UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

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

LICENSE SURRENDER ORDER LOWER KLAMATH PROJECT

Reservoir Drawdown and Diversion Plan

December 2022

PUBLIC VERSION

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project
FERC Project No. 14803

Reservoir Drawdown and Diversion 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 cofferdams, portions of the Iron Gate Fish Hatchery, residential facilities, and warehouses. Facility removal will be completed within an approximately 20-month period.

This Reservoir Drawdown and Diversion Plan describes the measures that the Renewal Corporation will implement to manage aquatic resources 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 (Y) approves the Reservoir Drawdown and Diversion 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 comply with the four requirements in Ordering Paragraph (Y); include refinement in means and methods due to further consultation with the Oregon Department of Environmental Quality and California State Water Resources Control Board pursuant to the requirements in Ordering Paragraphs (D) and (E), respectively; and reflect updates to the construction drawings as included in the Renewal Corporation's June 2022 filing of its Final Construction Documents[1]. Table 2-2 herein shows the material modifications to the Reservoir Drawdown and Diversion Plan. An updated Consultation Record for the Reservoir Drawdown and Diversion Plan is included as Appendix A.

[1] eLibrary accession number 20220630-5018

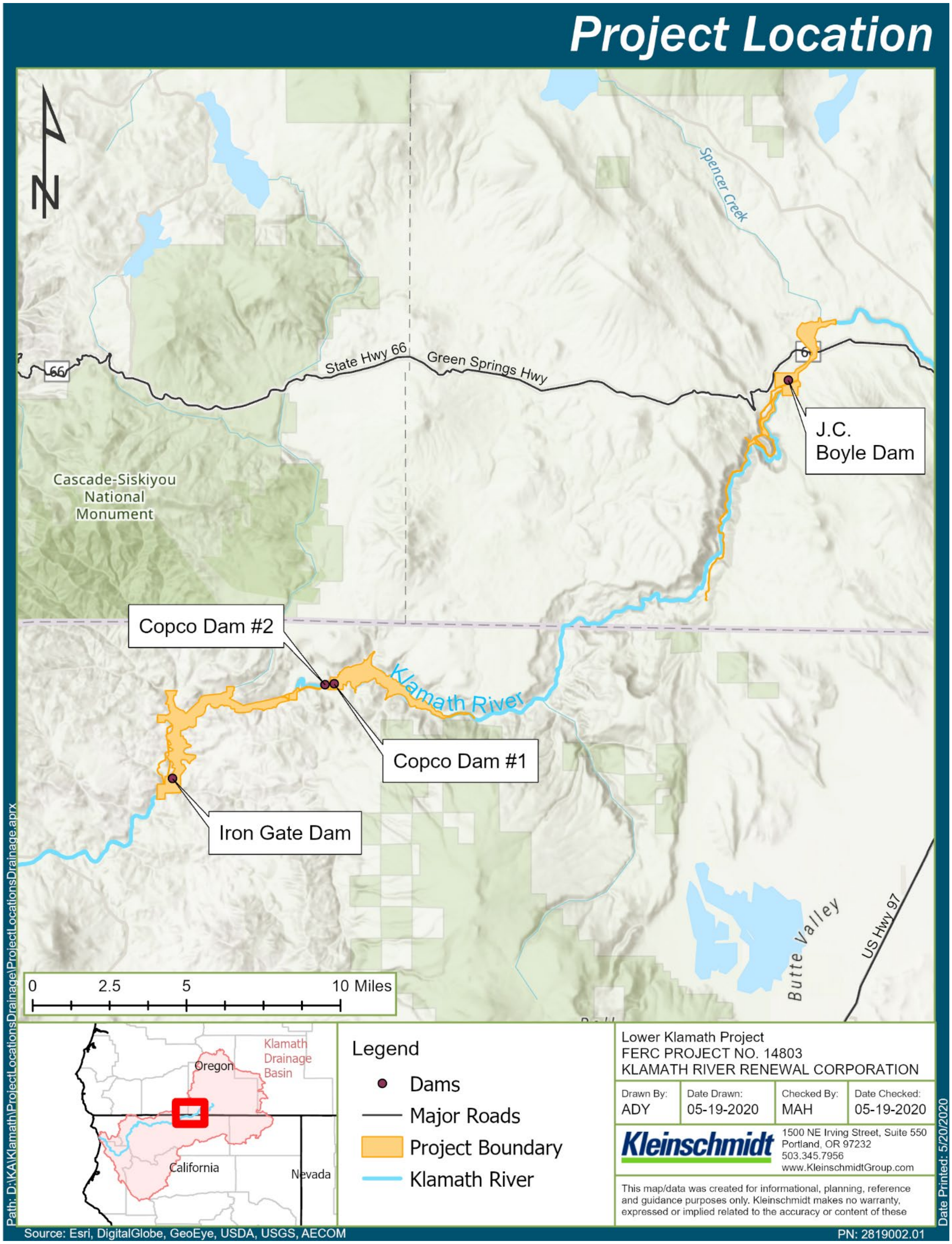

Figure 1-1. Lower Klamath Project Location

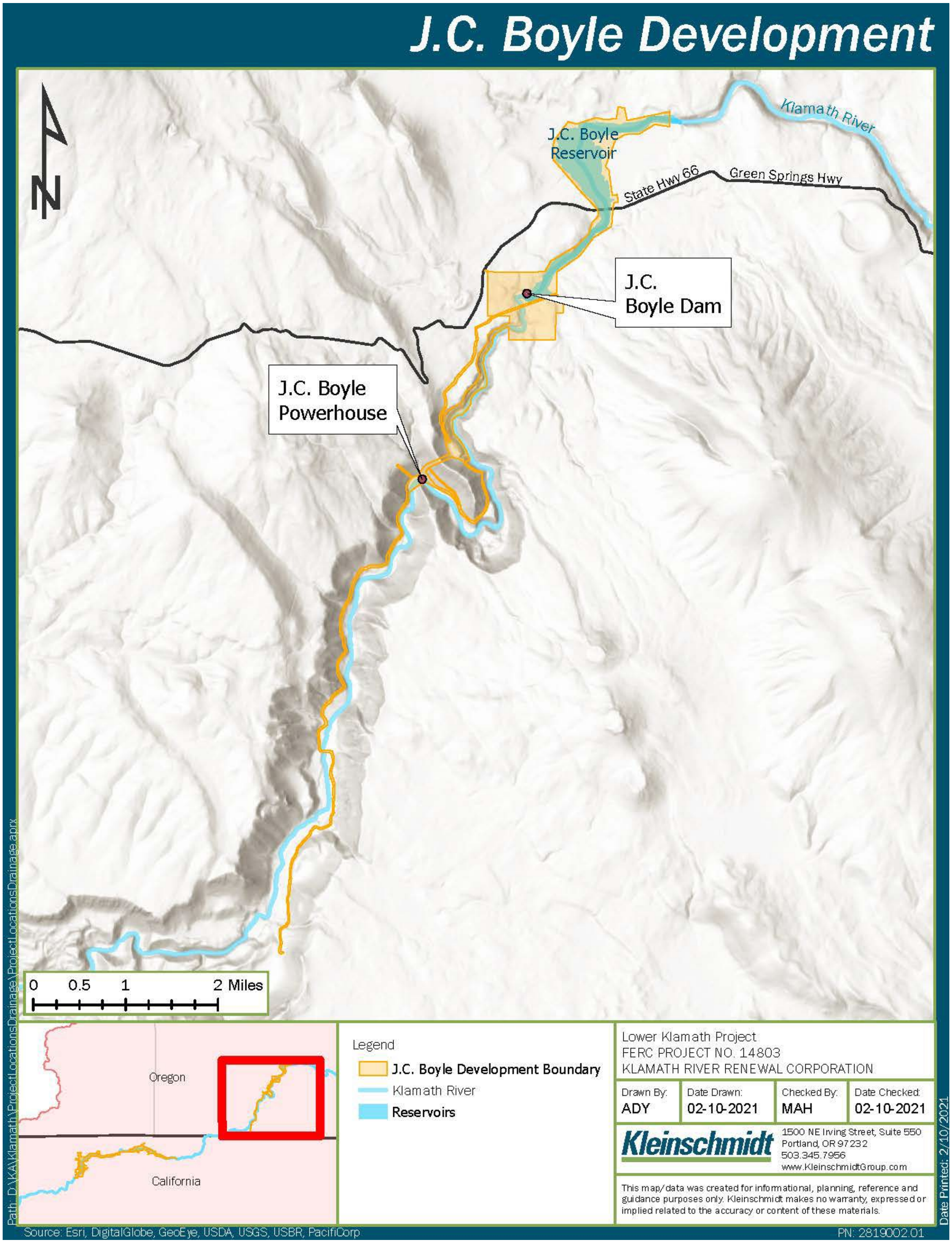

Figure 1-2. J.C. Boyle Development Facility Details

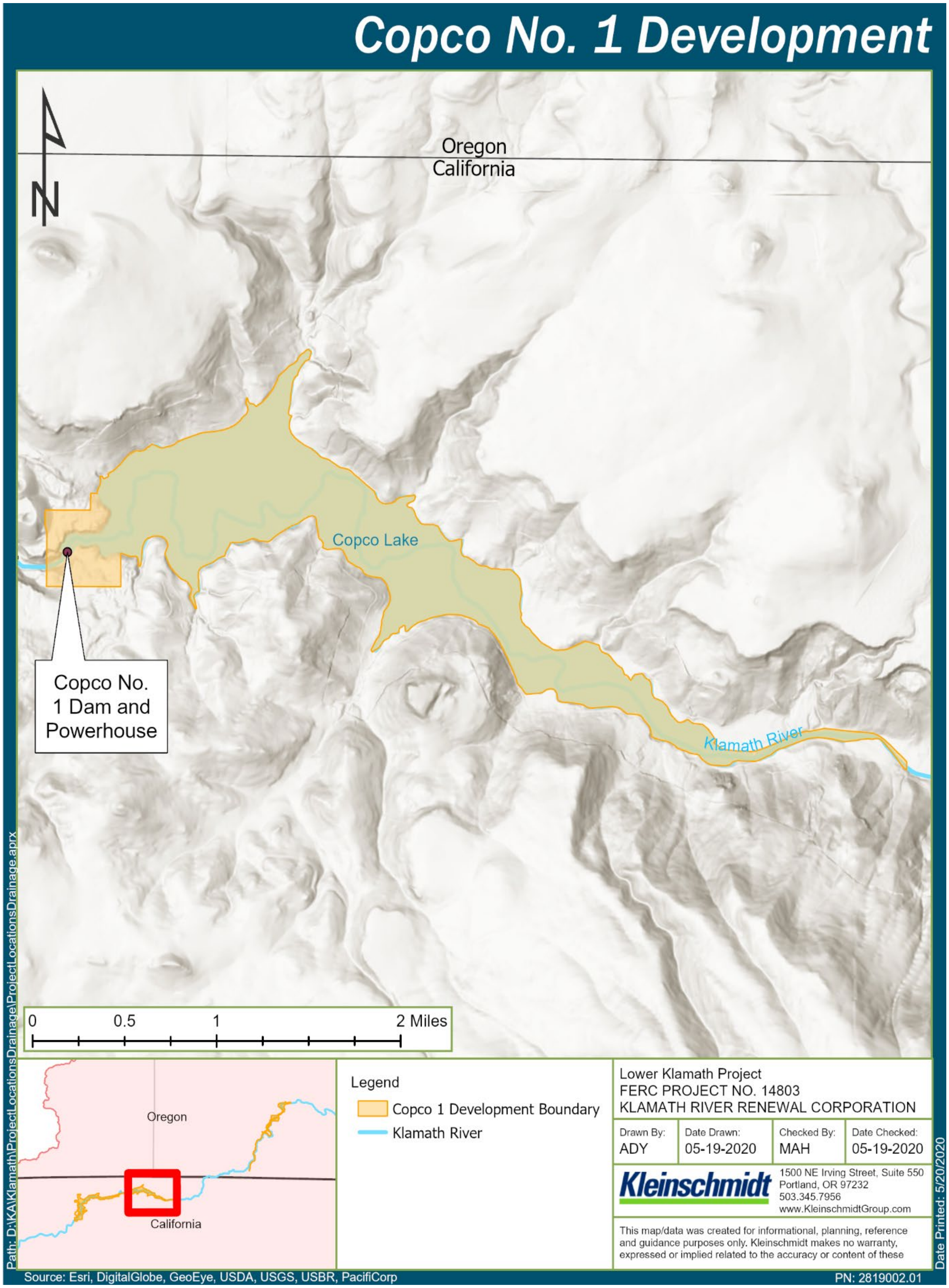

Figure 1-3. Copco No.1 Development Facility Details

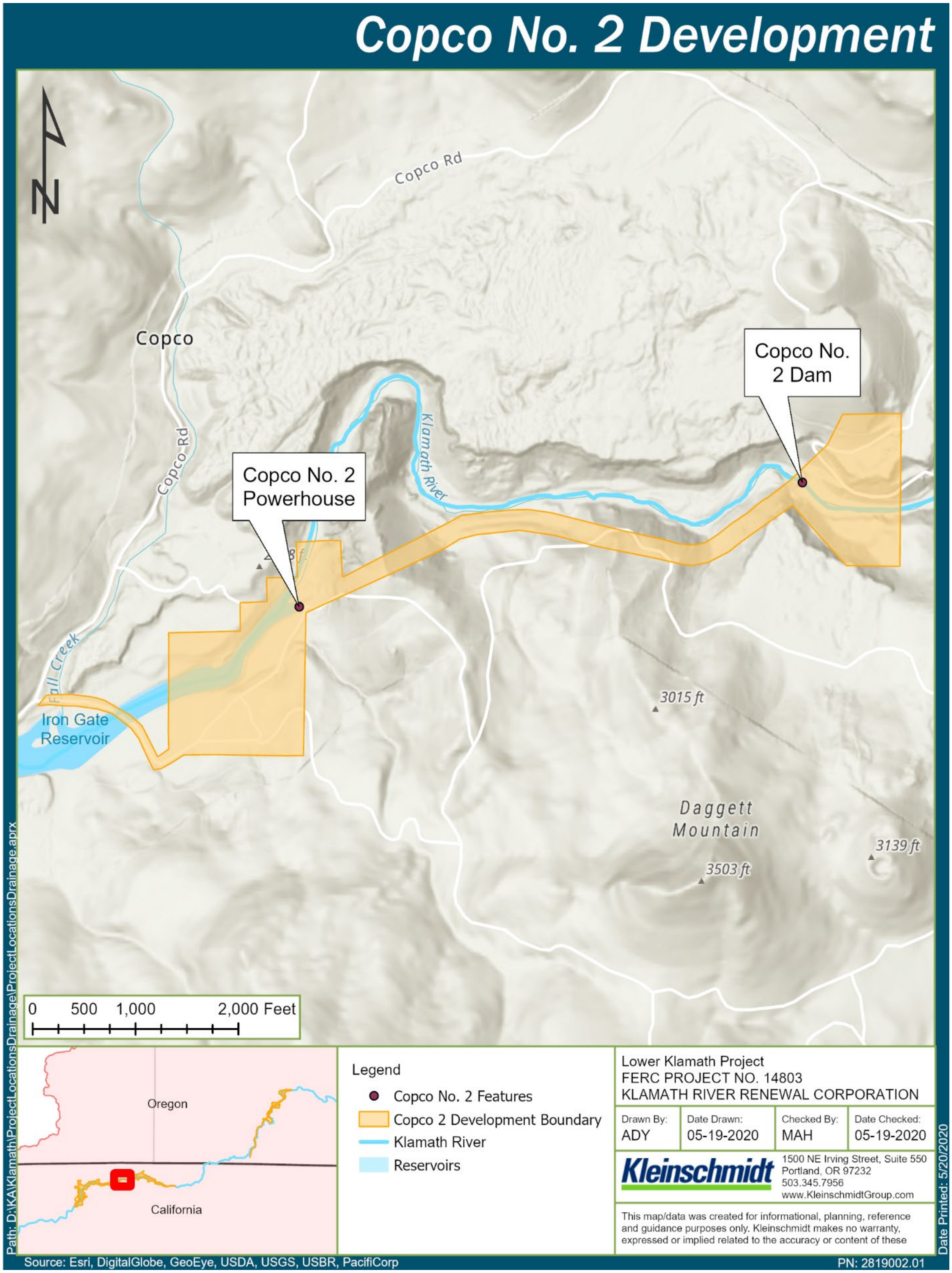

Figure 1-4. Copco No.2 Development Facility Details

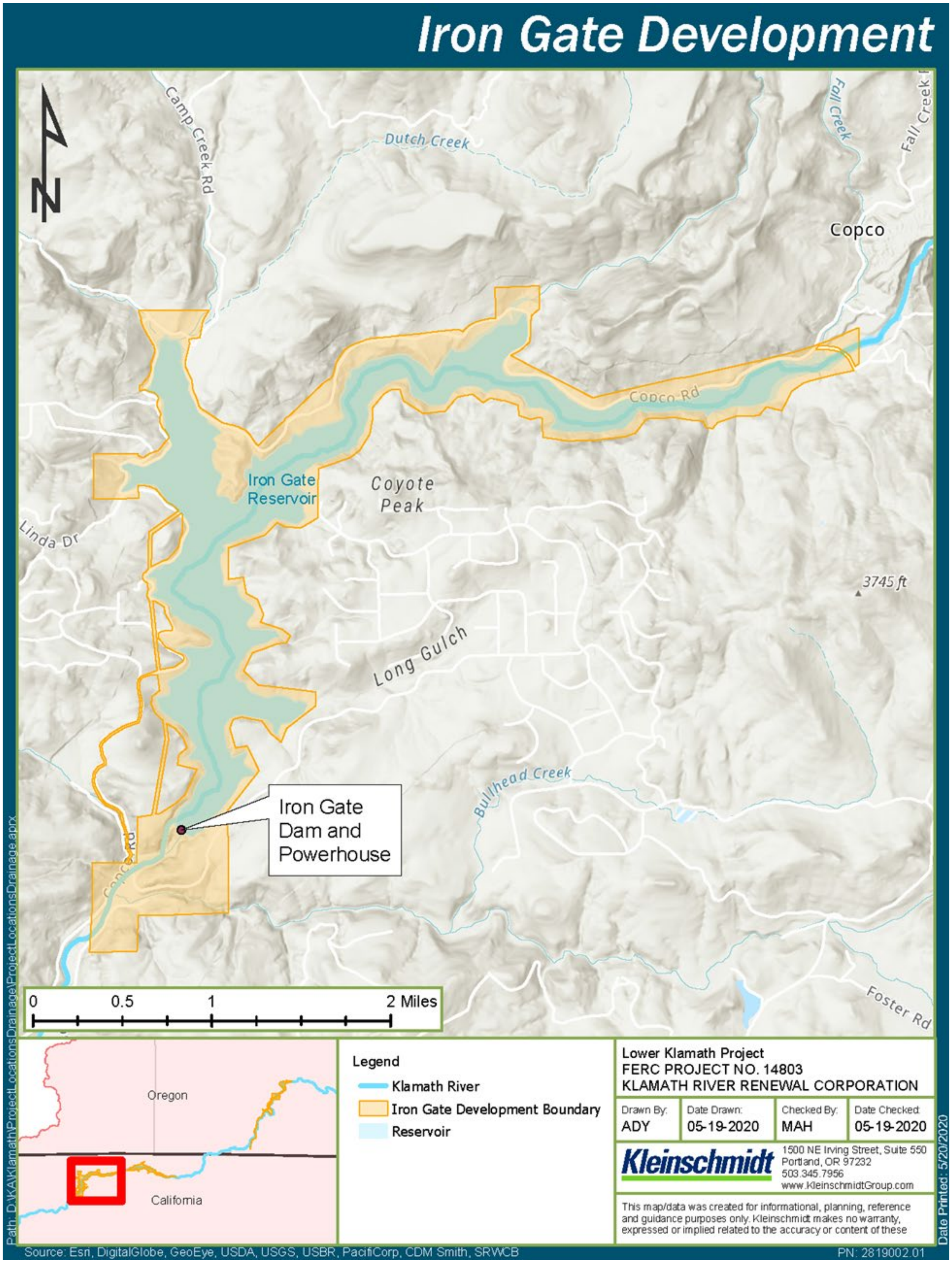

Figure 1-5. Iron Gate Development Facility Details

2.0 Regulatory Context

The Reservoir Drawdown and Diversion 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 Plan
7. Interim Hydropower Operations Plan	15. Water Quality Monitoring and Management Plan
8. Recreation Facilities Plan	16. Water Supply Management Plan

2.1 Organizational Structure

The Reservoir Drawdown and Diversion Plan identifies the measures that the Renewal Corporation will implement to draw down the reservoirs, including procedures, schedules, and monitoring efforts as part of the Proposed Action. Specifically, the Reservoir Drawdown and Diversion Plan includes an updated Consultation Record and three subplans, included amongst the Appendices identified below.

