, Table 2-8, Table 2-9, and Table 2-10 below summarize the hydraulic criteria, flow, and volume requirements for each of the rearing facilities at FCFH.

Table 2-8. Coho Rearing Hydraulic Criteria

Criteria	Units	Value	Comments
Maximum Rearing Volume Requirement	ft^3	3,850	See Bioprogram
Maximum Flow Requirement	gpm	765	See Bioprogram; Flow to rearing raceways only, additional flow to first-feeding vessels
Cleaning Method	-	See Comment	Vessels to be cleaned using vacuum system
Cleaning Maximum Flow	gpm	200	Assumed. Two vessels cleaned at one time. Intermittent flow.

Table 2-9. Chinook Rearing Hydraulic Criteria

Criteria	Units	Value	Comments
Maximum Rearing Volume Requirement	ft^3	20,190	See Bioprogram
Maximum Flow Requirement	gpm	4,040	See Bioprogram
Cleaning Method	-	See Comment	Vessels to be cleaned using vacuum system
Cleaning Maximum Flow	gpm	200	Assumed

Table 2-10. Adult Holding Hydraulic Criteria

Criteria	Units	Value	Comments
Chinook Holding Capacity	#	200	See Bioprogram
Coho Holding Capacity	#	100	See Bioprogram
Adult Chinook Weight	lbs	12	Estimated, CDFW
Adult Coho Weight	lbs	8	Estimated, CDFW
Minimum Holding Volume	ft^3/lb-biomass	0.75	NMFS, 2011; long-term holding: Holding > 72 hours, 0.75 x Weight of Fish: If temperature exceeds 50°F, reduce pounds of fish by 5% for each degree over 50°F
Minimum Adult Holding Flow	gpm/fish	2 (long-term holding)	NMFS, 2011; 0.67 gpm per fish for short-term holding. Increase three times for fish held over 72 hours.
Jump Protection Height	ft	5.0	NMFS, 2011; to meet jump minimization criterion, alternatively nets, coverings, or sprinklers may be used

2.6.8 FCFH Wastewater Treatment

Flow-through water through the rearing facilities will be discharged to the adult holding ponds and ultimately through the fish ladder without treatment. Wastewater flows consisting of solids collected through vacuuming rearing vessels and flows treated with therapeutants will be discharged to a new settling pond for treatment. The downstream end of the settling pond will be equipped with an overflow structure that will divert overflows into the fish ladder to be mixed with the adult holding pond overflows and ultimately to Fall Creek.

The east-most pond in the existing lower concrete raceway bank will be repurposed as a settling pond that will be used to settle out any biosolids or other solid waste from cleaning of the upstream facilities. This pond will be refurbished and parsed into two distinct chambers such that solids can be dried in one chamber while the other is in use. It is assumed that the waste stream from FCFH will be required to meet effluent limitations included in the California Regional Water Quality Control Order No. R1-2015-0009, General NPDES CAG131015, and Waste Discharge Requirements for Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters. The General NPDES CAG131015 effluent limitations and the hydraulic criteria used to design the settling basin are summarized in Table 2-11 and Table 2-12 below.

Table 2-11. General NPDES CAG131015 Effluent Limitations

Criteria	Units	Value	Comments
Average Monthly Total Suspended Solids (TSS)	mg/L	8	Net Increase Over Influent Limitations
Maximum Daily TSS	mg/L	15	Net Increase Over Influent Limitations
Average Monthly Settleable Solids	ml/L	0.1	Net Increase Over Influent Limitations
Maximum Daily Settleable Solids	ml/L	0.2	Net Increase Over Influent Limitations
pH	-	7 to 8.5	Receiving water shall not be depressed below or above the pH values identified. If the influent exceeds a pH of 8.5, the pH of the effluent shall not exceed the pH of the influent.
Receiving Water Dissolved Oxygen (DO) Non-Spawning	mg/L	≥7.0	Effluent shall not cause the dissolved oxygen (DO) of the receiving water to be depressed below 7.0 mg/L during non-spawning and egg incubation periods.
Receiving Water DO during Critical Spawning and Egg Incubation Periods	mg/L	≥9.0	Effluent shall not cause the DO of the receiving water to be depressed below 7.0 mg/L during spawning and egg incubation periods.
Turbidity	%	20	Effluent shall not cause receiving waters to be increased more than 20% above naturally occurring background levels.
Temperature	ºF	≤5	Net Increase above natural temperature of receiving water.

Table 2-12. Settling Pond Hydraulic Criteria

Criteria	Units	Value	Comments
Design Discharge	gpm	200	Only water used during vacuum cleaning routed through the settling pond. Intermittent flow.
Design Settling Velocity	ft/s	1.51×10^{-3}	Idaho DEQ, nd; Settling velocity is the maximum overflow rate from the settling pond
Overflow Weir Discharge Coefficient	-	3.33	Assumed

2.6.9 FCFH Fish Ladder

A concrete fish ladder will be constructed from Fall Creek up to the existing concrete outlet structure at the lower raceway bank. The ladder will terminate at the finger weir at the downstream end of the trapping and sorting pond and will convey fish into the pond for sorting. The fish ladder will be of the Denil steep pass type as described in the NMFS (2011) guidelines and will have two pools separated by a weir at the top for turning into the pond structure. The design criteria used to design the fish ladder, so that the fish ladder is passable to the target fish with available flow, are included in Table 2-13 below.

Table 2-13. Fish Ladder Hydraulic Criteria

Criteria	Units	Value	Comments
Fish Ladder Type	-	See Comment	Denil Steep pass
Design Discharge	cfs	10	Full water right
Minimum Attraction Flow	cfs	4.7	NMFS, 2011; Section 4.2.2.3; 10% Fish Passage High Flow
High Tailwater Elevation	ft	2,484.77	Modeled in HEC-RAS
Typical Tailwater Elevation	ft	2,484.27	Modeled in HEC-RAS
Low Tailwater Elevation	ft	2,484.12	Modeled in HEC-RAS
Debris Characterization		See Comment	NMFS, 2011; Section 4.10.2.1; Very little debris is expected as this is the downstream extents of the facility and water will have been screened multiple times
Maximum Slope	%	20	NMFS, 2011; Section 4.10.2.1
Maximum Average Chute Velocity	ft/s	5	NMFS, 2011; Section 4.10.2.1
Maximum Horiz. Distance between Rest Pools	ft	25	NMFS, 2011; Section 4.10.2.1
Minimum Flow Depth	ft	2	NMFS, 2011; Section 4.10.2.1
Minimum Flow Depth over Weir	ft	1.0	NMFS, 2011; Section 4.5.3.2
Energy Dissipation Factor	ft-lbs/s/ft^3	4.0	NMFS, 2011; Section 4.5.3.5

2.6.10 FCFH Fish Barriers

A system of fish exclusion barriers will be constructed that will (1) exclude adult and juvenile fish passage upstream of existing Dams A and B year-round, and (2) direct adult fish into the fish ladder during the trapping season. The fish barrier system will consist of three components: (1) a high-velocity concrete apron on the downstream side of Dam A, (2) a high-velocity concrete apron on the downstream side of Dam B, and (3) a set of removable picket panels on a concrete apron immediately upstream of the fish ladder. The NMFS requirements and design criteria for both velocity barriers at Dams A and B, and for a picket barrier at the fishway entrance are presented in Table 2-14 below.

Table 2-14. Fish Barrier Hydraulic Criteria

Criteria	Units	Value	Comments
Fishway Entrance (Trapping Only)			
Fish Barrier Type	-	-	Picket Barrier
Adult Fish Passage High Flow	ft^3/s	71.9	1% Exceedance during months of October - December
Adult Fish Passage Low Flow	ft^3/s	23.4	95% Exceedance during months of October - December
Juvenile Fish Passage High Flow	ft^3/s	76.9	1% Exceedance during March (max release month)
Juvenile Fish Passage Low Flow	ft^3/s	23.4	95% Exceedance during May (min release month)
Maximum Picket Clear Spacing	in	1.0	NMFS, 2011; Section 5.3.2.1
Maximum Average Velocity Through Barrier	ft/s	1.0	NMFS, 2011; Section 5.3.2.2; Discharge evenly distributed over gross wetted area
Maximum Head Differential (over clean picket condition)	ft	0.3	NMFS, 2011; Section 5.3.2.3
Minimum Picket Freeboard on Fish Passage High Flow	ft	2.0	NMFS, 2011; Section 5.3.2.6
Minimum Submerged Depth at Fish Passage Low Flow	ft	2.0	NMFS, 2011; Section 5.3.2.7; often relaxed in smaller drainages such as this
Minimum Picket Porosity	%	40	NMFS, 2011; Section 5.3.2.8
Sill/Apron Construction	-	See Comment	Picket barrier sill shall consist of a concrete sill with cutoff walls
Dams A & B (Year-Round)			
Fish Barrier Type	-	-	Velocity Barrier
Dam A High Flow	ft^3/s	50.0	Maximum powerhouse discharge
Dam A Low Flow	ft^3/s	15.0	Minimum flow requirement downstream of Dam A
Dam B Juvenile High Flow	ft^3/s	62.1	1% Exceedance during March (max release month); adjusted to Dam B reach
Dam B Fish Passage High Flow	ft^3/s	56.9	1% Exceedance during months of October – December; adjusted to Dam B reach
Dam B Fish Passage Low Flow	ft^3/s	8.4	95% Exceedance during months of October – December; adjusted to Dam B reach
Minimum Weir Height	ft	3.5	NMFS, 2011; Section 5.4.2.1
Minimum Apron Length	ft	16	NMFS, 2011; Section 5.4.2.2
Minimum Apron Slope	ft/ft	1 / 16	NMFS, 2011; Section 5.4.2.3
Maximum Weir Head	ft	2.0	NMFS, 2011; Section 5.4.2.4

Criteria	Units	Value	Comments
Downstream Apron Elevation	-	-	Above fish passage high flow tailwater

2.7 Geotechnical

To support final engineering efforts, the following geotechnical criteria will be required:

- Soil Bearing Pressure
- Water Table Height
- Active/Passive Lateral Earth Pressure
- Passive Soil Pressure (Lateral)
- Soil Weight
- Soil Friction Factor
- Site Class as Defined by ASCE 7-16 Table 3.13
- Frost Depth
- Minimum Footing Bearing Depth
- Minimum Footing Width
- Anticipated Total Settlement
- Anticipated Differential Settlement

CDM Smith and AECOM Technical Services, Inc. prepared a Geotechnical Data Report for KRRC in June 2019. Two borings, B-13 and B-14, were drilled near Fall Creek Bridge by Gregg Drilling between September 25 and October 18, 2019, with a truck-mounted Mobile B-53 drill rig. The borings reached depths of 21 feet (B-13) and 29 feet (B-14) below ground surface.

The Project site is mapped as Quaternary (Qv) and Tertiary (Tv) volcanic rock with nearby landslide deposits (Qls) associated with steep slopes on the east side of Fall Creek and just south of the Project site. Cobble- and boulder-sized rocks were observed on the ground surface at the proposed hatchery site and will likely need to be cleared to support construction. The borings advanced in the Project vicinity indicate approximately 18 inches of fill (road base) overlying slightly to completely weathered basalt. Based on the presence of sand, clay, and root structures at depth, we interpreted the deposit to be colluvium consisting of cobbles and boulders within a clay/sand matrix. Colluvium was interpreted to extend to the depths explored in boring B-13 and to a depth of 13 feet in boring B-14. Highly weathered andesite was observed below the colluvium in boring B-14 and extended to the depth explored (29 feet).

2.8 Architectural

2.8.1 Applicable Codes and Standards

The following references will serve as the basis for preparation of the architectural design elements specific to the currently adopted codes of the County of Siskiyou, California:

- 2019 California Building Code, Title 24, Volumes 1 & 2, Part 2
- 2019 California Energy Code, Title 24, Part 6
- 2019 California Fire Code, Title 24, Part 9

2.8.2 Building Summary

With respect to the Coho Building, the Chinook Incubation Building and the Spawning Building, all will be constructed utilizing a pre-engineered metal building system. A specific pre-engineered metal building manufacturer has not been identified and will be open to a competitive bid process. Documents submitted illustrate a typical basis-of-design and final building packages will be subject to the proprietary components and detailing of the awarded vendor. The vendor will be required to provide the necessary shop drawings and engineering to validate compliance with the design intent. Structural design requirements are further discussed in Section 2.9 of this document.

2.8.3 Energy Code Compliance

All the above-mentioned building envelopes are considered "Processed Spaces" based on the nature of their use. As such, Title 24, Part 6 exempts these building envelopes from meeting energy compliance requirements that would normally apply to a pre-engineered metal building. Exemption is based on the following conditions:

- Process space is a nonresidential space that is designed to be thermostatically controlled to maintain a process environment temperature less than 55F or to maintain a process environment temperature greater than 90F for the whole space that the system serves, or that is a space with space-conditioning system designed and controlled to be incapable of operating at temperatures above 55F or incapable of operating at temperatures below 90F at design conditions.

While all buildings meet the exemption requirements, they will be clad with insulated metal wall and roof panels that meet the prescriptive energy compliance mandates per Title 24, Part 6. In addition, all buildings will be daylit by means of Solatube daylighting devices. These devices will also meet the minimum energy code requirements.

2.9 Structural

The design criteria apply to all design procedures to be implemented during the Project design phase. Structural design considerations listed in this section—including detailing of structural components, material selection, and design requirements—are intended to be incorporated into Project design. The structural facilities consists of 11 main systems: (1) the intake structure, (2) the dam A velocity barrier, (3) the dam B velocity barrier, (4) the coho building, (5) the chinook raceways, (6) the chinook incubation building, (7) the spawning building, (8) the adult holding ponds, (9) the meter vault, (10) the fish ladder, (11) the temporary picket barrier, and (12) the fish release pipe support.

2.9.1 Applicable Codes and Standards

The following codes, standards, and specifications will serve as the general design criteria for the structural design of the facilities. The applicable version of each document is the latest edition in force unless noted otherwise. References to the specific codes and standards will be included in the applicable technical specifications as the final design documents are prepared.

The structural design, engineering, materials, equipment, and construction will conform to the codes and standards listed in Table 2-15.

Table 2-15. Structural Codes and Standards

Code	Standard
2018 IBC	2018 International Building Code
2019 CBC	2019 California Building Code
SEI/ASCE 7-16	Minimum Design Loads for Buildings and Other Structures, 2016 Edition
ANSI/AISC 360-16	Specification for Structural Steel Buildings, 2016 Edition
AISC 341-16	Seismic Provisions for Structural Steel Buildings, 2016 Edition
ACI 318-14	Building Code Requirements for Structural Concrete
ACI 350-06	Code requirements for Environmental Engineering Concrete Structures
ACI 350.4R-04	Design Considerations for Environmental Engineering Concrete Structures
ADM1-2015	Aluminum Design Manual, 2015 Edition
AWS D1.1-2020	Structural Welding Code – Steel, 2020 Edition
AWS D1.2-16	Structural Welding Code – Aluminum, 2016 Edition
AWS D1.6	Structural Welding Code – Stainless Steel

The following references are used in development of the structural design elements of the Project:

- American Institute of Steel Construction (AISC) (2017). "Steel Construction Manual," Fifteenth Edition.
- County of Siskiyou Building Code – Design Information, https://www.co.siskiyou.ca.us/building/page/design-information.

2.9.2 Materials

The material properties assumed for preparation of the design and engineering are listed in Table 2-16.

Table 2-16. Structural Material Properties

Structural Stainless Steel	
Bars and Shapes	ASTM A240, Type S31600
Plates	ASTM A240, Type S31600
Hollow Sections	ASTM A312, Type S31600
Structural bolts	ASTM F593 Type 316
Nuts and washers	ASTM F593 Type 316
Anchor bolts	ASTM F593 Type 316
Structural Mild Steel	
Wide Flanges	ASTM A992, Gr. 50

Other Shapes, Plates, Angles, and Bars	ASTM A36
Pipe	ASTM A53, Gr. B
Hollow Structural Sections (HSS)	ASTM A500. Gr. B
Structural Weathering Steel	
Wide Flanges	ASTM A588, Gr. 50
Rectangular and Square HSS	ASTM A847, Gr. 50
Other Shapes, Plates, and Bars	ASTM A588, Gr. 50
Miscellaneous	
Grating	Fiberglass reinforced plastic (FRP)
Stair Treads	Fiberglass reinforced plastic (FRP)
Handrails	Fiberglass reinforced plastic (FRP)
Ladders	Fiberglass reinforced plastic (FRP)
Aluminum alloy shapes	6061-T6
Aluminum alloy plates	5052-H32
Concrete	
Concrete	4,500 psi normal weight
Rebar	ASTM A615, Grade 60

2.9.3 Design Loads

The general loads considered in the design of the facilities are summarized in this section. All loads will be combined per the requirements of ASCE 7 for the various loading conditions to assess factors of safety. The actual design loads for each structure are included on the structural drawings.

2.9.3.1 Dead Load

The structural system for all Project elements will be designed and constructed to support all dead loads, permanent or temporary, including but not limited to self-weight, pipe systems, fixed mechanical and electrical equipment, stairs, walkways, and railings.

2.9.3.2 Live Load

Live loads during construction and operation consist of workers on the structures, temporary stored materials or equipment on the Project elements, impact, and construction equipment and vehicles. Live loads on the access stairways will be superimposed as per the CBC codes.

2.9.3.3 External Hydrostatic Loads

A triangular distribution of static water pressure is assumed to act normal to the upstream faces of all screen panels, stop logs, and gate structures.

2.9.3.4 Buoyancy Loads

Structures will be designed to resist upward hydrostatic pressures from high groundwater or river levels. Design factors of safety follow ACI 350.4R Section 3.1 guidelines recommending a factor of safety of 1.1 for groundwater to the top of wall, not considering soil, and 1.25 considering soil and groundwater elevations below the top of wall.

2.9.3.5 Earthquake Loads

Earthquake loads have been selected based on the IBC related maps and tables. S_s=0.584g, S_1=0.304g. The buildings will be designed for Risk Category II with an importance factor of 1.0 and assuming Site Class D or worse. Using Site Class D: S_{DS}=0.519g, C_V=1.089. The Seismic Design Category classification for the Project is D.

2.9.3.6 Earth Loads

Below-grade structures and water-holding basins will be designed for worst-case load combinations of full height of backfill plus a minimum 2-foot soil surcharge. Additional surcharge loads will be applied to account for unique conditions due to adjacent structure proximity and traffic or equipment loading.

2.9.3.7 Snow Loads

The structures will be designed to carry the applicable snow load. The flat roof snow load at this site is 40 pounds per square foot (psf) in accordance with the County of Siskiyou Building Code. Design snow loads include effects from drift surcharge loads and unbalance snow load requirements. Grating area will be treated as impervious surface with no reductions applied for the open area of the grating surface.

2.9.3.8 Wind Loads

Wind loads will be applied in the design of the buildings and elevated structures. For structures, wind loads will be computed per the IBC using an ultimate design wind speed of 115 miles per hour and a minimum design wind pressure of 20 psf, exposure category C, Risk Category II, and an importance factor of 1.0. Wind loads will be compared to the earthquake forces and the controlling load will be used.

2.9.3.9 Temperature Loads

Temperature changes for expansion and contraction will be considered based on the site location.

2.9.4 Frost Depth

The design minimum frost depth is 12 inches in accordance with the County of Siskiyou Building Code.

2.10 Mechanical

2.10.1 Applicable Codes and Standards

The following references will serve as the basis for preparation of the mechanical design elements:

- American Society of Testing and Material (ASTM)

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Welding Society (AWS)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- National Fire Protection Association (NFPA)

2.10.2 Materials

The material properties assumed for preparation of the preliminary design are listed in Table 2-17. Yellow metals and galvanized systems that would come in contact with fish production water supply will not be allowed.

Table 2-17. Mechanical Materials

Component	Materials
Gates	Cast iron, Aluminum, Stainless Steel
Buried Piping	PVC, Ductile Iron
Exposed Piping	PVC, Carbon Steel, Ductile Iron
Valves	PVC, Ductile Iron
Hardware	Stainless, PVC
Ductwork	Galvanized Sheet Metal, Aluminum for high humidity areas
Transport Flumes	Aluminum
Fish Transport Pipes	HDPE
Intake Fish Screens	Stainless steel, Mild Steel
Incubation Trays	Fiberglass, Plastic
Feeding Vessels	Fiberglass

2.10.3 Design Loads

The mechanical loads are listed in Table 2-18.

Table 2-18. Mechanical Loads

Load	Description
Pump Loads	Net Positive Suction Head Required and Net Positive Suction Head Available will be determined to size all pumps to prevent cavitation.
Piping Loads	Piping and fittings will be designed to the working pressure of the fluid and the pipe wall thickness will be designed for a sufficient bursting pressure.
Gate Loads	Load calculations for deflection for gates at the maximum expected head.

Load	Description
Valve Loads	Valves will be designed for expected maximum pressure and expected maximum differential pressure.
Debris Screens	Debris screens will be designed for a maximum differential pressure of 3-ft of water across the upstream and downstream faces.
Building Cooling	Cooling will not be provided; air circulation will be provided by large high-volume wall mount fans to allow airflow across the building space. The ventilation system will be designed based on a maximum summer ambient temperature of 97°F.
Building Heating	The heating system will be designed to maintain building space temperature above freezing (40°F). Heating system will be designed based on a minimum winter ambient temperature of 15.9°F.

2.10.4 HVAC

Heating and ventilation will be provided to the Coho Rearing Building, Chinook Incubation Building, and the Spawning Building. Heating in all buildings will be provided by wall- or ceiling-mounted electric unit heaters. Cooling will not be provided.

2.10.5 Plumbing

No sanitary waste collection system or potable water distribution system is included in the project. An outdoor vault toilet with a sealed inground tank will be provided on site.

2.10.6 Fire Protection

Automatic fire sprinklers are not required. A fire extinguisher will be provided according to applicable building codes and NEPA standards at all buildings.

2.11 Electrical

The electrical design criteria apply to all design procedures to be implemented during the Project design phase. Electrical design considerations listed in this section, including detailing of electrical components, material selection, and design requirements, are intended to be incorporated into Project design.

2.11.1 Applicable Codes and Standards

The following references and design standards will serve as the general design criteria for the electrical design of the Project. The applicable version of each document is the latest edition enforced, unless noted otherwise. References to the specific codes and standards are included in the applicable technical specifications. The electrical design, materials, equipment, and construction will conform to the codes and standards listed in Table 2-19.

Table 2-19. Electrical Codes and Standards

Code	Standard
ANSI	American National Standards Association

Code	Standard
CARB	California Air Resources Board
CCOR Title 24	California Code of Regulations
CPUC GO 128	California Public Utilities Commission – General Order No. 128: Construction of Underground Electric Supply and Communication Systems
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America – Lighting Application Handbook
ISA	Instrument Society of America
NEMA	National Electrical Manufacturers Association
NETA ATS	International Electrical Testing Association Acceptance Testing Specifications
NFPA 70	National Electrical Code (NEC)
NFPA 70E	Standard for Electrical Safety in the Workplace
NFPA 101	Life Safety Code
NFPA 110	Standard for Emergency and Standby Power Systems
OSHA	Occupational Safety and Health Act
UL	Underwriters Laboratory

2.11.2 Materials

The materials assumed for preparation of the preliminary design and applicable for engineering of the Project are listed in Table 2-20.

Table 2-20. Electrical Materials

Material	Standard
Panelboards	NEMA PB 1, UL 67
Transformers, Dry Type	NEMA ST 1, UL 1561, 10 CFR – Part 431 DOE 2016
Circuit Breakers	NEMA AB 1, UL 489
Switches	NEMA KS 1, UL 98
PLCs	NEMA ICS 1, UL 508
Terminal Blocks	UL 1059
Instrumentation Cable: THWN Copper	ASTM B8, NEMA WC 57, UL 13, UL 83, UL 1277
Power Conductors/Cable: THWN Copper; XHHW-2 Copper	ASTM B3, ASTM B8, ASTM B496, NEMA WC 70, UL 83

Material	Standard
Splices, Connectors, and Terminations	UL 486A-486B, UL 486C, UL 510
Grounding: Copper	UL 467
Boxes and Enclosures: NEMA 1, 12, 3R, & 4	NEMA 250, UL 514A
Raceway: Rigid Galvanized Steel; Intermediate Metal Conduit; PVC Schedule 80; Liquid-tight Flexible Metal Conduit	NEMA C80.1, NEMA C80.6, NEMA RN 1, UL 6, UL 360, UL 514B, UL 651, UL 1242
Transfer Switches	NEMA ICS 1, NEMA ICS 2, UL 1008
Motors: TEFC or submersible	IEEE 112, NEMA MG 1, UL 2111
Motor Controls	NEMA ICS 2
Wiring Devices	NEMA WD 1, NEMA WD 6
Luminaires: LED	IESNA HB-9, IESNA LM-80, IEEE C62.41.1, UL 1598, UL 2108, UL 8750, U.S. DOE Energy Star
Surge Protective Devices	UL 1449

2.11.3 Design Loads

All currently anticipated electrical loads are summarized in Table 2-21.

Table 2-21. Electrical Loads

Load	Description
Booster Pump Skids	480V, 3-phase, 3 hp, 3 ea.
Intake Traveling Screens	480V, 3-phase, 1 hp, 2 ea.
Intake Screen Spray Pumps	480V, 3-phase, 2 hp, 2 ea.
Existing Conveyor Belt	208V, single-phase, 1.5 hp
Existing Fish Crowder and Lift	480V, 3-phase, 1.5 hp (crowder drive) 1.5 hp (crowder lift)
Existing Electro-Anesthesia Tank	120V, single-phase, 1.92 kVA
Existing Electro-Anesthesia Tank Hydraulic Hoist	120V, single-phase, 2 hp
Electro-Anesthesia Tank Fill Pump	480V, 3-phase, 2 hp
Existing UV Lamp Ballast Outlet	120V, single-phase, 75 VA

Load	Description
Waste Drain Wet Well Sump Pumps	480V, 3-phase, 2 hp, 2 ea.
Coho Building Unit Heaters	480V, 3-phase, 5 kW, 5 ea.
Chinook Incubation Building Unit Heaters	480V, 3-phase, 5 kW, 5 ea.
Spawning Building Unit Heater	480V, 3-phase, 10 kW
Coho Building Radiant Heaters	208V, 3-phase, 3 kW, 2 ea.
Chinook Incubation Building Radiant Heaters	208V, 3-phase, 3 kW, 2 ea.
Spawning Building Radiant Heaters	480V, 3-phase, 4.5 kW, 1 ea.; 208V, 3-phase, 3 kW, 2 ea.
Electrical Room Split AC Unit	208V, single-phase, 2.08 kVA
Building Exhaust Fans	120V, single-phase, 3/4 hp, 2 ea., 1/2 hp, 3 ea., 1/6 hp, 2 ea., 1/20 hp, 1 ea.
Meter Vault Exhaust Fan	120V, single-phase, 170 VA
Motorized Dampers	120V, single-phase, 100 VA, 8 ea.
Meter Vault Sump Pump	120V, single-phase, 1/2 hp
Tagging Trailer Receptacles, 100A	240V, single-phase, 19.2 kVA, 2 ea.
Tagging Trailer – Fish Pump Receptacles, 60A	240V, single-phase, 11.5 kVA, 2 ea.
Waste Drain Pump Receptacles, 20A	208V, single-phase, 3.33 kVA, 7 ea.
Lighting, LED	120V, single-phase, 4.27 kVA
Sky Light Dimmers	120V, single-phase
Convenience Receptacles	120V, single-phase, 180 VA, 47 ea.
Standby Generator Loads	208V, single-phase, 2.50 kVA (block heater); 120V, single-phase, 400 VA (battery heater), 100 VA (battery charger)
SCADA Panel	120V, single-phase, 400 VA
Autodialer	120V, single-phase, 36 VA
Instrumentation	120V, single-phase or 24 Vdc, 4-20 mA
Intrusion Detection	120V, single-phase

2.12 Instrumentation and Controls

2.12.1 Applicable Codes and Standards

The following references and design standards will serve as the general design criteria for the instrumentation and control design of the Project. The applicable version of each document is the latest edition enforced, unless noted otherwise. References to the specific codes and standards are included in the applicable technical specifications. The instrumentation and control design, materials, equipment, and construction will conform to the codes and standards listed in Table 2-22.

Table 2-22. Instrumentation and Control Codes and Standards

Code	Standard
IEEE	Institute of Electrical and Electronics Engineers
ISA 5.1	Instrumentation Symbols and Identification
NEMA	National Electrical Manufacturers Association
NFPA 70	National Electrical Code (NEC)
UL	Underwriters Laboratory

3.0 Project Description

3.1 General Description

The general site layout is depicted in Figure 3-2, with the major components of the layout summarized in Table 3-1, as well as in the following sections.

3.2 Intake Structure and Meter Vault

A hatchery intake structure will be located along the southeast bank of Fall Creek directly adjacent to Dam A and opposite the City of Yreka intake structure (see Figure 3-1). The intake will be constructed of concrete and will divert flows up to 10 cfs from Fall Creek. A buried 24-inch-diameter pipe will supply the site and will divide flows into four buried water supply pipes to deliver flow to the various hatchery facilities. A debris screening system will be added at the entrance to the new intake structure to prevent large sediment, detritus, and other debris from entering the intake chamber. The debris screening system will be equipped with an automated screen-cleaning system that will operate at regular intervals or based on an acceptable head differential across the screen. Behind each screen will be stop log guide slots for isolation of the pipeline, or closure of one of the screen slots for general maintenance.

Inside the intake structure, the 24-inch-diameter supply line will be set in the concrete wall at a sufficient depth to preclude significant air entrainment at the pipe entrance. After the flow split, the four hatchery facility supply pipelines will be equipped with magnetic flow meters and isolation valves located in a concrete vault that will transmit flow rates to a programmable logic controller (PLC) located in the electrical room connected to the Chinook Incubation Building (see below). The intake will also be equipped with a sediment sluiceway outside of the intake chamber, for bypassing sediment and bedload that may accumulate at the toe of the intake screens.

Figure 3-1. Intake Structure Location and City of Yreka Intake (Source: McMillen Jacobs)

Table 3-1. Major Facilities Schedule

Facility	Species	Required Capacity / Volume	Rearing Volume Provided	Flow Requirement	Total Dimensions (Rearing Dimensions)	Comments
Intake Structure	-	-	-	10 ft^3/s	8’ (W) x 8.9’ (L) x 8.5’ (H)	Concrete Structure
Meter Vault	-	-	-	-	13’ (W) x 15’ (L) x 6.4’ (H)	Concrete In-Ground Vault
Coho Building	Coho	-	-	-	53’ (W) x 65’ (L)	Pre-engineered Metal Building
Incubators	Coho	48 trays	48 trays	40 gpm	25” (W) x 25” (L) x 34.5” (H) (per stack)	Existing, from IGFH
Incubation Working Vessel	Coho	150 ft^3	150 ft^3	30 gpm	(2) 2’ (W) x 15’ (L) x 3’ (H)	Existing, from IGFH
First-Feeding Vessel	Coho	750 ft^3	825 ft^3	150 gpm	(2) 4’ (W) x 16’ (L) x 3’ (H), Existing (3’ W x 15’ L x 2.5’ Depth) Existing	Existing, from IGFH
					(2) 6’ (W) x 21’ (L) x 4’ (H), New (5’ W x 20’ L x 3’ Depth) New	Fiberglass Vat
Rearing Ponds	Coho	3,850 ft^3	5,400 ft^3	764 gpm	(2) 11’ (W) x 40’ (L) x 3.8’ (H), Existing (11’ W x ~38’ L x 3’ Depth) Existing	Existing Concrete Raceway
					(2) 12.0’ (W) x 34.8’ (L) x 5’ (H), New (12.0’ W x 30’ L x 4’ Depth) New	Concrete Raceway
Chinook Incubation Building	Chinook	-	-	-	50’ (W) x 60’ (L)	Pre-engineered Metal Building
Incubators	Chinook	1,088 trays	1,088 trays	680 gpm	25” (W) x 25” (L) x 34.5” (H) (per stack)	Existing, from IGFH
Incubation Working Vessel	Chinook	290 ft^3	290 ft^3	60 gpm	(4) 2.5’ (W) x 14.5’ (L) x 2.5’ (H)	Existing, from IGFH
Chinook Rearing Ponds	Chinook	20,200 ft^3	23,040 ft^3	4,040 gpm	(8) 12’ (W) x 64.8’ (L) x 5’ (H) (12’ x 60’ L x 4’ Depth)	Concrete Raceway
Trapping/Sorting Pond	Coho/Chinook	3,350 ft^3	3,350 ft^3	200 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway (1495 gpm provided)
Chinook Adult Holding Pond	Chinook	1,800 ft^3	3,350 ft^3	400 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway (1495 gpm provided)
Coho Adult Holding Pond	Coho	600 ft^3	3,350 ft^3	200 gpm	12.6’ (W) x 66.3’ (L) x 5’ (H)	Concrete Raceway 1495 gpm provided
Spawning Building	Coho/Chinook	-	-	-	25’ (W) x 35’ (L)	Pre-engineered Metal Building
Settling Pond	-	3,200 ft^3	3,200 ft^3	-	(2) 12.6’ (W) x 31.8’ (L) x 5’ (H)	Concrete Pond (2 Bays)
Fish Ladder	Coho/Chinook	-	-	10 ft^3/s	2.5’ (W) x 24.6’ (L)	Denil Type (Concrete)
Fish Barrier (Dam A)	Coho/Chinook	-	-	-	29’ (W) x 16’ (L)	Velocity Apron (Concrete)
Fish Barrier (Dam B)	Coho/Chinook	-	-	-	11.5’ (W) x 20’ (L)	Velocity Apron (Concrete)
Fish Barrier (Fishway)	Coho/Chinook	-	-	-	17.3’ (W) x 8’ (L) x 4.5’ (H)	Picket Panels on Concrete Sill

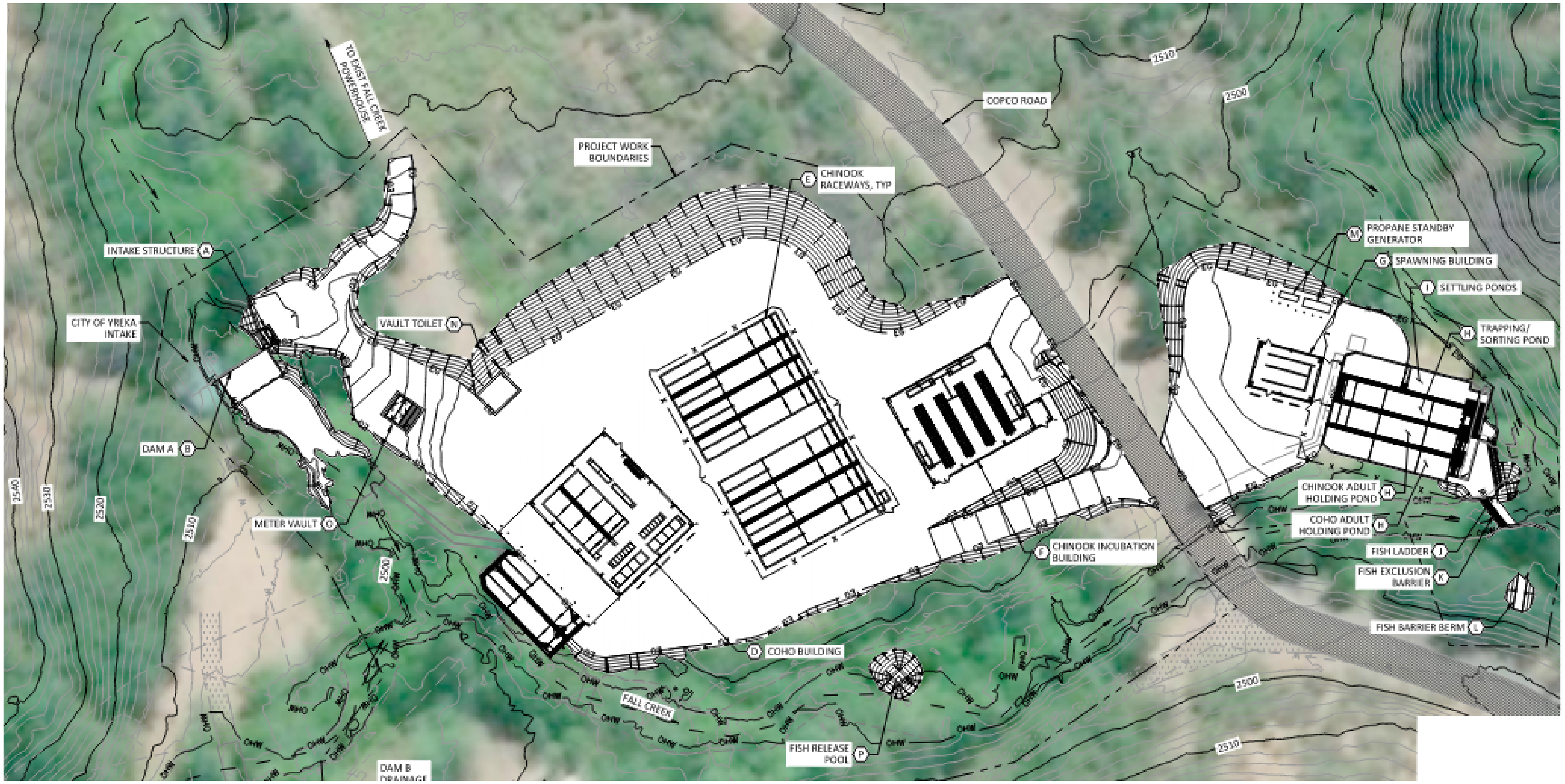

Figure 3-2. General Site Layout

3.3 Coho Building

The Coho Building will be located at the north end of the Project site at pad elevation 2503.0 (North American Vertical Datum [NAVD] 88), and will house all Coho incubation, grow-out, and rearing infrastructure Coho production facilities. The Coho Building will be a pre-engineered metal building with interior dimensions of 53 feet wide by 66.5 feet long.

Existing incubation stacks and trays will be reused from IGFH (see Figure 3-3), and will be configured in a row of six half-stacks (i.e., eight trays per stack) along the southwest wall. This will accommodate the 120,000 Coho green eggs discussed in the bioprogram at 2,500 eggs per tray. A water flow rate of 5 gpm will be provided to each of the incubation stacks via a head tank located above the stacks. The intent of a head tank design is to protect against any potential flow interruption. Water will flow downward through the stacks to a floor drain that discharges to a production drain system, with flows diverted to one of two systems (adult ponds as online flow; effluent ponds as effluent flow). The incubation stacks will be supplemented with two working vessels (egg picking, enumeration) that will be reused from IGFH (see Figure 3-3).

Figure 3-3. Existing IGFH Incubators (Left) and Working Vessels (Right) (Source: McMillen Jacobs)

Four first-feeding vessels will be provided for initial ponding of the Coho fry consisting of two existing vats from IGFH and two new fiberglass aquaculture vats, providing a total of 825 ft^3 of ponding volume. First-feeding vessels will be equipped with screen guides, such that a quiescent zone can be maintained at the downstream end of the vessel. These vessels will operate in a flow-through condition with a 150-gpm (total) renewal rate, and online overflows will pass through a standpipe in the quiescent zone that flows into the drain system and then routed to the adult holding ponds; effluent will be conveyed to the effluent pond (or holding tanks if designed) via an effluent standpipe adjacent to the vats in the floor, which will discharge to the effluent drain system.

Grow-out and rearing space will be provided in part in the existing upper raceway bank (see Figure 3-4). There are two existing concrete raceways (approximately 11 feet wide by 40 feet long by 3.8 feet deep) adjacent to Fall Creek that will be just outside of the Coho building. These will be rehabilitated with a surficial mortar layer and resurfaced with an epoxy liner for use in Coho grow-out and rearing. This raceway bank will be covered with a roof above and predator netting and fencing provided along the sides of the site. The existing flume that feeds these raceways will be demolished and replaced with pipe manifolds that provide a maximum of 210 gpm to each of the existing raceways. The raceways will be further subdivided by two 20-foot-long pony walls, equipped with dam boards and fish screen slots. This will provide approximately 1,300 ft^3 of early rearing volume for use prior to fish tagging/marking. After fish have been tagged/marked, the dam boards and fish screens can be removed, allowing the full 2,500 ft^3 of rearing space to be used.

Figure 3-4. Existing Upper Raceway Bank (Source: McMillen Jacobs)

At the downstream end of the existing raceways, dam boards and fish screens will be installed upstream of the outlet works. Additionally, a set of dam boards will be installed in the existing concrete outlet flume, and pond overflow will be directed into a production drainpipe that will convey flow to the adult holding ponds. When fish are to be released from these raceways, a gate will be closed on the production drainpipe, and dam boards will be lowered in the existing concrete flume to allow fish to pass over the dam boards and directly into Fall Creek.

Further rearing space will be provided by two additional constructed concrete raceways 12 feet wide by about 35 feet long by 5 feet deep, located approximately 20 feet from the existing raceways inside the Coho Building. A roadway will pass under the roof structure between the existing and the new. At tagging and marking, the trailer will pull between the existing and new raceways and the roll-up doors on the Coho Building will be opened. Newly tagged/marked fish can then be distributed among the four raceways as required by rearing volume.

Overflow from the new concrete raceways will discharge to an approximately 2-foot-wide exit channel that will direct flows to a production drainpipe in the concrete wall. In addition, there will be in the exit channel a 2-foot by 2-foot box behind a set of dam boards leading to the volitional fish release pipe. If it is desired that fish be volitionally released from these ponds, the gate on the production drainpipe can be closed and dam boards can be removed at the volitional fish release box. Fish will volitionally go over the dam boards and enter a 10-inch-diameter fish release pipe that will convey fish to the existing concrete flume on the discharge end of the existing Coho rearing raceways, and ultimately out to Fall Creek.