- Appendix A: California Reservoir Drawdown and Diversion Plan
- Appendix B: California Slope Stability Monitoring Plan
- Appendix C: Oregon Reservoir Drawdown and Diversion Plan
- Appendix D: Consultation Record

2.2 Specific Regulatory Interests

The Renewal Corporation considered the following regulatory interests in the development of the Reservoir Drawdown and Diversion Plan:

- California Section 401 Water Quality Certification
- Oregon Section 401 Water Quality Certification
- California Department of Fish and Wildlife Memorandum of Understanding
- Oregon Memorandum of Understanding
- Federal Energy Regulatory Commission Final Environmental Impact Statement
- Federal Energy Regulatory Commission License Surrender Order

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

SUB-PLAN	MODIFICATIONS
Appendix A: California Reservoir Drawdown and Diversion Plan	• Added a description of coordination between the Renewal Corporation and the U.S. Bureau of Reclamation regarding the operation of the Klamath Irrigation Project. • Added measure describing the Renewal Corporation's obligation to develop a Water Quality Monitoring and Protection Plan for each in-water work activity not addressed in an NPDES permit or the CA 401 WQC.
Appendix B: California Slope Stability Monitoring Plan	• Added measure describing the Renewal Corporation's obligation to continue monthly monitoring of displacements of the ground surface for six months following the completion of drawdown. • Added measure describing the Renewal Corporation's obligation to realign affected road segments, engineer structural slope improvements, and revegetate areas affected by slope instability. • Added detail regarding the Renewal Corporation's commitment to address potential impacts to private properties related to slope instabilities, including costs of moving or repairing structures damaged by the Proposed Action. • Added measure describing the Renewal Corporation's obligation to include a public outreach component that addresses communication with environmental justice communities. • Removed details about emergency action thresholds and action levels that were not relevant to this plan and could cause confusion with other documents.
Appendix C: Oregon Reservoir Drawdown and Diversion Plan	• No material modifications.

2.4 Regulatory Approval Process

The Renewal Corporation will implement the Reservoir Drawdown and Diversion 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

By April 15th of each year, the Renewal Corporation will prepare and submit to the Commission an Annual Report which will include information pertaining to implementation of the Reservoir Drawdown and Diversion Plan.

Appendix A

California Reservoir Drawdown and Diversion Plan

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project FERC Project No. 14803

California Reservoir Drawdown and Diversion Plan

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1.0 Introduction

This California Reservoir Drawdown and Diversion Plan is a subplan of the Reservoir Drawdown and Diversion Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project.

1.1 Purpose of California Reservoir Drawdown and Diversion Plan

The purpose of the California Reservoir Drawdown and Diversion Plan is to describe the proposed drawdown methods, procedures, schedules, and monitoring measures that the Renewal Corporation will implement in California as part of the Proposed Action.

The Renewal Corporation and PacifiCorp have entered into an Operations and Maintenance Agreement (2022) filed with the Commission. Under the agreement, PacifiCorp will continue to operate the hydroelectric facilities until final drawdown is initiated after the spring freshet when the reservoir levels drop below the power intakes. At that point, the Renewal Corporation will use the low-level outlets at each dam to release water to completely lower the reservoirs.

1.2 Relationship to Other Management Plans

The California Reservoir Drawdown and Diversion Plan is supported by elements of the following management plans for effective implementation: Remaining Facilities Plan, Waste Disposal and Hazardous Materials Management Plan, Health & Safety Plan, and the Reservoir Area Management Plan. So as not to duplicate information, elements from these other management plans are not repeated herein but are, where appropriate, referenced in this California Reservoir Drawdown and Diversion Plan. The Renewal Corporation will develop a Water Quality Monitoring and Protection Plan for each in-water work activity not addressed by the National Pollution Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities Construction General Permit or in the CA 401 WQC in accordance with Condition 10.

1.3 Elevation Datum

All elevations reported within this plan use the North American Vertical Datum of 1988 (NAVD88), which, at the Copco No. 1 and No. 2 locations, is 3.48 ft higher than the National Geodetic Vertical Datum of 1929 (NGVD29), and at the Iron Gate location, is 3.33 ft higher than NGVD29.

2.0 Drawdown and Diversion Plan

2.1 Drawdown Criteria

Pertinent drawdown criteria for the Proposed Action are summarized in Table 2-1, below, which includes information from the Design Report (Knight Piésold 2022a).