Finally, because production periods will overlap and all Coho infrastructure, with the exception of the existing upper raceways, will be housed in the same building, biosecurity will be maintained by curtain systems between the respective areas of the Coho Building (e.g., incubation, first-feeding, rearing/grow-out).

3.4 Chinook Incubation Building

The Chinook Incubation Building will be located immediately north of Copco Road at pad elevation 2,503.0 (NAVD 88) and will house only the Chinook egg incubation operations. The Chinook Incubation Building will be a pre-engineered metal building with interior dimensions of 50 feet wide by 60 feet long.

Existing incubation stacks and trays will be reused from IGFH and will be configured in eight rows of 17 half-stacks, for a total of 136 stacks or 1,088 trays. Incubation trays will accommodate the 4.5 million Chinook green eggs discussed in the bioprogram at an approximate loading density of 4,150 eggs per tray. Rows of incubation stacks will maintain a 7.5-foot buffer on other rows to mitigate any cross-contamination from splashing. A flow of 5 gpm will be routed to each of the incubation half-stacks via head tank above, as in the Coho Building, and water will flow to the drain system in the floor.

Four incubation working vessels will be reused from IGFH and will be positioned around the inside perimeter of the building for hatchery operations.

3.5 Chinook Raceways

Eight concrete raceways will be constructed in two raceway banks north of the Chinook Incubation Building at pad elevation 2,503.0 (NAVD 88), with the pond invert set 3 feet below the pad elevation (2,500.0 NAVD 88). Raceways will be constructed with 26-foot-long pony walls and fish screen guide slots and stop log slots at intervals along the length of the structure, such that ponding volumes can be incremented based on fish development. The eight raceways provide a total rearing volume of 23,040 ft^3. Bioprogram requirements for tagging and marking assume Chinook will be marked at 150 fpp with a required rearing volume of 16,045 ft^3. CDFW staff have indicated that Chinook sub-yearling cohort releases will begin immediately after marking has been completed. If required, the total rearing volume available (23,040 ft^3) provides adequate rearing flexibility for CDFW staff to rear fish up until approximately 104 fpp before approaching the recommended 0.3 density index maximum.

Chinook rearing raceways will be operated in a flow-through condition, with manifolds at the upstream end of the pond supplying a maximum of 500 gpm to each of the ponds, and dam board overflows draining to a sloped concrete exit channel that connects the two raceway banks. The concrete exit channel will be equipped with two open concrete boxes at the southwest end of the channel containing the production drainpipe and the volitional fish release pipe, respectively. During normal operations, dam boards will be in place to isolate the volitional fish release pipe, such that all water is directed to the production drainpipe and on to the adult holding ponds.

During volitional fish release, it is anticipated that the adult holding ponds may be used for raising fish on second-pass water, and therefore flow through the Chinook raceways will need to be divided between the production drain system and the volitional fish release pipe. At volitional fish release, fish screens in each of the raceways will be removed and a fish screen will be installed in front of the production drain box. Dam boards in front of both pipe boxes will be adjusted for the desired distribution between the two pipes, while maintaining a pool in the exit channel for fish that volitionally leave the raceways. Fish will be contained in the exit channel until they volitionally pass over the dam boards into the volitional fish release pipe. The volitional fish release pipe will convey fish entrained flows in an open channel condition to a constructed plunge pool adjacent to Fall Creek, approximately 150 feet upstream of the existing Copco Road bridge.

Predator netting and security fencing will be supplied to protect the Chinook rearing raceways. Predator netting will be connected to an exterior security fence with a metal frame structure that will allow personnel to stand and move around in the enclosure for access to the ponds. The security fence will generally be maintained 3 foot from edge of concrete, such that personnel will have access to all sides of the ponds from inside the fence enclosure. The security fence will be equipped with man gates and double-leaf gates between the raceway banks such that vehicles could access the 12-foot-wide center aisle between the raceway banks. At tagging/marking, it is anticipated that the tagging/marking trailer will pull along the north end of the ponds for access to electrical outlets and easy access through the double-leaf gates to the ponds.

3.6 Adult Holding Ponds

The existing lower concrete pond bank consists of four ponds approximately 12.5 feet wide by 70 feet long, with a concrete outlet structure at the downstream end (see Figure 3-5). Three of these ponds will be refurbished for use as adult holding ponds: one for trapping and sorting, one for Coho holding, and one for Chinook holding. Existing pond concrete walls are in poor structural condition and will require demolition and reconstruction. Reconstructed walls will be equipped with walkways between each of the ponds and sprinkler systems to mitigate fish jumping.

Based on estimates of holding 200 Chinook and 100 Coho at any given time and estimated adult weights (Chinook – 12 lbs, Coho – 8 lbs), NMFS guidance (2011) dictates a minimum of 1,800 ft^3 of pond volume for Chinook and 600 ft^3 of storage for Coho. Each individual pond is estimated to have approximately 3,350 ft^3 of storage, which provides ample capacity for adult holding. Because of the available capacity in the reconstituted ponds, these ponds may additionally be used for raising fish on second-pass water at the option of CDFW. Therefore, the ponds will be retrofitted with fish screen slots for partitioning, as needed operationally.

The adult holding ponds will be fed by a supply pipe from the intake structure, but will also be fed by the fish production drain system, such that at any given time (aside from nominal losses to cleaning) the adult ponds will be fed with the full water right of 10 cfs. In the Coho and Chinook holding ponds, during normal operations, the water supply will flow over a set of dam boards at the downstream end and through a floor diffuser into the fish ladder. The trapping-and-sorting pond will be equipped with an adjustable finger weir at the downstream end through which pond outflow will be routed. This will then serve as the trap at the end of the fish ladder. As fish go over the weir, they will remain in the trapping-and-sorting pond until they are transferred into their respective holding ponds. The trapping-and-sorting pond will be equipped with the existing Iron Gate Hatchery fish crowder and lift to aid in sorting and transfer of the respective species.

The adult holding ponds have been designed with fish screen keyways that will allow for culture and effluent collection for a limited number of Chinook juveniles during the periods when adult Coho and Chinook are not present. Acknowledging that the water source will be serial reuse from upper facility fish rearing systems (Coho and Chinook production raceways), the conservative density and flow indices used in the program should provide second-pass water of sufficient quality and oxygen levels to support serial reuse for a limited number of surplus juvenile Chinook. If juvenile fish are to be raised in these ponds, the Coho and Chinook holding pond outflow can be isolated from the fish ladder with a set of dam boards to full height. A fish release pipe with another set of dam boards in the exit channel provides the option of volitional release from these ponds. The fish release pipe will convey fish to the pool at the toe of the fish ladder. It should be noted, however, that the fish release pipe is not designed for concurrent use with the Denil fishway (i.e. during adult trapping), and the plunging flow from the release pipe could inhibit adults from accessing the fishway. It is not the design intent that juveniles would be released from these ponds while adult trapping is occurring. Finally, the adult holding ponds will be connected by dam boards that may be removed such that fish can be directed into any of the three ponds.

Figure 3-5. Existing Lower Raceway Bank Ponds (Source: McMillen Jacobs)

The lower raceway bank will be surrounded by an enclosure of perimeter fencing. Sufficient clearance to the perimeter fencing will be maintained around the ponds, such that personnel will be able to access the ponds and associated infrastructure. Security fencing will tie into the Spawning Building at the north end of the pond.

3.7 Spawning Building

Immediately north of the adult holding ponds at pad elevation 2491.5 (NAVD 88) will be the Spawning Building. The Spawning Building will be a pre-engineered metal building with interior dimensions of 25 feet wide by 35 feet long and will house equipment relocated from IGFH. A roll-up working door will be located on the southeastern wall of the building, providing direct access to the head of the sorting/trapping raceway. Within the sorting/trapping raceway, the existing fish crowder and lift will be provided to transfer fish from the raceway to the existing IGFH electro-anesthesia tank for fish sedation or euthanasia. A sorting table will be placed immediately outside of the roll-up door to sort and transfer sedated fish into the Spawning Building through removable troughs.

Within the Spawning Building, a holding table and air spawning table are provided for egg retrieval. The existing egg rinsing table and water hardening table will be relocated from IGFH for egg processing prior to incubation. A conveyor belt will be provided for transferring fish carcasses to a collection bin located outdoors. Additional return pipes are to be provided along the southeastern wall of the building for returning fish to either the trapping/sorting pond or the Chinook holding pond.

Excess space is provided within this structure for storage of hatchery supplies, as needed. Additional workspace is provided for any collaborator activities.

3.8 Settling Pond

The final pond in the existing lower concrete raceway bank (eastern-most pond) will be used as a settling pond to settle out any biosolids or other solid waste from cleaning of the upstream facilities discharged to a waste drain. The effluent treatment is discussed in greater detail in Section 10.4. This pond will be refurbished and parsed into a wet well and two distinct bays such that solids can be dried and removed as necessary over the life of the facility, while the waste drain system remains in operation.

When cleaning of the settling pond is required, a septic pump truck will access the pond from the adjacent pad, and the solids can be vacuumed out of the pond.

The downstream end of each of the settling pond bays will be equipped with an overflow structure that will divert flow-through water into the fish ladder (see below) for mixing with the adult holding pond flows and release to Fall Creek. At the interval required by the NPDES permit, measurements of the settling pond effluent flow rate will be performed by hand measurements using a staff gage at the overflow weir, and a calibrated discharge relationship to determine the flow rate from the facility. This will be added to measurements taken at the upstream end of the fish ladder to determine a total discharge rate.

3.9 Fish Ladder

The fishway is a baffled chute which is a type of roughened chute designed to meet the NMFS criteria. The baffled chute type is a Denil fishway. The Denil fishway is 2.5-foot-wide by approximately 25-foot-long. The entrance to the fishway will be located just downstream of the picket barrier at the upstream terminus to maximize fish passage efficiency. The fishway will ascend to the constructed concrete outlet structure at the lower raceway bank and will terminate at the finger weir at the downstream end of the trapping and sorting pond to convey fish into the pond for sorting. The fish ladder will consist of 14 standard baffles in total and will be of the Denil-type, as described in the NMFS (2011) guidelines (see Figure 3-6). At the top of the Denil ladder will be a pool for fish to turn into the constructed outlet structure. This turning/resting pool is sized to provide adequate energy dissipation characteristics and will be equipped with a dam board weir for fish to enter the constructed outlet structure. This pool, and the upstream overflow weir, will serve as the location for measuring flow rates from the ponds into the Denil fishway. At the interval required by the NPDES permit, hatchery personnel will perform hand measurements using a staff gage at the weir, and a calibrated discharge relationship to determine the flow rate into the Denil fishway. This will be added to the effluent flow rate determined at the settling ponds to determine an overall flow rate out of the hatchery.

The uppermost pool in the constructed outlet structure will be fed by the flow over the finger weir, and by flow from the Coho and Chinook holding ponds through a floor diffuser. The finger weir is sized according to recommendations from the U.S. Army Corps of Engineers *Fisheries Handbook* (Bell, 1991), and maintains approximately 4 inches above the fingers of the finger weir.

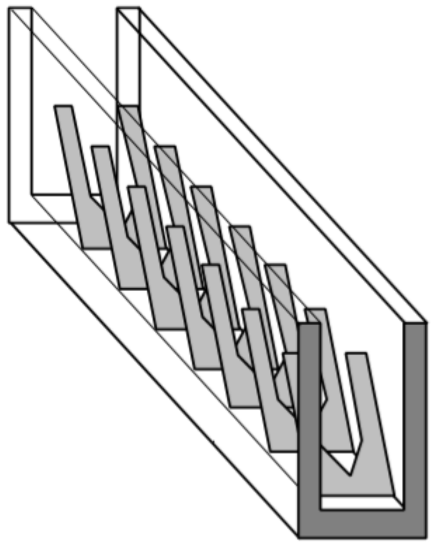

Figure 3-6. Perspective of Denil-Type Fish Ladder with Single-Plane Baffles (Source: NRCS, 2007)

During seasons when the fish ladder is not in operation, a bar screen will be installed at the downstream end of the ladder and baffles will be removed to exclude both adult and juvenile native fish populations from entrainment in the fish trap.

3.10 Fishway Picket Fish Barrier

A removable fish exclusion picket barrier will be constructed with the fish ladder that will guide fish to the fish ladder entrance pool and ultimately up to the trap. The fish barrier will consist of a set of aluminum pickets with 1-inch-maximum clear spacing that will be installed on a permanent concrete sill and removed each year at the beginning and end of the trapping season. The sill will have side walls and a 6-inch-tall curb across the bottom that the picket panels will be able to seal against, forming a continuous barrier across the stream. The sill and removable pickets will be oriented at an angle of approximately 30 degrees to the stream transect, such that an anadromous fish moving upstream will encounter the barrier and be directed toward the stream's east bank, where the fish ladder entrance pool is situated. The typical fish ladder flow of 10 cfs will act as an attraction flow to the anadromous fish. NMFS (2011) recommendations for attraction flow in smaller streams are typically greater than 10 percent of the design high flow during the fish passage season. In this case, 10 cfs is approximately 20 percent of the design high flow and will provide effective attraction flow. The orientation of the picket barrier will also aid in reducing approach velocities at the barrier.

The picket framing will consist of ultra-high molecular weight (UHMW) stringer bars with penetrations for the aluminum pickets to slide in. UHMW stringer bars will be overlapped at installation to tie the individual picket panels together. These picket panels will rest at the bottom against the concrete sill, with a 6-inch-tall curb to prevent fish from passing underneath the panels. The picket panels will then be connected to a stand that will be secured to the concrete sill. A small walkway will be cantilevered from the framing/stringer bars above the high water level, such that access may be maintained to the whole length of the barrier without entering the stream (see Figure 3-7).

When debris or bedload accumulates on the pickets, the pickets will need to be manually cleaned to ensure that less than 0.3 feet of additional headloss from the clean picket condition is maintained (per NMFS, 2011). This can be performed with the use of a simple hand-rake or stiff-bristled broom, or by raising and lowering individual pickets through the stringer bars to allow the accumulated debris or bedload to be washed downstream. This will be performed from the small access way and will only need to be performed during the trapping season, as the pickets will be removed from the creek at all other times.

Figure 3-7. Temporary Picket Barrier for Adult Fish Trap (Source: McMillen Jacobs)

3.11 Dam A Velocity Barrier

Immediately downstream of existing Dam A, a 16-foot-long by 29-foot-wide sloped concrete apron will be constructed from the downstream face of Dam A. The apron will be sloped at 16H:1V (about 6.3 percent), resulting in high velocities and shallow flow depths. The combined high-velocity apron and the jump required to pass upstream of Dam A will effectively bar passage to both juvenile and adult anadromous fish for the anticipated creek flow range expected during juvenile fish release, adult migration, and up to larger flood events. This barrier follows design guidance from NMFS (2011).

3.12 Dam B Velocity Barrier

Immediately downstream of existing Dam B, a 16-foot-long by 11.5-foot-wide sloped concrete apron will serve as a similar velocity barrier to preclude fish from approaching the Dam B reservoir and exclude juvenile fish passage upstream. In order to prevent significant downstream modifications to the stream corridor inside of the ordinary high-water mark (OHWM), the Dam B concrete apron will primarily be constructed above grade. This will result in some demolition of the existing pier and sill for construction of the concrete apron. The existing sill where the stop logs are located will be raised approximately 1-foot 10-inches and new aluminum stop logs will be fabricated to fit the existing stop log slots.

Because of the limited height of Dam B, the stop logs will have insufficient height above the new concrete apron to meet the NMFS (2011) weir conditions for a standard velocity barrier. Therefore, the stop logs will be fitted with a newly fabricated nappe extension piece that will push the nappe overflow approximately 3.0 feet downstream of the aluminum stop logs, making for more difficult jump conditions for upstream migrating fish. This method has proven effective for similar conditions excluding anadromous salmonids in McMillen Jacobs Associates previous project experience.

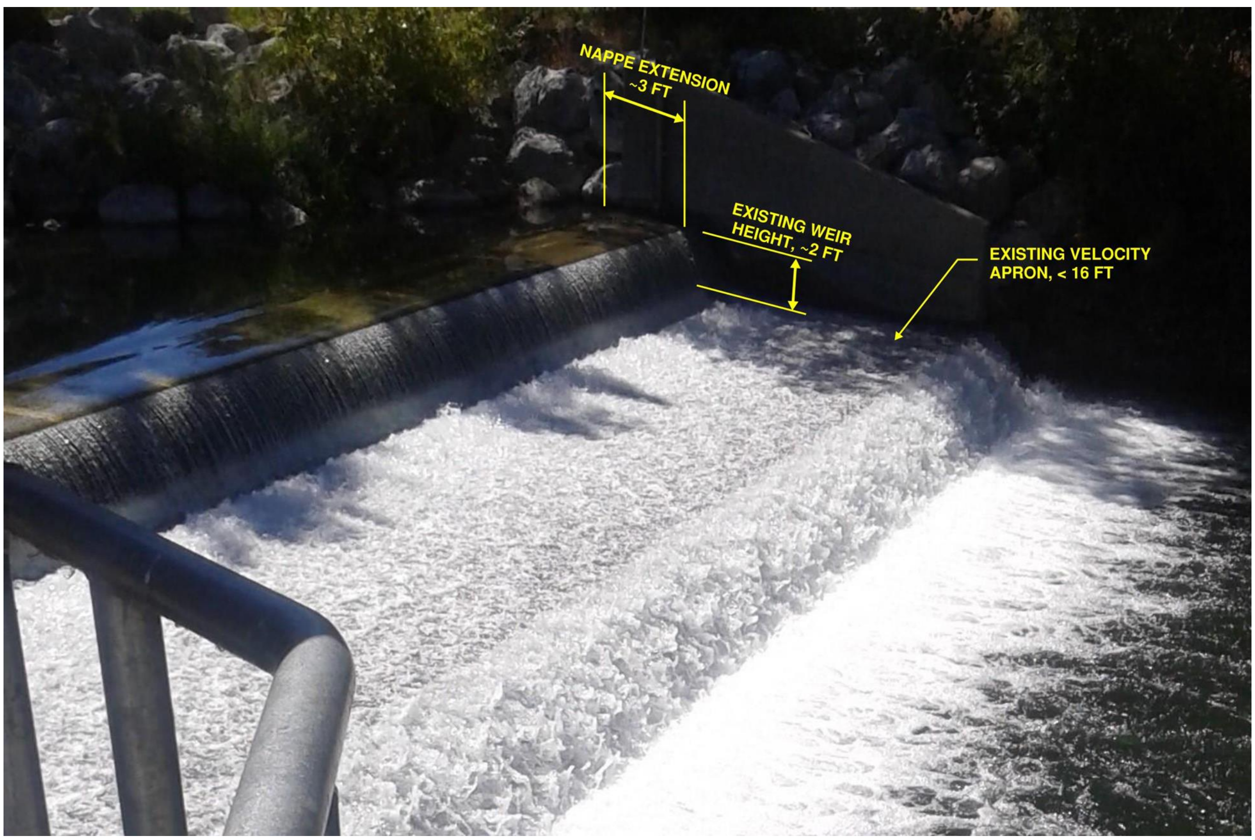

Figure 3-8. Nappe Extension Retrofit (Source; McMillen Jacobs)

In all other regards, the barrier follows design guidance from NMFS (2011). A sluicing gate and pipe will pass underneath the velocity barrier to allow flushing of accumulated sediment upstream of Dam B.

4.0 Hydraulic Design

The facility hydraulic design consists of four main piping systems:

1. Water supply piping system
2. Production drain system
3. Waste drain system
4. Volitional fish release pipes

The design also includes three fish passage/trapping elements:

1. Fish Ladder
2. Finger Weir
3. Fish Barriers

The design also includes the effluent treatment system. Hydraulic calculations for each of these elements can be found in Appendix A of this DDR, and each is discussed in detail below.

4.1 Supply Piping System

The supply piping system consists of four primary pipelines from the intake structure to the major production facilities, which include: (1) the Coho Building, (2) the Chinook rearing raceways, (3) the Chinook Incubation Building, and (4) the adult holding ponds. All pipes were assumed to be schedule 80 PVC, which are typical in hatchery applications, and present considerable cost savings over alternatives. The site is relatively constrained in terms of hydraulic head. The assumed water surface at the intake structure is at elevation 2,510.4 (NAVD 88), and the pad for the majority of the site is at elevation 2,503.0 (NAVD 88), providing only about 7.4 feet of hydraulic head across much of the site. For this reason, pipes were conservatively sized to minimize dynamic head losses through the piping system. At the same time, pipes were sized to maintain a minimum velocity of 1.5 feet per second (ft/s) and a typical velocity of approximately 2.0 ft/s such that they would be self-cleaning, and would not settle out any sediment, detritus, or other material in suspension that may pass the upstream traveling screen.

Modeling of the supply piping system using EPANET software (Appendix A) was performed for a series of 5 scenarios to ensure that water supply would be available under a number of contingency conditions. Scenarios that were modeled are described below:

1. **Scenario 0, Base Case:** The base case scenario evaluates the pipe flow under normal conditions, at the time in the bioprogram when demands on the supply lines are the greatest. Pipes were assumed to be in a clean, new condition (Hazen-Williams coefficient 140), and the minor loss coefficients as enumerated in Section 2.6.4 were applied.

2. **Scenario 1, Pipe Degradation:** Scenario 1 evaluates the condition where the pipes have degraded over time, either through accumulation of biomass or through a failure of the screen

leading to introduction of sediment, debris, or detritus to the pipeline. The friction loss coefficient was adjusted for this case while still being appropriate to plastic pipe (Hazen-Williams coefficient 120).

3. **Scenario 2, Operational Change & Pipe Degradation:** Scenario 2 evaluates the same degraded pipe condition as Scenario 1, but for an operational change that requires the maximum bioprogram flow to all design points (incubation stacks, working vessels, raceways, etc.) on each supply line simultaneously.

4. **Scenario 3, Intake Loss Contingency, Operational Change, & Pipe Degradation:** Scenario 3 builds on Scenario 2 by adding contingency losses at the intake structure, due to a traveling screen being taken out of operation, or excessive blockage, or some other additional head losses being introduced at the intake structure.

5. **Scenario 4, Minor Loss Contingency & Pipe Degradation:** Scenario 4 retains the pipe degradation condition from Scenario 1 and uses much more conservative estimates of minor losses. For this condition, the highest water demand from the bioprogram was used.

For all of the above scenarios modeled, the pipe system was found to meet the demand at each of the demand nodes with positive driving head, including critical locations such as the incubation head tanks.

Table 4-1. Available Head at Demand Nodes

Supply Line	Critical Location	Available Head (ft)				
		Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Coho Building	Incubation Head Tank	1.27	1.09	0.64	0.35	0.73
Chinook Rearing	Final Raceway Manifold	2.48	2.24	2.24	1.95	0.61
Chinook Incubation	Incubation Head Tank	1.07	0.88	0.37	0.08	0.19
Adult Holding	Chinook Holding Pond Manifold	15.89	15.85	13.71	13.42	14.71

It is noteworthy, however, that hydraulic head is limited and therefore infrastructure was kept as low as possible, including the use of half-stacks for incubation. In addition, pressurized cleanouts are provided at intervals along the supply pipelines such that water may be blown out and pipes cleaned if fouling of the pipe or accumulation of fine sediments occurs. The supply pipes will be screened at the upstream end, and these cleanouts are provided as a contingency feature to ensure that the hydraulic head is not impacted over time. Pipe sizes are shown in the Drawing package accompanying this document.

4.2 Production Drain System

The production drain system is the primary drain system for all hatchery infrastructure and drains to the adult holding ponds and out to Fall Creek through the fish ladder. The production drain system consists of lateral lines that convey flow from individual hatchery elements to larger trunk lines that collect and convey flows to their terminus. The system was designed to convey flows primarily in a gravity flow regime, such that pipes would not pressurize and hydraulically connect the ponds. Pipes were sized such that at maximum flow rates the pipes would flow at most 75 percent full, which is typical for the design of open channel drain piping.

In the lower portion of the production drain system, riser pipes distribute flows into the three adult holding ponds, and therefore, the trunk line in the lower portion of the site will pressurize. Calculations demonstrate that this lower pressurization of the pipe occurs well below the invert elevation of all the upstream pond and raceway systems, and therefore no impacts will be conveyed to those design elements. This transition from gravity flow to pressure pipe flow will require the pipe to have adequate venting to provide the necessary air flow into the pipe to accommodate the transition.

While the production drain system is expected to have minimal solids content due to the outlet configurations of the upstream ponds, the pipes were designed to maintain minimum self-cleaning velocities such that accumulation of biosolids or suspended sediment would not occur in the pipeline. Thus, it is expected that biofouling will occur over the 8-year life of the facility. Regularly spaced cleanouts are provided to the ground surface such that these pipes can be cleaned at intervals and operations are not inhibited. Calculations in support of the production drain system hydraulics, including vent pipes, can be found in Appendix A, and pipe sizing information can be found on the Drawings accompanying this document.

4.3 Waste Drain System

The waste drain system will be used when cleaning the facilities, and significant content of biosolids is anticipated in the effluent. The waste drain system conveys biosolid-laden flows from each of the hatchery vessels or raceways to the settling pond located adjacent to the adult holding ponds. At each of the hatchery vessels or raceways, a riser pipe will be provided to the ground surface with a cam-lock fitting on the end. When cleaning the ponds or vessels, hatchery operators will vacuum waste to these riser pipes that will then discharge to the waste drain system. Because this system is fed by vacuum cleaning flows only, the system has a uniform design flow of approximately 200 gpm, under the assumption that only one to two of the raceways or vats will be cleaned simultaneously.

The waste drain system was designed similar to the production drain system to operate in a gravity flow regime, and pipes were sized to flow at most 70 percent full at the maximum design flow. These pipes, however, will maintain an open channel regime all the way to their outlet at the settling pond wet well. Vent pipes are provided at locations of steep slopes, such that sufficient airflow is maintained in the pipe. The waste drain system will have cleanouts to grade at regular intervals for cleaning, as necessary. Calculations associated with the waste drain system, including vent pipes, are provided in Appendix A, and pipe sizes are summarized in the Drawings accompanying this document.

4.4 Volitional Fish Release Pipes

The volitional fish release pipes are provided from the Coho rearing raceways, the Chinook rearing raceways, and from the adult holding ponds, where there is potential for raising juvenile fish, to various outlet points in Fall Creek. Volitional fish release pipes were subject to more stringent criteria than the other pipe systems, because of the entrained fish in the flow. Design criteria are summarized in Section 2.6 above and follow guidance from NMFS (2011) for fish bypass pipes. All volitional fish release pipes will be butt-welded HDPE and will have any internal weld beads or burrs removed for fish safety.

For the Coho rearing raceways, flow-through rates were limited, and therefore at volitional release the entirety of the flow is to be directed through the volitional release pipe to the existing concrete flume and ultimately out to Fall Creek. This location appears to have been previously used for fish release, and therefore was deemed appropriate and the most cost-effective solution due to the proximity of the existing raceways to Fall Creek. The drop into Fall Creek is relatively limited, and therefore impact velocities will be well below the maximum threshold recommended by NMFS. Because fish are released in a juvenile state, and generally not during the trapping period, fish released to Fall Creek will have free egress down from the hatchery site to the lower reaches of Fall Creek and into the Klamath River.

For the Chinook rearing raceways, the majority of the hatchery water right will be flowing through the Chinook raceways at volitional release, and therefore, the flow needs to be distributed between the volitional release pipe and the production drain system that supplies water to the lower raceway bank. Due to the constraints on the volitional release pipe (depth in pipe greater than 40 percent full, but less than 70 percent full), the pipe will only be able to accommodate a limited range of flows. A flow range from 2.6 cfs to 4.5 cfs (about 25 to 50 percent of the Chinook pond outflow) was selected for the volitional release pipe, allowing a majority of the water to supply the lower site. Outside of the defined flow range, the volitional release pipe will not operate as intended. The fish ladder is not anticipated to be in operation during volitional fish release. Juveniles reared in the adult ponds, if utilized, will need to be transferred off station and/or volitionally released *prior to* release of the primary Chinook production ponds; this is an important operational consideration as surplus juveniles reared in the adult ponds are on second-pass water and biomass estimates for surplus production assume 100% of the flow coming from the Chinook ponds (this will not be the case when production Chinook in the upper rearing ponds are being released volitionally).

The Chinook volitional release pipe will convey fish to a constructed plunge pool in the east overbank area adjacent to Fall Creek, approximately 150 feet upstream of the existing Copco Road bridge. The pipe invert at the plunge pool will be approximately 1.7 feet above the high tailwater level in Fall Creek, and approximately 2.3 feet above the low tailwater level. The plunge pool will be excavated such that it is approximately 4.5 feet deep at high tailwater and 4.0 feet deep at low tailwater. This results in impact velocities at the low water surface of approximately 13 ft/s and at the bottom of the pool of approximately 17 ft/s. Both of these values are within the 25 ft/s recommended by NMFS (2011), and the plunge pool was deemed appropriate.

Finally, the adult holding volitional release pipe will convey the entirety of the flows through the Coho and Chinook adult holding ponds, and possibly the flow through the sorting/trapping pond, as well. This results in a design flow range from 6.7 cfs to 10 cfs. The adult holding volitional release pipe is located less than 20 ft from the fish ladder entrance pool, and therefore will only convey fish a short distance.

Further details regarding the design of the volitional fish release pipes and the plunge pools can be found in the calculations in Appendix A. Pipe design and sizing are summarized in the Drawing package accompanying this report.

4.5 Fish Ladder

The Denil fish ladder was designed according to standard Denil geometry, as provided by USFWS (2017), and according to the guidance provided by NMFS (2011). It was assumed that during the trapping season, when the fish ladder is in operation, the full water right (10 cfs) would be directed to the adult holding ponds (either through the production drain system or the supply pipe) and out through the fish ladder, with only occasional, minimal losses to cleaning and utility water. The slope of the fish ladder was selected to minimize the slope and resultant turbulence in the ladder, while avoiding the introduction of turns and rest pools. It was found that at the design flow, a 2.5-foot-wide ladder at 18 percent slope would result in flow depths in excess of 2.0 feet and cross-section average velocities less than 2.0 ft/s. This was within guidance for these structures and provided flow characteristics that would be passable to both adult Chinook and Coho. The rating curve calculated in association with the designed fishway is presented in Figure 4-1.

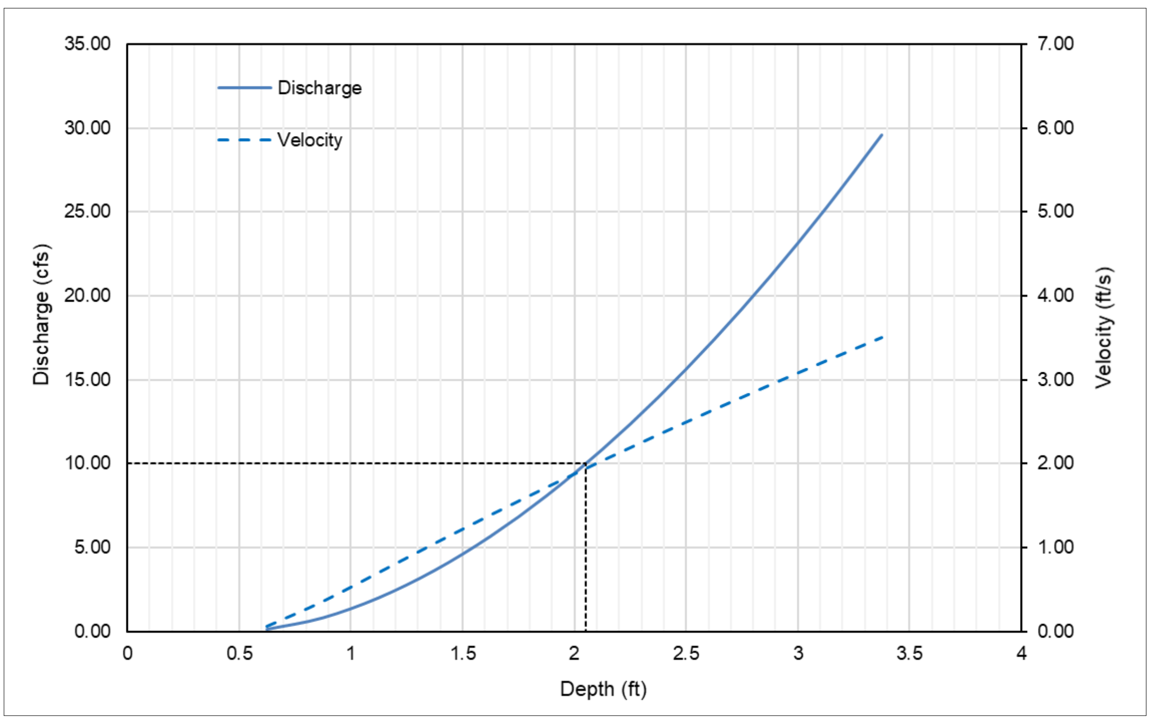

Figure 4-1. Denil Fish Ladder Rating Curve

At the top of the Denil fish ladder will be a resting and turning pool with a set of dam boards that will allow fish to pass into the adult holding raceway outlet structure and on to the finger weir. The turning and resting pool provides an energy dissipation factor of 2.8 ft-lbs/s-ft^3, which is below the maximum value recommended by NMFS (2011) of 4.0 ft-lbs/s-ft^3.

4.6 Finger Weir

After passing the fish ladder, a 1-foot drop will be maintained across a finger weir coming out of the trapping and sorting pond. The finger weir was designed according to the hydraulic guidance provided by the U.S. Army Corps of Engineers (Bell, 1991), to maintain 2 to 6 inches of water depth above the fingers of the weir. The finger weir will be attached to a gate that will allow for raising and lowering of the weir based on the desired water surface level in the pond. This water surface will need to be coordinated with the downstream set of dam boards, such that the hydraulic control in the pond is maintained at the finger weir.

4.7 Fish Barrier

The fish barrier system consists of three components. Dam A and Dam B will be modified to serve as permanent velocity barriers to preclude both juvenile and adult fish passage to the impoundments above the dams. At the fishway, a removable picket barrier with a concrete sill will be installed to direct adult fish to the fishway during the trapping season. The hydraulic design of each of these barriers is discussed below.

4.7.1 Dam A and Dam B Velocity Barriers

NMFS (2011) recommended velocity barriers consist of two components: (1) a downstream high-velocity apron, and (2) an upstream weir. The combination of these two components produces a shallow flow depth and a high velocity on the apron, which makes the jump for an adult anadromous fish impassable over the weir. The design of the Dam A and Dam B velocity barriers use the existing dams as the weir portion of the barrier and are amended with a downstream steep concrete apron to form an impassable barrier to adult fish.

Downstream aprons were provided in accordance with NMFS (2011) recommendations and maintain a minimum length of 16 feet and a slope of about 6.3 percent (16H:1V). Open-channel flow calculations with an assumed Manning's roughness of 0.015 (concrete, float finish; Chow, 1959) were performed for the flows on the aprons to ensure flows were shallow and fast such that the jump over the dams would be impassable. Table 4-2 summarizes the calculated depths and velocities.

Table 4-2. Velocity Apron Depths and Velocities

Location	Flow Condition	Flow (cfs)	Depth (in)	Velocity (ft/s)
Dam A	High Flow	50.0	2.4	8.5
	Low Flow	15.0	1.2	5.3
Dam B	Juvenile High Flow	62.1	4.9	13.1
	Adult High Flow	56.9	4.7	12.7
	Adult Low Flow	8.4	1.5	6.0

The Dam B velocity barrier, as described above in Section 3.12, is unable to meet the NMFS (2011) recommended weir height of 3.5 feet. In order to pass the fish passage high flows without overtopping the dam, the crest of the stop logs will be set approximately 2-feet 2-inches above the invert at the top of the velocity apron. Therefore, the stop logs at this location will have a nappe extension fitting that will be placed over the aluminum stop logs and will push the nappe approximately 3.0 feet away from the stop logs making for more difficult jump conditions for upstream migrating fish. This extension is based on McMillen Jacobs' successful past experience retrofitting sites that did not meet NMFS (2011) criteria.

The velocity barriers will also be equipped with vent pipes located under the overflow nappe with risers built onto/into the concrete walls. The pipe risers will be open to the atmosphere above the high-water elevation at the weir overflow. These vent pipes will ensure an aerated nappe which decreases upstream water surface elevations and minimizes the potential for fish jumping past the barrier.

4.7.2 Removable Picket Barrier

The removable picket barrier to be installed yearly at the beginning of the trapping period was designed according to typical guidance from NMFS (2011) for picket barrier systems. Through picket velocities were calculated for the pickets based on the gross area of picket panels and adjusted for the rotation about the stream transect and the rotation about vertical. Table 4-3 summarizes the calculations through the picket barrier.

Table 4-3. Picket Barrier Flow Characteristics

Flow Condition	Flow (cfs)	Depth (ft)	Through Picket Velocity (ft/s)	Head Loss Across Pickets (in)
Fish Passage High Flow	71.9	1.7	2.0	4.0
Fish Passage Low Flow	23.4	1.1	1.0	1.0

The picket barrier is not able to meet the through picket velocity criterion of 1 ft/s for the design high flow. Meeting the 1 ft/s picket velocity criterion, however, has proven challenging in the setting of small mountain streams across the Pacific Northwest, such as Fall Creek. It is not anticipated that the 1 ft/s picket velocity criterion will be met by this design; however, it is not expected that the picket barrier will pose a fish impingement concern for the following reasons:

1. The fish habitat above this barrier is very limited, and fish (especially anadromous fish) are not anticipated upstream of the picket barrier where impingement could occur.
2. The exposure window when the pickets will be in place is limited to the period of trapping. At all other times, the pickets will be removed, and the stream will flow through naturally.
3. The screen is oriented at an angle to the stream transverse, increasing the wetted area of the picket panels and decreasing average velocities through the pickets to the greatest degree possible.

4. Natural flow velocities in the stream around this location are as high as 4.5 ft/s under high-flow conditions. The flow through the pickets will be much less than the natural surrounding stream, due to the orientation of the barrier, and effects of the sill on the stream hydraulics. In addition, the angle of the picket will guide the fish to the entrance of the fishway and the attraction flows emanating from the fishway.

Likewise, it may be observed that the minimum submerged picket depth at the barrier of 2 feet is not attained under any of the design flows. This is to be expected as the natural flow depth in this portion of the stream is only about 9 inches at low flow. Meeting the minimum submerged picket depths would require significant deviation about the natural channel flows. Therefore, the current design meets the intent of the picket barrier guidelines and criteria, though, like many other sites on small mountainous streams, it is unable to meet the values specified.

4.8 Effluent Treatment

Primary effluent concerns for the FCFH will be settleable solids (see *TM 002 – Design Criteria* for a complete listing of NPDES requirements), and particularly biosolids produced in the hatchery vessels. As discussed above, biosolids will be cleaned from all vessels and ponds via vacuum to the waste drain system, where they will be deposited in the settling pond. Idaho DEQ (nd), which has been widely used in aquaculture applications across the Pacific Northwest, recommends that a settling pond be sized based on a settling velocity of 0.00151 ft/s, such that the overflow velocity is less than the settling velocity ($V_o < V_s$). It was found that the existing pond in the lower raceway bank provided approximately 2.6 times the surface area required for settling of the biosolids, or if the pond is split into two chambers, each would maintain approximately 1.3 times the surface area required.

The other effluent concern for the facility will be the use of therapeutants or inorganics that could occasionally be required for treatment of fish. Use of such therapeutants is not anticipated due to the high quality of the intake water and the short design life of the facility. If it is determined that therapeutants will be required, the use of therapeutants used for fish treatments can be addressed operationally by using the 3,200 ft^3 of effluent holding provided by the effluent pond. While use would depend on flow rates supplied to each individual rearing unit, the effluent ponds provide short-term storage of up to 24,000 gallons of therapeutant laden flow that could then be pumped to appropriate storage tanks and transferred to approved off-site disposal areas, or discharged to Fall Creek after a prescriptive residence time.

5.0 Civil Design

5.1 General Description

This section presents the civil design elements at each of the Project structures and summarizes the design of the overall site layout.

5.2 Erosion and Sediment Control

The Contractor is required to install, monitor, and maintain erosion and sediment control measures as identified within the Project Drawings, and prepare the required documents discussed in Section 2.5 as determined by the various regulatory agencies. The erosion control measures shall be maintained for the duration of the construction project.

The Contractor will be required to install specified permanent post-construction measures as required for the Project. The permanent measures are designed to protect the exposed slopes until the vegetation is fully established. Following construction, the disturbed areas of the Project site will be revegetated with native plant mixes. The Contractor will be required to submit a Notice of Termination (NOT) to the State Water Resources Control Board (SWRCB) after completing the Project. This is required to be relieved from the Construction General Permit requirements. Final soil stabilization throughout the proposed Project area must be achieved prior to the SWRCB approval of the NOT.

5.3 North Site

The North Site, or the Project site north of existing Copco Road, consists of a pad at approximate elevation 2503 (NAVD88) that was designed to support the Coho Building and infrastructure, the Chinook raceways, the Chinook Incubation Building and supporting infrastructure, and the vault toilet. The pad elevation was selected such that sufficient hydraulic head would be maintained from the intake structure at elevation 2510.4 (NAVD88) to the design elements, while minimizing earthworks quantities.

Pad limits were determined to maintain a footprint within previous work boundaries, to the extent possible. The pad maintains sufficient space for access and egress around structures such that the whole site is accessible via standard pickup truck. The site layout also maintains access for an assumed tagging and marking trailer to locations near the Coho rearing raceways and the Chinook rearing raceways. Additionally, access is maintained for an assumed, design pump truck to the new vault toilet, and the storm drain system hydrodynamic separator. A swept path analysis was performed to ensure site access, and discussion of design vehicles, clearances, and swept path results can be found in Appendix B.