Table 2-1. Reservoir Drawdown Design Criteria

FEATURE/CONSIDERATION	CRITERIA	REMARKS	REFERENCE
OPERATING REQUIREMENTS			
Daily Minimum Downstream Flows	Downstream of Iron Gate: • September through November and March - 1,000 cfs • December through February - 950 cfs • April - 1,325 cfs • May - 1,175 cfs • June - 1,025 cfs • July and August - 900 cfs	• Minimum flows will be dictated by USBR requirements which may supersede the biological opinion flows as set out.	• USBR, BiOp 2019
Normal Maximum Operating Surface Elevation (ft NAVD88)	• Copco Lake = 2,611.0 ft • Copco No. 2 = 2,486.5 ft • Iron Gate = 2,331.3 ft		FERC License Application - Exhibit A (2004) - NAVD88 Elevations Copco No. 2 is not a high-hazard dam; therefore, operating surface elevations were supplied by PacifiCorp.
Normal Minimum Operating Surface Elevation (ft NAVD88)	• Copco Lake = 2,604.5 ft • Copco No. 2 = 2,486.1 ft • Iron Gate = 2,327.3 ft		

PRE-DRAWDOWN			
Pre-Drawdown Construction Activities (Downstream of Reservoirs)	• Construction and commissioning to occur prior to January 1 of the drawdown year		
	• All reservoirs to be operated at or below minimum operating water levels during early works construction; minimum operating water levels are specific to each facility	• Water levels to be defined through consultation with PacifiCorp	• PacifiCorp STID Section 4 Standard Operations Procedures (PacifiCorp 2007, 2015, 2016)
Pre-Drawdown Flow Regulation	• Regulate project operation flows to keep reservoir levels at or below minimum operating levels to maintain construction safety • The reservoir lowering will begin prior to construction and will be accomplished through normal project power and water bypass operations on a site-specific basis	• Required for construction staging and work safety	• PacifiCorp STID Section 4 Standard Operations Procedures (PacifiCorp 2007, 2015, 2016)
DRAWDOWN			
Initial Drawdown	• To begin on or about January 1 of the drawdown year.		
Reservoir Drawdown Rate	• Target drawdown water surface level rate 5 ft/day	• Each facility is unique relative to reservoir area capacity and proposed drawdown. Actual drawdown will be based on the actual water year	
Drawdown Completion	• Water surface level at or below historic cofferdam level		• Knight Piésold Memo VA20-01231 - Klamath Drawdown Model

GEOTECHNICAL REQUIREMENTS			
Slope Stability of Reservoir Rim			
Minimum Required FOS	• Drawdown FOS = 1.2	• Reservoir Drawdown criterion applies to existing dam, rim, and embankment slopes.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003
	• Long-term, Post Drawdown FOS = 1.5		• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003
Design Earthquake for Temporary Construction	• 10% Probability of Exceeding Operating Basis Earthquake in 50 Years (1/475-Year Event); 0.2% Probability in 1 Year • 2% Probability of Exceeding Maximum Design Earthquake in 50 Years (1/2,475- Year Event); 0.04% Probability in 1 Year		• Appendix A4 of the Design Report
Slope Stability of Temporary Embankment Slopes			
Reservoir Drawdown	FOS = 1.3	• Reservoir Drawdown criterion applies to temporary embankment slopes during removal.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003

Notes:

BiOp = Biological Opinion
CFS = Cubic feet per second
EM = Engineer Manual
FERC = Federal Energy Regulatory Commission
FOS = Factor of Safety

NAVD88 = North American Vertical Datum of 1988
STID = Supporting Technical Information Document
USBR = United States Bureau of Reclamation
USACE = United States Army Corps of Engineers

2.1.1 Discharge Volumes and Rates

2.1.1.1 Copco No. 1 Development

Discharges during the drawdown stage will be made through a newly constructed low-level outlet tunnel, through the existing historic diversion tunnel, and by spillway releases. Low-level outlet tunnel discharge rating capacities are outlined in Appendix C of the Design Report (Knight Piésold 2022a) and are summarized below. The low-level outlet has been designed to withstand spillway releases if they occur during drawdown. The proposed discharge rating curves for Copco No. 1 are presented in Appendix A (drawing C2056). Discharge capacities of the Copco No. 1 Dam are presented in Table 2-2, below.

Table 2-2. Copco No. 1 Total Discharge Capacity for Low-Level Outlet Tunnel

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,609	4,197
2,604	4,099
2,599	3,998
2,594	3,894
2,589	3,789
2,584	3,680
2,579	3,568
2,574	3,453
2,569	3,334
2,564	3,211
2,559	3,084
2,554	2,951
2,549	2,813
2,544	2,667
2,540	2,546
2,539	2,515
2,538	2,483
2,537	2,451
2,536	2,419
2,535	2,386
2,534	2,353
2,533	2,319
2,532	2,285

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,531	2,250
2,530	2,215
2,529	2,179
2,528	2,143
2,527	2,106
2,526	2,069
2,525	2,031
2,524	1,653
2,523	1,264
2,522	934
2,521	659
2,520	500
2,519	268
2,518	144
2,517	63
2,516	18
2,515	0

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix C2 of the Design Report (Knight Piésold 2022a).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.1.2 Copco No. 2 Development

To allow for dam modifications works (i.e., removal of a portion of Spillway Bay No. 1), the Renewal Corporation will manage Copco No. 2 reservoir water surface levels during pre-drawdown by using the conveyance system to the powerhouse. The outlet works for reservoir drawdown will be comprised of discharge through the existing spillway gates and the removal of Spillway Bay No. 1. Discharge rating capacities for the spillway gates and removal of Spillway Bay No. 1 are outlined in Appendix D of the Design Report (Knight Piésold 2022a) and are summarized below. Discharge rating curves for Copco No. 2 are also presented in Appendix A (drawing C3057). Discharge capacities of the Copco No. 2 Dam components are presented in Table 2-3, below.

Table 2-3. Copco No. 2 Total Discharge Capacity

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)	SPILLWAY 4 GATES RATES (CFS)	TOTAL RATES (CFS)
2,490	15,328	24,168	39,496
2,489	14,581	21,533	36,114
2,488	13,846	19,002	32,847
2,487	13,123	16,578	29,701
2,486	12,249	14,267	26,516
2,485	11,327	12,075	23,401
2,484	10,445	10,008	20,452
2,483	9,603	8,074	17,678
2,482	8,801	6,285	15,086
2,481	8,038	4,651	12,690
2,480	7,314	3,190	10,504
2,479	6,789	1,926	8,715
2,478	6,393	895	7,288
2,477	5,991	172	6,163
2,476.5	5,768	0	5,768
2,476	5,496	-	5,496
2,475	4,969	-	4,969
2,474	4,464	-	4,464
2,473	3,962	-	3,962
2,472	3,490	-	3,490
2,471	3,045	-	3,045
2,470	2,170	-	2,170
2,469	1,345	-	1,345
2,468	773	-	773
2,467	641	-	641
2,466	517	-	517
2,465	402	-	402
2,464	298	-	298
2,463	204	-	204
2,462	123	-	123
2,461	57	-	57
2,460	11	-	11

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)	SPILLWAY 4 GATES RATES (CFS)	TOTAL RATES (CFS)
2,459.5	0	-	0

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix D2 of the Design Report (Knight Piésold 2022a).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.1.3 Iron Gate Development

Discharges during drawdown will be made through the modified diversion tunnel using the existing outlet control gate, through the existing power intake and turbine/bypass, and by spillway releases. The Computation Fluid Dynamics (CFD) model developed for the diversion channel and existing outlet control gate confirmed that the hydraulic capacity is approximately 4,000 cfs. Discharge rating capacities for the diversion tunnel with gate fully open are outlined in Appendix E of the Design Report (Knight Piésold 2022a) and are summarized below. Discharge rating curves for Iron Gate are also presented in Appendix A (drawing C4050). Discharge capacities of the Iron Gate Dam are presented in Table 2-4, below.

Table 2-4. Iron Gate Total Discharge Capacity

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,331.3	3,930
2,291.3	3,380
2,251.3	2,530
2,211.3	1,650
2,188	0

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix E2 of the Design Report (Knight Piésold 2022a).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.2 Slope-Stability Analysis

The Reservoir Rim Stability Report (Knight Piésold 2020) provides analysis in support of the California Reservoir Drawdown and Diversion Plan and describes the reservoir rim and associated properties (private vs. public) abutting the rim. Additional detail on slope stability can be found in the California Slope Stability Monitoring Plan.

2.2 Drawdown and Diversion Procedures

The Renewal Corporation will initiate the release of sediment to the Klamath River from the three larger reservoirs (J.C. Boyle, Copco No. 1, and Iron Gate) with reservoir drawdown. Proposed pre-January 1 reservoir releases will be accomplished with the facilities' existing structures to bring the reservoirs at or near their minimum allowable operating levels. Then, starting January 1 of the drawdown year, the Renewal Corporation will allow regulated releases to draw down the reservoirs and release associated sediment in a controlled manner. Drawdown will continue until removal of the dams. The following reservoir drawdown and diversion approach described in this section is from the Design Report (Knight Piésold 2022a). Drawdown and diversion procedures for the J.C. Boyle Development are detailed in the Oregon Reservoir Drawdown and Diversion Plan

2.2.1 Cofferdams

In lieu of cofferdams, the Renewal Corporation will install work pads at the base of Copco No. 1 and Iron Gate dams to allow for construction equipment access. Work pads serve the function of a cofferdam by establishing a dry working environment. Construction of the work pads include installing rock into the wetted area allowing equipment to then extend further into the wetted area in the dry. The equipment then installs more rock further into the wetted area allow the construction equipment to roll further out into the area while remaining dry. This process continues until the entire pad is constructed. A cofferdam is not used in these applications because more active stream channel work would be required to install a cofferdam prior to work pad construction. The work pad functions like a dike, allowing dry access above the water elevation. Please refer to the Klamath River Renewal Project 100% Design Completion Drawings (Knight Piésold 2022b) Sheets C2501 and C2501 for Copco No. 1 and Sheet C4500 for Iron Gate. The work pads will be removed in reverse succession as their installation, and the river channel at the dam sites will be graded prior to the final breach of historic cofferdams and diversions.

Work pads will be inspected upon completion of construction and initial dewatering inside of the work pads to make sure that no fish or other aquatic or terrestrial species are trapped on the inside and cannot return to the river. Daily inspection will occur during construction to ensure the work pad condition is maintained. There will be short term turbidity increases during their installation as the river bottom is agitated by placed rock. At Copco No. 1 the turbidity will be limited to the bypass reach or will be directed through the Copco No. 2 diversion tunnel. At Iron Gate, turbidity will occur in the mainstem Klamath River.

Construction of work pads at Copco No. 1 will take approximately 13 days and Iron Gate will take approximately 18 days.

2.2.2 Copco No. 1 Development

2.2.2.1 Existing Development Components

The Copco No. 1 Development construction has been well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report (Knight Piésold 2022a). STIDs are provided in Appendix J of the Design Report.

2.2.2.2 Pre-Drawdown Works

The Renewal Corporation will construct a new low-level outlet tunnel under spillway bay 3, which will be used to draw down the reservoir. The construction of the low-level outlet tunnel will require temporary construction access from the right bank to develop a work platform beside the spillway plunge pool. This spillway plunge pool work platform will also provide access to the historic diversion tunnel outlet, which is required to reopen the tunnel and complete drawdown. The proposed work includes dredging of the low-level outlet tunnel approach channel and the historic diversion tunnel approach channel.

The Renewal Corporation will conduct dredging of deposited sediment and debris in the reservoir at the low-level outlet tunnel approach channel to remove obstructions and facilitate the safe passage of river flows and sediment during drawdown. Dredging of the historic diversion tunnel approach channel is also required to facilitate its usage during dam demolition and removal. Design drawings C2160, C2210, and C2272 (Appendix A) show the extents of the dredging location and material disposal.

The low-level outlet will be excavated as a 10.5-ft high and 10.5-ft wide D-shaped tunnel with vertical sides, a 10-ft concrete plug orifice to the reservoir, and a 10.5-ft diameter steel outlet conduit (drawings C2205 and C2225 in Appendix A). When opened, the outlet will connect the reservoir to the spillway plunge pool and drain the reservoir. The Renewal Corporation will accomplish excavation of the low-level outlet tunnel by first constructing a work platform at the toe of the dam to access the proposed adit. Then the concrete will be drilled, blasted, and excavated in sections (vertically and horizontally) until the final section/plug is reached. The final section will terminate in the upper cut-off wall, leaving a concrete plug separating the dry tunnel and the reservoir, as shown on drawing C2225 (Appendix A). The concrete plug is designed to provide the plug length required for structural strength and includes additional contingency length to account for possible fractures in the concrete mass induced by vibration during excavation of the tunnel. The tunnel plug design will allow normal power operations to continue until reservoir drawdown.

The low-level outlet terminates in a narrow canyon with an existing spillway plunge pool. The Renewal Corporation will embed a 10.5-ft diameter pipe into the concrete tunnel section to extend the outlet into the spillway plunge pool. The outlet pipe will direct outflow into the spillway plunge pool and allow access to a spillway work platform while flow is discharging through the outlet and pipe.

2.2.2.3 Reservoir Operations

During the pre-drawdown construction period, the Renewal Corporation will operate the Copco No. 1 Development to comply with the procedures set out below.

2.2.2.3.1 Normal Flow Condition

The Renewal Corporation will keep the Copco No. 1 reservoir level at or below the spillway ogee crest level (elevation 2,597.1 ft), to as low as the minimum operating level (elevation 2,592 ft) during and after pre-drawdown construction. The Renewal Corporation will bypass reservoir inflows through the powerhouse turbine generator units 1 and 2, which provide a combined discharge capacity of 3,000 cfs (PacifiCorp 2016).

The Renewal Corporation will lock out spillway gates to comply with dam safety requirements during the pre-drawdown construction period and to allow safe access below the spillway to construct the new low-level outlet tunnel. Proposed reservoir operation under this procedure will provide sufficient freeboard to provide attenuation capacity and time to monitor inflows and vacate the downstream area in the event of large reservoir inflows that exceed the powerhouse capacity. During this period, coordination between the Iron Gate Reservoir level and the Copco No. 1 work will be required to ensure adequate capacity is in Iron Gate Reservoir to maintain minimum river flow conditions below Iron Gate Dam.

The Renewal Corporation will maintain the operating water level (as described in the previous paragraph) for reservoir inflow rates up to 3,000 cfs, which exceeds the average flow conditions during the pre-drawdown dam modification construction works period (ranging up to 2,110 cfs). However, average flow rates and flood risks increase through the fall. By November and December average flows are estimated to be 1,230 cfs and 1,490 cfs, respectively. To avoid these higher-flow months, the Renewal Corporation will complete low-level outlet tunnel works prior to November of the pre-drawdown year.

2.2.2.3.2 Flood Condition

Reservoir inflow rates greater than 3,000 cfs exceed the powerhouse flow capacity and will cause reservoir water levels to rise. The Renewal Corporation will stop work at the downstream construction area if reservoir water levels exceed the minimum freeboard.

A work stoppage may require the removal of all personnel from the downstream construction area and the unlocking of the spillway gates, as defined in the Emergency Response Plan (Kiewit 2020) and STIDs. The facility will continue to discharge through powerhouse units 1 and 2. Work will be resumed when water levels recede below the minimum freeboard criteria. If water levels rise to above the spillway ogee level (2,597.1 ft), the Renewal Corporation will lower the reservoir level by release of water through the spillway gates. Damage to the temporary downstream work platform is expected if spillway operation occurs. In this event, the Renewal Corporation will re-establish the work area to facilitate ongoing construction of the low-level outlet tunnel works after flood water levels have receded.

2.2.2.4 Drawdown Works

The Renewal Corporation will maintain the lowered Copco No. 1 Reservoir level for pre-drawdown construction until drawdown begins on or around January 1 of the drawdown year. The proposed drawdown operation will be governed by two main events: opening of the low-level outlet tunnel for primary reservoir lowering, and subsequent opening of the historic diversion tunnel to divert flows around the dam and facilitate dam removal works. Initial drawdown occurs when the concrete plug is opened to the low-level outlet tunnel.

The Renewal Corporation will achieve final drawdown through the historic diversion tunnel and when the water surface elevation is maintained below elevation 2,515 ft (crest of the historic cofferdam). The proposed drawdown process is discussed below and included on drawings C2055, C2056, and C2057 in Appendix A.

2.2.2.4.1 Opening of the Low-Level Outlet Tunnel

The shape and profile of the low-level outlet tunnel was selected to facilitate construction, reduce stresses acting on the crown of the tunnel, and provide the internal cross-section necessary to discharge design flows (Table 2-2). The Renewal Corporation will commence drawdown on or about January 1 of the drawdown year when the low-level outlet tunnel is opened to the reservoir. This will be achieved by precision blasting the concrete plug left in place during the pre-drawdown tunnel excavation works. Access to remove the concrete plug is only possible from the dry downstream side of the outlet conduit vent pipe and will require predrilling of the blast holes at the time of the tunnel construction. Upon removal of the plug, the surge of water from the reservoir will remove concrete debris that will settle in the plunge pool.