5.3.1 Fencing

Per direction from CDFW, perimeter fencing around the entirety of the North Site will not be required. Fencing will be required, however, around the Chinook rearing raceways as part of the predator exclusion system. Fencing will be 8-foot-tall chain link fence with three strands of barbed wire oriented at 45 degrees outward to prevent larger predators from climbing over the fence. The fencing layout will be as indicated on the drawings and will have man-gates and vehicular access double-leaf gates in the locations indicated.

5.3.2 Grading

Site grading at the North Site will generally be a flat pad at elevation 2503 (NAVD88) but will be graded at slopes (0.02 ft/ft) away from all buildings and structures. Cut-and-fill slopes will be graded at a maximum slope of 2H:1V in accordance with the Project civil design criteria. Locally steepened slopes, as indicated on the Drawings, may be required in some locations, provided they meet approval of the project geotechnical engineer. The pad will be surfaced with a 4-inch-thick ¾-inch-maximum Type Granular Fill per specifications, and an 8-inch-thick Type Aggregate Subbase material per specifications beneath.

5.3.2.1 Site Drainage

The majority of the site drainage from impervious areas, including rooftops, will be directed to a series of CalTrans standard catch basins distributed about the site. From these catch basins, storm drainpipes will convey flows to the north site hydrodynamic separator that will be sized to treat a water quality storm (WQS) event of 0.33 cfs, prior to discharging back to Fall Creek in the Chinook volitional release plunge pool. The north site hydrodynamic separator will be a proprietary system that will treat both suspended solids entrained in the site runoff, and any oils, grease, or hydrocarbons from the roadway and parking areas on site.

A small portion of the north site, around the Chinook incubation building, will drain to a drain rock sump adjacent to Copco road. The drain rock sump will be below grade and will be lined with an impervious geomembrane that will contain any accumulated runoff. A perforated PVC pipe in the drain rock will collect flows and convey them to the south site storm drain system for treatment and release.

The drain rock sump and outlet pipe were sized such that the sump could contain runoff from the 2-year storm event. Runoff volumes in excess of the 2-year event will overflow the sump area across the driveway and will drain directly to Fall Creek. Pollutant load in runoff is typically taken up by the initial stages of runoff, prior to arrival of peak flow, which will report to the drainage sump first and will pass into the storm drain system for treatment and release.

Calculations supporting the design of the site drainage system, including the runoff modeling, pipe system sizing, hydrodynamic separator selection, and drainage sump sizing are provided in Appendix B.

5.3.3 Intake Structure and Dam A Velocity Barrier Modifications

5.3.3.1 Cofferdam and Dewatering

It is anticipated that a cofferdam will be required to aid construction of the intake and Dam A velocity barrier modifications and will need to be staged with construction. The Contractor will review the hydrology and hydraulics of the powerhouse canal (Specification 01 12 00) and determine the elevations required for any cofferdam system. Dewatering pumps will be placed inside the cofferdam and the intake construction area to collect seepage and pump it over the cofferdam to the Dam A impoundment. The Contractor will be responsible to treat flows in accordance with their CGP, prior to discharge in the impoundment. Staging of the cofferdam must always maintain water to the City of Yreka intake . Therefore, it is expected that the cofferdam will be in place around the working area on the southeast bank of the powerhouse canal and will extend across the upstream face of the existing Dam A, such that the intake screens for the City of Yreka are not obstructed. Flows in excess of the City of Yreka withdrawals will need to be bypassed downstream past the work area. Staging and design of the cofferdam system will ultimately be the responsibility of the Contractor.

5.3.3.2 Excavation and Backfill

Around the intake structure, a pad at elevation 2512.4 (NAVD88) will be constructed to exclude water behind the intake. The pad will be constructed from available on-site fill materials, in accordance with the specifications, and will be lined with riprap available from the North Site pad grading excavation. A cutoff wall will be installed down to bedrock along the north and east faces of the intake structure extending 30-feet into the overbank area to mitigate any seepage that may occur from the Dam A impoundment.

Under the intake, a 6-inch-thick layer Type Drain Rock, Graded (DRG) will be placed to mitigate any pore water pressure that may develop on the bottom of the structure.

The Dam A concrete velocity apron will likewise be constructed over a 6-inch-thick layer of free-draining graded drain rock and will have French drains on either side of the apron to relieve any pressure that may build up on the bottom of the slab. French drains will consist of a coarse drain rock backfill, surrounding a perforated pipe that will outlet to the powerhouse channel immediately downstream of the velocity barrier.

5.3.3.3 Fencing

Fencing will be provided around the intake structure for safety and for protection of equipment such as the traveling screens and gates from theft or vandalism. The intake structure enclosure will be accessed through a double leaf gate such that vehicles can access the structure for maintenance or for hauling away accumulated debris from the traveling screens. Fencing will be 8-foot-tall chain link fence with three strands of barbed wire oriented at 45 degrees outward.

5.3.4 Dam B Velocity Barrier Modifications

5.3.4.1 Cofferdam and Dewatering

It is anticipated that a cofferdam will be required to aid construction of the Dam B velocity barrier modifications. The Contractor will review the hydrology and hydraulics of Fall Creek (Specification 01 12 00) and determine the elevations required for any cofferdam system. Dewatering pumps will be placed inside the cofferdam and construction area to collect seepage and pump it downstream into Fall Creek beyond the limits of construction. The Contractor will be responsible to treat flows in accordance with their CGP, prior to discharge in the creek. The Dam B velocity barrier modifications will span a portion of the creek at this location, but will maintain flows to the City of Yreka Dam B intake. A bypass pipe will need to be installed to maintain flows past the construction area.

5.3.4.2 Excavation and Backfill

The concrete velocity apron will be constructed above grade on the downstream side of Dam B. After clearing and grubbing, and scarifying and recompacting the subgrade, the concrete subgrade will be built up on Type Structural Fill (SF) compacted to 95 percent maximum dry density as determined by ASTM D 1557, to 6 inches below the bottom of the concrete, as depicted on the Drawings. The structural fill will be overlaid with a 6-inch-thick layer of Type DRG fill, per specifications, that will drain to French drains on either side of the concrete velocity apron.

Above the French drains, a 2.0-foot thick layer of approximately 12-inch (D_{50}) riprap will be placed to mitigate any potential erosion that would arise from dam overtopping during extreme events. This riprap layer will be placed against the valley side walls, which are expected to consist of bedrock (per the City of Yreka as-built information). Downstream of this structure, any in-stream disturbance will be replaced with natural cobbles removed during clearing and grubbing of the site.

5.3.5 Coho Building

The Coho Building will be located at the northern extent of the North Site pad grading. The pre-engineered metal building will consist of one room that houses Coho infrastructure from incubation, through first-feeding, and grow-out. The building will be accessible via man-door on the south side of the building, or through one of three roll-up doors (two on the north side of the building, one on the south side). To the north of the building, the concrete slab will extend approximately 22 feet from the outside face of the building to the two existing Coho rearing raceways. The roof from the building will extend out over the existing rearing raceways, and predator netting connected to the roof will form an enclosure around the outdoor rearing raceways. Bollards will be located at all building corners, and along the length of the existing raceways at 10-foot spacing to ensure that a 5-foot offset is maintained by vehicles at all times.

5.3.5.1 Excavation and Backfill

In order to provide a consistent subgrade below the Coho Building, the subgrade will be over-excavated to a minimum of 18 inches under all footings and 6 inches under all slabs The subgrade will be scarified to a depth of 6-inches and compacted per the specifications. The areas will be back-filled with Type SF material per specifications, which is a readily compacted, crushed rock with 1.5-inch-maximum aggregate. The Type SF fill should extend a minimum of 18 inches beyond the edge of the footings. The structural fill should be compacted to 95 percent maximum dry density as determined by ASTM D 1557.

5.3.6 Chinook Raceways

The Chinook raceways will be outdoors and will consist of two banks of four ponds. These raceways will all discharge to a common exit channel, and the exit channels between the two raceway banks will be connected by a 2.5-foot-wide by 3.0-foot-tall buried box culvert. The two raceway banks will have a 12-foot center aisle running between them for vehicular access. The ponds will be surrounded by fencing and predator netting (see Section 5.3.1 above) that will maintain a minimum 3.0-foot offset from the pond concrete, such that personnel can access all sides of the ponds from the inside of the enclosure.

The pond inverts will be located at elevation 2500 (NAVD88) and the pond walls will extend 2 feet above grade to elevation 2505 (NAVD88).

5.3.6.1 Excavation and Backfill

The ponds will be excavated 3 ft below the pad elevation (2503 NAVD88) and will be over-excavated an additional 6 inches. The subgrade shall be scarified and recompacted, and a 6-inch layer of Type DRG, per specifications, will be placed and compacted to form a suitable subgrade for the ponds.

5.3.7 Chinook Incubation Building

The Chinook Incubation Building is located at the southern extent of the North Site adjacent to the existing Copco Road. The pre-engineered metal building will house all Chinook incubation infrastructure, including incubation stacks and working vessels. The building will be accessed on the west side through a set of double doors, or through one of roll-up doors (north, south, and west building faces) for equipment access.

Along the southern edge of the building, a separate room will house the site's electrical infrastructure. The electrical room will be accessed through a man-door on the west side of the building. Around the outside of the building, the building corners will be protected by bollards.

5.3.7.1 Excavation and Backfill

In order to provide a consistent subgrade below the Chinook Incubation Building, the subgrade will be over-excavated to a minimum of 18 inches under all footings and 6 inches under all slabs and will be back-filled with Type SF material per specifications, which is a readily compacted, crushed rock with 1.5-inch-maximum aggregate. The Type SF fill should extend a minimum of 18 inches beyond the edge of the footings. The structural fill should be compacted to 95 percent maximum dry density as determined by ASTM D 1557.

5.4 South Site

The South Site, or the Project site south of existing Copco Road, consists of a pad extending down from the existing road to elevation 2491.5 (NAVD88) designed to support the Spawning Building. In addition, the South Site contains the genset and propane tank, the adult holding ponds, the settling pond, the fish ladder, and the removable fish barrier.

The South Site was designed to provide vehicular access to the Spawning Building and to the settling pond by the design vehicles. A swept path analysis was performed for this area, and the design vehicles have access and egress to the design points. The swept path analysis is summarized in Appendix B.

5.4.1 Fencing

Fencing is provided around the majority of the South Site, to preclude unhindered access to the Spawning Building equipment, the holding ponds, and the settling pond. Fencing will be 8-foot-tall chain-link fence with three strands of barbed wire oriented at 45 degrees outward to prevent larger predators from climbing over the fence. The fencing layout will be as indicated on the Drawings and will have man-gates and vehicular access double-leaf gates in the locations indicated.

5.4.2 Grading

Grading of the area was primarily driven by the elevation of the Spawning Building and existing concrete raceways and the elevation of Copco Road. Grades were maintained from Copco Road (approx. elevation 2496 [NAVD88]) down to this lower site (approx. elevation 2491.5 [NAVD88]) at no greater than 8 percent for vehicular access. At elevation 2491.5 (NAVD88), the pad flattens out and remains at or slightly below that elevation. The pad is primarily in cut, and maximum cut slopes of 2H:1V were maintained.

The pad will be surfaced with a 4-inch-thick ¾-inch-maximum Type Granular Fill per specifications, and an 8-inch thick Type Aggregate Subbase material per specifications beneath.

5.4.2.1 Site Drainage

Due to the grading constraints, the pad is naturally graded toward the Spawning Building. Concrete swales will collect water around the Spawning Building and will direct any surface runoff to catch basins located around the South Site pad grading. Catch basins will direct flows through the storm drain system to the south site hydrodynamic separator. The hydrodynamic separator will be sized for a WQS event of 0.36 cfs, and will treat suspended sediment loads and oil, grease, and hydrocarbons from parking and driveway areas, prior to discharge into Fall Creek.

5.4.3 Spawning Building

The Spawning Building is located at the north end of the existing lower raceway bank, approximately 10 feet 3 inches from the outside face of the concrete. The pre-engineered metal building will house all infrastructure necessary for spawning activities, including the egg-rinsing table, water hardening table, holding table, air spawning table, fish chutes, fish conveyors, collection bins, etc. To the south, the Spawning Building will have an awning that will be used to keep personnel out of the elements during spawning activities and collection of fish from the adult holding ponds.

The Spawning Building will have access from the east and the west by man-doors and will have roll-up doors to the north and south for equipment access. A parking area will be maintained on the west side of the building, and all building corners will be protected by bollards.

5.4.3.1 Excavation and Backfill

In order to provide a consistent subgrade below the Spawning Building, the subgrade will be over-excavated to a minimum of 18 inches under all footings and 6 inches under all slabs with the subgrade being scarified to a depth of 6 inches and compacted per the earthwork specifications. The area will be back-filled with Type SF material per specifications, which is a readily compacted, crushed rock with 1.5-inch-maximum aggregate. The Type SF fill should extend a minimum of 18 inches beyond the edge of the footings. The structural fill should be compacted to 95 percent maximum dry density as determined by ASTM D 1557.

5.4.4 Fish Ladder and Temporary Picket Barrier

The fish ladder and temporary picket barrier will be located at the southern end of the existing raceway bank, and in the adjacent stretch of Fall Creek. The temporary picket barrier will be placed yearly at the beginning of the trapping period; however, a concrete sill and walls will be permanently in the stream. Both the fish ladder and the sill will be concrete structures, as depicted in the plans. In addition, some localized grading will be provided around these structures.

5.4.4.1 Cofferdam and Dewatering

It is anticipated that a cofferdam will be required to aid construction of both the fish ladder and the temporary picket barrier sill. The Contractor will review the hydrology and hydraulics of Fall Creek (Specification 01 12 00) and determine the elevations required for any cofferdam system. Dewatering pumps will be placed inside the cofferdam and construction area to collect seepage and pump it downstream into Fall Creek beyond the limits of construction. The Contractor will be responsible to treat flows in accordance with their CGP, prior to discharge in the creek. The concrete sill will span the entire creek at this location, and therefore a bypass pipe will need to be installed to maintain flows past the construction area.

5.4.4.2 Excavation and Backfill

After the area is cleared and grubbed and topsoil is stripped from the site, the fishway will be excavated into the eastern bank of Fall Creek. The fish ladder will be over-excavated an additional 6 inches and after the subgrade is scarified and recompacted, a 6-inch layer of Type DRG material per specifications will be placed and compacted to form a suitable subgrade for the concrete construction.

For the concrete sill, a similar process will be performed with a 6-inch-thick layer of Type DRG material underlaying the concrete construction. Following completion of the concrete work in this area, the natural creek bed will be restored with any material or cobbles that were removed during the initial clearing of the site.

6.0 Geotechnical Design

6.1 Engineering Soil Properties

Engineering soil properties were selected based on the subsurface conditions described in the Geotechnical Data Report. Anticipated ranges in soil properties are provided below.

Table 6-1. Soil Properties

Soil Unit	Total Unit Weight (pcf)	Friction Angle, ϕ (deg)	Cohesion, c (psf)
Existing Fill	140	38	0
Colluvium	115-120	26-30	50 - 200
Alluvium	120	28-32	0

6.2 Shallow Foundations

The Coho Building, Hatchery Building, and Chinook Raceways will be supported on shallow foundations. Recommendations for shallow foundations are provided in the following sections.

6.2.1 Bearing Surface Preparation

Based on available geotechnical data, structures will bear primarily within colluvium soils. Footings bearing in colluvium should be supported on an 18-inch to 24-inch section of imported structural fill (SF) foundation base material. The bearing surface should be inspected prior to placement of SF and should be clear of deleterious material and standing water. If soft, pumping soils are observed at the bearing elevation, an additional 6- to 12-inches of colluvium should be removed from below the footing. A non-woven geotextile consisting of Mirafi RS280i or equivalent, should be placed at the base of the footing excavation for added stability.

Structural fill should be placed in loose lifts of 6- to 8-inches and compacted to 95 percent of maximum dry density (MDD).

6.2.2 Bearing Resistance

Structures bearing on soils prepared as outlined in the previous section may be design using an allowable bearing resistance of 2 kips per square foot (ksf). This allowable bearing resistance applies to the total of dead and long-term live lads and may be increased by up to one-third for wind or seismic loads.

6.2.3 Lateral Resistance

Lateral forces on shallow foundation may be resisted by passive resistance on the side of footings and by friction on the base of the footings. Frictional resistance may be computed using an allowable coefficient of friction of 0.49 for cast-in-place foundations and 0.39 for precast concrete foundations applied to vertical dead load forces.

Passive pressure acting at the side of the shallow foundation can be estimated using an equivalent fluid density of 400 pounds per cubic foot (pcf) (triangular distribution).

The above coefficients of friction and passive equivalent fluid density values incorporate a FS of 1.5.

6.3 Lateral Earth Pressures

Lateral earth pressures are needed for design of the raceways and adult holding ponds. The raceways and holding ponds are restrained against deflection; therefore, at-rest earth pressures are recommended for use in design. At-Rest earth pressure coefficients are presented below.

Table 6-2. At-Rest Earth Pressure Coefficients

Soil Unit	At-Rest, K_O	At Rest + Seismic, K_{OE}
Colluvium	0.53	0.91

7.0 Architectural Design

7.1 General Description

Architectural design for the Project was largely driven by building use and occupancy. The scope of work included the coordination of the pre-engineered metal buildings and associated doors, skylights and accessories. Each building is a stand-alone structure and is comprised of primary frame members, end wall columns, horizontal wall girts and roof purlins. Cross bracing, moment frames and/or portal frames are provided as necessary. Each building is clad with 42-inch wide and 3-inch thick insulated standing seam metal roof panels and 42-inch wide and 2-inch thick insulated metal wall panels. Overhead sectional doors, overhead coiling doors and man doors are provided based on use.

7.2 Coho Building

The Coho Building has a covered roof area of 6,960 sf with an enclosed area of 3,635 sf and an overhang comprised of 3,325 sf. The roof overhang protects existing raceways that will receive some minor upgrades and be enclosed with predator netting. Within the confines of the building envelope, there are two new raceways and various other components that will be separated with ceiling hung biosecurity curtains. This building will have three (3) overhead coiling doors in lieu of sectional doors to avoid conflicts with the biosecurity curtains and one (1) man door to access the space. Natural light will be provided within the space by means of 12 solar tube directional skylights.

7.3 Chinook Incubation Building

The Chinook Incubation Building is fully enclosed and has a floor area of 3,227 sf. The floor plan is divided into the Chinook Incubation space and a smaller adjacent Electrical Room. Within the confines of the building envelope, there are multiple rows of incubational tanks and holding tanks. There is a network of floor trenches and sump drains that cater to the wet environment within the building. The Chinook Incubation space will have three (3) overhead sectional doors and one (1) double man door to access the space. The adjacent Electrical Room is accessed via its own man door from the exterior of the building. Natural light will be provided within the space by means of 12 solar tube directional skylights.

7.4 Spawning Building

The Spawning Building is the smallest building on site and has a covered roof area of 1,089 sf with an enclosed area of 812 sf and an overhang comprised of 277 sf. The roof overhang protects personnel when completing spawning activities outside of the building. Within the confines of the building envelope, the floor plan is wide open and the slab on grade, unlike the other buildings this building does not have raceways or incubation trays. There is a network of floor trenches and sump drains that cater to the wet environment within the building. This building will have two (2) overhead sectional doors and two (2) man door to access the space. Natural light will be provided within the space by means of four (4) solar tube directional skylights.

8.0 Structural Design

8.1 General Description

The structural facilities consists of 11 main systems: (1) the intake structure, (2) the dam A velocity barrier, (3) the dam B velocity barrier, (4) the coho building, (5) the chinook raceways, (6) the chinook incubation building, (7) the spawning building, (8) the adult holding ponds, (9) the meter vault, (10) the fish ladder, (11) the temporary picket barrier, and (12) the fish release pipe support. Structural calculations for these systems can be found in Appendix D of this DDR.

8.2 Intake Structure

The intake structure measuring approximately 10 feet by 10 feet is situated at the south end of dam A. Portions of the existing dam will need to be demolished in order to construct the intake structure, as the bottom of the intake structure extends below the bottom of the dam. The dam would therefore be undermined during the construction of the intake structure. Since a portion of the dam will be removed, a cutoff wall will be constructed below the intake structure and extend to the end of the previous southern end of dam A. The cutoff wall will tie into the existing cutoff wall at dam A and provide a continuous cutoff to the extent that is currently provided at the existing dam.

The intake structure is composed of reinforced concrete walls with a concrete wingwall measuring 8 feet long, travelling screens with stainless steel support system, and FRP grating across the top providing access to the screens. The new intake structure walls and slab will tie into the existing dam A at the interface with drilled epoxy dowels. Retrofit waterstops will be provided at all joints between new and existing concrete. An oversized travelling screen support column will also provide stop logs slots for dewatering the intake behind the travelling screens.

The new intake structure improves the overall stability of dam A. The intake structure consists of a considerable amount of additional concrete, increasing the overall weight and base width of the structure. This will increase the factor of safety of the dam due to sliding and overturning.

8.3 Dam A Velocity Barrier Modifications

In addition to the demolition work at the south end of the dam, the toe of the dam for the entire width of the proposed downstream velocity barrier apron will need to be demolished. The velocity barrier apron consists of a reinforced concrete apron slab measuring approximately 29 feet wide by 16 feet long with vertical retaining walls at both canal banks. The apron and retaining walls will tie into the existing dam A concrete with drilled epoxy dowels. Retrofit waterstops will be provided at all joints between new and existing concrete. The functionality and condition of the existing dam cutoff wall is unknown; therefore, it is conceivable that uplift pressures could be generated underneath the new velocity barrier. To combat this, a drainage layer with parallel french drains will be provided in the apron slab to allow any buildup of water pressure.

The new velocity barrier also improves the overall stability of dam A. The velocity barrier consists of a considerable amount of additional concrete, increasing the overall weight and base width of the structure.

This will increase the factor of safety of the dam due to sliding and overturning, while also reducing bearing pressures at the toe.

8.4 Dam B Velocity Barrier Modifications

The velocity barrier apron consists of a reinforced concrete apron slab measuring approximately 11.5 feet wide by 16 feet long with vertical retaining walls at both canal banks. The apron and retaining walls will tie into the existing dam B concrete with drilled epoxy dowels. The existing stoplog slots will be replaced with shorter slots on top of a concrete platform, effectively raising the sill elevation of the stoplogs. Retrofit waterstops will be provided at all joints between new and existing concrete. The functionality and condition of the existing dam cutoff wall is unknown; therefore, it is conceivable that uplift pressures could be generated underneath the new velocity barrier. To combat this, a drainage layer with parallel french drains will be provided in the apron slab to allow any buildup of water pressure.

The entire center pier will need to be demolished in order to install the flush drain and ventilation piping. A new steel supported FRP walkway will span across the full width just downstream of the piers. New aluminum stoplogs will be fabricated with a custom top piece that will seal against a nappe extension. The nappe extension is fabricated of aluminum plate reinforced with transverse angle stiffeners. Four (4) threaded eye-bolts provide ample lifting points on the top side of the nappe extension. The extension is set into place by aligning the male side of the four threaded eye-bolts with the holes located on the horizontal flange of the support angle. This prevents the nappe-extensions from lateral movement once in place. The weight of the water on top of the nappe extensions prevents it from lifting out of the holes. The nappe extension is independent of the dam boards, so that the dam boards can be removed prior to removing the nappe extension. This facilitates removal of the system with two laborers.

The new velocity barrier also improves the overall stability of dam B. The velocity barrier consists of a considerable amount of additional concrete, increasing the overall weight and base width of the structure. This will increase the factor of safety of the dam due to sliding and overturning, while also reducing bearing pressures at the toe.

8.5 Coho Building

The Coho Building is the largest of three buildings on the Project. The building consists of a fully enclosed portion measuring approximately 54 feet by 66 feet, and a roof-only portion measuring approximately 50 feet by 66 feet. The roof of the fully enclosed building continues over the roof-only portion for a seamless transition. The building itself is a pre-engineered metal building with insulated metal panels. All exposed steel surfaces of the building will be hot dip galvanized. Flooring will consist of a 6-inch concrete slab. The foundation system consists of cast-in-place (CIP) reinforced concrete stem walls and spread footings for the enclosed portion and four individual column footings for the roof-only portion. The interior column loads are transferred to the soil through square spread footings.

The enclosed portion of the building houses new concrete Coho raceways and various incubation and feeding vessels. The raceways will consist of two ponds measuring approximately 38 feet by 12 feet each. The ponds will consist of 8-inch cast-in-place reinforced concrete walls with embedded stainless guide slots for the existing aluminum fish screens and new aluminum dam boards, and a 2-foot-wide FRP walkway on top of the interior wall. Hinged sections of grating allow access to the guide slots underneath.

Directly adjacent to the building under the roof only portion will be a 20-foot-wide concrete drive-through area for the fish tagging and marking trailer. This area is designed for a 250 psf uniform vehicular surcharge pressure.

The existing concrete raceways will also be under the roof of this structure, directly adjacent to the drive-through. The existing raceway walls and slabs will remain in place, while all of the walls will be raised to finish-floor elevation. The new wall extensions will be tied to the existing walls with drilled epoxy dowels. The existing raceways will be retrofitted with new reinforced concrete pony walls, stainless steel guide slots, FRP walkways, aluminum dam boards and fish screens, and a fish-friendly polyurethane coating. Hinged sections of grating allow access to the guide slots underneath. Predator netting extending down from the roof framing to grade will protect the Coho ponds from birds of prey, namely kingfishers.

8.6 Chinook Raceways

The new Chinook raceways are located just south-east of the Coho Building. The raceways will consist of two banks of four ponds each, with a 12-foot drive-through between the two. Each pond measures approximately 70 feet by 12 feet. The ponds will consist of 8-inch cast-in-place reinforced concrete walls with embedded stainless guide slots for the existing aluminum fish screens and new aluminum dam boards, and a 2-foot-wide FRP walkway on top of all interior walls. Hinged sections of grating allow access to the guide slots underneath. The two bays of fish screen piers will be removeable, with a pipe welded to the bottom of the steel pier that slides and locks into an embedded pipe in the concrete slab.

Chain-link fencing around the perimeter of the Chinook raceways will prevent large predators from entering. A predator netting support structure consisting of weathering steel framing and cable wire-rope will surround the ponds. The netting will run across the top of the support structure and connect to the chain-link fencing to provide complete protection from birds of prey. The netting and cable system has a design sag of 5’ under its self-weight. A counter-weight system will be provided which allows the netting to deflect in the event of a snow load greater than 1.25 psf. The system is designed so that when the counter-weight rises, the net sags and hits the water surface which thereby knocks off any accumulated snow causing the net to again rise to its original position of 5’ of sag. A situation in which the accumulated snow does not become dislodged by the counter-weight system could arise. In this situation, operations staff will need to physically knock this material off with a pole.

8.7 Chinook Incubation Building

The Chinook Incubation Building is fully enclosed, measuring approximately 63 feet by 53 feet with a 12-foot by 10-foot electrical room attached to the south corner. The main building and electrical room both have an eave height of 15 feet. The building is a pre-engineered metal building with insulated metal panels. All exposed steel surfaces of the building will be hot dip galvanized. The building houses incubation vessels and tray storage. Flooring will consist of a 6-inch concrete slab. The foundation system consists of cast-in-place (CIP) reinforced concrete stem walls and spread footings. The interior column loads are transferred to the soil through square spread footings.

8.8 Spawning Building

The Spawning Building is the smallest of three buildings on the Project. The building consists of a fully enclosed portion measuring approximately 37 feet by 27 feet and a roof-only portion measuring approximately 10 feet by 27 feet. The roof of the fully enclosed building continues over the roof-only portion for a seamless transition. The enclosed portion of the building houses various worktables used for collecting eggs from adult salmon. Flooring will consist of a 6-inch concrete slab. The foundation system consists of cast-in-place (CIP) reinforced concrete stem walls and spread footings for the enclosed portion, and two individual column footings for the roof-only portion. The interior column loads are transferred to the soil through square spread footings. The roof-only portion will exhibit a limestone surfacing and provide shelter for the electro-anesthesia (EA) tank and hatchery workers.

8.9 Adult Holding Ponds

The adult holding ponds are located directly adjacent to the roof-only portion of the Spawning Building. The holding ponds will consist of four ponds measuring approximately 70 feet by 12 feet. The ponds will consist of 8-inch cast-in-place reinforced concrete walls with embedded stainless guide slots for new aluminum fish screens and new aluminum dam boards, and a 2-foot-wide FRP walkway on top of all interior walls. Hinged sections of grating allow access to the guide slots underneath. Jump prevention netting will be provided at all interior walls along the walkway to prevent fish from jumping between ponds. Floor diffusers located at the north end of the ponds provide an obstacle-free path on that side of the ponds. For egg collection, hatchery workers can crown the fish to the north end of the sorting pond into a hoist that will lift the fish into the EA tank.

Chain-link fencing around the perimeter of the adult holding ponds ties into the Spawning Building and will prevent large predators from entering. A predator netting support structure consisting of stainless steel HSS and cable wire-rope will be mounted to the top of the exterior walls. The netting will run across the top of the support structure and connect to a cable running along the top of the walls to provide protection from birds of prey. There will be some small openings in the netting along the southern side where the netting crosses the ponds.

8.10 Meter Vault

The meter vault will house various flow meters and mechanical valves for the intake piping for the Project. The vault will consist of cast-in-place reinforced concrete slab, walls, and roof with an aluminum access hatch measuring 8 feet 13 feet. The inside dimensions of the vault are approximately 13 feet by 15 feet. Due to the close proximity to Fall Creek, the meter vault will need to be designed to resist buoyant forces due to water pressure beneath the slab. This will be accomplished with a thickened slab to add weight to the overall structure.

8.11 Fish Ladder

The fish ladder structure connects the adult holding ponds to Fall Creek downstream of the facility. Adult salmon will travel up the fish ladder and be sorted into the various ponds during spawning season. The fish ladder consists of CIP reinforced concrete with timber Denil-style baffle sections which slide into plain concrete guides. The guides extend to the top of the walls so that the baffles can be placed from the top of the ladder walls. Embedded stainless steel guides at the entry of the fish ladder will house a removable aluminum bar screen which can be installed to prevent fish from entering the facility during certain times of the year.

8.12 Temporary Picket Barrier

The temporary picket barrier prevents fish from travelling farther upstream Fall Creek and directs the fish into the Denil fish ladder. The barrier is removeable and will only be in place during spawning season. The barrier consists of three separate panels weighing approximately 60 lbs each. Each panel consists of an aluminum HSS A-frame which is bolted to concrete embed tabs. Forty-six (46) aluminum rods are then individually placed into pre-cut holes in the A-frame and rest on the concrete apron. The panels can be set in place in their location in the channel in a relatively short amount of time due to their light weight and simple design. A CIP reinforced concrete apron measuring approximately 8 feet by 17 feet will serve as a uniform sill surface for the temporary barrier to sit on. The apron will span between CIP reinforced concrete retaining walls at each bank.

8.13 The Fish Release Pipe Support

The volitional release of fish from the Chinook Raceways occurs through a 14” PVC pipe that discharges into Fall Creek. The pipe extends approximately 16 ft – 6 inches from its daylight points out into the canal. A concrete piling pipe support has been designed to support the pipe in the canal. The piling consists of a 1 ft – 6 inch diameter concrete piling with a 4 ft square footing. The pipe rests on a UHMW saddle which allows temperature expansion/contraction of the PVC piping.

9.0 Mechanical Design

9.1 General Description

This section presents a narrative description of the mechanical elements at each of the Project facilities and provides details on the mechanical design of each component.

9.2 Intake Structure

The mechanical components of the intake structure include debris screens and pumps, a sluicing gate, isolation valves, vacuum breaker valves, and flow meters. The design, sizing, and operation of these components are discussed in the following subsections.

9.2.1 Debris Screens

The debris screens at the intake of the hatchery will consist of two vertically oriented traveling screens located in guide slots immediately upstream of the hatchery supply piping inlet. The debris screens will serve to filter out larger debris and detritus from entering the facility to minimize the risk of clogging small piping and valves. The screens will have 1-inch clear openings and will be mobilized such that any debris captured on the upstream face is lifted out of the water to a spray wash system, where any material caught on the screen will be dislodged and fall into a debris trough. The debris trough will rest on the operator’s platform atop the intake structure and will be cleaned out periodically by operations and maintenance staff.

The screen and spray wash system can have three different modes of operation:

- The screen and spray wash may be set to automatically operate at time intervals defined by hatchery personnel, based on site experience.
- The screen and spray wash may be set to automatically operate when a set head differential is measured across the screen by the surrounding level sensors.
- The screen and spray wash may be set by manual actuation, as necessary, by hatchery personnel.

The spray wash will consist of a pump and piping system that draws water from the downstream side of the screen and conveys it to a spray bar with nozzles that will extend across the screen above the debris trough. It is expected that when the spray wash system is engaged, there will be some minor losses to evaporation and aberrant sprays, but these losses are expected to be minimal.

9.2.2 Intake Sluice Gate

As flow passes over the concrete lip at the entrance of the intake structure, some debris is anticipated to settle out of the flow immediately upstream of the debris screens. A cast iron sluice gate with self-contained frame will be located on the upstream face of Dam A, intended to discharge any collected debris from the intake structure though a new 1-foot square penetration through the dam. This gate is anticipated to be normally closed and opened via a handwheel-actuated rising stem by hatchery personnel as part of routine maintenance activities.

9.2.3 Isolation Valves

Immediately downstream of the intake structure the intake piping branches into four individual supply pipes and enters a metering vault. Within this vault, each pipe will be provided an isolation gate valve to allow shutting off flow to any of the structures within the hatchery. The valves are anticipated to be normally open and are intended to be closed during major maintenance activities or whenever a complete dewatering of the facility is required. Each valve will be a flanged, ductile iron, resilient seated gate valve with a manual 2-inch square nut actuator.

9.2.4 Air/Vacuum Valves

An air/vacuum valve will be located downstream of the isolation valves within the valve vault on each supply pipeline. These valves will allow air to be released from the pipeline during initial filling and prevent vacuum formation within the line during a dewatering event. The combination air release/vacuum breaker valve is anticipated to be 2-inch diameter, of cast iron construction, and located at the crown of each supply pipeline. Each Air/Vacuum Valve will be equipped with an isolation ball valve to shut off the air valve if the pipe is being dewatered or cleaned using pressurized air.

9.2.5 Flow Meters

Each supply line will be equipped with an inline magnetic flowmeter for reliable flow measurement to each structure in the hatchery. The flowmeters will be located a sufficient distance upstream of the isolation valves to minimize flow disturbance and ensure accurate flow measurement readings. Each meter will be of steel or cast-iron construction and contain a polyurethane liner. The flow meters will be sized based on the design criteria shown in Table 9-1.

Table 9-1. Flow Meter Design Criteria

Equipment ID	Description	Flow Range (GPM)	Accuracy
FE-200	Coho Building Supply	0 - 1000	±5%
FE-201	Adulting Holding Pond Supply	0 - 4500	±5%
FE-202	Chinook Rearing Supply	0 - 4500	±5%
FE-203	Chinook Incubation Supply	0 - 750	±5%

9.2.6 Vault Sump

To allow for collection and removal of any leakage or infiltration of water into the metering vault, a sump will be provided with single sump pump. The sump pump will be actuated based on a level sensor within the vault, operating periodically to remove any water accumulation.

9.3 Dam B

The mechanical components at Dam B include the sluicing pipe, shear gate, and flap gate. The design, sizing, and operation of these components are discussed in the following subsections.

9.3.1 Sluicing Pipe

To allow for the flushing of any accumulated debris/sediment upstream of Dam B, a sluice pipe will be located through the dam and velocity apron foundation. This pipe will be 8” diameter and contain a cast iron shear gate on the upstream face. To prevent fish from entering the sluice pipe downstream of the velocity barrier, a cast iron flap gate will be located to allow free flow during discharge operations while preventing entry when the pipe is not in use.

9.4 Coho Building

The mechanical components within the Coho Building include the rearing raceway banks, incubation head tank, incubation working vessels, feeding vessels, waste drain system, plumbing system, and building HVAC. The design, sizing, and operation of these components are discussed in the following subsections.

9.4.1 Rearing Raceways

Two sets of raceways exist within the Coho Building:

- A pair of existing raceways, located outdoors underneath the building awning, and;
- A pair of new raceways located within the building structure

Each raceway will contain segmented bays for varying the allocated space requirement of the juvenile Coho salmon. The bays will be separated by the removable aluminum fish screens currently in use at the Iron Gate Hatchery facility. To facilitate use of the existing fish screens, piers will be installed down the centerline of each raceway allowing for two 5 foot -3/8-inch screens to be inserted and removed by hatchery personnel.

At the head of each raceway, flow is controlled with a 4-inch PVC ball valve, manually throttled to achieve the desired flow rate. At the downstream end of each raceway, flows pass over a dam board weir, set to a height required to achieve necessary flow depth for fish rearing. An aluminum stop gate is located at the inlet to the drainage piping, which shall be installed to divert flow through the fish release pipe during volitional fish releases to Fall Creek.

9.4.2 Coho Incubation Head Tank

Incubation stacks will be re-used from the Iron Gate Hatchery to facilitate Coho egg incubation. The incubation head tank/stack design will consist of an aluminum tray stand with adjustable feet supporting six stacks of eight trays. Approximately 5 gpm will be supplied to each stack through a head trough, with a 1-inch PVC ball valve at each stack used for flow regulation and isolation purposes. The head trough will be supported from the wall of the Coho Building and will be equipped with an overflow standpipe, providing a constant head for easier adjustment of the flow rate into each stack.

9.4.3 Coho Incubation Working Vessels

Existing fiberglass tanks will be re-used from the Iron Gate Hatchery as working vessels for the Coho incubation area. These vessels are anticipated to be used for egg picking and enumeration purposes. A 3-inch ball valve will be provided at the head of each working vessel for flow regulation and isolation purposes. Flow will be drained through a removable standpipe at the downstream end of each vessel.

9.4.4 Coho Feeding Vessels

Four feeding vessels will be located within the Coho building, two of which are re-used from the Iron Gate Hatchery, and two will be newly fabricated for the Fall Creek Hatchery. The new feeding vessels will be of fiberglass construction with a width of 5 feet 1 inch and a length of 20 feet. The feeding vessels will be segmented into quarters, with fish screen slots to facilitate insertion of the existing aluminum fish screens from the Iron Gate Hatchery. Flow will be regulated by a 3-inch PVC ball valve at the upstream end and drained by a removable standpipe at the downstream end.

9.4.5 Waste Drain System

A waste drain system will be provided within the Coho Building and adjacent to the outdoor raceways to facilitate removal of fish fecal matter and uneaten food from the ponds. The waste drain system will consist of 2-inch-diameter pipe protrusions from the floor with a stainless-steel cam locking-type quick disconnect for attaching a waste removal vacuum attachment during regular cleaning cycles. All waste will be conveyed through this piping to the settling pond, where it will be collected and removed from the facility. Note that the maximum capacity of the settling pond is approximately 200 gpm. The waste vacuum systems are designed such that this will not be exceeded, however if flow from the Chinook Incubation Stacks (170 gpm) is being diverted to the settling pond, waste drain vacuuming should not occur simultaneously.

9.4.6 Plumbing System

Non-potable utility water will be provided within the Coho Building to supply washdown water through numerous hose bibs located internally and externally throughout the structure. A booster pump will tap off the adult holding pond supply line to fill and pressurize two 80-gallon hydropneumatic tanks located at the eastern corner of the building. The hydropneumatic tanks are anticipated to provide a flow at a relatively constant pressure to the hose bib system located throughout the building.

9.5 Chinook Rearing Area

Mechanical design elements at the Chinook rearing area consist of components within the Chinook rearing raceways and the waste drain system.

9.5.1 Rearing Raceways

Eight raceways are provided for the rearing of Chinook salmon. Each raceway will contain segmented bays for varying the allocated space requirement of the juvenile fish. The bays will be separated by the removable aluminum fish screens currently in use at the Iron Gate Hatchery facility. To facilitate use of the existing fish screens, piers will be installed down the centerline of each raceway allowing for two 5 foot-3/8-inch screens to be inserted and removed by hatchery personnel.

At the head of each raceway, flow is controlled with a 6-inch butterfly valve, manually throttled to achieve the desired flow rate. At the downstream end of each raceway, flow passes over a dam board weir, set to a height required to achieve necessary flow depth for fish rearing purposes. Additional dam board slots are provided upstream of the fish release and drain pipelines for diversion of flow during volitional release operations.

9.5.2 Waste Drain System

A waste drain system will be provided around the Chinook rearing raceways to facilitate removal of fish fecal matter and uneaten food from the ponds. The waste drain system will consist of 2-inch-diameter pipe protrusions from the floor with a stainless-steel cam locking-type quick disconnect for attaching a waste removal vacuum attachment during regular cleaning cycles. All waste will be conveyed through this piping to the settling pond, where it will be collected and removed from the facility.

9.6 Chinook Incubation Building

The mechanical components within the Chinook Incubation Building include the incubation head tanks, incubation working vessels, plumbing system and building HVAC. The design, sizing, and operation of these components are discussed in the following subsections.

9.6.1 Chinook Incubation Head Tank

Incubation stacks will be reused from the Iron Gate Hatchery to facilitate Chinook egg incubation. The incubation head tank/stack design will consist of an aluminum tray stand with adjustable feet supporting 17 stacks of eight trays. Approximately 5 gpm will be supplied to each stack through a head trough feeding back to back rows of incubation trays (34 stacks total), with a 1-inch PVC ball valve at each stack used for flow regulation and isolation purposes. The head trough will be equipped with an overflow standpipe, providing a constant head for easier adjustment of the flow rate into each stack. The Chinook Incubation Building will house four back-to-back rows of incubation trays, for a total of 136 incubation tray stacks.