The low-level outlet tunnel is designed to lower the reservoir without addition of power operations. The reservoir level range expected for normal hydrologic conditions (50^{th} percentile) during drawdown, using only the low-level outlet tunnel, is at elevations between 2597.1 ft to 2530 ft. The maximum drawdown rate of the reservoir for normal hydrologic conditions is approximately 5 ft/day and occurs in early January.

The 10.5-ft low-level outlet tunnel orifice inlet diameter provides an initial discharge capacity of about 3,680 cfs at a reservoir elevation of 2,592 ft. The outflow capacity decreases to approximately 2,115 cfs at a reservoir elevation of 2,530 ft., which is the water level at or below which the historic diversion tunnel will be opened. The proposed rating curve for the low-level outlet tunnel is provided on drawing C2056 (Appendix A).

The design of the 10.5 ft diameter tunnel orifice and high discharge velocity of the outlet allows the passage of sediment and reduce the risk of blockages. Concentrated flow velocities upstream of the dam promote sediment mobilization in the original river channel and sediment transport downstream. The energy of the outflowing water dissipates within the spillway plunge pool.

The Renewal Corporation will implement measures to address potential debris blockage during drawdown. In advance of drawdown, the Renewal Corporation will conduct dredging on the upstream side of the adit and historic diversion tunnel intake. If sediment and/or debris materials accumulate in the adit or tunnel, the Renewal Corporation will use mechanical means or controlled blasting to remove the obstruction. In addition to these measures, the low-level outlet tunnel slopes downward at a 10% grade, from the intake to the outlet. This slope allows for the clearing of the concrete plug debris and sediment passage of bed material during reservoir drawdown, and debris materials will end up in the plunge pool at the end of the pipe (see drawings C2210 and C2225). To further prevent debris from accumulating in the adit or tunnel, the Renewal Corporation will conduct debris management and removal operations during drawdown and will install a debris boom upstream of the adit and tunnel intake area.

The low-level outlet tunnel functions as an uncontrolled hydraulic structure and drawdown rates and the overall drawdown period will depend on the reservoir inflow rates during the drawdown period. Partial reservoir refilling can occur due to large inflow events that exceed low-level outlet tunnel capacity.

2.2.2.4.2 Left Bank Access

Access to the historic diversion tunnel inlet structure is required to open the historic tunnel during the late stages of drawdown when water levels have receded to 2,530 ft or lower. The Renewal Corporation will lower equipment down the left bank to the concrete inlet structure. Two methods are proposed for lowering the equipment. Under the first method, and after initial removal of the top of the dam that will leave a wider passage, equipment will traverse the dam to the south side (i.e., left abutment looking downstream) and then track-walk down the abutment using an anchoring system that will winch the excavator down to the intake elevation. If equipment is not able to traverse the top of the dam, the Renewal Corporation will bring equipment through private property to the south side.

2.2.2.4.3 Opening of the Historic Diversion Tunnel

The Renewal Corporation will complete opening of the historic diversion tunnel when reservoir water surface elevations have subsided to 2,530 ft or lower. The invert elevation of the historic diversion tunnel is assumed as 2494.8 ft. The initial step is to remove the concrete inlet structure to elevation 2,505.8 ft or lower, followed by removal of the existing concrete plug by drilling and blasting from the downstream side of the plug. Re-establishing flow in the historic diversion tunnel results in the lowering of water levels to at or below the historic cofferdam crest elevation (2,515 ft), thereby routing river flows around the dam site and facilitating dam demolition and removal. The Renewal Corporation will complete the removal of the remaining intake structure and embedded items to elevation 2,494.8 ft once the reservoir level is lowered to an approximate elevation 2,515 ft to fully open the diversion tunnel. The additional diversion capacity reduces the risk of reservoir refilling during the dam removal period.

The historic diversion tunnel provides a flow capacity of 4,200 cfs when water levels are at approximately 2,515 ft, which exceeds normal flows during the summer period when dam removal will occur. The historic diversion tunnel originally functioned as the diversion tunnel during construction of Copco No. 1. The range of diversion flows are the same as the flows expected after the diversion tunnel is reopened. The proposed diversion tunnel reopening is shown on drawing C2100 in Appendix A.

2.2.3 Copco No. 2 Development

2.2.3.1 Existing Development Components

The Copco No. 2 Development construction has been well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report (Knight Piésold 2022a). STIDs are provided in Appendix J of the Design Report (Knight Piésold 2022a).

2.2.3.2 Pre-Drawdown Works

The Renewal Corporation will use the existing diversion dam structure to pass the river flows and avoid the use of cofferdams or the need to develop large new structures in the river channel. The base-case design involves removing a portion of a spillway bay and preparing the remaining spillway ogee section for initiation of drawdown. After drawdown, the dam will be progressively removed laterally. The proposed removal of the elements of the diversion dam and intake structure are shown on drawings C3200 to C3232 in Appendix A.

During the pre-drawdown period, the Renewal Corporation will remove the downstream portion of the left-most spillway bay (Spillway Bay No. 1), extending down to the concrete apron (elevation 2,459.5 ft). The Renewal Corporation will remove all concrete, except for the upstream 17 ft of the ogee spillway, which will be left in place. The ogee spillway provides support to the left bank wing wall, which is required to remain stable after the ogee crest is removed to prevent erosion of the bank during drawdown. Results of a structural analysis conducted for the spillway left wing wall indicated it should be stable when the entire ogee structure is removed for the diversion of river flows.

The Renewal Corporation will build a temporary construction work platform from the right bank onto the spillway apron, which will function as a work platform for the pre-drawdown works, as shown on drawing C3210 (Appendix A). The spillway apron work platform will be built to elevation 2,462.5 ft, above expected tailwater elevations, to provide a competent dry working surface. Additionally, concrete between the two piers of Spillway Bay No. 1 will be removed using blasting techniques or mechanical demolition. Concrete will be removed to elevation 2,459.5 ft during the pre-drawdown works to match the top of the spillway apron. The spillway apron, sill, and left bank retaining wall will be left in place to provide erosion protection for the riverbed, since high flows may pass through the confined opening during the drawdown year. The work platform material will be removed following concrete removal to the target elevation.

2.2.3.3 Reservoir Operations

To complete pre-drawdown construction works, the Renewal Corporation will close the spillway gates, and all water will be diverted through the intake to the powerhouse. After pre-drawdown dam modifications are complete, the Copco No. 2 Development will continue to operate as a power generating station under normal operating conditions until drawdown begins the following year. The reservoir will be lowered and maintained at the normal minimum reservoir operation level (elevation 2,486.1 ft) prior to the commencement of drawdown (January 1 of the drawdown year). Section 2.3 outlines alternative drawdown procedures and reservoir operations.

2.2.3.4 Drawdown Works

The Renewal Corporation anticipates no restrictions regarding Copco No. 2 drawdown, except that it must not be initiated prior to January 1 of the drawdown year. The Renewal Corporation will initiate drawdown of the reservoir by opening the spillway gates and increasing the flow through the conveyance system to the powerhouse. The average monthly flow at Copco No. 2 is less than 2,000 cfs in January and the capacity of the conveyance system and turbines is 3,200 cfs. The drawdown below the spillway crest can therefore be completed entirely through the intake, provided inflows to Copco No. 2 are not substantially higher than average during drawdown. Drawdown of the reservoir and the spillway bay removal will occur over a short timeframe, so high-flow events are not anticipated to affect the drawdown period. Drawdown will reduce the head pond to a minimum level below the spillway crest, which is controlled by the hydraulics of the tunnel and inflows from the river. By using the conveyance system to lower the reservoir, removal of the final 17 ft of dam at Spillway Bay No. 1 can occur under a lower head.

The Renewal Corporation will remove the Spillway Bay No. 1 concrete plug to elevation 2,459.5 ft through a controlled blast or by mechanical methods. The intake caterpillar gate will be closed permanently after Spillway Bay No. 1 is opened and the reservoir level can then become limited by the constriction at the spillway bay. The rating curve for the reservoir with Spillway Bay No. 1 excavated to elevation 2,459.5 ft and the four remaining spillway gates open is shown on drawing C3057.

An alternative option for Copco No. 2 drawdown and removal is discussed in Section 2.3.2, which uses Copco No. 1 to block flow to the Copco No. 2 reservoir and complete removal in the dry.

2.2.4 Iron Gate Development

2.2.4.1 Existing Development Components and Preconstruction Inspections

The Iron Gate Development construction is well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report. STIDs are provided in Appendix J of the Design Report.

The existing low-level outlet control at Iron Gate Dam consists of a hydraulically actuated, gravity-close, reinforced concrete bulkhead gate. The outlet control is installed at the bottom of a 160 ft-long shaft and is comprised of two sections of concrete bulkhead, the lower of which has not been moved since original construction. The gate slot and concrete bulkheads close a waterway opening that is horseshoe-shaped and is 15 ft – 6 inches wide by 16 ft – 9 inches high. A concrete collar and 9-ft diameter blind flange were installed downstream of the control gate during a 2007 construction program, to allow isolation and underwater inspection of the control gate.

A detailed underwater inspection and survey was completed for the concrete-lined upstream tunnel from the intake structure to the control gate using a Remote Operating Vehicle (ROV) in late August 2020. ASI Marine (ASI) used an ROV to investigate the configuration and condition of the Iron Gate diversion tunnel upstream of the control gate and intake structure, and control gate and operator. Using multibeam profiling sonar equipment, a 3-dimensional model of the gate structure, gate, and diversion tunnel was developed. The diversion tunnel gate and associated components appear to be in good condition with only minor spalling observed in several areas. On average, the height of the tunnel profiles along the vertical center of the profile from Station 3+06 to Station 6+66 is approximately 172 inches, which differs approximately 26 inches from the height indicated in historic drawings (G-8862 in Appendix A).

ASI also conducted an underwater inspection of the Iron Gate diversion gate. The inspection identified debris build-up that will need to be cleared; the gate rollers and guides will also need to be cleared of debris. This work will be scheduled in the pre-drawdown period. Additionally, a 9-ft diameter steel head will be attached to an existing flange located just downstream of the gate. The 9-ft diameter steel head will be installed during pre-drawdown work to create a balanced head condition, followed by a partially unbalanced head condition, across the diversion tunnel gate. Once all debris is removed, the gate and its hydraulic power unit (hoist) will be cycled up and down. Components will be lubricated, maintained, and replaced as necessary. The gate will be raised to its fully open position and then closed three times to demonstrate its ability to open and close. Once confirmed, the diversion tunnel gate and hoist will be considered ready for the scheduled opening to begin drawdown on January 1.

The downstream tunnel from the control gate to the outlet portal currently features a concrete-lined segment for approximately 90 ft immediately downstream of the gate. The rest of the tunnel downstream of the gate (approximately 500 ft long) is unlined, except for a 25 ft long concrete-lined segment at the outlet. This section of the diversion tunnel has been visually inspected above the water line, and surveyors from the Yurok Tribe Design and Construction Division surveyed the Iron Gate low-level diversion tunnel in November 2020 from the control gate to the downstream tunnel outlet. This survey was completed to corroborate the information, configuration, and dimensions of the downstream portion of the diversion tunnel provided in as-constructed drawings. Subaqueous and aqueous 3-dimensional model data were collected and indicate that the existing concrete is of sound quality and the concrete is in good condition.

2.2.4.2 Pre-Drawdown Works

Pre-drawdown works at Iron Gate will involve developing access to the low-level outlet tunnel, installing a new concrete liner system in a portion of the tunnel, and installing an air vent. A reinforced concrete liner will be installed with a 1-ft thickness on the side walls and 1.5-ft thickness on the tunnel invert for a length 150 ft downstream of the existing reinforced concrete liner. Modeling conducted by the Renewal Corporation has indicated that this portion of the tunnel will experience the greatest water velocities during drawdown, and the new liner will prevent tunnel erosion. Modeling has also shown that tunnel flows during drawdown may cause unsteady variations in the air space within the tunnel, so to prevent the development of adverse air pressures, ventilation pipes will be installed and placed near the roof of the tunnel.

2.2.4.3 Reservoir Operations

During the pre-drawdown construction period, the Iron Gate Development will need to be operated at minimum levels. This will be achieved by directing maximum flows through the powerhouse. The discharge capacity of the powerhouse is 1,735 cfs (PacifiCorp 2016). The minimum operating water level is at elevation 2,327.3 ft, as set out in the design criteria in Table 2-1.

Average flow rates and flood risks increase through the fall, and by December, average flows are estimated to be 1,580 cfs. The construction risk for in-water work will increase with increased flows.

2.2.4.4 Drawdown Works

Initial drawdown will begin when the reservoir surface water level is at or about the spillway level. The existing diversion tunnel reinforced concrete bulkhead control gate will be utilized as the main drawdown control mechanism. A preliminary assessment of the gate and hoist system has been completed and results indicate the existing capacity of the hoist is adequate to operate the gate during drawdown. The Renewal Corporation will initiate drawdown of Iron Gate reservoir by opening the existing outlet control gate to its maximum opening height of 57 inches. The penstock and powerhouse bypass valve will be used to supplement initial drawdown flows. The maximum outflow rate, at full reservoir with the control gate fully open, is estimated to be 4,000 cfs and the flow rate will decrease as the reservoir level lowers. The gate will remain fully open for the period of reservoir drawdown. The maximum drawdown rate (12 ft/day) was visually assessed and defined based on the steepest part of the slope from the power intake invert (elevation 2,295.3 ft) to the historic cofferdam crest (elevation 2,212 ft). The upgraded tunnel concrete invert and sidewall liner will provide erosion protection to safely pass outflows throughout drawdown and dam removal. The Renewal Corporation determined use of the existing gate in the fully open position to be an acceptable drawdown method. In making this determination, the Renewal Corporation considered:

- Embankment stability,
- Reservoir rim stability,

- Downstream erosion, and
- Tunnel integrity.

Reservoir pre-drawdown operations will begin in November and December to bring the reservoir water surface level to the normal minimum operating surface elevation of 2,327.3 ft, as permitted by inflows at the time. The Renewal Corporation will commence drawdown on or about January 1 of the drawdown year and drawdown will continue concurrently with embankment removal until water levels are low enough to initiate the final dam breach, as discussed further in Section 4.3. The penstock and powerhouse bypass may be used to supplement drawdown flows while the reservoir level remains high enough to allow for flow through the penstock. Final drawdown is achieved when the reservoir water surface level is at or below the historic cofferdam level.

2.3 Alternative Drawdown Procedures

2.3.1 Copco No. 1 Development

The alternative drawdown procedures planned for this facility are directly tied to Copco No. 2, as discussed in the section below.

2.3.2 Copco No. 2 Development

The Renewal Corporation is considering an option that involves using Copco No. 1 to fully dewater the Copco No. 2 reservoir, allowing for Copco No. 2 Dam removal in the dry and without the need for staged diversion. Current Copco No. 1, Copco No. 2, and Iron Gate operations allow the river channel between Copco No. 1 and Copco No. 2 dams to be dewatered for short periods of time. Construction activities can proceed directly to removal of the entire concrete diversion dam, and a portion of the intake structure, during the pre-drawdown year to the final excavation limits shown on drawing C3221 (Appendix A), without having to follow the Spillway Bay No. 1 removal activities described in Section 4.2.

There are certain benefits to demolishing the Copco No. 2 Dam in the dry, including that it is a faster and safer means and method for removal, and it provides a safer working condition for personnel, reduces potential river water contamination by eliminating the use of equipment within the water system, and eliminates the need for special erosion measures required for in-water work. In addition, it will be easier and faster to install the fish passage in the dry, which also allows fish to be accommodated immediately.

The Renewal Corporation is evaluating two factors that will determine whether this alternative is viable. First, the Renewal Corporation will need to lower Copco No. 1 Reservoir to the minimum operating level to provide the greatest capacity for water retention upstream when flows from that reservoir are shut off to prevent flows to Copco No. 2. Additionally, the Renewal Corporation is in discussions with the USBR to allow for temporary flow control measures to minimize flows upstream at Keno Dam and Upper Klamath Lake. Second, the Renewal

Corporation will need to fill Iron Gate Reservoir with enough water to provide at least 5 to 7 days of required downstream environmental flows for fish preservation.

2.3.3 Iron Gate Development

There are currently no alternative drawdown procedures planned for this facility.

2.4 Flood Frequency and Hydrological Evaluation

This Section 2.4 of the California Reservoir Drawdown and Diversion Plan is informational and discusses the results of the drawdown model and implications to the Proposed Action. The section does not contain specific measures to be implemented by the Renewal Corporation as part of the Proposed Action.