Each tray will discharge into a drainage trench located within the concrete underneath the centerline of each head tank. The end of the drainage trench will contain two 8-inch-diameter standpipes, one leading to the adult holding ponds (drain) and the other leading to the settling ponds (waste drain). During normal operations, the water will be directed into the drain directing flow to the adult holding ponds. Hatchery personnel will have the option of pulling the waste drain standpipe under one row of 34 stacks at a time and diverting all flow to the settling pond during cleaning operations. Note that if more than one row is diverted through the waste drain simultaneously, the capacity of the settling ponds will be exceeded.

9.6.2 Chinook Incubation Working Vessels

Existing fiberglass tanks will be reused from the Iron Gate Hatchery as working vessels for the Chinook Incubation Building. These vessels are anticipated to be used for egg picking and enumeration purposes. A 3-inch ball valve will be provided at the head of each working vessel for flow regulation and isolation purposes. Flow will be drained through a removable standpipe at the downstream end of each vessel.

9.6.3 Plumbing System

Non-potable utility water will be provided within the Chinook Incubation Building to supply washdown water through numerous hose bibs located internally and externally throughout the structure. A booster pump will tap off the adult holding pond supply line to fill and pressurize two 80-gallon hydropneumatic tanks located at the southern corner of the building. The hydropneumatic tanks are anticipated to provide a flow at a relatively constant pressure to the hose bib system located throughout the building.

9.7 Spawning Building

Mechanical design elements within the Spawning Building include the electro-anesthesia tank, egg rinse/water hardening stations, conveyor belt, and building plumbing.

9.7.1 Electro-Anesthesia System

An electro-anesthesia system will be located at the head of the trapping/sorting pond for the purposes of anesthetizing fish for sorting and spawning purposes. This device is an existing element that will be reused from the Iron Gate Hatchery. Fish are deposited into the electro-anesthesia tank from the existing fish crowder on the trapping and sorting pond, where they are sedated or euthanized, depending on the operation being performed. The electro-anesthesia tank is additionally equipped with a separate hydraulic hoist where fish are raised and deposited on a sorting table for further processing.

9.7.2 Egg Rinse/Water Hardening Station

An existing egg rinsing table and water hardening table will be relocated from the Iron Gate Hatchery to the Spawning Building. Both units will be located against the northeastern wall of the structure and provided with water from the adult holding ponds supply line. Water is discharged through the tables into a drainage trench where it is drained to the settling pond.

9.7.3 Conveyor Belt

The existing motorized conveyor belt at the Iron Gate Hatchery will be relocated to the Spawning Building. The conveyor belt contains multiple sections and may be connected to an approximate 100-foot length. This system is primarily intended to be used for transporting fish carcasses to a collection bin located outside the northern wall of the structure.

9.7.4 Plumbing System

Non-potable utility water will be provided within the Spawning Building to supply washdown water through numerous hose bibs located internally and externally throughout the structure. A booster pump will tap off the adult holding pond supply line to fill and pressurize two 80-gallon hydropneumatic tanks located at the eastern corner of the building. The hydropneumatic tanks are anticipated to provide a flow at a relatively constant pressure to the hose bib system located throughout the building. One hose bib shall be located on a retractable hose reel above the holding table to provide washdown water and a wetted surface during fish sorting/spawning operations.

9.8 HVAC Design

9.8.1 Winter Heating

The Coho Building, Chinook Incubation Building, and Spawning Building heating systems will consist of four wall mounted electric resistance heaters and single downflow electric unit heater located in the middle of the building. The downflow electric heater will be used to provide additional heating if the four wall mounted heaters are unable to meeting the heating requirements of the space. The downflow heater will also be utilized during power outages to provide on demand heating to the building space as needed by the operator. During a Standby Power condition time relays in the 4 wall mounted unit heaters will sequence the startup of each individual heater so that one heater will power up at a time so that only one heater is started at a time. Supplemental spot heating will be provided by electric radiant heaters at the locations recommended for personnel comfort.

9.8.2 Building Fresh Air Requirements

Fresh air ventilation will be provided by the use a single inline fresh air fan and louver in each building. The fan will provide continuous ventilation through the year. Wall mounted occupancy sensor will trigger the fresh air fans on during building operation. During unoccupied mode the fresh air fans will turn off to conserve energy. A wall mounted pressure relief damper will allow excess air pressure to escape the building and prevent over pressurization. The fresh air requirements for each building will be per American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62.1-2019.

9.8.3 Summer Cooling

The Coho Building and Chinook Incubation Building cooling systems will consist of two wall-mount propeller fans with two fresh air louvers that will provide free air cooling. The fan flow rate is designed for six air changes per hour to minimize condensation build-up and provide air circulation through the building space. The wall-mount fans will be controlled by a wall mounted speed controller to allow the operator to select between a low and high setting fan speed.

The Spawning Building's cooling system will consist of a single wall-mount propeller fans with a fresh air louver that will provide free air cooling. The fan flow rate is designed for six air changes per hour to minimize condensation build-up and provide air circulation through the building space. The wall-mount fans will be controlled by a wall mounted speed controller to allow the operator to select between a low and high setting fan speed.

The electrical room located within a separate room attached to the Chinook Incubation building will require cooling. The cooling system will consist of a 1-ton mini split wall-mount unit and condenser unit. The condenser unit will be mounted on a small support stand to protect it from snow and water build-up. The electrical equipment heat output in the room is anticipated to be 2.5 kW. Mechanical heating will not be required due to the high heat output of the electrical equipment in the room.

9.8.4 California title 24 Energy Compliance Requirements

The electrical resistance heaters are compliant with the California energy compliance title 24 requirements due to Exception 5 to section 140.4(g). Exception 5 section 140.4(g) states: Where an electric resistance heating system serves an entire building that is not a high-rise residential or hotel/motel building; has no mechanical cooling; and is in an area where natural gas is not currently available.

9.9 Sorting/Trapping Ponds

Mechanical design elements at the Sorting and Trapping Pond include the finger weir trap and fish crowder and lift system.

9.9.1 Fish Crowder/Lift

The existing fish crowder/lift will be transferred from the Iron Gate Hatchery for use at the sorting and trapping pond at Fall Creek Hatchery. ASCE 25-lb rails will be provided atop the walls of the raceway for guiding the unit. Modifications to the crowder will be performed by the contractor prior to transferring the device to the new facility to ensure it will suit the dimensions of the ponds at the Fall Creek Facility.

9.9.2 Finger Weir

At the discharge of the trapping and sorting pond, a finger weir will be installed on a new aluminum weir gate for trapping adult salmon that have traveled up the fish ladder and into the pond. This finger weir gate will allow for adjustable head in the pond, controllable by a handwheel actuator atop the pond wall. The finger weir contains adjustable fingers for modifying the angle to optimize fish trapping or prevent fish from entering the pond.

10.0 Electrical Design

10.1 Utility Power Service

Power from a locally available source will need to be conveyed to the site. The nearest power source would be from the three-phase power utility lines to the east owned by PacifiCorp. The distance from the existing utility lines to the proposed site is approximately 520 feet. The installation contractor will coordinate with PacifiCorp to provide a new power utility service drop for the site location. The service voltage required is 480 volt, three-phase power, connected in wye-ground configuration. Load calculations place the service transformer size at a minimum of 225 kVA. Service equipment will be located at the Chinook Incubation Building due to its proximity to the utility power alignment, with the utility metering equipment installed on the exterior wall of the electrical room for ease of access.

10.2 Facility Power Distribution

Due to the presence of splashing and spraying water in the incubation and spawning rooms at each building during normal operations, electrical equipment has been located either in the electrical room of the Chinook Incubation Building or exterior to each building. The Chinook Incubation Building will house the majority of electrical equipment in a dry electrical room. The Chinook Incubation Building will subfeed the Coho Building and Spawning Building, with the Intake Structure and Meter Vault subfed from the Coho Building. The general distribution arrangement for the majority of loads at each building will consist of a 480V, three-phase panel, a step-down transformer, and a 208V/120Y, three-phase panel. The 480V panelboards will serve the large motor loads and HVAC equipment, while the 208/120V panelboard will serve lights, convenience receptacles, instrumentation, SCADA, and small HVAC and motor loads as required. Detailed load calculations are included in the panel schedules on the drawings. Local disconnects will be provided in accordance with the NEC for equipment that is not within sight of the panelboard feeding it, either integral to control equipment or with a dedicated safety switch. Additionally, a step-down transformer and 240/120V, single-phase panel will be provided to feed the tagging trailer and fish pump power receptacles, which require 240V to operate at 100A and 60A respectively.

As stated above, two sets of power receptacles will be provided near the Coho and Chinook raceways for use by the CDFW-owned tagging trailer and fish pump. Power distribution is sized assuming that only one tagging trailer and one fish pump can be used at a time, as discussed with CDFW. Power receptacles have also been provided around the Coho and Chinook raceways and the holding ponds to provide power to a portable waste drain pump. Similarly to the other power receptacles, power distribution is sized assuming that only two portable waste drain pumps would be in use throughout the facility at a time. No power receptacle has been provided for settling ponds, as those will be pumped periodically using a truck.

Starters will be provided for each exhaust fan in each building. Fan starters will either be manual or magnetic type as shown, have a red pilot light, and open the motorized louver related to the fan when the fan is turned on. The duct ventilation fan starters will have provisions for automatic control by an occupancy switch supplied by the HVAC contractor. The walls fans will have a simple adjustable speed controller supplied by the fan supplier. All heaters will be controlled by thermostats and time delay relays supplied by the HVAC contractor. The split unit in the electrical room will be controlled by a thermostat supplied by the HVAC contractor. The meter vault exhaust fan will be controlled by an on-off switch.

10.3 Propane Standby Generator

The existing 100 kW Kohler generator set has been assessed for reuse at this facility to provide standby power to all critical loads for the facility. Generator sizing calculations were performed using Kohler's generator sizing software, and are included in Appendix E. As the existing generator is a recent model, this sizing calculation represents a reasonable approximation of its characteristics. This design includes methods for automatic load-stepping of equipment starting and disabling/ignoring non-essential loads during a power outage to avoid procuring a larger generator. In order to meet this requirement, a manual transfer switch will be provided, and the below operation sequence for power outages in Table 10-1 is anticipated.

Table 10-1. Anticipated Standby Power Operation Sequence

Step No.	Description
(1)	Upon power outage, travel to site.
(2)	Disable all Spawning Building equipment that may have been active at the time of the outage (e.g. electro-anesthesia unit, conveyor, fish crowder, etc.), if any.
(3)	Disable the waste drain wet well sump control panel.
(4)	Disable all radiant heater loads for all buildings. Unit heaters and exhaust fans are not required to be disabled.
(5)	Start generator from transfer switch. When generator is ready, initiate manual transfer of facility to standby power.
(6)	The traveling screen system, SCADA cabinet, split unit, lighting, and outlets will turn on immediately. Verify traveling screens are operating. Inline duct fans will operate as usual. Exhaust fans will turn on if left in on position.
(7)	Unit heaters will automatically heat to the t-stat setting after a pre-set time delay. The meter vault sump pump will operate normally.

The generator will be designed to run on liquid propane (LP) stored in an on-site tank. This design anticipates reusing the existing propane tank currently suppling the existing generator above. It is assumed that this tank will provide a minimum of 24 hours' worth of power.

10.4 Lighting Design

High bay lighting on dimmer switches will be provided at each building, and switched lights will be provided above building exterior doors and at the intake structure for maintenance purposes. Lighting will conform to the requirements of the California Energy Code (CEC) and will be exclusively LED-based fixtures. Excluding the electrical room, interior lighting will be provided primarily by skylight refraction tubes during the day, with high bay fixtures providing supplementary illumination to each building during night operations and other times when natural light is limited. The electrical room lighting will be provided with dimming control down to 5% to meet CEC requirements. Lighting level calculations for each room have been provided under Appendix E.

The underlying design assumption for each building is that high intensities of light (88 ft-c and greater) will act as a lethal agent to Coho and Chinook salmon eggs, as found by Eisler (1958). Further, dimmable lighting levels may be desirable to the facility operators to limit adult and juvenile salmon exposure to light to a natural, circadian schedule. Under those assumptions, both the skylight refraction tubes and high bay fixtures will be controlled by manual dimmer switches to allow the operators to dim lighting as much as necessary to prevent premature egg mortality, but also provide lighting necessary for natural salmon growth rates. Preliminary lighting levels for the Coho and Chinook Incubation Buildings are designed to provide 40 ft-c on average from skylight refraction tubes and 20 ft-c on average from high bay lighting. For the Spawning Building, both skylight refraction tubes and high bay lighting levels are designed to provide 20 ft-c on average. The lighting fixtures as specified will allow dimming down to 10 percent illumination for the high bays, and 2 percent for the skylight refraction tubes. Options for further dimming are available, but not currently included in the design. No lighting occupancy sensors, photocell control, or other intelligent lighting control are planned for the facility.

11.0 Instrumentation and Controls

11.1 General Description

All instrumentation and controls will be mustered to a single SCADA cabinet located in the Chinook Incubation Building electrical room. The SCADA cabinet will house a PLC, an HMI, a UPS, an ethernet switch, and alarms, relays, terminal blocks, and other components required for a complete system. There will be no remote control of the facility; all subsystems will be controlled locally through manual or sensor-based actuation.

PLCs used in the Project will be Emerson, Allen Bradley, Schneider Electric, or equal models. The SCADA cabinet will have a UPS to maintain operability of critical monitoring functions at the fish hatchery for a short duration, with the on-site standby generator providing up to 24 hours of backup power to the facility. In the event of a primary PLC failure, the facility will alert operators of the loss through SCADA.

Telemetry communication for system visibility to the operators will be achieved using an automatic cellular alarm dialer (autodialer). The autodialer will call site operators when an alarm occurs and will allow for multiple sequential alarm dial-out numbers and alarm acknowledgement from remote phones. The autodialer will be equipped with automatic battery backup, in addition to being backed up by the standby generator. Additionally, an alarm siren will provide local annunciation of alarm conditions to the site. Provisions for interconnecting future communications with remote systems have been included in the design.

The water surface elevation sensors will be submersible pressure transducers in stilling wells. The raw water flowmeters will be magnetic, inline type, as described above in Section 9.2.5. The level switches will be the float type. Intrusion switches will be standard magnetic type with normally closed contacts.

11.2 Intake Structure

The traveling screen vendor will supply a control panel for control of the screens and screen spray pumps. The traveling screens and spray wash pumps will be controlled locally from the vendor-supplied control panel only, either automatically or manually as described above in Section 9.2.1. The control panel will include a main breaker, a microcontroller, provisions for level control and remote level annunciation, and alarms, relays, terminal blocks, and other components required for a complete system.

A sump pump control panel will be provided by the meter vault sump pump supplier for pump control. It will include a lockable, outdoor enclosure, an alarm beacon, and provisions for automatic level control and remote level alarm annunciation.

Instrumentation at the Intake Structure will consist of intake water surface elevation sensors (for measurement of differential pressure across the screen), raw water supply piping flowmeters located in a vault, level switches in the meter vault, and a vault intrusion detection switch.

11.3 Coho Building

Instrumentation at the Coho Building will consist of a level switch in the incubator head tank and door intrusion detection switches. Status I/O points will be sent to SCADA from each of the switches. No other process instrumentation and control are planned for this building.

11.4 Chinook Raceways

Process instrumentation and control are not planned for this feature.

11.5 Chinook Incubation Building

The facility SCADA cabinet and the autodialer will be installed in the electrical room, and will act as the main monitoring equipment for facility operations. This SCADA cabinet will be supplied by the installing contractor. A detailed panel layout, bill of materials, and schematic diagrams have been provided in the drawings for use in the panel fabrication process. The SCADA cabinet will have an HMI that allows status and alarm monitoring – but not control – of plant processes, and LED pilot lights for "general alarm" and "SCADA control power on". Additional alarms and statuses originating inside the SCADA cabinet include "PLC fault", "surge protection fault", "UPS battery on", "UPS low battery", "UPS fault", "ethernet switch fault", and "loss of dc power". A set of spare conduits to the SCADA cabinet and an exterior-located junction box will be provided for future communication connection.

The autodialer will receive a specific set of critical alarms for annunciation over a cellular antenna. These consist of "general system fault", "traveling screen fault", "meter vault flood alarm", "intrusion alarm", "incubation tanks water low", and "wet well high level alarm". A cellular service will need to be set up in order for this system to function properly.

The alarm siren control station will be located on the east exterior corner of the main building and aimed east for alerting the area east of the plant, which is planned for future use as an operator living area. The alarm siren control station will have an audible alarm and silence pushbutton. These will be connected directly to the SCADA cabinet, and all alarm logic for this siren will be programmed at the PLC.

Instrumentation at the Chinook Incubation Building will consist of a level switch in each of the incubator head tanks and door intrusion detection switches. Status I/O points will be sent to SCADA from each of the switches. No other process instrumentation and control are planned for this building.

11.6 Spawning Building

Instrumentation at the Spawning Building will consist of door intrusion detection switches. Status I/O points will be sent to SCADA from each of the intrusion switches. No other process instrumentation and control are planned for this building; however, see the holding and settling ponds section below for additional instrumentation and control requirements in this area.

11.7 Adult Holding and Settling Ponds

CDFW has informed McMillen Jacobs that it is desirable to retain the existing controls and instrumentation for the spawning building and holding pond areas from the existing Iron Gate Fish

Hatchery facility for reuse at Fall Creek. The following controls and instrumentation will be relocated for reuse:

- The spawning area control station, to be installed at the sorting table, and controls the fish crowder drive and lift, the electro-anesthesia hydraulic tank hoist, and the tank fill pump;
- The electro anesthesia unit, control panels, shock paddles, cabling and other associated appurtenances;
- The foot-pedal safety switch for the electro-anesthesia system, to be installed below the sorting table;
- All other controls and instrumentation related to the electro anesthesia tank hydraulic hoist system;
- The motor starter panels for the crowder lift, crowder drive, and conveyor belt;
- Four limit switches for stopping fish crowder lift and drive movement, and;
- The conveyor belt control pendant and instrumentation integrated into the conveyor mechanism;

As the electro anesthesia tank fill pump is being replaced, a new starter control panel will be provided as well. The starter control panel will have an outdoor enclosure, an external disconnect, a combination full-voltage non-reversible magnetic starter, a motor circuit protector, an on-off pushbutton, and a red pilot light. This panel will interconnect with the existing spawning area control station to provide pump control at the sorting table.

The waste drain wet well pumps will be controlled by a local pump control panel supplied by installing contractor. For this control panel, a detailed panel layout, bill of materials, and schematic diagrams have been provided in the drawings for use in the panel fabrication process. The waste drain wet well pumps will be controlled locally from the control panel only, either manually or automatically based on a lead/lag level switch alternating pump control scheme. The pump control panel will contain a main breaker and disconnect, two combination full-voltage non-reversible magnetic starters, two motor temperature and leak protection relays, a phase monitoring relay, a duplex alternating lead-lag relay, and alarms, relays, terminal blocks, and other components required for a complete system.

Instrumentation at the holding and settling ponds will consist of the foot-pedal safety switch for the electro-anesthesia unit and waste drain wet well level switches. Status I/O points will be sent to SCADA from the wet well pump control panel and the wet well alarm high level switch. The safety switch will be used for local shutoff of the electro-anesthesia unit only. No other process instrumentation and control are planned for this feature.

12.0 Operations

12.1 General Description

The following subsections discuss general operations of the Fall Creek Hatchery. The information is intended to be high-level for this design phase and will be further defined through discussions with KRRC and CDFW in future design phases.

12.2 Water Distribution and Collection Systems

The intake located at Dam A for the Project is intended to operate autonomously, with self-cleaning screens set to initiate a cleaning cycle based on pre-set head differential or time interval. Debris removed from the screens will be collected in a trough, which will require occasional removal by hatchery personnel. The isolation valves on each of the four (4) supply pipelines are intended to be normally open, with all flow being controlled in the downstream distribution systems.

Supply piping will generally be operated by valves located at each of the raceways, vessels, or working spaces. Flows through each of the supply pipelines will be monitored by the flow meters located in a below grade vault with flow rate estimates transmitted to the PLC. To maintain the 10 cfs water right, the PLC will be programmed to alert hatchery personnel if the water right is exceeded. There has been a 0.5 cfs contingency built within the FCFH bioprogram to ensure that the water right is not exceeded while hatchery production goals are achieved.

Flow to individual rearing raceways or vessels will be adjusted by operating the supply manifold valve and estimating flow at the overflow discharge. The production drain piping system will simply convey the rearing raceway and vessel drain flows to the adult holding ponds. There are no control valves on the drain piping system. Clean-outs have been provided on all pipelines throughout the facility to allow hatchery staff to flush the pipelines, as needed, if flow disturbances are observed.

Under typical operations, water will return to Fall Creek after being routed through the drain piping system, through the adult holding ponds and ultimately through the fish ladder downstream of the adult holding ponds.

During times of fish release, water can also return through any of the three (3) volitional release pipes located at the Coho Raceways, Chinook Raceways, or the adult holding pond discharge channel. Stop gates or dam boards shall be placed in front of the raceway drain, diverting all flow through the fish release piping after those respective dam boards have been removed. The volitional release pipes will only be in operation when hatchery staff release fish to Fall Creek throughout the year.

12.3 Waste Management

Waste management will be performed with a vacuum system that discharges to the waste drain system. Quiescent zones will be maintained near the downstream end of the raceways and rearing vessels, where biosolids will settle. Vacuums, as depicted in Figure 12-1, will be used to suction out the solids, and discharge into the waste drain system. The waste drain system will discharge the solids with a transport water flow to the settling pond.

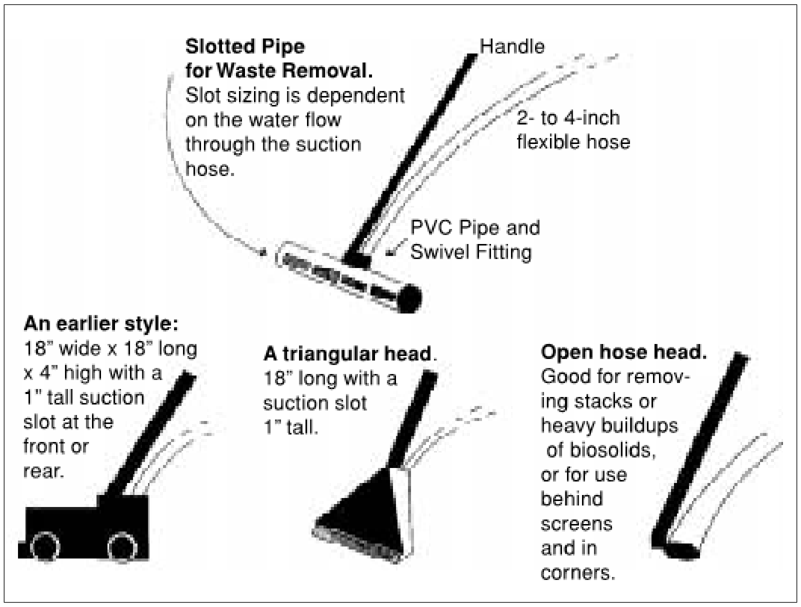

Figure 12-1. Typical Vacuum Removal of Solids (Source: Idaho DEQ, nd)

The settling pond will be partitioned into two sections with the flow from the waste drain system directed to one or the other of these partitions by a valve. One of these subdivisions will collect flows from the upstream cleaning of the ponds, while the water content in the other is allowed to evaporate. Once the drying partition is sufficiently dry, biosolids will be removed and disposed of. The valve will be adjusted to direct flows to the now empty partition, and the water content in the other partition will be allowed to evaporate.

The downstream end of each of the settling pond bays will be equipped with an overflow structure that will divert flow-through water into a pipe that discharges into the fish ladder. The fish ladder will be the primary outfall from the hatchery.

12.3.1 NPDES Sampling

Water quality samples will be required to be sampled at fish ladder downstream of the settling pond discharge location to verify the effluent is within the allowable parameters set by the NPDES permit. CDFW is in the process of negotiating the NPDES permit for the Project. At this design phase, it is assumed that the waste stream from FCFH will be required to meet effluent limitations included in the California Regional Water Quality Control Order No. R1-2015-0009, General NPDES CAG131015, and Waste Discharge Requirements for Cold Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters. The General NPDES CAG131015 effluent limitations are summarized in Table 2-11. This NPDES design criteria for the Project will be updated once an NPDES permit has been issued for the site.

12.3.2 Treatment of Therapeutants

Another effluent concern for the facility will be the use of therapeutants or inorganics that could occasionally be required for treatment of fish. Use of such therapeutants is not anticipated due to the high quality of the intake water and the short design life of the facility. However, if therapeutants are used for treatment of fish operationally hatchery staff can isolate and direct the flow to the waste drain system and utilize the 3,200 ft^3 of effluent holding provided by the effluent settling pond. While use would be dependent on flow rates supplied to each individual rearing unit, the effluent settling ponds provide short-term storage of up to 24,000 gallons of therapeutant laden flow that could then be pumped to appropriate storage tanks and transferred to approved off-site disposal areas, or discharged to Fall Creek after the required residence time.

12.4 Adult Holding and Spawning

12.4.1 Trapping/Sorting

Adult salmon will be guided to the base of the fish ladder by the fish exclusion picket barrier located adjacent to the holding ponds on Fall Creek. At the head of the fish ladder, adult salmon will pass over a dam board weir and enter the holding pond outflow structure where attractant flows will guide them over a finger weir trap into the sorting/trapping pond. A manual crowding screen will be placed by hatchery personnel to guide fish to the head of the pond and into the fish lift, where they may be hoisted into the electro-anesthesia tank for temporary sedation. Sedated fish will be raised to a sorting table, where adult Chinook are placed in their respective pond through a removable pipe and adult Coho are processed and placed in a separate pond by hatchery personnel.

12.4.2 Spawning

During Chinook spawning operations, the dam boards separating the Chinook holding pond from the sorting/trapping pond will be removed, and a fish screen will be installed in the upper quarter of the trapping pond. The manual fish crowder will be placed by hatchery personnel in the Chinook pond to guide fish into the sorting pond and into the fish lift, where they may be hoisted into the electro-anesthesia tank for sedation. At the sorting table, males and females will be separated and transferred to the holding table within the spawning building. Female salmon eggs will be gathered on the air spawning table, where they will be rinsed, water hardened, and prepared for incubation. If male salmon are to be used more than once during the spawn season, stripped males will be manually returned to their respective rearing containers (raceways for Chinook and spawning tubes for Coho). Fish carcasses will be placed on the conveyor belt and deposited in a collection bin outside, where they will be periodically gathered and processed by hatchery personnel.

12.5 Incubation

Incubation trays are provided in the Coho and Chinook buildings for egg/alevin incubation within the hatchery. Multiple ½-stack incubators (8 trays per stack) are provided in both buildings and hold eggs during incubation, with the water supply provided by a constant head tank feeding each row. Hatchery personnel will be required to perform periodic cleaning of the trays during the incubation period, and working vessels are provided for egg picking and enumeration purposes.

12.6 Juvenile Rearing

Rearing of juvenile salmonids is anticipated to take place in the Coho and Chinook raceway banks. Additionally, the adult holding ponds are provided with dam boards and fish screen slots to allow for juvenile rearing if elected by hatchery personnel. Each raceway contains segmented bays, with the total rearing volume configurable by insertion of removable fish screens. A final screened bay shall be used for initial settling of waste, to be periodically cleaned by hatchery personnel through the waste drain system.

Each raceway bank is equipped with a volitional release piping system, returning juvenile salmon to Fall Creek at the end of the rearing season. Stop gates or dam boards shall be placed in front of the raceway drain, diverting all flow through the fish release piping after those respective dam boards have been removed.

13.0 References

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Appendix C

Preliminary Biological Program – Fall Creek

Technical Memorandum 001

To:	Klamath River Renewal Corporation California Department of Fish and Wildlife	Project:	Fall Creek Fish Hatchery
From:	Jodi Burns, Project Manager Derek Nelson Jeff Heindel	cc:	Mort McMillen, P.E. – McMillen Jacobs File
Date:	March 11, 2020	Job No.:	20-024
Subject:	Technical Memo 001 – Fall Creek Fish Hatchery Biological Design Criteria, Rev 02		

Revision Log

Revision No.	Date	Revision Description
0	02/27/2020	Initial Draft
1	03/02/2020	KRRC Comments Addressed
2	03/11/2020	CDFW Comments Addressed; Final

1.0 Introduction

Technical Memorandum (TM) No. 001 summarizes the biological design criteria that will be used as the basis for the development of the California Department of Fish and Wildlife's (CDFW) Fall Creek Fish Hatchery (FCFH) project (Project). The criteria presented within this TM provide key water supply and fish culture facility programming information that will serve as the foundation for the Alternatives Analysis to evaluate potential modifications to the existing fish hatchery facility, as well as the selected alternative design development.

The following acronyms and abbreviations are used within this TM:

CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CTU	Celsius temperature unit
CWT	coded-wire tag
DI	density index
D.O.	dissolved oxygen
FCFH	Fall Creek Fish Hatchery
FI	flow index
fpp	fish per pound
ft^3	cubic feet
gpm	gallons per minute
HRT	hydraulic retention time

IGFH	Iron Gate Fish Hatchery
lb/cf/in	pounds of fish per cubic foot of rearing volume per inch of fish length
lbs/ft^3	pounds of fish per cubic foot of rearing space
mm	millimeter
NPDES	National Pollutant Discharge Elimination System
Project	Fall Creek Fish Hatchery Project
R	water turnovers per hour
TM	Technical Memorandum

2.0 Background

The Klamath River Restoration Project includes removal of four (4) dams along the Klamath River and a new hatchery to provide salmon mitigation production for a period of eight (8) years. The original 50 percent design package was developed by CDM Smith as a subconsultant to AECOM. The 50 percent design included proposed modifications to FCFH with the capability of rearing the current Coho Salmon *Oncorhynchus kisutch* yearling target (~ 75,000 yearlings at ~ 10 fish per pound [fpp]; ~ May release [age-1+]), ~ 115,000 Chinook Salmon *O. tshawytscha* yearlings (~ 10 fpp; November release [age-1+]), and approximately 2,885,000 Chinook sub-yearlings (~ 90 fpp; May release [age-0+]) using mixed-size, dual-drain circular tanks. The design included incubation and spawn-building structures, a concrete pad for ball-and-hitch camper (single-resident temporary housing), and a clarifier to handle increased effluent demands. Limited impacts to the existing facility "footprint" were considered throughout the design process. The design included facilities and land-disturbing activities on both the east and west sides of Fall Creek.

During the technical review of the 50 percent design package (CDM Smith, 2019), several areas of the proposed FCFH design were identified that could benefit from a refined analysis and design approach. The analysis started with the basic input parameters of the hatchery bioprogram with the goal of achieving an optimum rearing configuration considering fish numbers, rearing flow, and rearing densities. The refined bioprogram is presented within this TM. Once the proposed program has been reviewed and approved by CDFW, the FCFH layout will be updated to reflect the final rearing unit numbers, type, water supply piping, and effluent treatment.

3.0 Proposed Facility Upgrades

Site layout and land-disturbing activities/areas were generally addressed in the 50 percent drawing package. Moving forward with continued facility design alternatives, CDFW acknowledged that both ongoing and future permitting discussions dictate that future changes to the design/layout will not deviate from the impact areas provided in the previous design. The previous design suggested major facility upgrades on both the east and west sides of Fall Creek with recommendations to remove all existing infrastructure (e.g., old fish production raceways); initial site investigations conducted by McMillen Jacobs staff on January 28, 2020 suggest that future design is likely possible exclusively on the east side of Fall Creek (minimal to no infrastructure upgrades on west side) and that existing raceways (2 north of Copco Road, 4 south of Copco Road) could be retained (renovated) to minimize the need for "new" aquaculture rearing space.

Initial bio-programming efforts will determine an "optimum" number of fish to be reared over a calendar year based on CDFW guidelines. The total number of fish that can be reared to a certain size (biomass) are directly linked to the key variables of total water flow available (gallons per minute [gpm] and cubic feet per second [cfs]) and total rearing space available (cubic feet of rearing space). Bio-programming analysis presented within this TM will result in determination of a total flow and rearing space requirements to arrive at optimized aquaculture tank/rearing vessels and sizes to meet CDFW aquaculture operational requirements. These preliminary values will be refined as the design is advanced.

The water rights and maximum available flow for the Project are set at 10 cfs. This water right is non-consumptive and water must be returned to Fall Creek with the facility design addressing National Pollutant Discharge Elimination System (NPDES) water quality permit considerations. Facility water treatment designs will be determined after critical aquaculture variables are addressed. Future water treatment design efforts will prioritize the development of systems that maximize water quality/discharge to receiving water bodies (Fall Creek) while minimizing the technological and operational costs of these systems.

4.0 Production Goals

Discussions with CDFW Fish Production staff on January 27, 2020 resulted in a "priority" list of fish species, life stages, and numbers to aid in future design efforts:

- 75,000 Coho yearlings at approximately 10 fpp at release (top priority)
- Adult holding capacity for 100 Coho Salmon adults and 200 Chinook Salmon adults (ideally spawned at Fall Creek facility once production releases return adults to Fall Creek)
- Up to 3M Chinook sub-yearlings at approximately 90 fpp at release (at minimum, 1.5M coded-wire tag [CWT] groups would be ideal for monitoring and evaluation)
- Approximately 115,000 Chinook yearlings at approximately 10 fpp at release (lowest priority)

Table 4-1 provides a high-level overview of fish production goals for the proposed FCFH Program (data compiled from CDFW information):

Table 4-1. Fall Creek Hatchery – Fish Production Goals

Species (Juvenile Life History)	Adult Return*	Incubation Start Date	Incubation Start Number	Target Release Dates	Release Number	Release Size
Coho (Yearling)	Oct. – Dec.	Oct. – Mar.	120,000	Mar. 15 – May 1	75,000	10 fpp
Chinook (Sub-Yearling)	Oct. – Dec.	Oct. – Mar.	4.5M**	Pre-Mar. 31	1,250,000	520 fpp
Chinook (Sub-Yearling)	Oct. – Dec.	Oct. – Mar.	-	May 1 – June 15	1,750,000	90-100 fpp
Chinook (Yearling)	Oct. – Dec.	Oct. – Mar.	-	Oct. 15 – Nov. 20	250,000	10 fpp

*Adult trapping period from Iron Gate Fish Hatchery data

** Estimated Total Green Egg Requirement at Spawning

5.0 Biological Variables

The primary biological variables generally used to develop a preliminary fish hatchery operations schedule include water temperature, species-specific condition factors, growth rates, feed conversion rates, as well as density and flow indices. Understanding that CDFW has prior culture history with the target aquaculture species (Coho, Chinook) and rearing cycles (growth and feed rates relative to period of culture) for the program, the initial bio-programming analysis will identify high-level fish condition factor and growth rate assumptions, provide summary water temperature profile data for the facility, and present recommendations on industry-standard (State/Federal/Tribal conservation programs for Pacific salmon) density and flow indices. These variables will serve as general guidelines for assuring rearing units and water conveyance systems are sized appropriately.

5.1 Fish Condition Factor and Growth Rate

Fish condition factors provide fish culturists with a hypothetical "ideal" condition value of various fish species (body types) that is tied directly to mean fish weight and length. For the purpose of modeling growth and size (total length and/or total weight), a Coho Salmon condition factor of C3500 and a Chinook Salmon condition factor of C3000 are assumed. Coho of a given size (either length or weight) will generally have a higher condition factor than Chinook; for example, Coho juveniles compared to similarly-sized (fish per pound or grams per fish) Chinook juveniles will generally be *shorter* (total length) and *heavier* (mean weight) and have a resulting *higher* condition factor.

Fish growth rate was initially modeled at 0.035 millimeters (mm) per Celsius temperature unit (CTU) per day (0.035 mm/CTU/day) in the original hatchery bio-program documents. Actual growth rates for similar species of fish in similar rearing conditions (water temperature profiles) suggest that this rate is lower than actual rates of growth using conventional fish food diets. CDFW provided actual growth rate data from previous rearing events at FCFH (calendar year 2003 rearing history) that demonstrated that actual growth rates are closer to 0.05 mm/CTU/day for Chinook Salmon. CDFW identified that actual growth rates are controlled by hatchery feeding guidelines and fish may be restricted (growth slowed) during colder periods of rearing (lower metabolic requirements) to target specific release sizes. Fish growth modeling efforts assume a growth rate of 0.045 and 0.05 mm/CTU/day for Coho and Chinook rearing, respectively.

5.2 Water Temperature

Water temperature is a primary determining factor in the development and growth rate of fish. The Fall Creek Fish Hatchery water supply includes a 10 cfs year-round water right from Fall Creek. The Fall Creek water source has a demonstrated history of water temperature ranges (and assumed water *quality* based on prior positive rearing history) that generally favor the growth and development of anadromous salmonids. Figure 5-1 provides mean monthly rearing temperature data (degrees Fahrenheit) for the water source currently supplying the abandoned Fall Creek facility. Additional water chemistry testing is to be completed on source water, with the results described in future TMs.

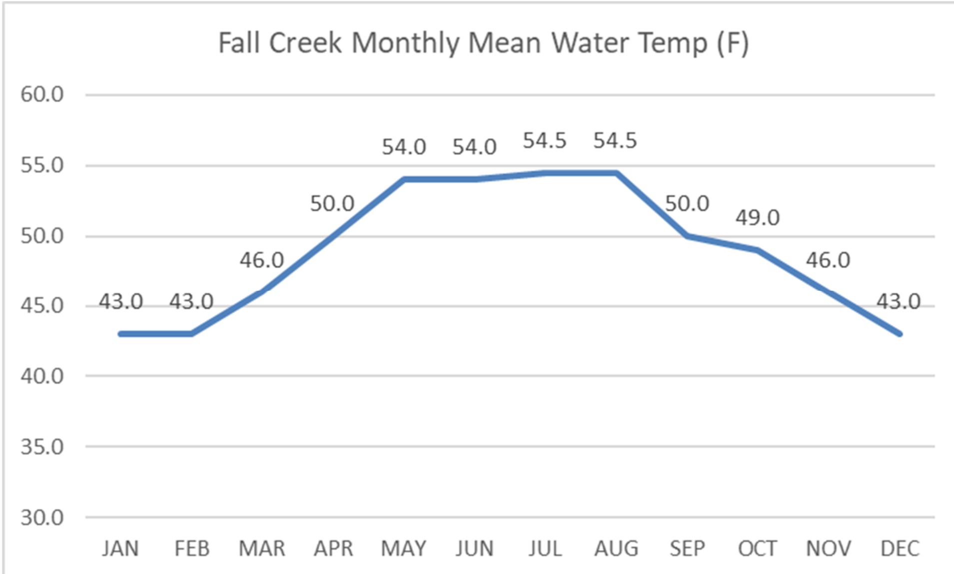


Figure 5-1. Mean Monthly Fall Creek Rearing Temperatures (Data from L. Radford, CDFW)

The proposed facility upgrades will use the existing Fall Creek source as the sole source for water supply to the facility (no groundwater well development planned). The water source, water rights, and general flow rates at the facility will remain unchanged for the proposed project design.

5.3 Density Index

Density index (DI) is a common method for estimating maximum carrying capacity in a rearing vessel. DI is a function of pounds of fish per cubic foot of rearing volume, per inch of fish length (lb/cf/in). The DI used for Pacific salmon species in a raceway (flow-through) environment is typically in the 0.2 to 0.3 range (Heindel, 2020), but can be highly variable depending on species, rearing goals, fish performance, and water quality. Additional information specific to DI is provided in the example below (adapted from Piper et al., 1982) and in Table 5-1:

"A common method for estimating maximum carrying capacity in a tank/raceway is the Density Index (DI). D.I. is a factor which, when multiplied by container volume in CUBIC FEET (V) and by fish length in inches (L) will give the maximum allowable weight of fish (W). A general rule of thumb for salmonids (Pacific salmon in this case) is DI should be from 0.2 to 0.5 (pounds of fish per cubic foot of tank space); fish densities should be no greater than 0.2 to 0.5 times their length in inches (for Pacific salmon)".

Table 5-1. Key DI Calculations

Design Question	Calculation
What is permissible weight of fish?	$W = D * V * L$
What is Density Index (D.I.)?	$D = \frac{W}{(L * V)}$

Design Question	Calculation
What Volume is Required at Certain D.I.?	$V = \frac{W}{(D * L)}$

Where: W = Weight in lbs. (biomass); D = Density Index; V = Volume of Unit in ft^3; L = Fish Length in Inches

"Example: If DI of 0.2 is used, 2-inch fish could be held at a density of 0.4 pounds per cubic foot (0.2 x 2 = 0.4) / If DI of 0.5 is used, 2-inch fish could be held at a density of 1 pounds per cubic foot (0.5 x 2 = 1). Note: DI is useful in estimating carrying capacity but only considers SPACE, not flow!"

CDFW staff generally employ aquaculture rearing guidelines that focus on pounds of fish per cubic foot of rearing space (lbs/ft3) and the rate of water exchange through a given sized vessel. The water exchange is identified as water turnovers per hour (R) and/or hydraulic retention time (HRT) in water exchanges every "X" minutes. Acknowledging that historic survival from green egg through release at Iron Gate Hatchery is extremely variable based on previous survival data provided by CDFW (sub-yearling and/or yearling Chinook and Coho), FCFH rearing volume estimates provided below will assume a maximum DI of 0.3.

It is important to note that conservative rearing values should always be utilized in designing new hatchery facilities. While higher DIs are possible in some circumstances and with some species/stocks of fish, the values used in the current design are considered a prudent starting point providing the greatest number of fish with the highest level of fitness and smolt quality. Production of high-quality juveniles should translate into higher downstream survival of anadromous emigrants with a corresponding increase in adults returning from original hatchery production efforts.

The DI is used to calculate the total volume of rearing space required in terms of cubic feet. Table 5-2 reflects the rearing volume required for the Coho yearling program proposed at the FCFH using density indices of 0.3 and a mean fish size of 10 fpp at release based on current production goals. The total volume can then be divided by the volume of individual rearing units in order to show the total number of rearing units required per scenario. The number of rearing units will vary with fish species, fish size, and management requirements.

Table 5-2. FCFH Coho Bio-Program – DI and Rearing Unit Calculations

75,000 Coho @10 fpp, 6.57" mean, 45.1 g/f mean (C3500 Piper)						
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**
75,000	10	6.570	45.4	7,500	0.3	3,805

The bio-program assumes that CDFW staff will manipulate feed rates (and resulting growth profile) during colder months to achieve the 10 fpp target release size. Based on the fish number and size in Table 5-2, the total maximum rearing volume for Coho yearlings is approximately 3,805 cubic feet. When considering a rearing buffer volume, a total rearing volume of 4,000 cubic feet would be required.

The fish rearing tank numbers and sizes will be discussed with CDFW to select the optimum configuration to meet fish marking, tank changes, and fish health management objectives.

Table 5-3 reflects the rearing volume required for the Chinook sub-yearling/yearling program proposed at the FCFH using density indices of 0.3 and a mean fish size at release based on current production goals. Discussions with CDFW Fish Managers suggest that the new design parameters should consider maximizing full use of the available water (10 cfs). Table 5-3 presents a rearing scenario that was developed to maximize Chinook production at the facility with the following guidelines:

- Initial ponding of approximately 3,250,000 first-feeding fry;
- Rear 3.25M through end of March and release ~ 1.25M sub-yearlings at ~ 520 fpp/0.871 g/f mean size;
- Rear remaining ~ 2.0M through end of May and release ~1.75M sub-yearlings at ~ 104 fpp/4.35 g/f mean size;
- Rear remaining ~250,000 yearlings and release ~ end of November at ~ 10 fpp/45.27 g/f mean size.
- Marking and tagging strategies will be determined at a later date.

Table 5-3. FCFH Chinook Bio-Program – DI and Rearing Unit Calculations

3,250,000 Chinook @521 fpp, 1.862" mean, 0.87 g/f mean (C3000 Piper)						
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**
3,250,000	521	1.862	0.87	6,241	0.3	11,170

2,000,000 Chinook @104 fpp, 3.175" mean, 4.35 g/f mean (C3000 Piper)						
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**
2,000,000	104	3.175	4.35	19,231	0.3	20,190

250,000 Chinook @10 fpp, 6.98" mean, 45.27 g/f mean (C3000 Piper)						
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**
250,000	10	6.980	45.27	25,000	0.3	11,915

The fish rearing tank numbers and sizes will be discussed with CDFW to select the optimum configuration to meet fish marking, tank changes, and fish health management objectives; a follow-up TM will be produced once tank sizes and configuration have been determined.

5.4 Flow Index

Flow index (FI) is a function of pounds of fish per fish length in inches times flow in gallons per minute (gpm). Flow index is an indication of how much oxygen is available for fish metabolism and is adjusted based on the elevation of the project site and water temperature. Both of these variables affect the amount of dissolved oxygen (D.O.) in the water supply at saturation. Additional information specific to FI is provided in the example below (adapted from Piper et al., 1982) and in Table 5-4.

"The Flow Index (FI) describes how rapidly fresh water will replace "used" water (water in which fish have reduced D.O. concentrations and excreted waste products). The FI takes flow rate into consideration when estimating maximum allowable weight of fish that a culture unit can hold."

Table 5-4. Key Flow Index Calculations

Design Question	Calculation
What is Flow Index (F.I.) if you know Weight, Length and Inflow?	$F = \frac{W}{(L * I)}$
What is permissible Weight if you know F.I., Length and Inflow?	$W = F * L * I$
What is Inflow requirement if you know Weight, F.I. and Length?	$I = \frac{W}{(F * L)}$

Where: W = Weight in lbs. (biomass); F = Flow Index; I = Inflow of water in gpm; L = Fish Length in inches

"As a rule of thumb for salmonids (certainly Pacific salmon), FI values should range from 0.5 to 1.5. Actual FI values will depend on several factors, especially the dissolved oxygen concentration of the inflowing water. To correctly estimate the FI for a specific unit, fish are added while water flow is held constant; when enough fish have been added to the system so that the DO level in the outflow has been reduced below ~ 6ppm, the unit is at maximum [fish capacity]."

According to Table 8 in *Fish Hatchery Management* (Piper et al., 1982), the recommended flow index for the FCFH at an elevation of 2,200 feet and a range of actual water temperatures (degrees Fahrenheit) is provided below:

- 40 F = 2.50 FI
- 45 F = 2.10 FI
- 50 F = 1.68 FI
- 55 F = 1.40 FI

Using the conservative design guidelines identified in the DI section above and experience with conservation stocks of both Coho and Chinook salmon (Heindel, 2020), flow considerations modeled below assume an FI of no greater than 1.5. As noted previously, this is a reasonable starting point for a new facility (at stated elevation and water temperature profiles). Rearing experience gained over multiple years will allow operators the opportunity to modify actual FIs based on demonstrated fish performance/survival. Flow indices of 1.5 are applied to the rearing scenarios described previously to establish maximum water requirements for the proposed Coho yearling and Chinook sub-yearling/yearling programs as illustrated in Tables 5-5 and 5-6.

Table 5-5. FCFH Coho Bio-Program – FI and DI Unit Calculations

75,000 Coho @10 fpp, 6.57" mean, 45.1 g/f mean (C3500 Piper)								Single-Pass	
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**	**F.I. (lb/gpm/in)**	**Flow Req (gpm)**	**Flow Req (cfs)**
75,000	10	6.570	45.1	7,500	0.3	3,805	1.50	761	1.70

Table 5-6. FCFH Chinook Bio-Program – FI and DI Unit Calculations

3,250,000 Chinook @521 fpp, 1.862" mean, 0.87 g/f mean (C3000 Piper)								Single-Pass	
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**	**F.I. (lb/gpm/in)**	**Flow Req (gpm)**	**Flow Req (cfs)**
3,250,000	521	1.862	0.87	6,241	0.3	11,170	1.50	2,234	4.98

2,000,000 Chinook @104 fpp, 3.175" mean, 4.35 g/f mean (C3000 Piper)								Single-Pass	
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**	**F.I. (lb/gpm/in)**	**Flow Req (gpm)**	**Flow Req (cfs)**
2,000,000	104	3.175	4.35	19,231	0.3	20,190	1.50	4,028	9.00

250,000 Chinook @10 fpp, 6.98" mean, 45.27 g/f mean (C3000 Piper)								Single-Pass	
Number Fish	**Fish Size Out (fpp)**	**Fish Size Out (L inches)**	**Fish Size Out (g/f)**	**End Biomass (lbs)**	**D.I. (lb/cf/in)**	**Tank Space Req (cu ft)**	**F.I. (lb/gpm/in)**	**Flow Req (gpm)**	**Flow Req (cfs)**
250,000	10	6.980	45.27	25,000	0.3	11,915	1.50	2,383	5.31

The initial flow modeling suggests that the fish numbers and sizes proposed above can be accommodated with the available 10 cfs water right. The analysis indicates that the peak flow of 9.0 cfs for the Chinook group is required about 1 month after the release of the Coho yearling. The maximum flow required for newly-ponded Coho during the same period is 166 gpm with sufficient water available for the proposed rearing and release scenario.

6.0 Incubation and Rearing Facilities

This section provides a brief summary of the incubation and rearing flows and volumes required for the program based on CDFW input. The bio-programming information provided is largely tied to incubation needs in early design.

6.1 Mean Survival Assumptions

Mean survival data by life stage was provided during a meeting with CDFW (CDFW, 2020). The initial sizing of incubation facilities is based on the following survival data provided by CDFW (2020):

- Green egg to eyed survival: 80% (~ 20% loss)
- Eyed egg to ponding survival: 93% (~7% loss)
- Green egg to ponding survival: 73% (~27% loss)
- Ponding inventory to release: 95% (5% loss)

Based on the mean survival data and tied to the rearing scenarios presented above, estimates of total green eggs required for the Project are provided in Table 6-1.

Table 6-1. Starting Inventory at FCFH - Coho and Chinook

Species	Incubation Period	Incubation Start Number	% Survival Green to Pond	Pond Number	Ponding Period
Coho	Oct. – Mar.	120,000	73%	~88,000	~ Jan. – Mar.
Chinook	Oct. – Mar.	4,500,000	73%	~3,250,000	~ Jan. – Mar.

6.2 Incubation

Incubation systems currently at Iron Gate Fish Hatchery (IGFH) will be used for egg/alevin incubation at FCFH. A total of 130 incubation stacks are currently available for future rearing needs. The existing incubation units are vertical stack incubators with a double-stack arrangement (15 useable trays per stack); hydraulic head requirements at Fall Creek dictate that new incubation systems will be reduced to "½" stack design with eight useable trays per incubator (empty tray on top for sediment collection). Water flow requirements are modeled at 5 gpm per manufacturer's recommendations (industry standard). Incubation requirements for Coho and Chinook based on updated tray loading densities are provided in Table 6-2.

Table 6-2. Incubation Loading at FCFH – Coho and Chinook (Proposed Loading Rates)

Species	Green Inventory	Mean # Eggs/Ounce	Ounces/Tray	Total Trays	Total Stacks**	Total Flow (gpm)
Coho	120,000	TBD	TBD	40*	6	30
Chinook	4,500,000	80	50-55	1,088	136	680

*Per CDFW Egg Incubation Data; L. Radford

**8-tray setup (1/2 stack); required because of reduced hydraulic head (no pumping)

Current facility bio-program efforts will assume a maximum incubation need of 40 gpm for Coho incubation and 680 gpm for Chinook incubation. Historic tray loading for the Chinook incubators at Iron Gate often approached ~8,000-10,000 green eggs per tray (100 ounces). Reducing the total number of eggs/tray to ~4,000 (approximately 50 ounces/tray) for the Chinook incubation increases the total footprint and water demand yet should improve survival of resulting eggs/alevins while also reducing the risks associated with disease/fungal infection.

6.3 First-Feeding Vessels

First-feeding vessel requirements will be addressed once the final Program size is determined. Estimates of total rearing volume and flow requirements will be refined at a later date. Coho brood cohorts (first-feeding fry & smolt program) will overlap from early-ponding through smolt release; Coho production for the second cohort is assumed to require approximately 500 ft^3 of rearing space from first-feeding through late-April transfer to larger production ponds (post-smolt release).

6.4 Grow-out Vessels

Grow-out vessel (post-marking and parr/smolt rearing containers/sizes) requirements will be addressed once the final Program size is determined. Estimates of total rearing volume and flow requirements will be refined at a later date. Initial bio-program estimates suggest a maximum grow-out rearing need of 3,800 ft^3 of Coho rearing space (April release) and approximately 20,200 ft^3 of Chinook rearing space (May release).

6.5 Adult Holding Ponds

Adult holding and spawning ponds will be designed per CDFW recommendations for design flows, holding volumes, and fish handling systems; adult flow and holding requirements will align with NOAA guidelines for anadromous adults. Initial site investigations suggest that the four (4) raceways currently on-site (south of Copco Road) could be retained, renovated, and would provide sufficient space to hold the requested 100 Coho and 200 Chinook pre-spawn adults. Early design efforts will assume that all non-cleaning (effluent) flows, which is approximately 10 cfs, will be routed to the adult ponds and used for adult holding and fish ladder attraction flows.

6.6 Peak Water Supply

Peak water demand is modeled based on the rearing scenarios presented within this TM. Considering the design limitation that the total surface water supplies from Fall Creek will not exceed 10 cfs, Table 6-3 provides an overview of the annual water budget based on initial modeling efforts.

Table 6-3. FCFH Water Requirements – Full Production (Concurrent Use of All Facilities)

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Juv. CFS	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1
Total Ladder CFS									10.0	10.0	10.0	10.0

7.0 Effluent Treatment Systems

Effluent treatment system requirements will be addressed once the final Program size is determined; estimates of total effluent treatment will be refined at a later date. We understand that an NPDES permit will be required for the Program and that all design efforts will focus on minimizing downstream water quality impacts to Fall Creek (and beyond).

8.0 Fish Passage Design and Screening Criteria

Fish passage design and screening criteria will be addressed in the Facility Design Criteria Technical Memorandum (TM 002).

9.0 Biological Reference Documents

Biological design criteria presented within this TM were obtained from the following sources/literature:

CDFW (California Department of Fish and Wildlife). 2020. CDFW Staff meeting held in Redding, CA on January 27 & 28, 2020.

CDM Smith. 2019. Basis of Design Report.

Heindel, J. 2020. Personal experience and industry standard rearing values for conservation stocks of Pacific salmon.

NMFS (National Marine Fisheries Service). 2011. Anadromous Salmonid Fish Passage Facility Design. Northwest Region. July 2011.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service. Washington, D.C.

Wedemeyer, G.A. 1996. Physiology of Fish in Intensive Culture Systems. New York: International Thompson Publishing.

PRELIMINARY BIOPROGRAM AND APPROXIMATE HATCHERY OPERATION SCHEDULE
Fall Creek Hatchery - Coho Yearling / Chinook Sub-Yearling & Yearling Program

9-Mar-20

				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
CHINOOK PRODUCTION																												
Egg Take - Green to Eyed Egg Period																												
On Station Incubation - Eyed Eggs xfr in Nov 15 at 400 CTU																												
Chinook Brood Year Rearing in TBD (~12x4x50 Vats Pond-Rls.)												Mark and Xfr by May 31																
~ 250k Chinook Yearlings																		Xfr out Nov										
Coho BY-A Early Rearing in Vats & Small Raceways											Xfr to Large Ponds																	
Coho BY-A in Production Raceways/Vats																							Xfr out Mid-April					
Coho BY-B in Early Rearing Vats & Small Raceways											Xfr to Large Ponds												Xfr to Large Ponds					
Coho BY-B in Production Raceways/Vats																												
			(F)	*49.0*	*46.0*	*43.0*	*43.0*	*43.0*	*46.0*	*50.0*	*54.0*	*54.0*	*54.5*	*54.5*	*50.0*	*49.0*	*46.0*	*43.0*	*43.0*	*43.0*	*46.0*	*50.0*	*54.0*	*54.0*	*54.5*	*54.5*	*50.0*	*49.0*
FC Sub-Yearling Chinook	*3,250,000*	*(Start Inv)*						3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000	250,000			3,250,000	3,250,000	2,000,000	2,000,000	250,000	250,000	250,000	250,000	250,000
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	*0.05*	*mm/ctu/day*						4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16	11.67			4.58	11.67	15.00	18.33	18.33	18.75	18.75	15.00	14.16
Fish Length Inches EOM - Assumes 1200 fpp & .376 g/f @ ponding				*L*				1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521	6.980		*L*	1.403	1.862	2.453	3.175	3.896	4.634	5.373	5.963	6.521
Fish Weight Grams EOM (Piper Tables; Assumes C3000)				*g/f*				0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65	45.27		*g/f*	0.376	0.871	2	4.35	7.98	13.7	20.96	28.94	37.65
Fish Per Pound EOM				*fpp*				1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #	10 #		*fpp*	1200 #	521 #	227 #	104#	57#	33 #	22 #	16 #	12 #
Biomass In Pounds EOM				*biom*				2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751	24,951		*biom*	2,694	6,241	8,819	19,180	4,398	7,551	11,552	15,951	20,751
Volume Required EOM (cu.ft.)	*0.3*	*DI*		*cu.ft.*				6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608	11,915		*cu.ft.*	6,401	11,169	11,983	20,139	3,763	5,431	7,167	8,916	10,608
Flow Required EOM (gpm)	*1.5*	*FI*		680	680	680	680	1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122	2,383			1,280	2,234	2,397	4,028	753	1,086	1,433	1,783	2,122
Assume ~4.5M green; 4,136 green eggs/tray; 1,088 trays = 136 1/2 stacks								680	1.25M Rls End Mar		1.75M Rls End May (post-mark 150/lb)				Incub:	680	680	680	680	680	1.25M Rls End Mar		1.75M Rls End May					680
CDFW Growth Reduction; Days Feed/Month																23 days	15 days	7 days	7 days	7 days	15 days							
									78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400	76,200	76,000	75,800	75,600	75,400	75,000						
FC Yearling Coho	*80,000*	*(Start Inv)*													Ration:	75%	50%	25%	25%	25%	50%	Ap. 15 Rls						
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	*0.045*	*mm/ctu/day*						4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77	5.25	1.92	1.92	1.92	5.25	4.50						
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				*L*				1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759	5.966	6.041	6.117	6.193	6.400	6.577						
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			***Brood Year A***	*g/f*				0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2	33.5	35.3	37.5	37.8	41.8	45.4						
Fish Per Pound EOM				*fpp*				1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #						
Biomass In Pounds EOM				*biom*				57	129	294	635	1,190	1,986	3,087	4,183	5,087	5,628	5,915	6,267	6,300	6,948	7,500						
Volume Required EOM (cu.ft.)	*0.3*	*DI*		*cu.ft.*				150	255	443	739	1,129	1,584	2,125	2,595	2,944	3,145	3,263	3,415	3,391	3,619	3,801						
Flow Required EOM (gpm)	*1.5*	*FI*		40	40	40	40	30	51	89	148	226	317	425	519	589	629	653	683	678	724	760						40
CDFW Growth Reduction; Days Feed/Month					15 days	7 days	7 days	7 days	15 days																			
					76,200	76,000	75,800	75,600	75,400	75,000																		23 days
FC Yearling Coho	*80,000*	*(Start Inv)*		Ration:	50%	25%	25%	25%	50%	Ap. 15 Rls											78,400	77,600	77,400	77,200	77,000	76,800	76,600	76,400
Fall Creek Monthly Mean Water Temperature (C)				9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44	7.78	6.11	6.11	6.11	7.78	10	12.22	12.22	12.5	12.5	10	9.44
Projected Growth Rate (mm/month)	*0.045*	*mm/ctu/day*			5.25	1.92	1.92	1.92	5.25	4.50										4.12	10.50	13.50	16.50	16.50	16.88	16.88	13.50	9.77
Fish Length Inches EOM - Assumes 1400 fpp & .323 g/f @ ponding				*L*	5.966	6.041	6.117	6.193	6.400	6.577									*L*	1.270	1.684	2.215	2.864	3.514	4.178	4.843	5.374	5.759
Fish Weight Grams EOM (Piper Tables; Assumes C3500)			***Brood Year B***	*g/f*	33.5	35.3	37.5	37.8	41.8	45.4									*g/f*	0.323	0.744	1.72	3.72	6.99	11.7	18.23	24.77	30.2
Fish Per Pound EOM				*fpp*	14 #	12.9 #	12.1 #	11.9 #	10.8 #	10 #									*fpp*	1400 #	610 #	263 #	122#	65 #	39 #	25 #	18 #	15 #
Biomass In Pounds EOM				*biom*	5,628	5,915	6,267	6,300	6,948	7,500									*biom*	57	129	294	635	1,190	1,986	3,087	4,183	5,087
Volume Required EOM (cu.ft.)	*0.3*	*DI*		*cu.ft.*	3,145	3,263	3,415	3,391	3,619	3,801									*cu.ft.*	150	255	443	739	1,129	1,584	2,125	2,595	2,944
Flow Required EOM (gpm)	*1.5*	*FI*		*gpm*	629	653	683	678	724	760						40	40	40	40	30	51	89	148	226	317	425	519	589
			GPM	720	1,349	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430	3,732	1,373	1,403	2,668	3,009	3,245	4,176	978	1,403	1,858	2,302	3,430
			CFS	1.6	3.0	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6	8.3	3.1	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	5.1	7.6
			Tot. Adult Flow	10.0	10.0	10.0									10.0	10.0	10.0	10.0									10.0	10.0
				OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT

Appendix D

Technical Memorandum - Operations and Maintenance for City of Yreka

Technical Memorandum

To:	City of Yreka Klamath River Renewal Corporation (KRRC)	Project:	Klamath River Renewal Project – Fall Creek Fish Hatchery
From:	Jodi Burns, Project Manager	cc:	California Department of Fish & Wildlife (CDFW) Morton D. McMillen, P.E. File
Date:	March 16, 2021	Job No.:	20-024
Subject:	Fall Creek Fish Hatchery Project Description Technical Memorandum		

Revision Log

Revision No.	Date	Revision Description
0	January 22, 2021	Initial Draft for Legal Review
1	January 28, 2021	Draft for City of Yreka Review
2	March 16, 2021	Draft incorporating City of Yreka comments

1.0 Introduction

1.1 Purpose

This technical memorandum (TM) presents a description of operation and maintenance (O&M) activities required for the intake structure for the Fall Creek Fish Hatchery Project (Project). This TM presents a description of intake structure and the O&M activities required to maintain the intake structure at Dam A. The TM also discusses coordination of O&M activities with the City of Yreka at their existing Diversion A and Diversion B intake structures specific to access, sediment flushing, and flow management.

1.2 Location

The Project is located in Siskiyou County northwest of Iron Gate Dam near Yreka, California. The Project is located at the existing Fall Creek Fish Hatchery site adjacent to Fall Creek.

1.3 Background

The Klamath River Renewal Project includes removal of four dams along the Klamath River. As part of the overall Project, the existing Iron Gate Fish Hatchery (IGFH) production will be moved to the Fall Creek Hatchery site. The existing hatchery site will be modified to upgrade existing facilities and construct new facilities for Coho and Fall Run Chinook Salmon production. California Oregon Power Company built the Fall Creek Fish Hatchery (FCFH) in 1919 as compensation for loss of spawning grounds due to the construction of Copco No. 1 Dam. FCFH was operated by the California Department of Fish and Wildlife (CDFW) to raise approximately 180,000 Chinook Salmon yearlings in continuous operation between 1979 and 2003, when it ceased operations and hatchery production on the Klamath River was consolidated at Iron Gate Fish Hatchery (IGFH). The existing Federal Energy Regulatory Commission (FERC) license requires fish production at Iron Gate Fish Hatchery. As part of the Amended License Surrender Application (ALSA) filed by Klamath River Renewal Corporation (KRRC), the fish production is proposed to be moved to FCFH for the purpose of license surrender.

The National Marine Fisheries Service (NMFS) and CDFW have determined the priorities for fish production at FCFH under the proposed Fish Hatchery Plan. As a state and federally listed species in the Klamath River, Southern Oregon Northern California Coastal (SONCC) Coho Distinct Population Segment (DPS) production is the highest priority for NMFS and CDFW, followed by Chinook Salmon, which support tribal, sport, and commercial fisheries. Steelhead production is the lowest priority. Due to limited water availability and rearing capacities at the two facilities, and recent low hatchery steelhead returns, NMFS and CDFW have determined that steelhead production will be discontinued. Table 1-1 summarizes the NMFS/CDFW goals for fish production at FCFH (data compiled from CDFW information).

Table 1-1. Fall Creek Hatchery – Fish Production Goals

Species (Juvenile Life History)	Adult Return*	Incubation Start Date	Incubation Start Number	Target Release Dates	Release Number	Release Size
Coho (Yearling)	Oct. – Dec.	Oct. – Mar.	120,000	Mar. 15 – May 1	75,000	10 fpp
Chinook (Sub-Yearling)	Oct. – Dec.	Oct. – Mar.	4.5M**	Pre-Mar. 31	1,250,000	520 fpp
Chinook (Sub-Yearling)	Oct. – Dec.	Oct. – Mar.	-	May 1 – June 15	1,750,000	90-100 fpp
Chinook (Yearling)	Oct. – Dec.	Oct. – Mar.	-	Oct. 15 – Nov. 20	250,000	10 fpp

*Adult trapping period from Iron Gate Fish Hatchery data

** Estimated Total Green Egg Requirement at Spawning
fpp = fish per pound

Currently CDFW is the operator of IGFH and FCFH under the existing license, and CDFW will be operator of future FCFH under a license surrender. Since ceasing operations in 2003, the FCFH raceways remain and CDFW continues to run water through the raceways. The facility has retained its water rights, but substantial infrastructure improvements will be required to achieve the fish production goals following dam removal. FCFH improvements will occur within the existing facility footprint to minimize environmental and cultural resource disturbances, and the facility must be in operation prior to the drawdown of the Iron Gate Reservoir. The water rights and maximum available flow for the Project are set at 10 cubic feet per second (cfs). This water right is non-consumptive and water must be returned to Fall Creek with final designs addressing National Pollutant Discharge Elimination System (NPDES) water quality permit considerations. The proposed Fish Hatchery Plan requires CDFW to employ Best Management Practices to minimize pollutants and therapeutants being discharged to Fall Creek during hatchery operations.

The City of Yreka's water right allows a diversion of up to 15 cfs (instantaneous) or 6,300-acre feet per annum (AFA). However, the City is required to maintain a minimum flow of 15 cfs in Fall Creek downstream of Daggett Road as measured by at USGS Gage Station No. 11512000.

2.0 Fall Creek Fish Hatchery Intake Structure

2.1 Introduction

This section presents a general summary of the Fall Creek Fish Hatchery intake structure at Dam A and O&M activities required.

2.2 FCFH Intake Description

A hatchery intake structure will be located along the southeast bank of Fall Creek directly adjacent to Dam A and opposite the City of Yreka intake structure (see Figure 2-1 and Figure 2-2). The intake will be constructed of concrete and will divert flows up to 10 cfs from Fall Creek. A buried 24-inch-diameter pipe will supply the site and will divide flows into four buried water supply pipes to deliver flow to the various hatchery facilities. A debris screening system will be added at the entrance to the new intake structure to prevent large sediment, detritus, and other debris from entering the intake chamber. The debris screening system will be equipped with an automated screen-cleaning system that will operate at regular intervals or based on an acceptable head differential across the screen. Behind each screen will be stop log guide slots for isolation of the pipeline, or closure of one of the screen slots for general maintenance.

Inside the intake structure, the 24-inch-diameter supply line will be set in the concrete wall at a sufficient depth to preclude significant air entrainment at the pipe entrance. After the flow split, the four hatchery facility supply pipelines will be equipped with magnetic flow meters and isolation valves located in a concrete vault that will transmit flow rates to a programmable logic controller (PLC) located in the electrical room connected to the Chinook Incubation Building. The intake will also be equipped with a sediment sluiceway outside of the intake chamber, for bypassing sediment and bedload that may accumulate at the toe of the intake screens

Figure 2-1. Intake Structure Location and City of Yreka Intake (Source: McMillen Jacobs)

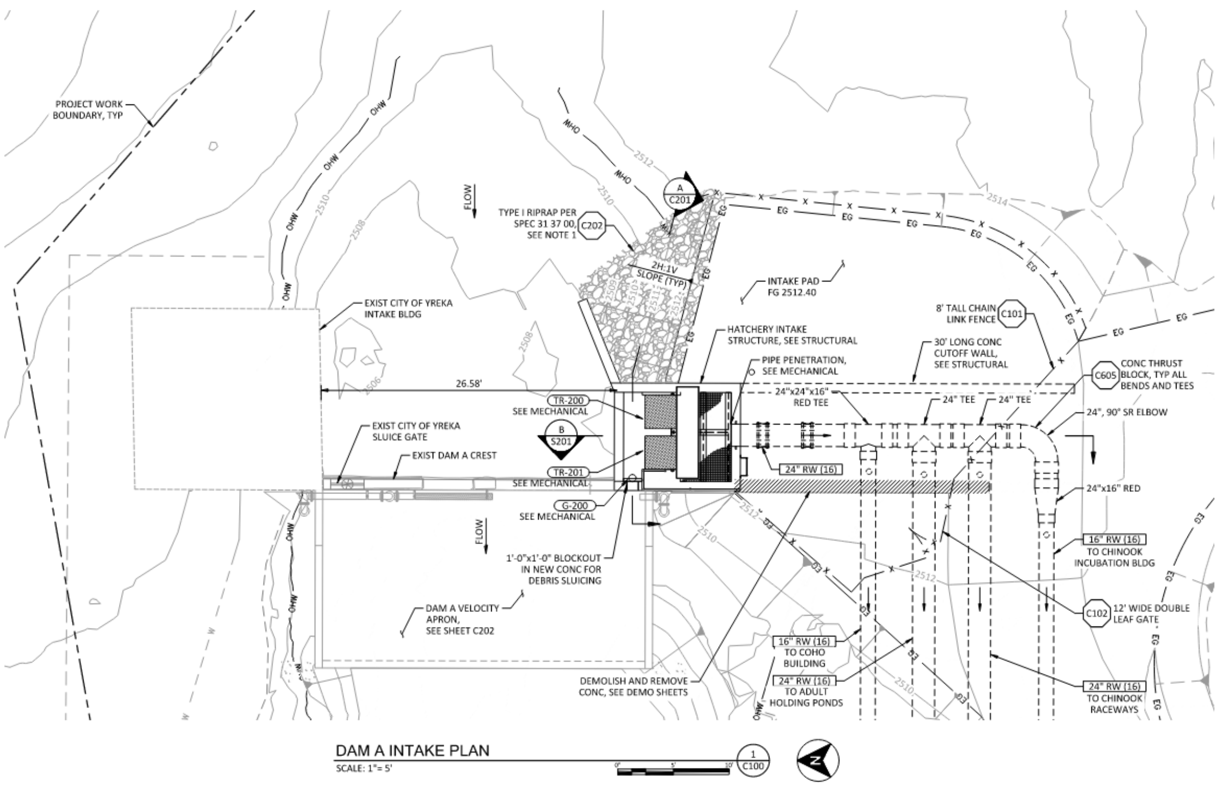


Figure 2-2. Dam A – FCFH Intake Plan

2.3 FCFH Intake O&M

2.3.1 Fall Creek Flow Summary

The USGS Gage Station No. 11512000 was used to estimate the hydrology of Fall Creek near the proposed FCFH site. This gage station is located approximately two-thirds of a mile downstream from the existing lower raceway bank at the site, and therefore provides the best representation of flows at the site. The data record consists of daily average discharge, and extends from 1933 to 1959, and then from 2003 to 2005. **Error! Reference source not found.** below presents the 50% and 95% Exceedance Flow estimated for Fall Creek at USGS Gage Station No. 11512000.

Table 2-1. Fall Creek Flow at USGS Gage Station No. 11512000

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Estimated Fall Creek 50% Exceedance Flow (cfs) [1]	41	44	48	43	36	33	32	31	33	34	37	38
Estimated Fall Creek 95% Exceedance Flow (cfs) [1]	28	30	33	30	28	27	25	25	25	28	29	29

Note 1: The City of Yreka (City) flow is not accounted for in the Fall Creek flow numbers presented above as the City intake is upstream of the USGS gage.

Fall Creek water is supplied through two diversion structures: Dam A and Dam B. PacifiCorp's Fall Creek Powerhouse water supply includes a 16.5 cfs water right from Spring Creek (see Figure 2-3). PacifiCorp maintains an earthen dam on Spring Creek which conveys the water down a long canal. The Spring Creek diversion canal is approximately 1.7 miles long and enters Fall Creek about 1.7 miles upstream of the Fall Creek canal diversion. There are several unnamed springs that are captured in the Spring Creek canal; and there are two other non-PacifiCorp diversions on Spring Creek, one approximately 0.1 mile above the PacifiCorp diversion; the other about 0.3 miles below PacifiCorp's diversion. These diversions are commonly referred to as the upper and lower Taylor diversions.

Figure 2-3. Spring Creek diversion canal above PacifiCorp's Fall Creek Powerhouse.

2.3.2 FCFH and City of Yreka Flow Summary

The FCFH intake is directly adjacent to Dam A and opposite the City of Yreka intake structure. The FCFH peak water demand of 9.3 cfs projected for May of each year immediately prior to Chinook sub-yearling releases and when juvenile Coho are in early rearing containers. However, a maximum flow of 10 cfs will be diverted during the months of September through December during adult collection. The monthly FCFH flow projection by month is presented in Table 2-2.

The City water system intake is located opposite of the FCFH intake. The existing operation of the City water system, according to the City, includes up to three pumps that will be called upon to run based on tank level set points at the 135,000-gallon Klamath Pass tank. Three of the available four pumps are fixed speed and can discharge about 2500 gallons per minute (gpm), therefore, flows rates are about 6 cfs for one pump running, 11 cfs for two pumps running, and 15 cfs for all three pumps in operation. The fourth (spare) pump is VFD controlled and can maintain a constant tank level sometimes in the winter when only one pump is sufficient.

Figure 2-4 and Figure 2-5 graphs were supplied by the City and show the typical flow rates in million gallons per day (MGD) for the winter and summer scenarios. During the winter months, as shown in Figure 2-4, the City water system typically conveys approximately 4 million gallons per day (MGD) or 6 cfs. During the summer months, as shown in Figure 2-5, the City water system typically conveys up to approximately 7 MGD or 11 cfs.

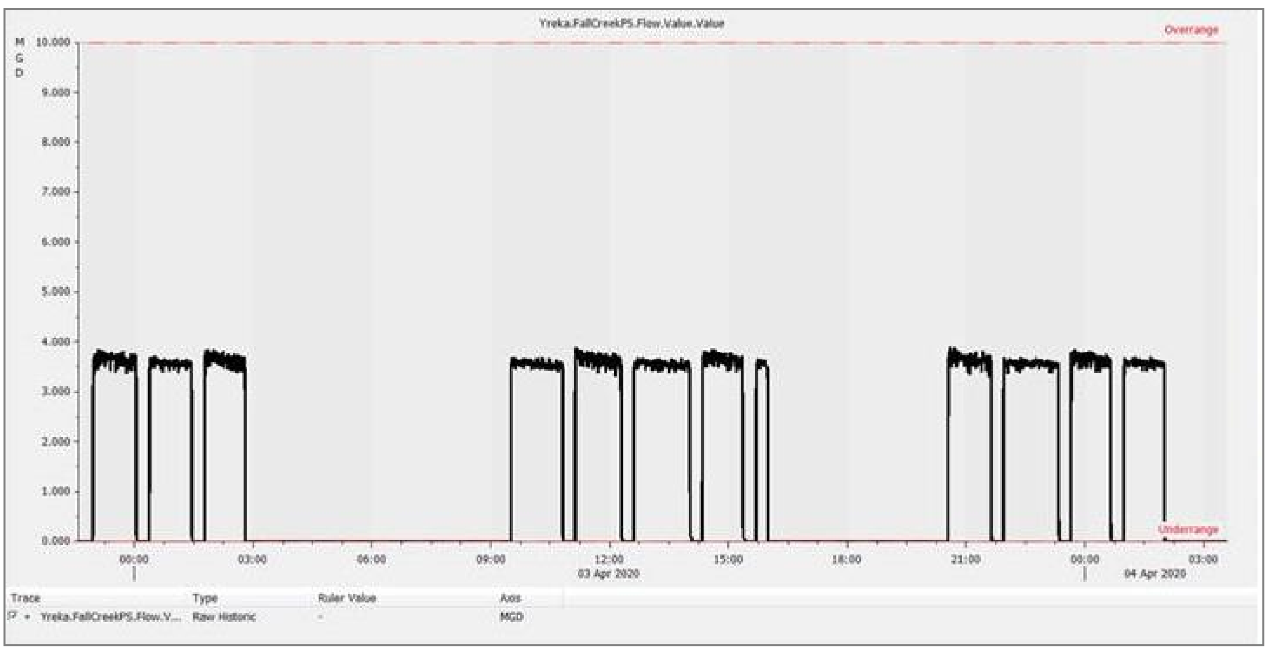


Figure 2-4. City of Yreka Winter Flow Rates in MGD.

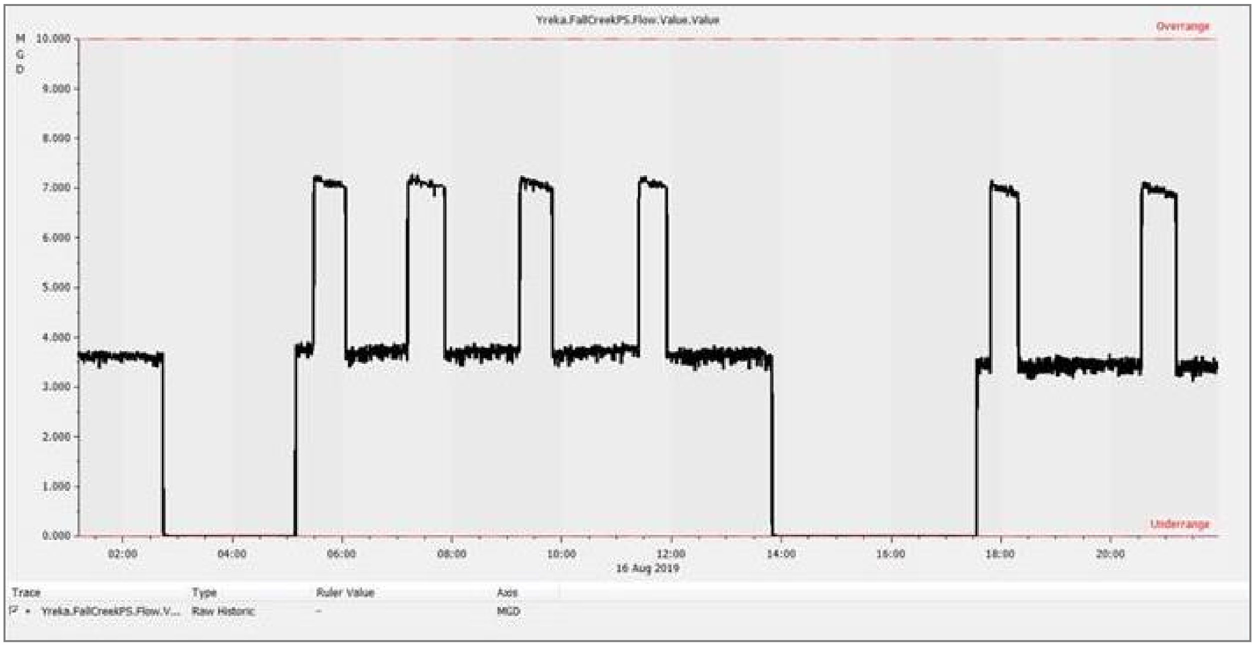


Figure 2-5. City of Yreka Summer Flow Rates in MGD.

The projected annual water budget by month diverted at Dam A to support the flow requirements at the City and FCFH are provided below in Table 2-2.

Table 2-2. FCFH and City of Yreka Water Requirements

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FCFH Intake Flow (cfs)	3.1	5.9	6.7	7.2	9.3	2.2	3.1	4.1	10.0	10.0	10.0	10.0
City of Yreka Typical Flow (cfs)	6	6	6	6	11	11	11	11	11	11	6	6
Total Flow Diverted from Fall Creek at Dam A (cfs)	**9.1**	**11.9**	**12.7**	**13.2**	**20.3**	**13.2**	**14.1**	**15.1**	**21**	**21**	**16**	**16**

Table 2-3 summarizes the flow diversion at Dam A to provide flow to the FCFH and the City, as compared to the 95% and 50% exceedance flow information at USGS Gage Station No. 11512000. It should be noted that the historic flow diverted from Fall Creek to support the City of Yreka water system is not accounted in the flow estimates at USGS Gage Station No. 11512000. When comparing the flow diverted at Dam A as compared to the flow at USGS Gage Station No. 11512000, it is clear that the flow available in Fall Creek exceeds the flow diverted at Dam A.

Table 2-3. Flow Comparison Table

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow Diverted from Fall Creek at Dam A (cfs)	**9.1**	**11.9**	**12.7**	**13.2**	**20.3**	**13.2**	**14.1**	**15.1**	**21**	**21**	**16**	**16**
Estimated Average Fall Creek Flow (cfs)	47	50	54	49	47	44	43	42	44	45	43	44
Historic Minimum Flow in Fall Creek (cfs)	34	33	35	34	36	35	34	32	33	38	32	34

2.3.3 Flow Operation during Fall Creek Powerhouse Downtime

2.3.3.1 Historical Operation during Fall Creek Powerhouse Downtime

The Fall Creek Powerhouse has an approximate two-week scheduled downtime that typically is scheduled in the spring and usually coincides with the last week of May of each year. This scheduled powerhouse downtime is to complete planned maintenance of the powerhouse. During planned powerhouse maintenance or unplanned outages at the Fall Creek Powerhouse, flow through the Fall Creek Powerhouse is turned off and therefore the flow is directed down Fall Creek toward Dam B. The City of Yreka begins the operation of diverting flow from Dam B to Dam A via an existing 24-inch diameter pipe. The 24-inch diameter pipe connects to the existing City intake, as shown in Figure 2-6, to maintain flow to the City of Yreka and after completion of construction, will provide flow to the FCFH. The City has stated that when the flow is turned off at the powerhouse, the City completes fish rescue in the channel upstream of Dam A to the discharge of Fall Creek Powerhouse. Flow continues to spill over Dam A to keep the tailrace channel downstream of Dam A flowing. The City has stated that historically there is adequate flow to meet their City's demand and up to three of the City's pumps (16 cfs) could operate, if needed. However, as described previously the pump station typically operates one pump, or 6 cfs, during winter operations and two pumps, or 11 cfs, during summer operation. During the operation of the flow transfer from Dam B to Dam A, the water can be turbid for a period of approximately 10 hours. Based on discussions with the City, we understand the City typically shuts down the intake when turbidity levels exceed 5 NTU's due to significant increases in chlorine demand at the pump station chlorination facilities.

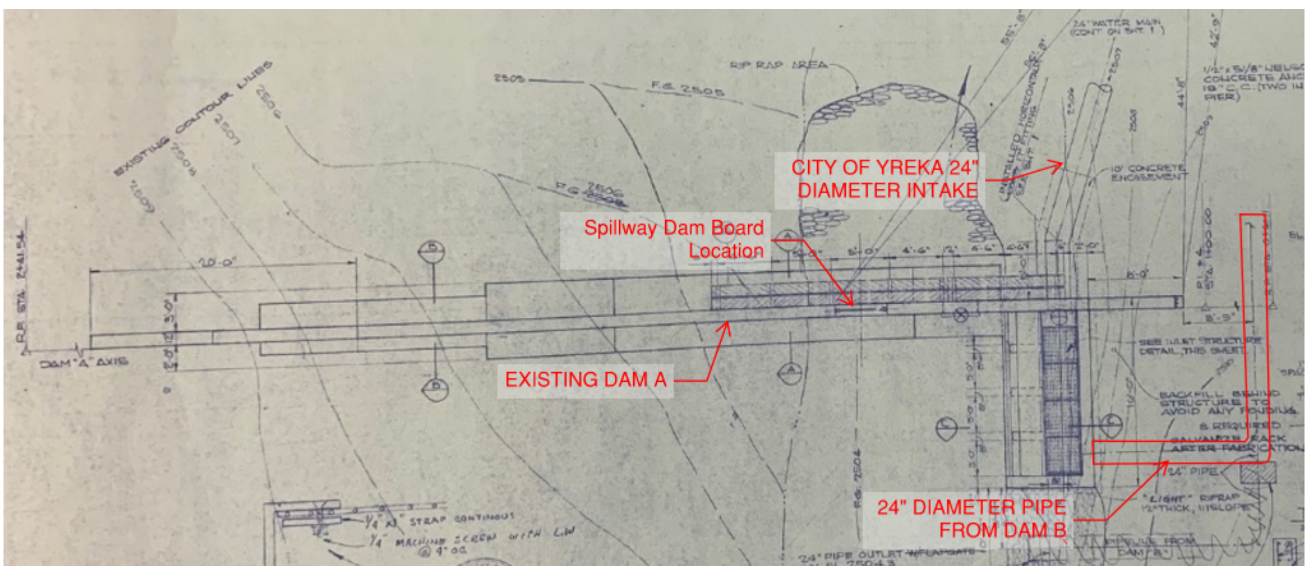


Figure 2-6. City of Yreka Intake Structure Historical Design Drawings.

2.3.3.2 Proposed Operation during Scheduled Maintenance at Fall Creek Powerhouse

The estimated maximum flow capacity of the 24-inch diameter pipe from Dam B to Dam A is approximately 27 cfs, as shown in Figure 2-7. However, this flow rate could only be achieved if the headwater upstream of the 24-inch diameter pipe was 7.5 feet above the invert of the pipe which would correspond to 460 cfs spilling over Dam B, per Figure 2-8. This is not a realistic flow rate for the Fall Creek watershed, as the peak historical flow for the watershed is approximately 474 cfs.

During the month of May when planned maintenance at the Fall Creek Powerhouse typically coincides, the flow rate in the Fall Creek watershed is approximately on average 36 cfs (per Table 2-3). After the FCFH is in operation, May will be a peak flow month (9.3 cfs) to support rearing activities at FCFH and also coincides with the release of approximately 1.75M Chinook sub yearlings (per Table 1-1). It is recommended that the City, KRRC, and CDFW coordinate with PacifiCorp to move the planned powerhouse maintenance to an agreed upon time period when the combined flow demand at FCFH and the City is low, if possible. If PacifiCorp agrees to move the planned maintenance, it is estimated that approximately 17 cfs can be transferred to Dam A from Dam B, while spilling a minimum of approximately 8 cfs at Dam B. To meet the City and FCFH demand while maintaining flow in the tailrace channel downstream of FCFH, the City or CDFW will be required to pull the spillway dam boards at Dam A (see Figure 2-6) to spill flow into the tailrace channel downstream of Dam A. By making this operational change during planned maintenance, the tailrace channel downstream of Dam A will remain flowing.

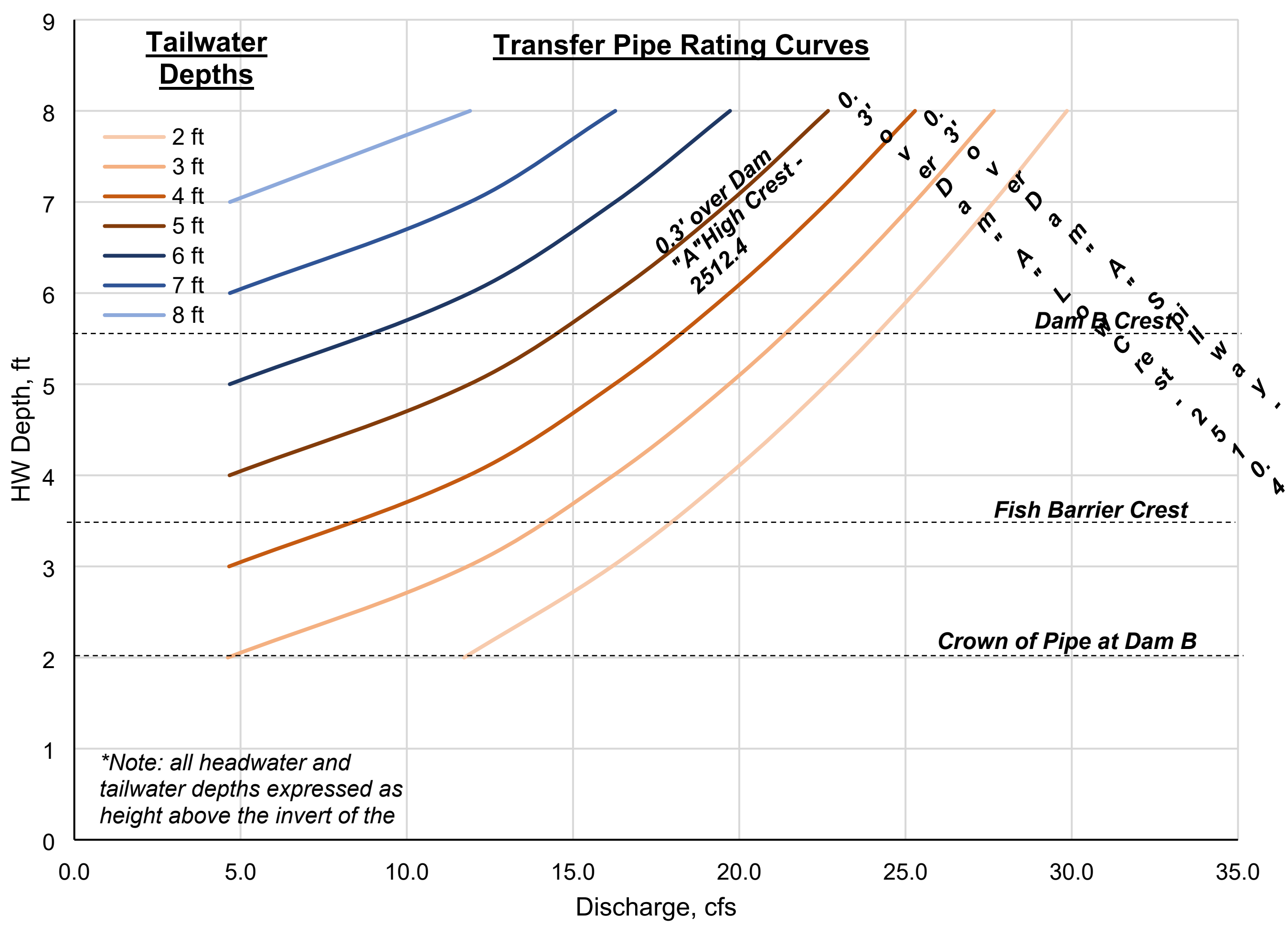


Figure 2-7. Rating Curve of the 24-inch Diameter Dam B to Dam A Diversion Pipeline.

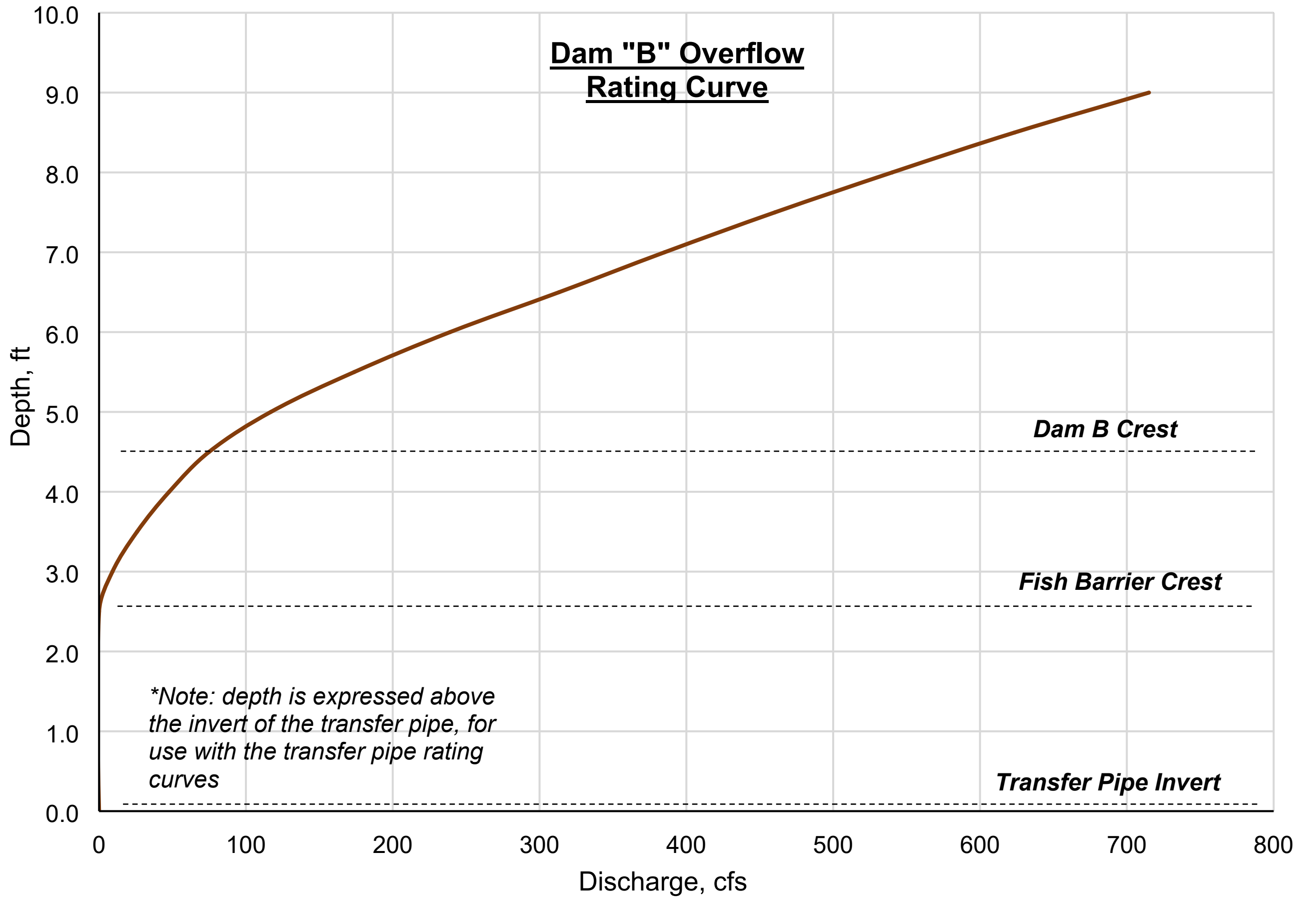


Figure 2-8. Rating Curve of the 24-inch Diameter Pipeline that Diverts Flow from Dam B to Dam A.

2.3.3.3 Proposed Operation during Unscheduled Outages at Fall Creek Powerhouse

Fall Creek Hydropower Powerhouse Facility provides the flow to Fall Creek upstream of Dam A. The hydraulic capacity of the Fall Creek Powerhouse Facility is 50 cfs. The powerhouse is equipped with a Howell bunger valve to bypass the hydropower units during a load rejection or if the hydroelectric units need to be bypassed. In this scenario, flow is maintained in the tailrace channel to support the City and FCFH demands. However, if flow is turned off at the Fall Creek Powerhouse due to penstock failure or other hydropower facility maintenance needs in which flow cannot be bypassed through the Howell bunger valve, flow will be required to be diverted from Dam B to Dam A to support City and FCFH flow demands. The flow transfer from Dam B to Dam A will operate similar to the Fall Creek Powerhouse planned maintenance scenarios described previously. It is estimated that 17 cfs is the optimum flow rate in the existing 24-inch diameter pipe from Dam B to Dam A based upon historical available flow in the Fall Creek watershed and the rating curve developed for the existing 24-inch diameter pipe (see Figure 2-7). Any flow in excess of the 17 cfs flow diverted through the existing 24-inch diameter pipe to Dam A will spill over Dam B. When reviewing historical data from the USGS gage, the minimum flow rate recorded in Fall Creek over the period of record is 32 cfs, therefore, a total of 15 cfs will spill over Dam B after 17 cfs is diverted to Dam A. This hypothetical scenario based upon the historical minimum flow scenario would meet the minimum Fall Creek flow requirement in the City's agreement. City and FCFH flow demands during the months of May, September, and October will not be able to be achieved, per Table 2-3 above, if peak flow rates are required when flow is being transferred from Dam B to Dam A. During this very rare scenario, the City and FCFH will need to coordinate flow diversion to ensure adequate flow for the City and FCFH fish needs while maintaining a minimum flow of at least 2 cfs in the tailrace channel downstream of Dam A. Also, it is recommended that oxygen tanks or oxygen stones be stored on the FCFH site to minimize fish mortality if flow to the FCFH is suddenly turned off.

2.3.4 Debris Control

According to the City, typical debris that accumulates on their screens includes leaves, pine needles. and algae/moss. Larger material such as limbs are removed above the powerhouse or on the bar screens at Dam B.

2.3.4.1 Debris Screens

The debris screens at the intake of the hatchery will consist of two vertically oriented traveling screens located in guide slots immediately upstream of the hatchery supply piping inlet. The debris screens will serve to filter out larger debris and detritus from entering the facility to minimize the risk of clogging small piping and valves. The screens will have 1-inch clear openings and will be mobilized such that any debris captured on the upstream face is lifted out of the water to a spray wash system, where any material caught on the screen will be dislodged and fall into a debris trough. The debris trough will rest on the operator's platform atop the intake structure and will be cleaned out periodically by operations and maintenance staff. The screen and spray wash system can have three different modes of operation:

- The screen and spray wash may be set to automatically operate at time intervals defined by hatchery personnel, based on site experience.
- The screen and spray wash may be set to automatically operate when a set head differential is measured across the screen by the surrounding level sensors.
- The screen and spray wash may be set by manual actuation, as necessary, by hatchery personnel.

The spray wash will consist of a pump and piping system that draws water from the downstream side of the screen and conveys it to a spray bar with nozzles that will extend across the screen above the debris trough. It is expected that when the spray wash system is engaged, there will be some minor losses to evaporation and aberrant sprays, but these losses are expected to be minimal.

2.3.4.2 Intake Sluice Gate

As flow passes over the concrete lip at the entrance of the intake structure, some debris is anticipated to settle out of the flow immediately upstream of the debris screens. A cast iron sluice gate with self-contained frame will be located on the upstream face of Dam A, intended to discharge any collected debris from the intake structure though a new 1-foot square penetration through the dam. This gate is anticipated to be normally closed and opened via a handwheel-actuated rising stem by hatchery personnel as part of routine maintenance activities. The sediment bypass gate will be operated in conjunction with the similar gate on the City's intake structure to enhance sediment movement past the intake structure during higher flow conditions, particularly when the powerhouse bypass valve is in operation which creates the highest turbidity conditions in the creek. Based on discussions with the City, we understand the City typically shuts down the intake when turbidity levels exceed 5 NTU's due to significant increases in chlorine demand at the pump station chlorination facilities. It should be noted that the FCFH can operate at higher turbidity levels for short periods of time during the early rearing and final rearing cycles with minimal impact to fish health. FCFH staff will be required to monitor turbidity levels and adjust operation of the facility to adjust to the turbidity levels as needed.

2.3.5 Isolation Valves

Immediately downstream of the intake structure the intake piping branches into four individual supply pipes and enters a metering vault. Within this vault, each pipe will be provided an isolation gate valve to allow shutting off flow to any of the structures within the hatchery. The valves are anticipated to be normally open and are intended to be closed during major maintenance activities or whenever a complete dewatering of the facility is required. Each valve will be a flanged, ductile iron, resilient seated gate valve with a manual 2-inch square nut actuator.

2.3.5.1 Additional Measures for Debris Removal

Fall Creek Hydropower Powerhouse Facility provides the flow to Fall Creek upstream of Dam A. The hydraulic capacity of the Fall Creek Powerhouse Facility is 50 cfs. The powerhouse is equipped with a Howell bunger valve to bypass the hydropower units during a load rejection or if the hydroelectric units need to be bypassed. When flow is bypassed through the Howell bunger valve the channel upstream of Dam A will scour as a result of the jetted flow, and, therefore, larger debris and rock could accumulate upstream of the FCFH intake that may be too large to flush through the Dam A sluice gates. Around the FCFH intake there is a gravel intake maintenance pad, see drawing C200 in the attached drawings and Figure 2-9, where a small excavator can be mobilized to remove any material that has accumulated upstream of the intake over time. This type of maintenance will be infrequent but may be required over time to maintain sediment accumulation at Dam A.

According to the City, sufficient supplemental flow from the Dam B could also reduce sediment build-up by scouring the ponded area above Dam A. In the past before their debris screens were self-cleaning, the City would crack open the valve from Dam B to increase the flow velocity passing across and in front of their debris screens to help reduce the frequency of cleaning. It should be noted that maintenance will be required at Dam B when water is being diverted from B-Dam.

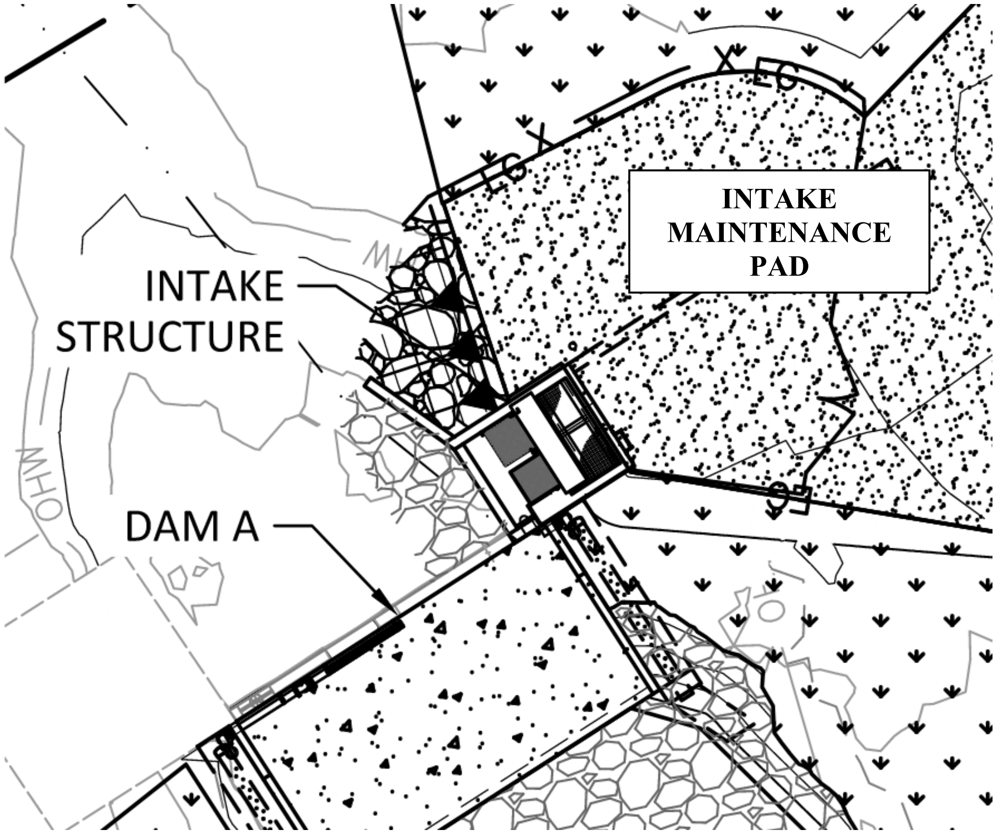


Figure 2-9. FCFH Intake Structure and Dam A Plan View.

2.3.6 City of Yreka Intake Access

The City will be provided access to the intake through the FCFH access roads. McMillen Jacobs has had discussions with the City about providing a pedestrian bridge across Dam A. This pedestrian bridge will provide the City with access to their intake from the FCFH side of Dam A. This will allow City employees can park on the FCFH side and walk across the pedestrian bridge to maintain their intake.

3.0 Summary

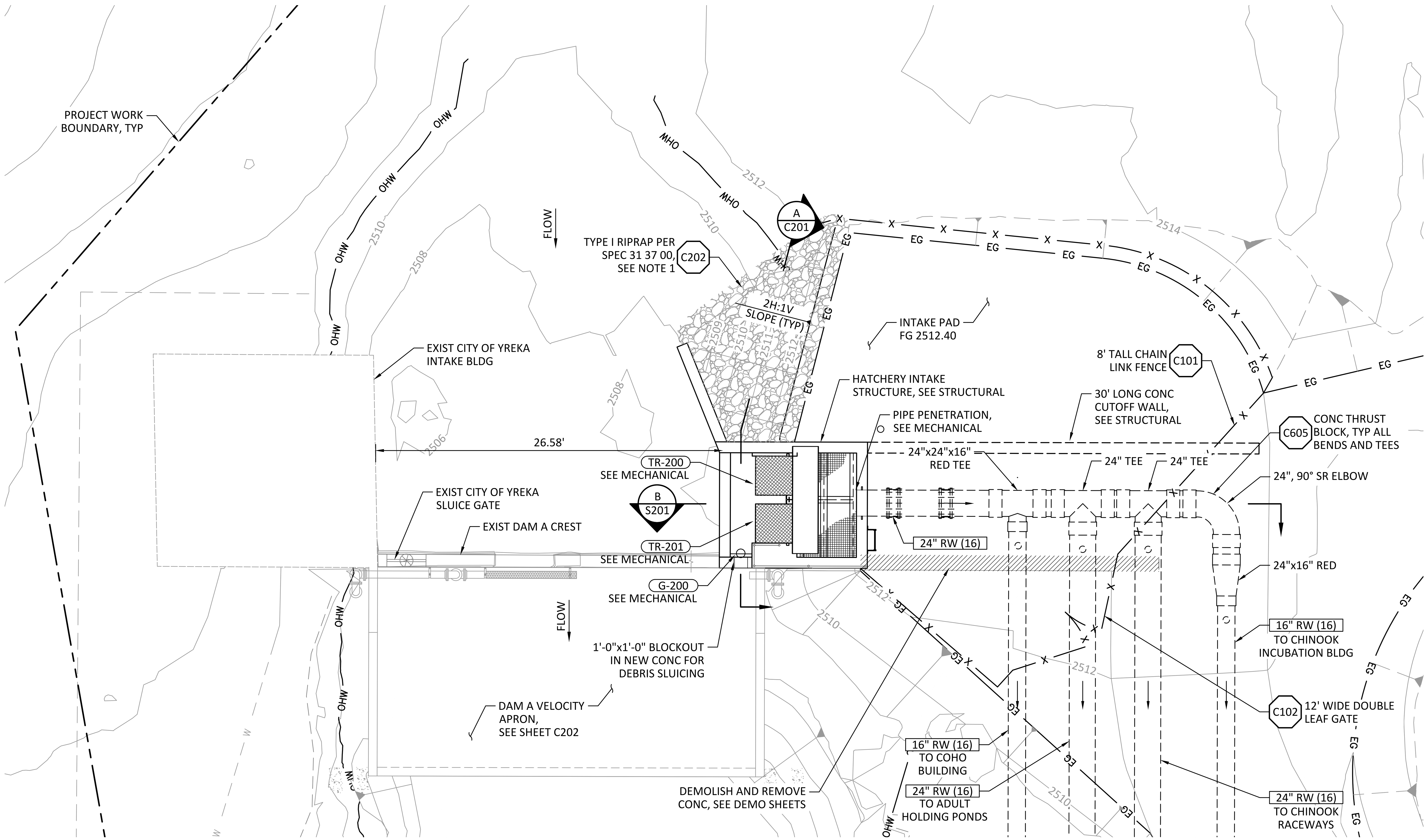
In summary, when comparing the USGS gage data with the projected flow diversion at Dam A to support fish rearing at the FCFH and the water system for the City of Yreka there is adequate flow within Fall Creek to support the FCFH and City diversions while maintaining flow in Fall Creek downstream of Dam A. It is recommended that the City, KRRC, and CDFW coordinate with PacifiCorp to move scheduled Fall Creek Hydropower maintenance activities to a date agreed upon by all parties to ensure that City and FCFH demand is maintained while spilling flow over Dam A to the tailrace channel downstream. If flow diversion from Dam B to Dam A is required during peak flow months and the rare occurrence of non-scheduled downtime at the Fall Creek Powerhouse, the City and FCFH diversion will need to be coordinated as it is estimated that approximately 17 cfs can be diverted in the existing 24-inch diameter pipe rating curve and the historical available flow in the Fall Creek watershed.

The FCFH intake has been designed to provide adequate maintenance of the FCFH intake structure to clean debris and material that would accumulate around the intake and upstream of Dam A. The intake has been designed to include a debris screen to screen out debris from the flow entering the FCFH, a sluice gate to allow flushing of accumulated debris upstream of the FCFH intake and Dam A, and a large intake maintenance pad will be constructed to allow for a small excavator to remove accumulated material upstream of Dam A, as required. CDFW and the City will operate the sluice gates to help manage debris accumulation above Dam A, as needed. The City will be provided access to the intake through the FCFH access roads. A pedestrian bridge will be constructed across Dam A to provide access to the City's intake from the FCFH side of Dam A. This will allow City employees to park on the FCFH side of Dam A to access the City's intake.

Attachment 1: Figures

SHEET NOTES:

1. LARGE DIAMETER ROCK IS AVAILABLE ON-SITE FROM THE NORTH PAD GRADING. IF ROCK IS ABLE TO BE AMENDED TO MEET SPECIFICATION 31 37 00, IT MAY BE USED IN THIS LOCATION FOR RIPRAP. EXTEND RIPRAP LINING A MINIMUM OF 3.0 FEET BEYOND CONSTRUCTED SLOPE LIMITS.
2. SEE MECHANICAL FOR ALL GATES AND EQUIPMENT.



DAM A INTAKE PLAN

SCALE: 1"= 5'

0" 5' 10'

1 C100

REV	DATE	BY	DESCRIPTION
0	10/28/20	MDM	ISSUED FOR CONSTRUCTION

WARNING

0 1/2 1

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

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

FALL CREEK FISH HATCHERY

DAM A INTAKE PLAN

DESIGNED A. LEMAN

DRAWN J. LAHMON

CHECKED V. AUTIER

PROJECT DATE 10/28/20

DRAWING

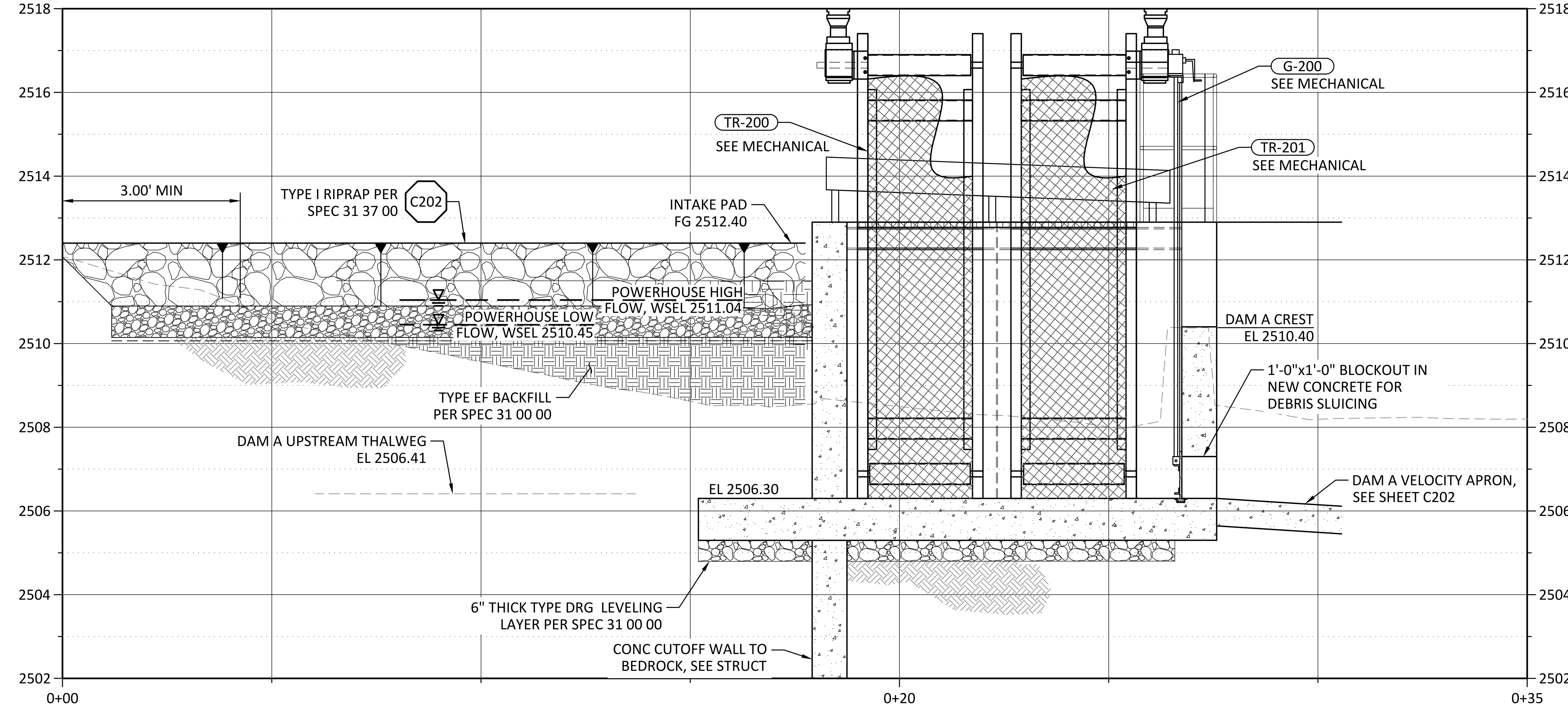
C200

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C200.dwg Plot date: Oct 28, 2020 01:18pm, CAD User: Guerrero

SHEET NOTES:

1. DEMOLISH DAM A CONCRETE PER DEMOLITION SHEETS.
2. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.



SECTION A C200
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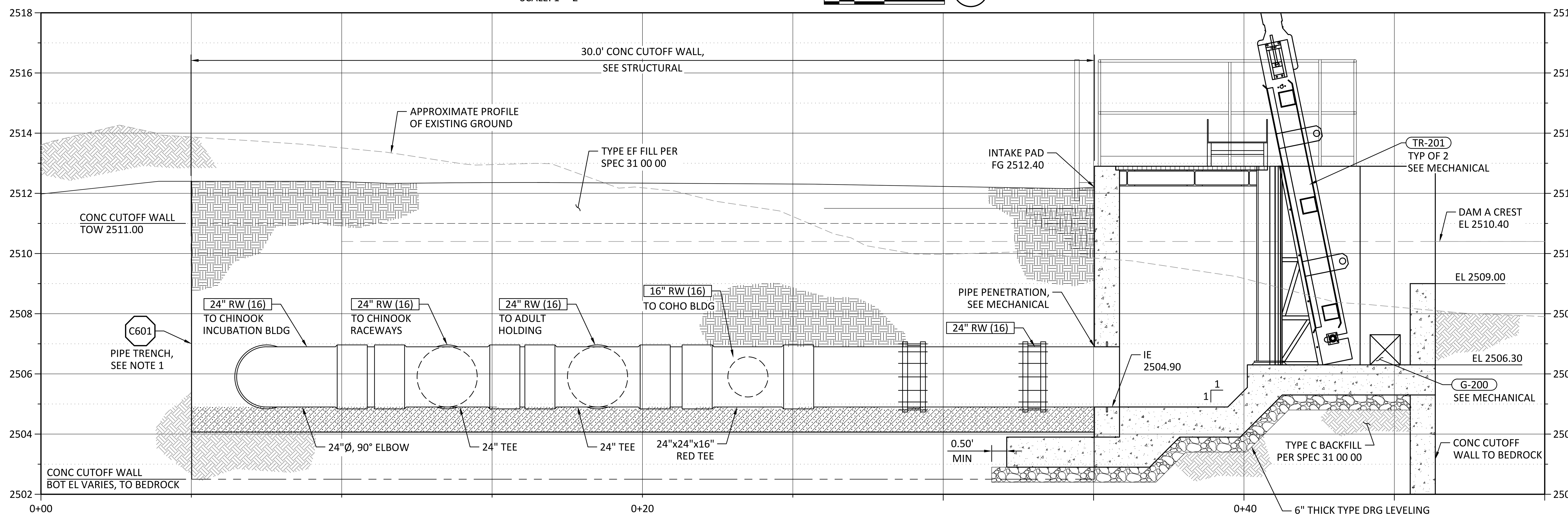

SECTION B C200
SCALE: 1"= 2'

REV	DATE	BY	DESCRIPTION
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WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

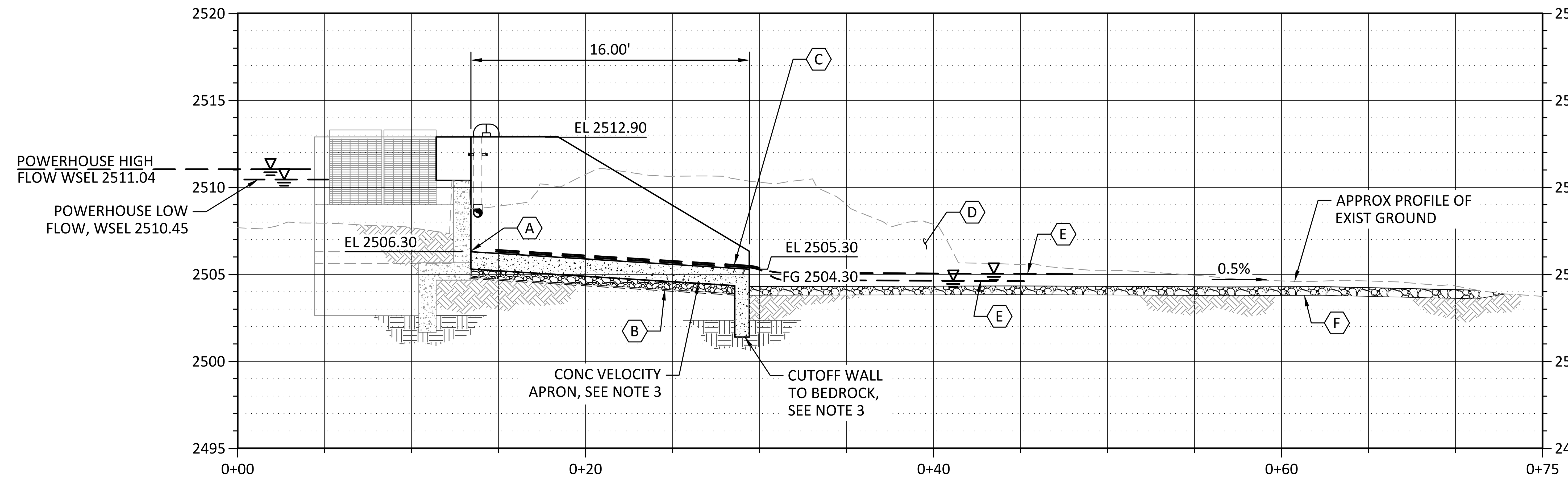
KLAMATH RIVER RENEWAL CORPORATION
FALL CREEK FISH HATCHERY
DAM A INTAKE SECTIONS

DESIGNED A. LEMAN
DRAWN J. LAHMON
CHECKED V. AUTIER
PROJECT DATE 10/28/20

DRAWING C201

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C201.dwg Plot date: Oct 28, 2020 01:19pm, CAD User: Guerrero



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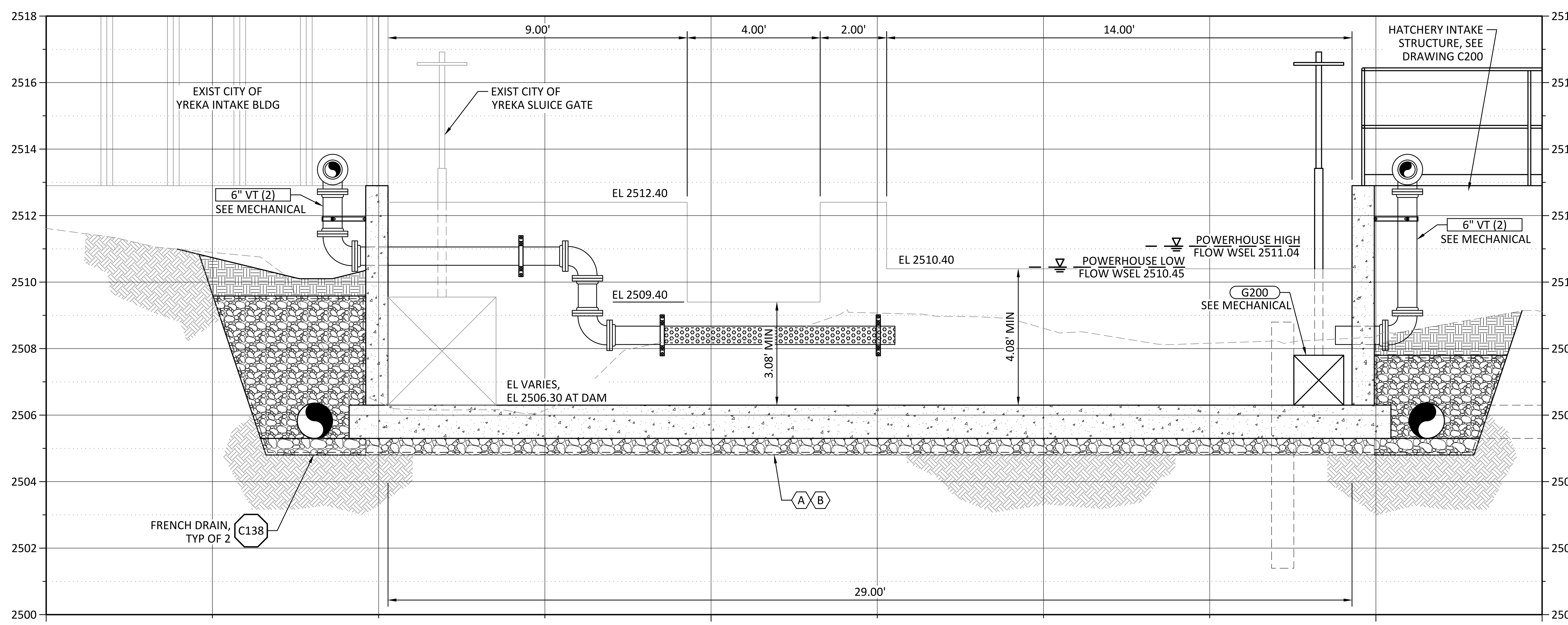

SECTION B C202
SCALE: 1"= 5'

SHEET NOTES:

1. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.
2. EXIST DAM A DIMENSIONS ARE BASED ON AS-BUILT DATA PROVIDED BY THE CITY OF YREKA, BUT MAY BE SUBJECT TO SOME VARIATION. PRIOR TO DEVELOPMENT OF SHOP DRAWINGS, CONTRACTOR TO CONFIRM ALL EXISTING DIMENSIONS OF DAM. IF DIMENSIONS VARY SIGNIFICANTLY FROM THOSE REPORTED, CONTRACTOR TO COORDINATE WITH THE OWNER AND ENGINEER.
3. FOR CONC VELOCITY APRON DETAILS AND DIMENSIONS, INCLUDING CONNECTIONS TO DAM A, WALL THICKNESS, WALL PENETRATIONS, ETC, SEE STRUCTURAL. FOR VENT PIPING DETAILS AND DIMENSIONS, INCLUDING PIPE SUPPORTS, PERFORATIONS, ETC, SEE MECHANICAL.

SHEET KEY NOTES:

A. HAND EXCAVATION WILL BE REQUIRED WITHIN THE FOOTPRINT OF DAM A AND THE DAM A FOOTING, AS INDICATED IN THE STRUCTURAL DRAWINGS. IN ACCORDANCE WITH NOTE 2 ABOVE AND THE UNCERTAINTY ASSOCIATED WITH THE AS-BUILT DRAWINGS, THE CONTRACTOR SHALL EXERCISE CAUTION DURING EXCAVATION OUTSIDE OF THESE LIMITS TO ENSURE THAT THE DAM A CONC FOOTING IS NOT IMPACTED.

B. OVER EXCAVATE 6" BELOW THE BOTTOM OF THE CONC VELOCITY APRON, PLACE AND COMPACT 6" THICK TYPE DRG LEVELING LAYER WITH 12oz NON-WOVEN GEOTEXTILE UNDERLAY PER SPEC 31 00 00 AND 31 05 19. AT EDGE OF STRUCTURE, TIE-IN THE LEVELING LAYER TO THE DRAIN ROCK OF THE TWO PERIPHERAL FRENCH DRAINS. IF OVER EXCAVATION OCCURS BELOW THE TYPE DRG LEVELING LAYER, BACKFILL TO 6" BELOW THE BOTTOM OF THE STRUCTURE WITH TYPE C FILL COMPACTED TO MIN 90% MAX DRY DENSITY PER ASTM D 1557 (MODIFIED PROCTOR). IF BEDROCK IS ENCOUNTERED AT OR ABOVE THE ELEVATION OF THE 6-INCH OVEREXCAVATION, CONTRACTOR SHALL NOTIFY ENGINEER IMMEDIATELY AND AWAIT DIRECTION.

C. THE EXPECTED FLOW CONDITIONS ON THE CONC VELOCITY APRON ARE SUMMARIZED BELOW:
   POWERHOUSE HIGH FLOW (50 CFS)
   FLOW DEPTH: 2.4"
   FLOW VELOCITY: 8.5 FT/S

   POWERHOUSE LOW FLOW (15 CFS)
   FLOW DEPTH: 1.2"
   FLOW VELOCITY: 5.3 FT/S

D. DOWNSTREAM OF DAM A, THE SITE SURVEY INDICATES THAT THERE EXISTS A MOUND OF MATERIAL. IT IS EXPECTED THAT THIS HIGH POINT IN THE SURVEY REPRESENTS SEDIMENT THAT HAS ACCUMULATED IN THE CHANNEL OVER TIME. AS PART OF THE EXCAVATION FOR THE CONC VELOCITY APRON AND DOWNSTREAM CHANNEL, THIS MATERIAL WILL NEED TO BE EXCAVATED AND DISPOSED OF OFF-SITE. THE REQUIRED EXCAVATION OF THIS ACCUMULATED MATERIAL IS EXPECTED TO BE APPROXIMATELY 85 CY (IN ADDITION TO THE CHANNEL REGRADING EARTHWORKS VOLUME).

E. THE EXPECTED FLOW CONDITIONS IN THE REGRADED CHANNEL IMMEDIATELY DOWNSTREAM OF THE VELOCITY APRON ARE SUMMARIZED BELOW:
   POWERHOUSE HIGH FLOW (50 CFS)
   FLOW DEPTH: 7.0"
   FLOW VELOCITY: 2.4 FT/S

   POWERHOUSE LOW FLOW (15 CFS)
   FLOW DEPTH: 3.4"
   FLOW VELOCITY: 1.5 FT/S

F. DURING EXCAVATION RETAIN SEPARATELY THE SURFACE MATERIAL FROM THE EXIST POWERHOUSE CHANNEL. OVER EXCAVATE TO 6" MIN BELOW THE FINISHED GRADE ELEVATION OF THE CHANNEL, AND BACKFILL WITH THE RETAINED EXIST CHANNEL SURFACE MATERIAL.

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C203.dwg Plot date: Oct 28, 2020 01:20pm, CAD User: Guerrero

REV	DATE	BY	DESCRIPTION
0	10/28/20	MDM	ISSUED FOR CONSTRUCTION

WARNING
0 1/2 1
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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
FALL CREEK FISH HATCHERY
DAM A MODIFICATIONS
SECTIONS

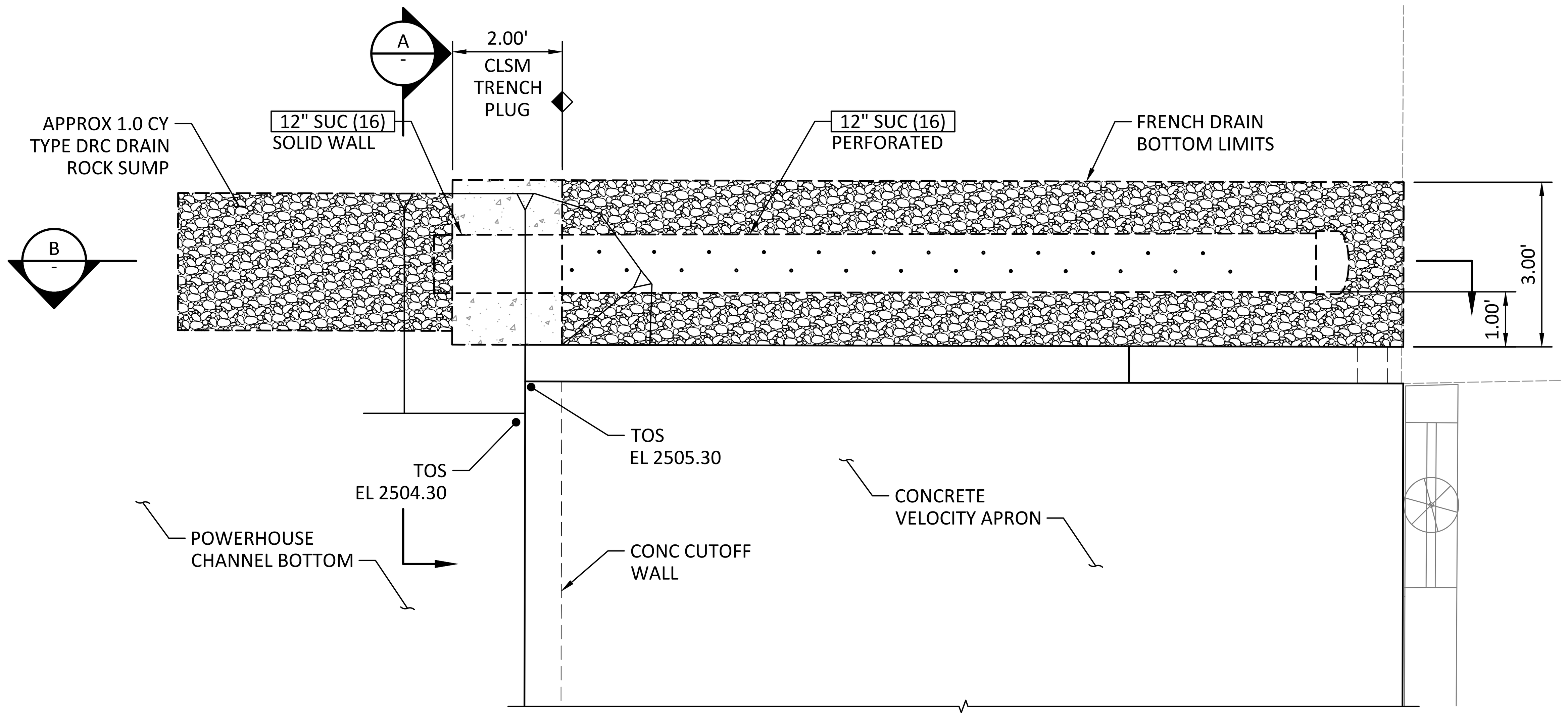
DESIGNED A. LEMAN
DRAWN J. LAHMON
CHECKED V. AUTIER
PROJECT DATE 10/28/20

DRAWING
C203

JOB NO: 000000

SHEET NOTES:

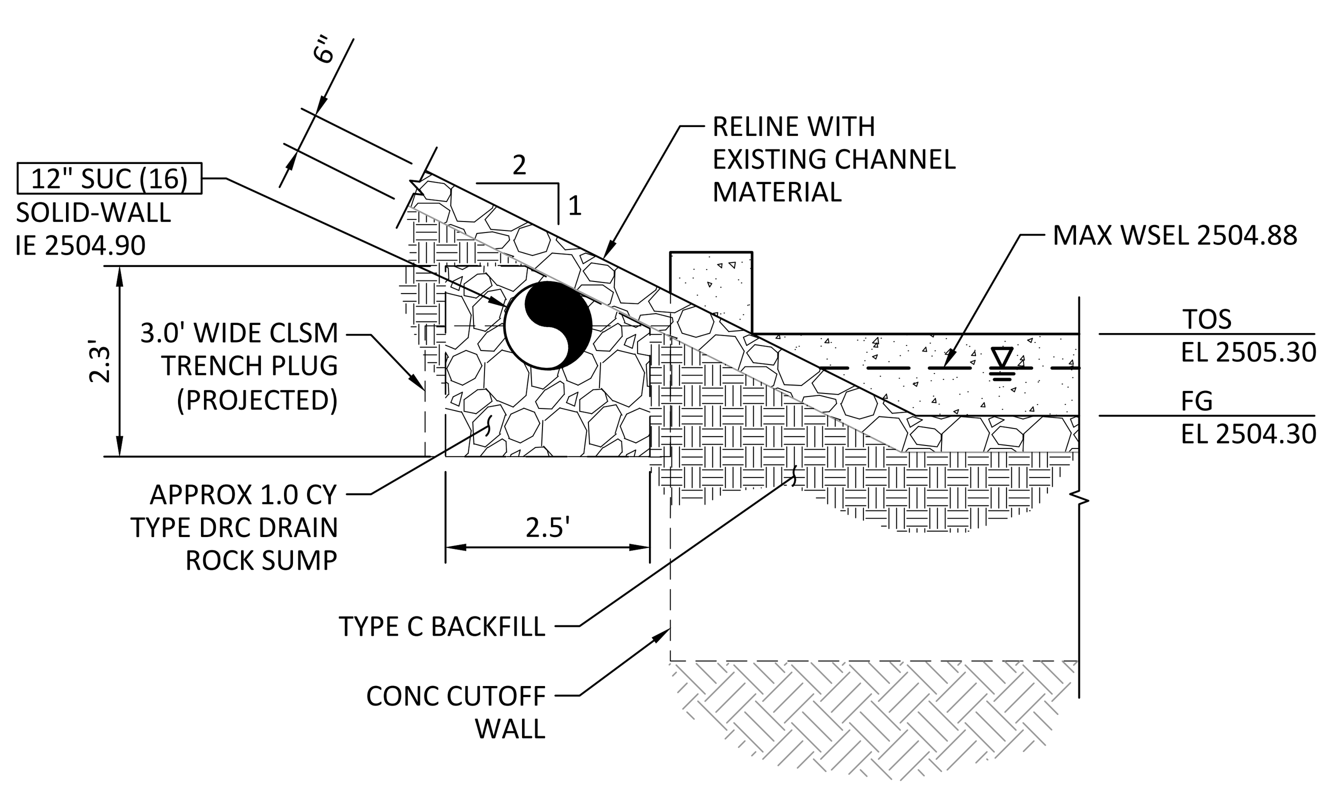
1. FRENCH DRAIN DETAIL AND SECTIONS TYPICAL OF BOTH SIDES OF THE DAM A CONC VELOCITY APRON. CONFIGURATION TO BE MIRRORED ON OPPOSITE SIDE OF APRON.
2. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.
3. ALL NON-WOVEN GEOTEXTILE TO BE OVERLAPPED A MINIMUM OF 1.0' AT SEAMS. CARE SHALL BE TAKEN DURING STORAGE, PLACEMENT, AND COMPACTION OF DRAIN ROCK MATERIALS THAT DRAIN ROCK IS NOT CONTAMINATED WITH FINE MATERIALS OR EXISTING SOILS. AFTER PLACEMENT AND COMPACTION (AS SPECIFIED) DRAIN ROCK IS TO BE IMMEDIATELY COVERED WITH GEOTEXTILE PRIOR TO FINAL BACKFILL.
4. IF SEEPAGE AT THE DAM IS ENCOUNTERED DURING CONSTRUCTION OF THE FRENCH DRAINS, CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER.



TYPICAL FRENCH DRAIN PLAN

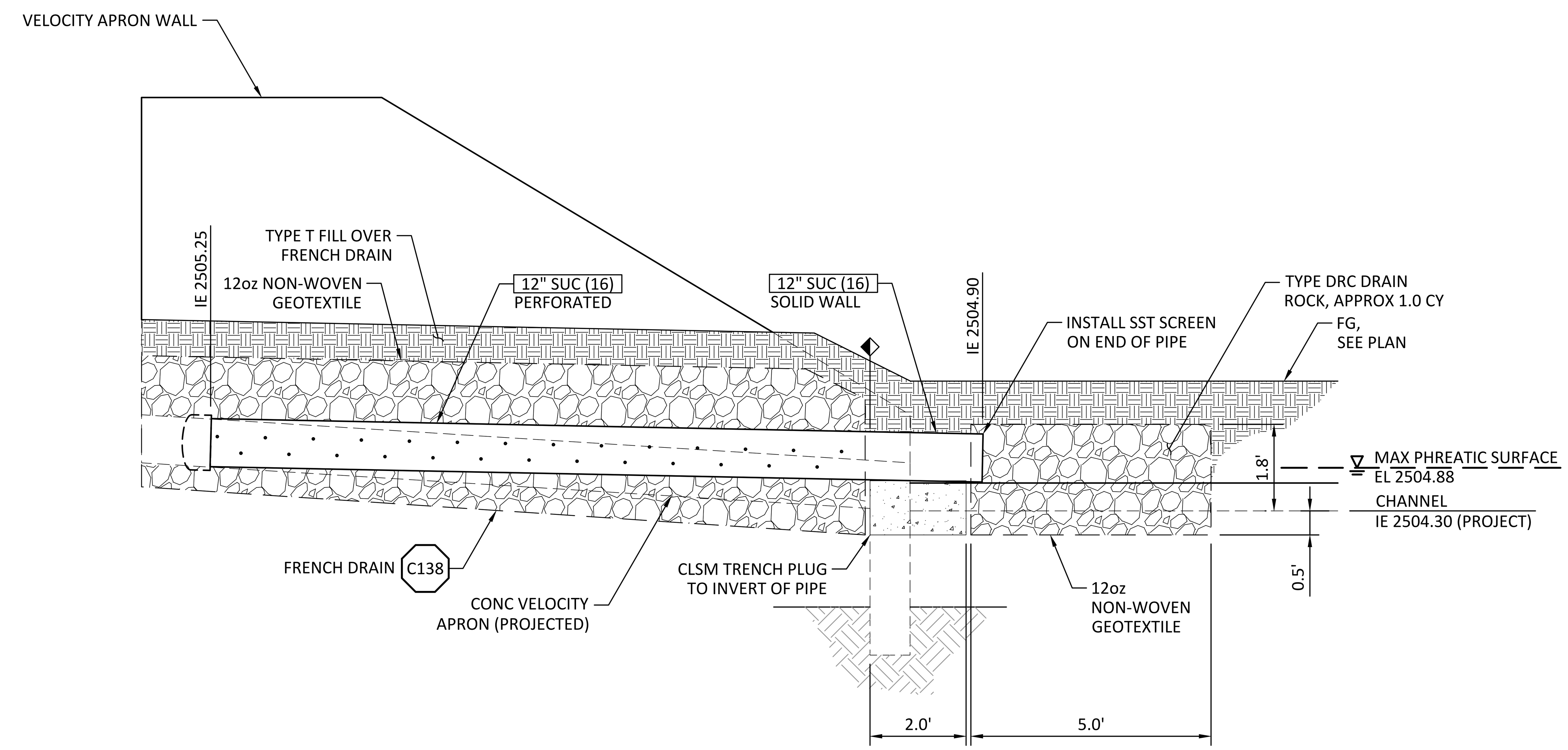
SCALE: 1"= 2'

1 C202



SECTION A

SCALE: 1"= 2'



SECTION B

SCALE: 1"= 2'

REV	DATE	BY	DESCRIPTION
0	10/28/20	MDM	ISSUED FOR CONSTRUCTION

WARNING

0 1/2 1

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

FALL CREEK FISH HATCHERY

DAM A FRENCH DRAIN
SECTIONS AND DETAILS

DESIGNED A. LEMAN

DRAWN J. LAHMON

CHECKED V. AUTIER

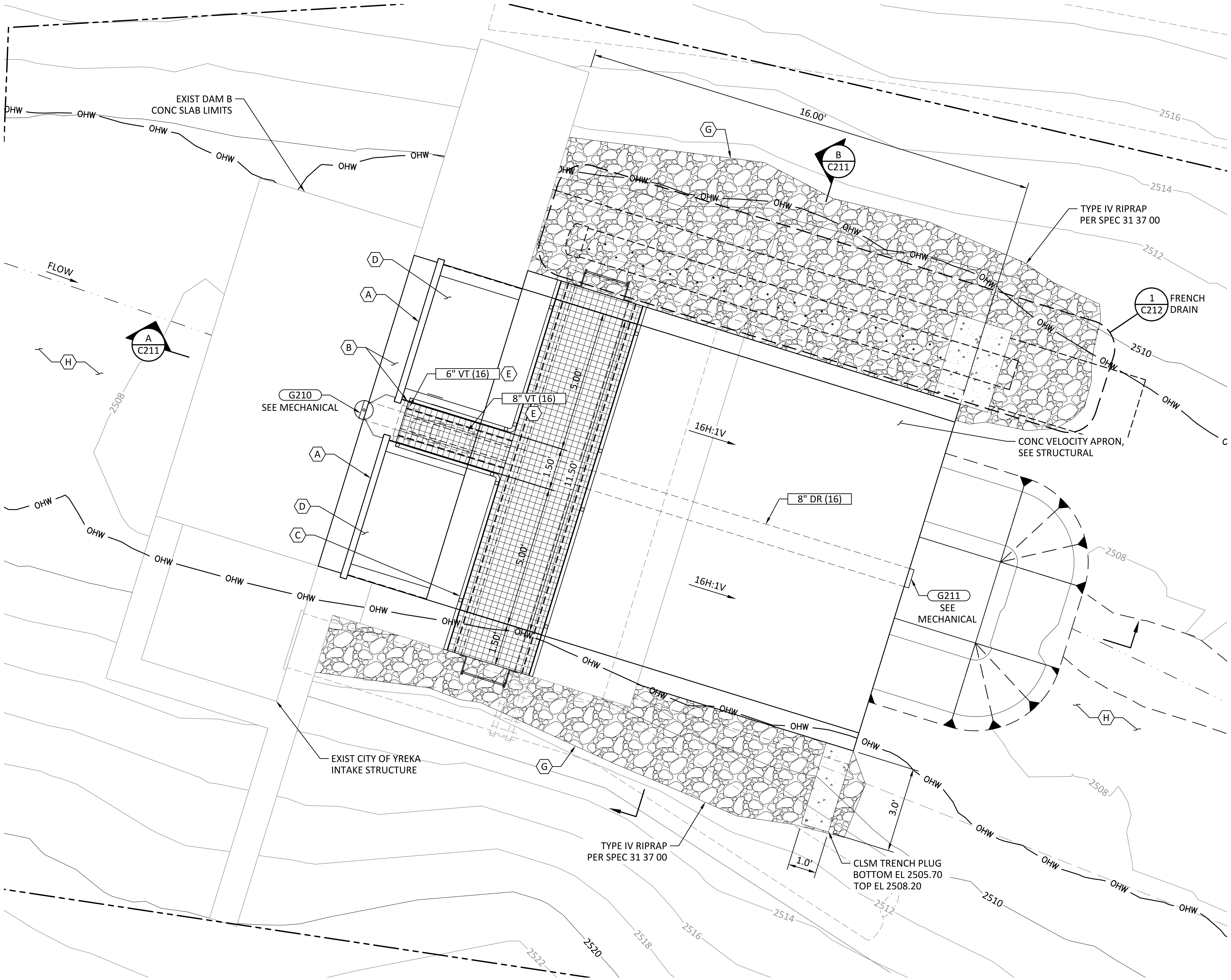
PROJECT DATE 10/28/20

DRAWING

C204

JOB NO: 000000

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C204.dwg Plot date: Oct 28, 2020 01:21pm, CAD User: Guerrero



DAM B MODIFICATIONS PLAN

SCALE: 1"= 2'

1 C100

SHEET NOTES:

1. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.
2. EXISTING DAM B DIMENSIONS ARE BASED ON AS-BUILT DATA PROVIDED BY THE CITY OF YREKA, BUT MAY BE SUBJECT TO SOME VARIATION. PRIOR TO DEVELOPMENT OF SHOP DRAWINGS, CONTRACTOR TO CONFIRM ALL EXISTING DIMENSIONS OF DAM. IF DIMENSIONS VARY SIGNIFICANTLY FROM THOSE REPORTED, CONTRACTOR TO COORDINATE WITH THE OWNER AND ENGINEER.
3. PRIOR TO ANY EXCAVATION FOR THE CONC VELOCITY APRON OR THE ASSOCIATED EARTHWORKS, CONTRACTOR SHALL FIELD LOCATE THE EXIST CITY OF YREKA SUPPLY LINE. THE CITY OF YREKA SUPPLY LINE SHALL NOT BE IMPACTED AND SHALL REMAIN IN SERVICE THROUGHOUT THE CONSTRUCTION DURATION.

SHEET KEY NOTES:

A FABRICATE NEW STOP LOGS THAT FIT EXISTING STOP LOG GUIDE SLOTS, SEE STRUCTURAL FOR DETAILS.

B EXISTING CENTER PIER TO BE DEMOLISHED. CONC TO BE PLACED TO RAISE INVERT ELEVATION OF STOP LOG SLOT TO EL 2509.25 FOR ENTIRE WIDTH OF DAM B. 8" DR PIPE TO BE CAST THROUGH THE MASS CONC, AND CENTRAL PIER TO BE RECONSTRUCTED OVER NEW MASS CONC. SEE STRUCTURAL FOR ALL CONC DETAILS INCLUDING CONC BASE, NEW CENTRAL PIER, AND CONNECTIONS TO EXIST CONC.

C INSTALL NEW WALKWAY ACROSS DAM B, FOR ACCESS TO GATE AND STOP LOGS, SEE STRUCTURAL.

D FABRICATE (2) NAPPE EXTENSION FITTINGS FOR PLACEMENT ATOP NEWLY FABRICATED STOP LOGS (SEE 'A' ABOVE). SEE STRUCTURAL FOR DETAILS.

E CAST VT PIPE IN THE RECONSTRUCTED CENTRAL PIER PER THE SECTIONS ON C211. VT PIPE INLET WILL BE LOCATED ON THE DOWNSTREAM FACE OF THE CONC PIER AT CENTERLINE EL 2512.60, AND THE OUTLETS WILL BE LOCATED EITHER SIDE OF THE PIER AT CENTERLINE EL 2510.75. ALL OPEN ENDS SHALL BE FITTED WITH SST BIRD SCREENS.

F CREATE 3.0'W x 3.0'L CONC POOL AT FG 2505.70 AROUND OUTLET OF DRAIN PIPE WITH 2H:1V SIDE SLOPES UP TO CHANNEL INVERT, SEE STRUCTURAL FOR DETAILS. ELSEWHERE REGRADE THE DOWNSTREAM CHANNEL FROM IE 2507.25 AT TOE OF CONC VELOCITY APRON DOWNWARD AT 1.0% SLOPE FOLLOWING THE EXIST CREEK ALIGNMENT UNTIL EXIST GRADE IS MET (APPROX 25'). WHERE NOT IN BEDROCK, OVER EXCAVATE 6" BELOW THE REQUIRED INVERT ELEV, AND DURING EXCAVATION RETAIN EXIST CHANNEL SURFACE MATERIAL. FOLLOWING EXCAVATION RELINE THE EXIST CHANNEL WITH 6" THICKNESS OF THE EXIST SURFACE MATERIAL.

G PLACE 30" THICK LAYER OF TYPE IV RIPRAP PER SPEC 31 37 00 BEHIND WALLS EITHER SIDE OF THE NEW CONC VELOCITY APRON, WITH 12 OZ NON-WOVEN GEOTEXTILE UNDERLAY. WHERE ADJACENT SLOPES ARE BEDROCK, PLACE TO ADJACENT SLOPES. WHERE ADJACENT SLOPES ARE SOIL, EXCAVATE AND LINE 30" THICK LAYER 2.0' UP THE SLOPE.

H AFTER COMPLETION OF THE WORK IN THIS AREA, BUT PRIOR TO BREACHING OF AND REMOVAL OF COFFERDAMS, CONTRACTOR SHALL RESTORE ORIGINAL CREEKBED MATERIAL TO ALL DISTURBED AREAS WITHIN THE OHWM. AREAS OUTSIDE OF THE OHWM THAT HAVE BEEN DISTURBED SHALL BE RESTORED WITH A 6" LAYER OF TOPSOIL AND RESEEDED.

EXIST CITY OF YREKA INTAKE STRUCTURE

EXIST STOP LOGS

EXIST DAM B STRUCTURE

EXISTING DAM B PHOTOGRAPH

SCALE: NTS

A -

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C210.dwg Plot date: Oct 28, 2020 01:21pm, CAD User: Guerrero

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WARNING

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION

FALL CREEK FISH HATCHERY

DAM B MODIFICATIONS PLAN AND PHOTOGRAPH

DESIGNED A. LEMAN

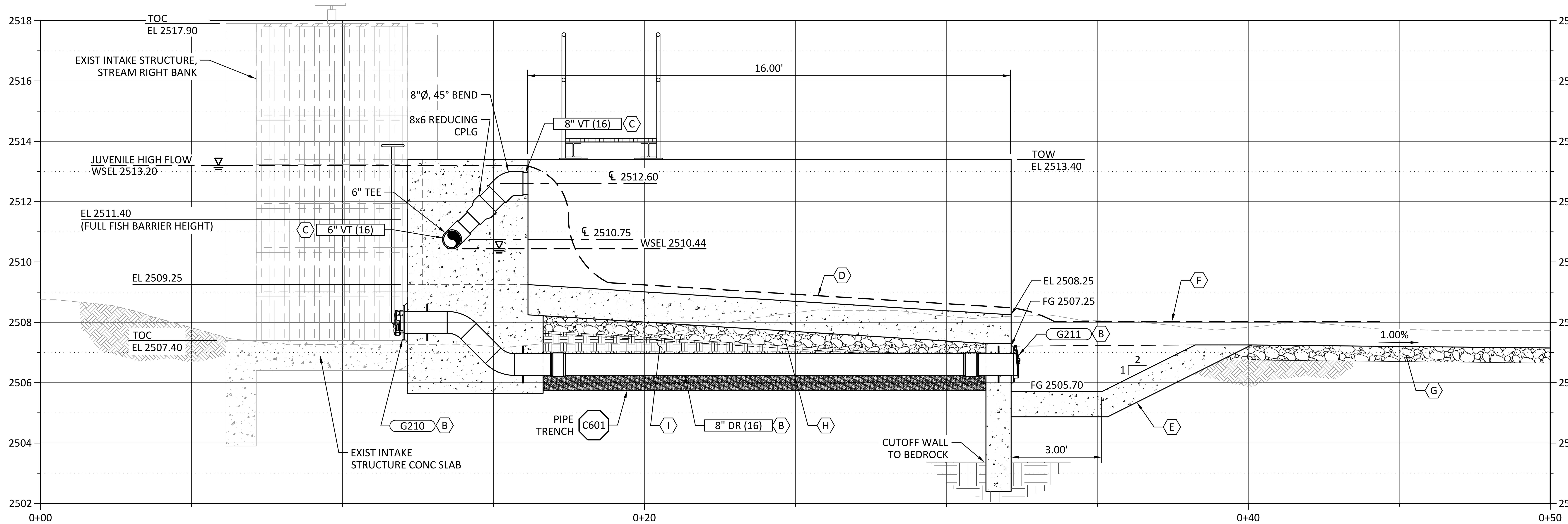
DRAWN J. LAHMON

CHECKED V. AUTIER

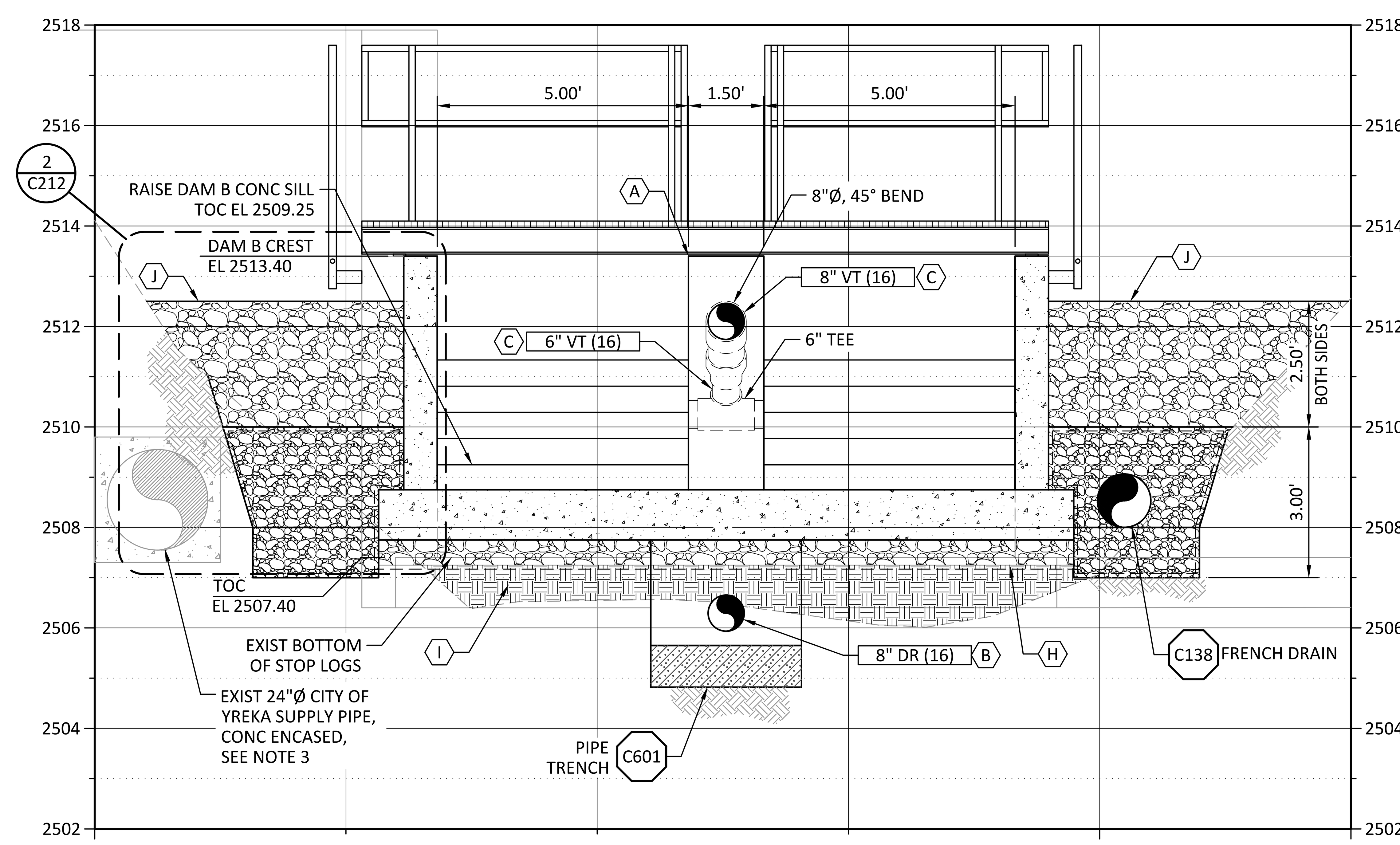
PROJECT DATE 10/28/20

DRAWING C210

JOB NO: 000000



SECTION A C210
SCALE: 1"= 2'



SECTION B C210
SCALE: 1"= 2'

SHEET NOTES:

1. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.
2. EXIST DAM B DIMENSIONS AND ELEVATIONS ARE BASED ON AS-BUILT DATA PROVIDED BY THE CITY OF YREKA, BUT MAY BE SUBJECT TO SOME VARIATION. PRIOR TO DEVELOPMENT OF SHOP DRAWINGS, CONTRACTOR TO CONFIRM ALL EXIST DIMENSIONS OF DAM. IF DIMENSIONS VARY SIGNIFICANTLY FROM THOSE REPORTED, CONTRACTOR TO COORDINATE WITH THE OWNER AND ENGINEER.
3. PRIOR TO ANY EXCAVATION FOR THE CONC VELOCITY APRON OR THE ASSOCIATED EARTHWORKS, CONTRACTOR SHALL FIELD LOCATE THE EXIST CITY OF YREKA SUPPLY LINE. THE CITY OF YREKA SUPPLY LINE SHALL NOT BE IMPACTED AND SHALL REMAIN IN SERVICE THROUGHOUT THE CONSTRUCTION DURATION.

SHEET KEY NOTES:

A SEE STRUCTURAL FOR CONC INVERT RAISE, NEW FABRICATED STOP LOGS, NEW FABRICATED NAPPE EXTENSION FITTINGS, AND WALKWAY.

B SEE MECHANICAL FOR 8" DRAIN PIPE, PIPE PENETRATIONS, AND GATES. SEE DEMO SHEETS FOR DEMOLITION OF EXIST CONC APRON.

C CAST VENT PIPE IN THE RECONSTRUCTED CENTRAL PIER AS SHOWN WITH 6" TEE ORIENTED AT 45° TO HORIZONTAL, AND 8x6 REDUCING COUPLING. VT PIPE INLET WILL BE LOCATED ON THE DOWNSTREAM FACE OF THE CONC PIER AT CENTERLINE EL 2512.60, AND THE OUTLETS WILL BE LOCATED EITHER SIDE OF THE PIER AT CENTERLINE EL 2510.75. ALL OPEN ENDS SHALL BE FITTED WITH SST BIRD SCREENS.

D THE EXPECTED FLOW CONDITIONS ON THE CONC VELOCITY APRON ARE SUMMARIZED BELOW:
JUVENILE HIGH FLOW (62 CFS)
FLOW DEPTH: 4.9"
FLOW VELOCITY: 13.1 FT/S

ADULT HIGH FLOW (57 CFS)
FLOW DEPTH: 4.7"
FLOW VELOCITY: 12.7 FT/S

E AT THE OUTLET OF THE 8" DR PIPE, CONSTRUCT 3.0'W X 3.0'L CONC POOL AT FG 2505.70 AROUND OUTLET OF DRAIN PIPE WITH 2H:1V SIDE SLOPES UP TO CHANNEL INVERT, SEE STRUCTURAL FOR DETAILS.

F THE EXPECTED FLOW CONDITIONS IN THE REGRADED CHANNEL IMMEDIATELY DOWNSTREAM OF THE VELOCITY APRON ARE SUMMARIZED BELOW:
JUVENILE HIGH FLOW (62 CFS)
FLOW DEPTH: 11.7"
FLOW VELOCITY: 3.9 FT/S

ADULT HIGH FLOW (57 CFS)
FLOW DEPTH: 11.1"
FLOW VELOCITY: 3.8 FT/S

G REGRADE THE DOWNSTREAM CHANNEL FROM IE 2507.25 AT TOE OF CONC VELOCITY APRON DOWNWARD AT 1.0% SLOPE FOLLOWING THE EXIST CREEK ALIGNMENT UNTIL EXIST GRADE IS MET (APPROX 25'). EXTEND EXIST BANKS DOWN TO THE REQUIRED INVERT ELEV AT 2H:1V SLOPE, TYP. WHERE NOT IN BEDROCK, OVER EXCAVATE 6" BELOW THE REQUIRED INVERT ELEVATION, AND DURING EXCAVATION RETAIN EXIST CHANNEL SURFACE MATERIAL. FOLLOWING EXCAVATION, RELINE THE EXIST CHANNEL WITH THE EXIST SURFACE MATERIAL.

H PLACE AND COMPACT 6" THICK TYPE DRG LEVELING LAYER WITH 12oz NON-WOVEN GEOTEXTILE UNDERLAY PER SPEC 31 00 00 AND 31 05 19 IMMEDIATELY UNDER THE CONC VELOCITY APRON. AT EDGE OF STRUCTURE TIE-IN THE LEVELING LAYER TO THE DRAIN ROCK OF THE TWO PERIPHERAL FRENCH DRAINS.

I BACKFILL TO BOTTOM OF TYPE DRG LEVELING LAYER WITH TYPE SF FILL AND COMPACT TO 95% MAX DRY DENSITY ACCORDING TO ASTM D 1557 (MODIFIED PROCTOR) PER SPEC 31 00 00.

J PLACE 30" THICK LAYER OF TYPE IV RIPRAP PER SPEC 31 37 00 BEHIND WALLS EITHER SIDE OF THE NEW CONC VELOCITY APRON, WITH 12 OZ NON-WOVEN GEOTEXTILE UNDERLAY. WHERE ADJACENT SLOPES ARE BEDROCK, PLACE TO ADJACENT SLOPES. WHERE ADJACENT SLOPES ARE SOIL, EXCAVATE AND LINE 30" THICK LAYER 2.0' UP THE SLOPE.

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C211.dwg Plot date: Oct 28, 2020 01:22pm, CAD User: Guerrero

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
FALL CREEK FISH HATCHERY
DAM B MODIFICATIONS
SECTIONS

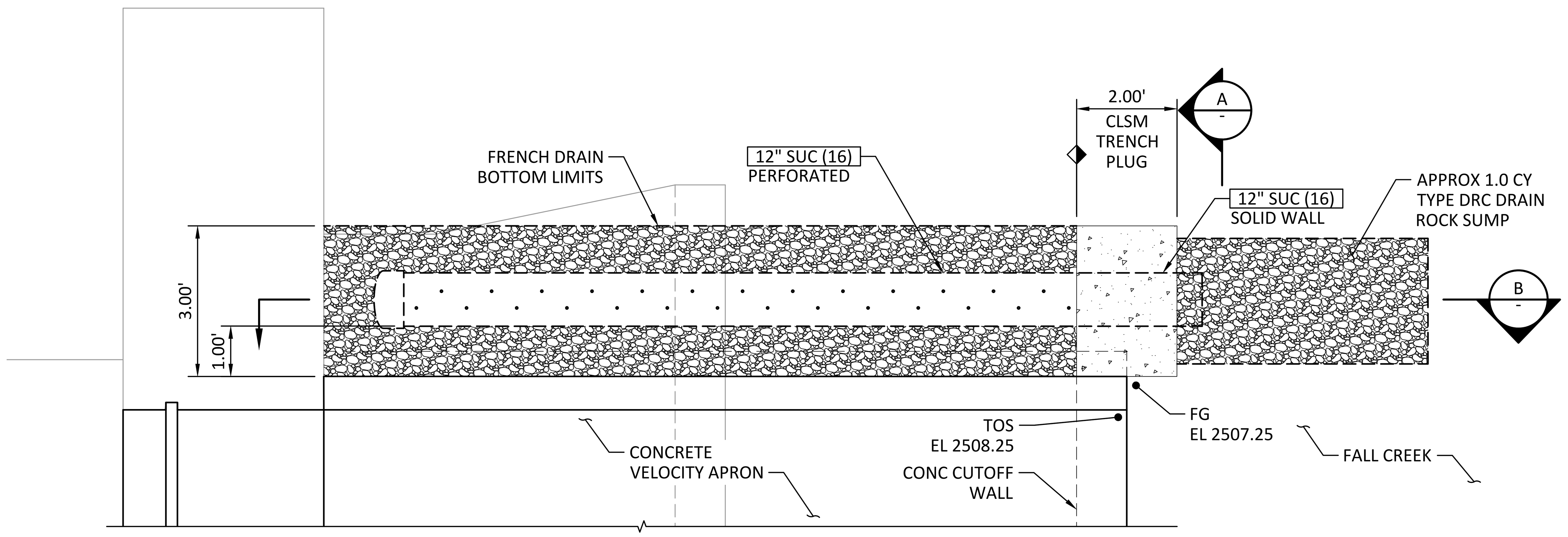
DESIGNED A. LEMAN
DRAWN J. LAHMON
CHECKED V. AUTIER
PROJECT DATE 10/28/20

DRAWING
C211

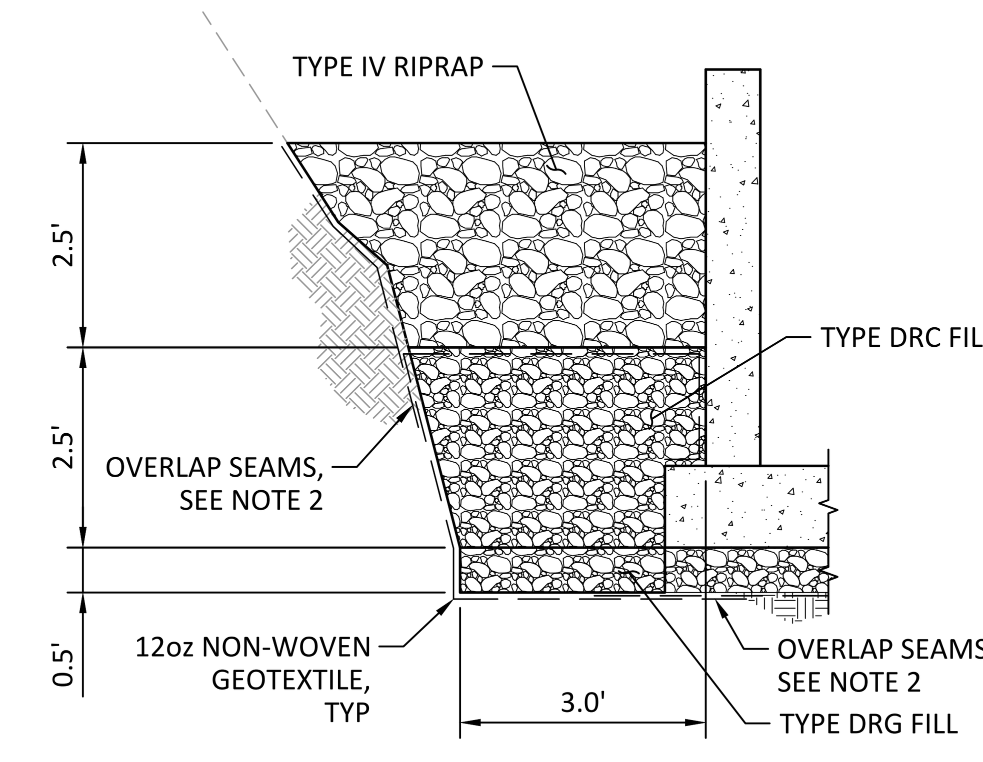
JOB NO: 000000

SHEET NOTES:

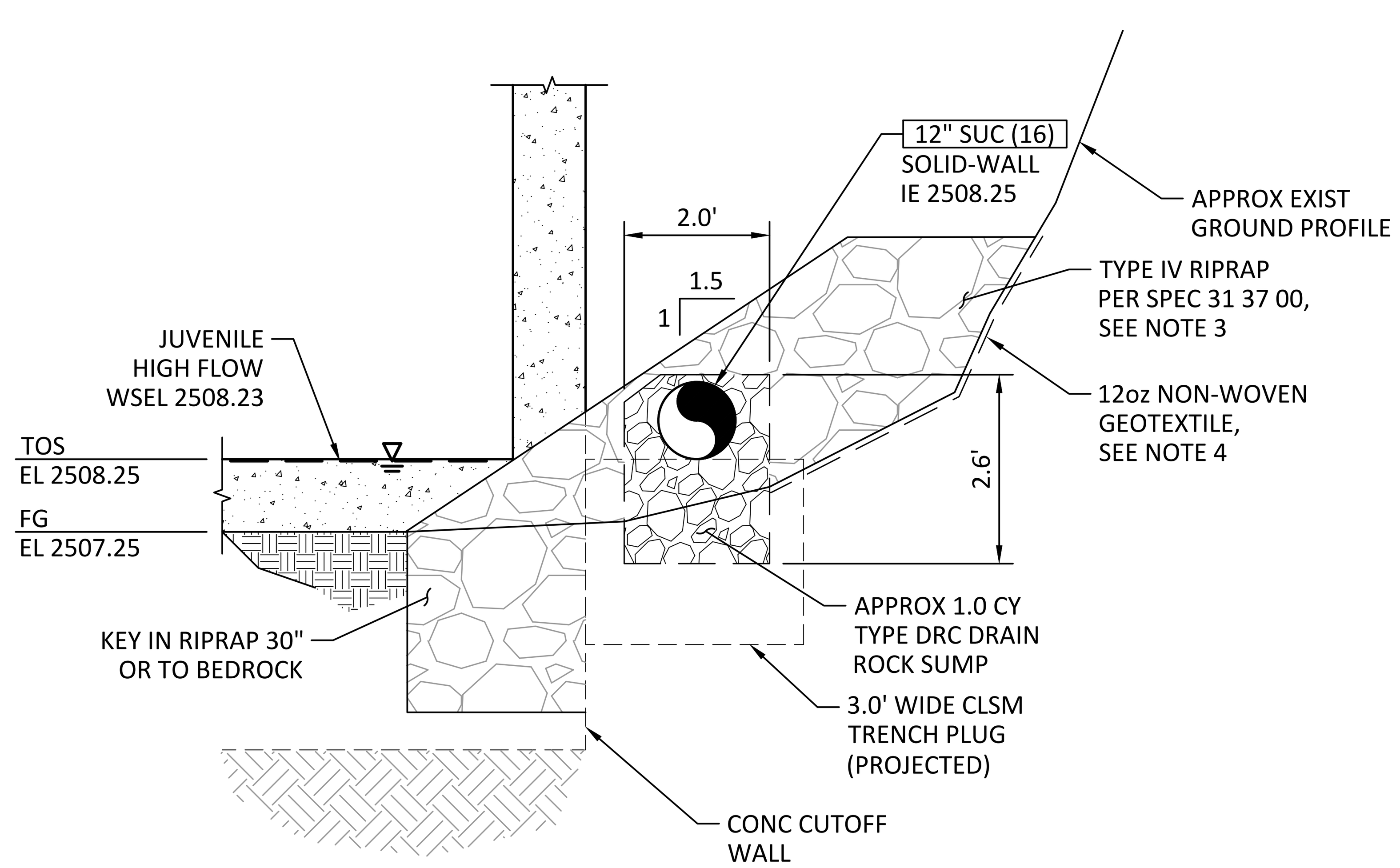
1. RIPRAP NOT SHOWN IN PLAN ON THIS SHEET FOR CLARITY. FOR RIPRAP LAYER ABOVE FRENCH DRAIN SEE SHEETS C210 AND C211.
2. ALL NON-WOVEN GEOTEXTILE TO BE OVERLAPPED A MINIMUM OF 1.0' AT SEAMS. CARE SHALL BE TAKEN DURING STORAGE, PLACEMENT, AND COMPACTION OF DRAIN ROCK MATERIALS THAT DRAIN ROCK IS NOT CONTAMINATED WITH FINE MATERIALS OR EXISTING SOILS. AFTER PLACEMENT AND COMPACTION (TYPE DRG FILL ONLY) DRAIN ROCK IS TO BE IMMEDIATELY COVERED WITH GEOTEXTILE PRIOR TO FINAL BACKFILL.
3. TYPE IV RIPRAP SHALL BE PLACED BY LIGHT EQUIPMENT OVER THE FRENCH DRAIN. NO END DUMPING WILL BE PERMITTED ON TOP OF THE FRENCH DRAIN PIPE OR DRAIN ROCK.
4. TYPE IV RIPRAP SHALL HAVE 12OZ NON-WOVEN GEOTEXTILE WHERE PLACED AGAINST NATURAL GRADE, OR IN LOCATIONS OF EXCAVATION WHERE PLACED AGAINST BACKFILL MATERIAL.
5. ALL EARTHWORKS MATERIALS ARE TO BE PLACED AND COMPACTED ACCORDING TO SPECIFICATION 31 00 00.



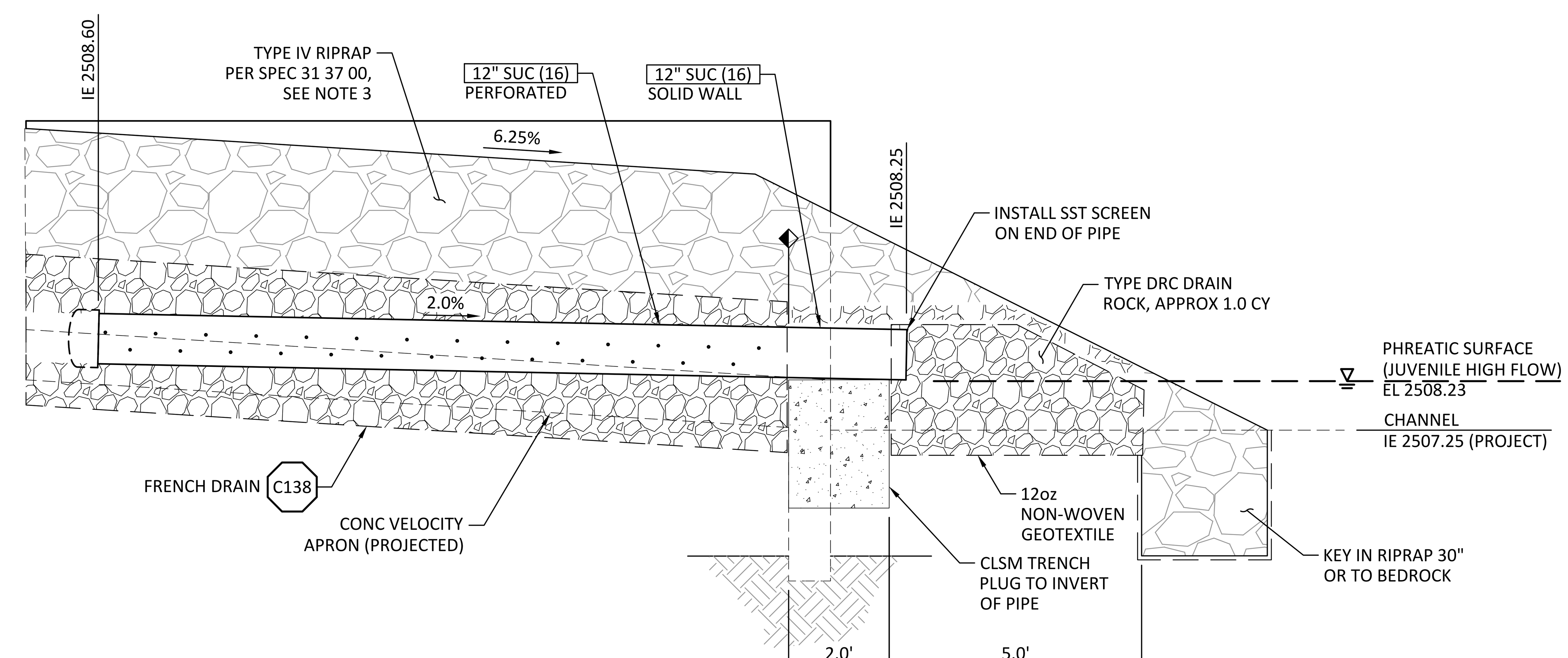
FRENCH DRAIN PLAN 1 C210
SCALE: 1"= 2'



FRENCH DRAIN (NO PIPE) DETAIL 2 C211
SCALE: 1"= 2'



SECTION A
SCALE: 1"= 2'



SECTION B
SCALE: 1"= 2'

Path: C:\Vault20\Klamath River Renewal Corp\Fall Creek Facility\C212.dwg Plot date: Oct 28, 2020 01:23pm, CAD User: Guerrero

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McMILLEN JACOBS ASSOCIATES

KLAMATH RIVER RENEWAL CORPORATION

KLAMATH RIVER RENEWAL CORPORATION
FALL CREEK FISH HATCHERY
DAM B FRENCH DRAIN
SECTIONS AND DETAILS

DESIGNED A. LEMAN
DRAWN J. LAHMON
CHECKED V. AUTIER
PROJECT DATE 10/28/20

DRAWING C212

JOB NO: 000000

Attachment 2: Hydraulic Calculations for the 24” Diameter Pipe from Dam B to Dam A

Calculation Cover Sheet

McMILLEN JACOBS ASSOCIATES

Project: Fall Creek Hatchery

Client: Klamath River Renewal Corporation **Proj. No.** 19-128

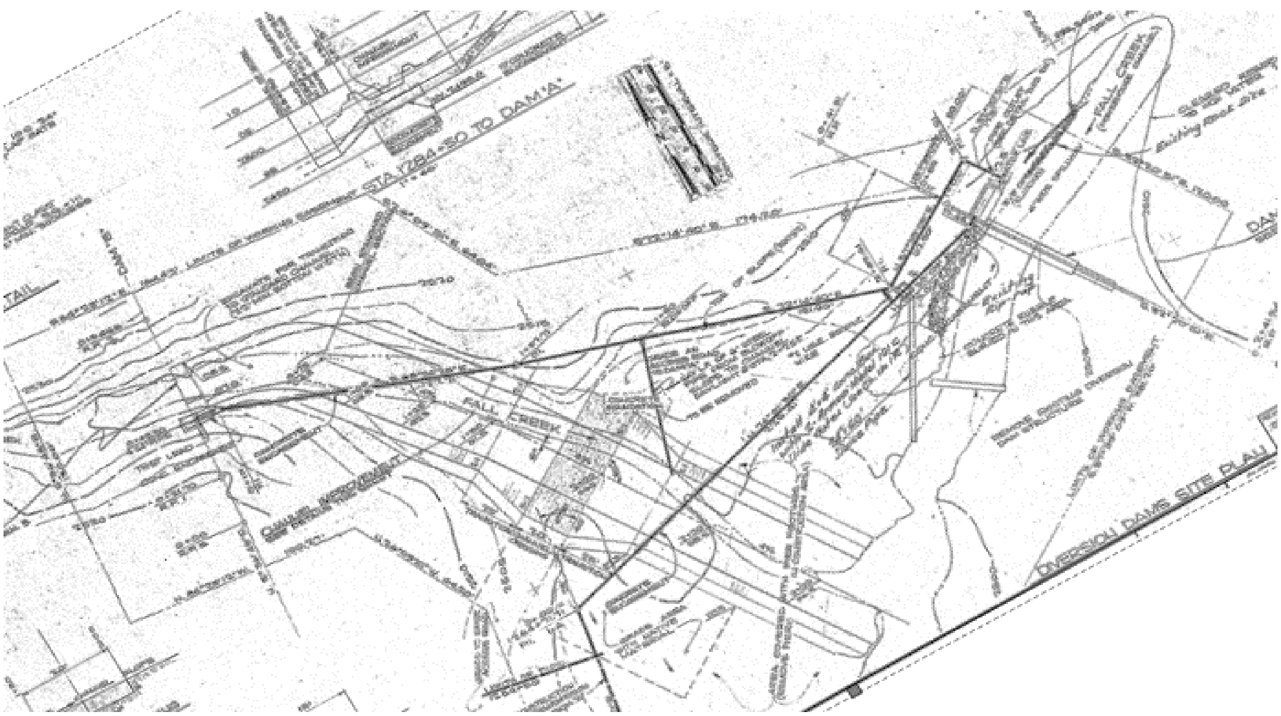
Title: Dam A/B Rating Curves

Prepared By, Name: Andrew Leman

Prepared By, Signature: ______________ **Date:** 1/20/2021

Peer Reviewed By, Name: Jodi Burns

Peer Reviewed, Signature: ______________ **Date:** 1/20/2021



SUBJECT: Klamath River Renewal Corporation
Fall Creek Hatchery
Rating Curves

BY: A. Leman **CHK'D BY:** J. Burns
DATE: 1/20/2021
PROJECT NO.: 19-128

Purpose

The purpose of this calculation sheet is to develop rating curves for use in developing an operational scheme for water distribution between Dams A and B.

References

- *Brater, E.F., H.W. King. 1976. Handbook of Hydraulics for the Solution of Hydraulic Engineering Problems. McGraw Hill.*
- *Lindeburg, Michael R. 2014. Civil Engineering Reference Manual, Fourteenth Edition. Professional Publications, Inc. Belmont, CA.*
- *Tullis, J. Paul. (1989). Hydraulics of Pipelines, Pumps, Valves, Cavitation, Transients. New York: John Wiley & Sons.*
- *U.S. Bureau of Reclamation (USBR). 1987. Design of Small Dams. Third Edition. U.S. Dept. of the Interior, Bureau of Reclamation: Washington, D.C.*

Background

The City of Yreka owns and operates Diversion Dams "A" and "B" in the Fall Creek drainage (see Figure 1). Dam A is located on the Fall Creek powerhouse tailrace channel, and is equipped with an intake structure and 24-inch water line (blue) that supplies the City of Yreka with flows up to its water right of 9.7 MGD (15 cfs). Diversion Dam "A" will likewise be used to supply the proposed Fall Creek Hatchery with its non-consumptive water right of 10 cfs. When powerhouse discharge is insufficient to meet these water rights and any downstream ecological requirements, the City of Yreka intends to operate Dam B to impound and convey water from Fall Creek into the Dam A impoundment as supplementary water, via a 24-inch water line (yellow). The purpose of these calculations are to develop rating curves for the 24-inch transfer line (yellow) and for the Dam B overflow, for the City of Yreka's operations.

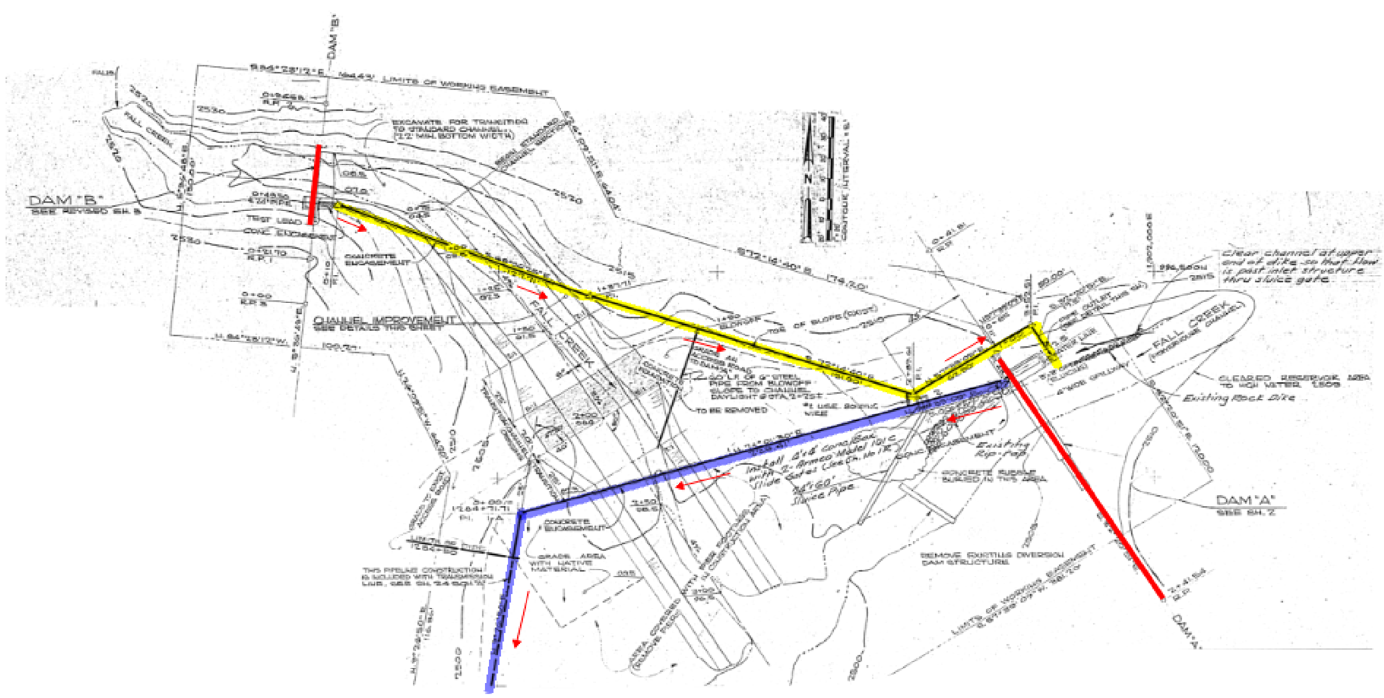


Figure 1. Operational Schematic for Fall Creek Diversion System

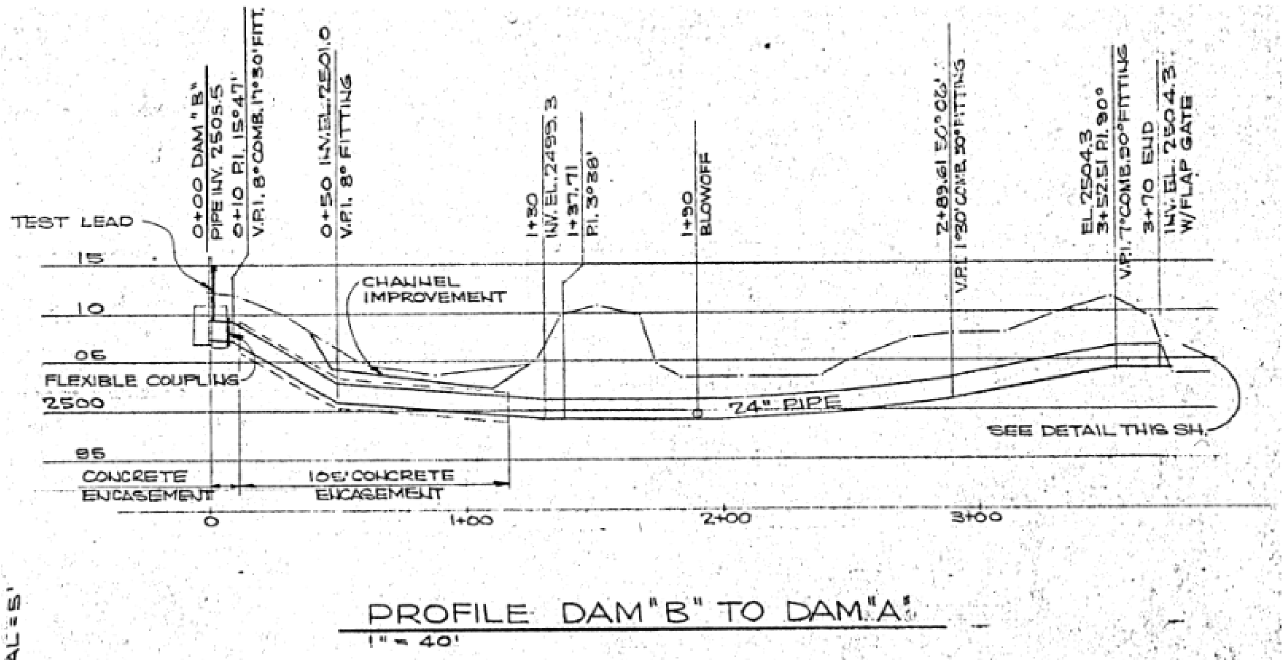


Figure 2. Pipe Profile Dam "B" to Dam "A"

Figure 3. Dam "B" Intake Photograph

Method

The method for development of the rating curves is discussed in the following sections:

Dam B to Dam A
24-inch Transfer Line

The Dam B to Dam A transfer line stage discharge relationship can be solved according to Bernoulli's equation. At both Dam B and Dam A, there is a dead pool elevation near the top of the pipe, with dam boards above that elevation. Therefore, it is expected that both pipes will be submerged. This configuration is sketched below:

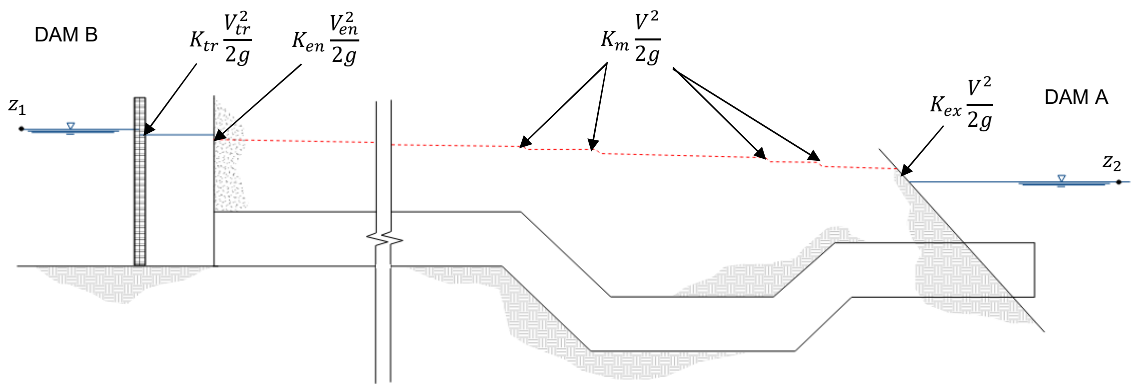


Figure 4. Hydraulic Profile Definition Sketch

Bernoulli's equation can then be formulated as follows to derive a modified orifice equation that accounts for the variable areas at the trash rack and at the pipe entrance contraction.

$$z_1 + \frac{p_1}{\gamma} + \frac{V_1^2}{2g} = z_2 + \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + h_f + h_m + h_{tr} + h_{en} + h_{ex}$$

$$\frac{fL}{D}\frac{1}{2g}\left(\frac{Q}{A}\right)^2 + K_m\frac{1}{2g}\left(\frac{Q}{A}\right)^2 + K_{ex}\frac{1}{2g}\left(\frac{Q}{A}\right)^2 + K_{tr}\left(\frac{A}{A_{tr}}\right)^2\frac{1}{2g}\left(\frac{Q}{A}\right)^2 + K_{en}\left(\frac{A}{A_c}\right)^2\frac{1}{2g}\left(\frac{Q}{A}\right)^2 = z_1 - z_2$$

$$Q = A\sqrt{\frac{2g(z_1 - z_2)}{\frac{fL}{D} + K_m + K_{ex} + K_{tr}\left(\frac{A}{A_{tr}}\right)^2 + K_{en}\left(\frac{A}{A_c}\right)^2}}$$

$z_1 =$ Elevation at point 1
$z_2 =$ Elevation at point 2
$p_1 =$ Pressure at point 1
$p_2 =$ Pressure at point 2
$V_1 =$ Velocity at point 1
$V_2 =$ Velocity at point 2
$\gamma =$ Unit weight of water
$g =$ Gravitational constant

$h_f =$ Friction losses
$h_m =$ Minor losses
$h_{tr} =$ Trash rack losses
$h_{en} =$ Entrance losses
$h_{ex} =$ Exit losses
$f =$ Darcy-Weisbach friction factor
$L =$ Length of pipe
$D =$ Pipe diameter

$Q =$ Discharge
$A =$ Pipe flow area
$K_{tr} =$ Trash rack loss coefficient
$K_{en} =$ Entrance loss coefficient
$K_{ex} =$ Exit loss coefficient
$K_m =$ Composite minor loss coefficient
$A_{tr} =$ Trash rack flow area
$A_c =$ Pipe entrance contracted flow area

In order to solve the above equation, relating the discharge to the water level in both reservoirs, the equation requires the following parameters to be defined:

Darcy Weisbach Friction Factor

The Darcy Weisbach friction factor is dependent upon the Reynolds number, except when pipe flow is fully turbulent (very high Reynolds numbers). As such, the friction factor is dependent upon the flow rate, and the Darcy Weisbach friction factor will need to be calculated iteratively with the discharge. Iterative calculations of the above equation and the Colebrook-White equation will be performed to determine both the discharge and the friction factor.

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\frac{\epsilon}{D}}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$$

$\epsilon =$ Pipe surface roughness
$Re =$ Reynolds number, VD/ν
$\nu =$ Kinematic viscosity of water

Composite Minor Loss Coefficient
and Entrance and Exit Loss Coefficients

The composite minor loss coefficients and entrance/exit loss coefficients were taken from standard values as defined in Tullis (1989), and in the Tentative Standards of the Hydraulic Institute. Minor loss coefficients used in this analysis are tabulated below:

Feature	Coefficient	Number	Source
Exit Losses	1	1	Typical
90^o Elbow (Short Radius)	0.24	1	Tullis, 1989
30^o Miter Bend	0.15	1	Tent Stds of Hyd Inst
17^o Miter Bend	0.07	1	Tent Stds of Hyd Inst (Interpolated)
8^o Miter Bend	0.03	1	Tent Stds of Hyd Inst (Interpolated)
3^o Miter Bend	0.01	1	Tent Stds of Hyd Inst (Interpolated)
Composite	1.50		Sum all coefficients multiplied by #

Trash Rack Loss Coefficient
USBR, 1987; Section 10.15, Eq 11

The head losses through the trash rack were calculated according to the method outlined in the *Design of Small Dams* (USBR, 1987). The losses through the debris screen are a function of the percent opening:

$$K_s = 1.45 - 0.45\frac{A_n}{A_g} - \left(\frac{A_n}{A_g}\right)^2$$

$$A_n = (1 - R_D)R_0A_g$$

$$h_s = K_s\left(\frac{v_n^2}{2g}\right)$$

where:
$K_s =$ Screen loss coefficient
$h_s =$ Screen head losses
$A_n =$ Net screen area (less screen and occlusions)
$A_g =$ Gross screen area
$v_n =$ Net velocity (through net screen area)
$g =$ Gravitational constant
$R_D =$ Ratio of debris coverage
$R_o =$ Ratio of open area (clean bars)

It should be noted that the head losses are calculated based on the net velocity. Therefore, in the formulation of Bernoulli's equation given above, the area of the trash rack is equal to the net area of the screen.

Contracted Flow Area
Lindeburg, 2014; Eq. 17.72 and Table 17.5

The contracted flow area at the entrance was selected based on a typical orifice contraction coefficient for a long tube square in a headwall. This is reported in the Civil Engineering Reference Manual (CERM; Lindeburg, 2014) as being unity. Therefore, the ratio of A/A_c in the Bernoulli formulation above will likewise be unity.

The entrance loss coefficient was selected from Tullis, 1989 for a sharp corner-flush connection to the headwall (0.5), and is reported in the inputs below.

Rating Curves

Dam B Weir Overflow
Weir Equation; USBR, 1987

The second component of this analysis is to develop a rating curve for the overflow at Dam "B". It should be noted that the rating curve developed here, is based on the proposed modifications to Dam "B" as submitted in the "Issued for Construction" drawings of the Fall Creek Fish Hatchery, issued Oct 28, 2020. Overflow at the dam will follow weir overflow, according to the following equation as reported in USBR (1987) and in numerous other places.

$$Q = CLH_e^{3/2}$$

where:
$Q =$ Discharge
$C =$ Discharge coefficient
$L =$ Effective crest length
$H_e =$ Actual head on crest

It should be noted that the dam will be equipped with removable stop logs and a removable nappe extension element as part of the fish barrier design. Therefore, the overflow at the dam will be dependent on the status of the stop logs and extension piece. For this analysis, it is assumed that the stop logs are placed to their full fish barrier height (as depicted in the construction drawings), 4-feet above the invert of the impoundment (i.e. the transfer pipe invert).

For lower flows, a pier is present between two bays of weir overflow. Effects from the piers and from the abutments are taken into account by the effective crest length, as shown below:

$$L = L' - 2(NK_p + K_a)H_e$$

where:
$L' =$ Net length of crest
$N =$ Number of piers
$K_p =$ Pier contraction coefficient
$K_a =$ Abutment contraction coefficient

Finally, the discharge coefficient will be interpolated from tabulated values for broad-crested weirs, as presented in Brater & King (1976).

Information - Input

The following information was used to develop the rating curves:

Transfer Pipe Information	Value	Units	Comments
Nominal pipe diameter	24	in	Record drawings
Pipe wall thickness	0.375	in	Sch Std, Assumed (no record information available)
Pipe inner diameter	23.25	in	Calculated
Pipe surface roughness	2.40E-03	in	Lindeburg (2014); steel pipe
Pipeline length	370	ft	Record drawings
Pipe internal flow area	2.95	ft^2	Calculated
Pipe entr inverse contraction coefficient (A/A_c)	1		Lindeburg, 2014
Pipe entrance loss coefficient	0.5		Tullis, 1989; square corner - flush
Pipe composite minor loss coefficient	1.50		Calculated above

Dam B Trash Rack Information	Value	Units	Comments
Trash rack width	5	ft	Record drawings
Ratio of open area	0.68	ft^2/ft^2	Scaled off of Figure 3 above, see also Dam "A" record dwgs
Ratio of debris coverage	0.05	ft^2/ft^2	Assumed nominal coverage, see e.g. Figure 3 above

Dam B Weir Information	Value	Units	Comments
Fish barrier total crest width (elev. 2511.4)	10	ft	IFC drawings
Dam "B" crest width (elev 2513.4)	9.5	ft	Record drawings
Fish barrier crest breadth	2.92	ft	IFC drawings
Dam "B" crest breadth	4	ft	Record drawings
Pier contraction coefficient	0	-	Negligible, based on USACE, 1990, Plate 3-6
Abutment contraction coefficient	0.1	-	USACE, 1990; Plate 3-11

Elevation Information*	Value	Units	Comments
Transfer pipe invert at Dam "B"	2508.9	ft	Record drawings, converted
Transfer pipe invert at Dam "A"	2507.7	ft	Record drawings, converted
Dam "B" fish barrier crest elevation	2511.4	ft	IFC drawings
Dam "B" crest elevation	2513.4	ft	IFC drawings

**Note: all elevations are shown in the IFC drawing datum (NAVD88, Geoid 12B)*

Miscellaneous Information	Value	Units	Comments
Kinematic viscosity of water	1.41E-05	ft^2/s	at 50^o F
Gravitational constant	32.2	ft/s^2	

Calculation

Transfer Pipe Rating Curves

**Note: all "depths" are relative to the pipe invert*

Depth at Dam "B" ft	Depth at Dam "A" ft	Trash Rack Gross Area ft^2	Trash Rack Net Area ft^2	Trash Rack Loss Coeff	Pipe Reynolds Number	Pipe Friction Factor	Calc'd Friction Factor	Discharge, Q cfs
2	2	10.0	6.5	0.74	5.46E+05	0.014	0.014	11.7
3	2	15.0	9.7	0.74	7.54E+05	0.014	0.014	16.2
4	2	20.0	13.0	0.74	9.16E+05	0.014	0.014	19.7
5	2	25.0	16.2	0.74	1.05E+06	0.013	0.013	22.6
6	2	30.0	19.5	0.74	1.18E+06	0.013	0.013	25.3
7	2	35.0	22.7	0.74	1.29E+06	0.013	0.013	27.7
8	2	40.0	26.0	0.74	1.39E+06	0.013	0.013	29.9
2	3	10.0	6.5	0.74	2.15E+05	0.016	0.016	4.6
3	3	15.0	9.7	0.74	5.51E+05	0.014	0.014	11.8
4	3	20.0	13.0	0.74	7.56E+05	0.014	0.014	16.2
5	3	25.0	16.2	0.74	9.18E+05	0.014	0.014	19.7
6	3	30.0	19.5	0.74	1.06E+06	0.013	0.013	22.7
7	3	35.0	22.7	0.74	1.18E+06	0.013	0.013	25.3
8	3	40.0	26.0	0.74	1.29E+06	0.013	0.013	27.7
3	4	15.0	9.7	0.74	2.17E+05	0.016	0.016	4.7
4	4	20.0	13.0	0.74	5.53E+05	0.014	0.014	11.9
5	4	25.0	16.2	0.74	7.57E+05	0.014	0.014	16.2
6	4	30.0	19.5	0.74	9.18E+05	0.014	0.014	19.7
7	4	35.0	22.7	0.74	1.06E+06	0.013	0.013	22.7
8	4	40.0	26.0	0.74	1.18E+06	0.013	0.013	25.3
4	5	20.0	13.0	0.74	2.18E+05	0.016	0.016	4.7
5	5	25.0	16.2	0.74	5.54E+05	0.014	0.014	11.9
6	5	30.0	19.5	0.74	7.58E+05	0.014	0.014	16.3
7	5	35.0	22.7	0.74	9.19E+05	0.014	0.014	19.7
8	5	40.0	26.0	0.74	1.06E+06	0.013	0.013	22.7
5	6	25.0	16.2	0.74	2.18E+05	0.016	0.016	4.7
6	6	30.0	19.5	0.74	5.54E+05	0.014	0.014	11.9
7	6	35.0	22.7	0.74	7.58E+05	0.014	0.014	16.3
8	6	40.0	26.0	0.74	9.19E+05	0.014	0.014	19.7
6	7	30.0	19.5	0.74	2.18E+05	0.016	0.016	4.7
7	7	35.0	22.7	0.74	5.55E+05	0.014	0.014	11.9
8	7	40.0	26.0	0.74	7.58E+05	0.014	0.014	16.3
7	8	35.0	22.7	0.74	2.18E+05	0.016	0.016	4.7
8	8	40.0	26.0	0.74	5.55E+05	0.014	0.014	11.9

Dam "B" Overflow Rating Curves

Depth at Dam "B"	Fish Barrier				Dam Crest				Total Discharge
	Head	Discharge Coefficient	Effective Length	Discharge	Head	Discharge Coefficient	Effective Length	Discharge	
ft	ft		ft	cfs	ft		ft	cfs	cfs
0.0	0.0	0.00	0.0	0	0.0	0.00	0.0	0	0
2.5	0.0	0.00	0.0	0	0.0	0.00	0.0	0	0
3.0	0.5	2.60	9.9	9	0.0	0.00	0.0	0	9
3.5	1.0	2.64	9.8	26	0.0	0.00	0.0	0	26
4.0	1.5	2.68	9.7	48	0.0	0.00	0.0	0	48
4.5	2.0	2.76	9.6	75	0.0	0.00	0.0	0	75
5.0	2.5	2.89	9.5	109	0.5	2.54	9.4	8	117
5.5	3.0	3.05	9.4	149	1.0	2.67	9.3	25	174
6.0	3.5	3.19	9.3	194	1.5	2.65	9.2	45	239
6.5	4.0	3.32	9.2	244	2.0	2.68	9.1	69	313
7.0	4.5	3.32	9.1	288	2.5	2.72	9.0	97	385
7.5	5.0	3.32	9.0	334	3.0	2.73	8.9	126	460
8.0	5.5	3.32	8.9	381	3.5	2.76	8.8	159	540
8.5	6.0	3.32	8.8	429	4.0	2.79	8.7	194	624
9.0	6.5	3.32	8.7	479	4.5	2.88	8.6	236	715

Conclusions

Transfer Pipe Rating Curves

Transfer pipe rating curves were developed for combinations of headwater and tailwater depth, and are depicted below in Figure 5. All headwater and tailwater depths are expressed in relation to the invert of the transfer pipe at that location (i.e. TW depth of 2 ft means 2 ft above the invert at Dam "A"; HW depth of 6 ft means 6 ft above the invert at Dam "B").

It can be seen from Figure 5, that to provide the maximum water right to both the City of Yreka and the hatchery (25 cfs total), while water to the powerhouse is shut off, it would require some amount of spillage over the dam crest at Dam "B". For typical water levels in the Dam "A" impoundment (the Dam "A" low crest), the headwater depth at Dam "B" would need to be about 1.5' over the crest elevation.

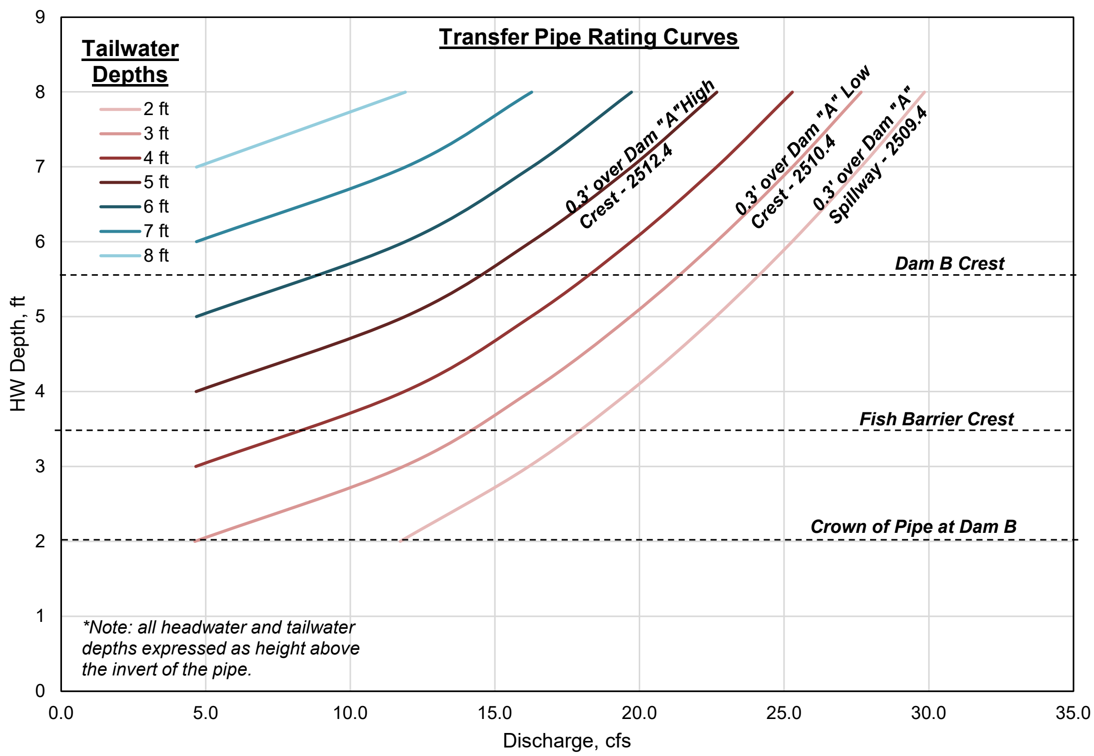


Figure 5. Transfer Pipe Rating Curves

Dam "B" Overflow Rating Curve

This can be further interpreted using the Dam "B" overflow rating curve. For the headwater elevation set by the transfer pipe capacity, derived from Figure 5 above, the overflow rate at Dam "B" can be calculated from Figure 6 below.

In the case mentioned above, for a 25 cfs transfer rate from Dam "B" to Dam "A", the headwater depth was about 7.0 ft. For a 7.0 ft headwater level at Dam "B", Figure 6 shows an overflow rate of almost 400 cfs. So, for the pool level at Dam "A" and the transfer rate specified, Fall Creek would need to be flowing at approximately 425 cfs (400 overflow + 25 delivered). This is a very large flood event, and therefore it is not recommended that the Fall Creek powerhouse maintenance be performed at a time of year when both the hatchery and the City of Yreka require their full water right. This could alternatively be managed by setting the pool elevation lower at Dam "A" using the dam board spillway.

Other combinations of transfer rates and headwater / tailwater elevations can be evaluated using these two sets of rating curves.

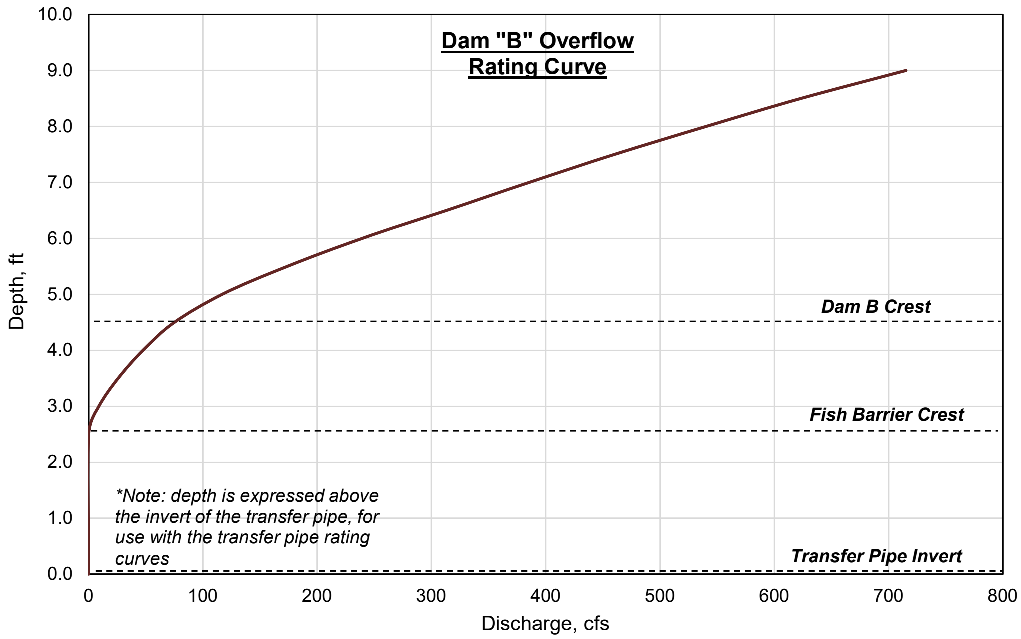


Figure 6. Dam "B" Overflow Rating Curve