2.4.1 Copco No. 1 Development

The Renewal Corporation has designed the reservoir drawdown outlet works and its operation to achieve the following:

- Outlet facilities for reservoir drawdown will be designed to discharge reservoir drawdown flows and natural inflows during the drawdown period up to flow events with 25% chance of exceedance between January 1 and June 15 of the drawdown year.
    - Drawdown outlet discharge capacity is designed to lower the reservoir levels at a reasonable rate for elevations above 50% of the hydraulic height of the dam. A reasonable drawdown rate of the reservoir water surface above elevation 2555 ft (50% of the hydraulic height of the dam) for normal hydrologic conditions (50th percentile) is approximately 5 ft/day and occurs between January 1 and January 6.
    - Reservoir refill can occur when natural inflows exceed the drawdown outflows.
- The reservoir drawdown will occur when the capacity of the drawdown discharge outlet exceeds the natural inflow and drawdown discharge. This condition is achieved when:
    - The reservoir volume is equal to the average inflow multiplied by one day (inactive storage).
    - Storage capacity is less than 10% of the capacity of the long-term normal reservoir operation level.

2.4.1.1 Reservoir Conditions During Drawdown

Hydrologic simulations of the reservoir drawdown inflows into the Copco No. 1 Reservoir and drawdown regulation and outflows through the Copco No. 1 Dam are included in Appendix G of the 100% Design Report (Knight Piésold 2022a). Appendix G of the 100% Design Report (Knight Piésold 2022a) also shows the hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle[1], Copco No. 2, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

Operation of the Copco No. 1 reservoir during drawdown will achieve successful evacuation of the reservoir impoundment. The Renewal Corporation will complete reservoir drawdown and river diversion utilizing the spillway, newly constructed low-level outlet tunnel, and the historic diversion tunnel. The drawdown model was developed to assess drawdown sequencing in terms of reservoir water surface levels under a range of hydrologic conditions for the 2019 Biological Opinion (2019 BiOp [National Marine Fisheries Service 2019]) flows. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. These drawdown sequencing assessments were performed to provide the magnitude and timing of expected reservoir water surface elevations, inflows, and outflows, which were important for the design and staging of drawdown.

Reservoir water surface levels were simulated in the drawdown model for the full record of inflows available for the 2019 BiOp dataset described above. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Copco No. 1 Simulated Drawdown. These plots indicate the following:
    - Reservoir water surface levels.
    - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway, low-level outlet tunnel, and flows through the historic diversion tunnel).
- Maximum daily reservoir water surface level non-exceedance percentiles (percentiles) are shown on Figure 2-1. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the results on any given day of the simulations. Figure 2-1 illustrates the upstream water surface up to the point where the historic diversion tunnel is opened, then it drops below the historic cofferdam crest elevation. At this point, the water surface drops to the required driving head to push water into the existing diversion tunnel which has been re-opened. Rating curves were provided in the hydraulic model to estimate this water surface elevation based on the flows during the specified time frame.
- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-2. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

[1] Detailed drawdown procedures for the J.C. Boyle Development are included in the Oregon Reservoir Drawdown and Diversion Plan.

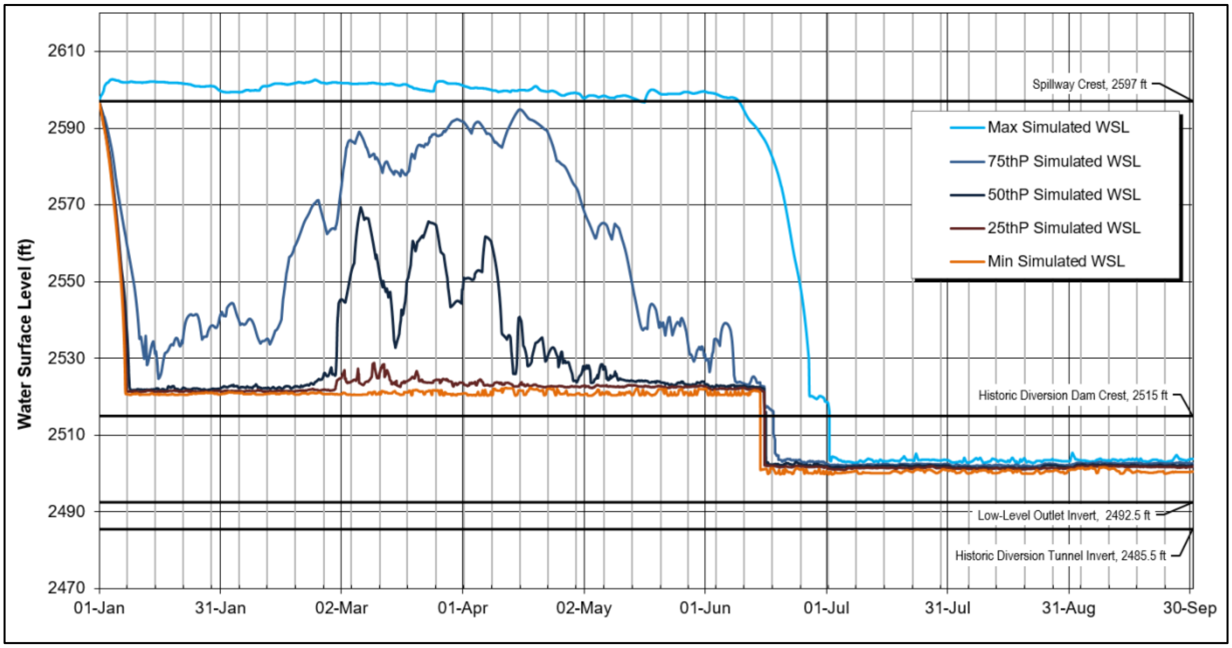

Figure 2-1. Copco No. 1 Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

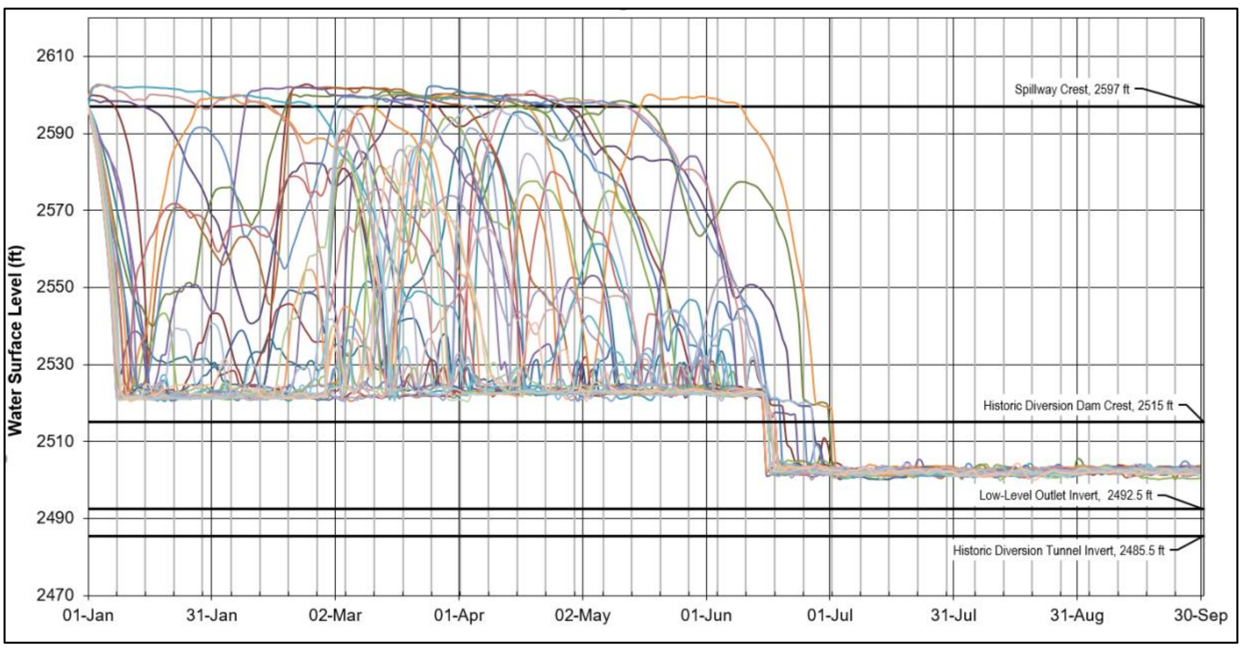

Figure 2-2. Copco No. 1 Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-1 show that the reservoir water levels drop below the crest of the historic diversion dam in mid-June for the 75th percentile, while the remaining model simulations achieve a lowered reservoir water level by the beginning of July.

Figure 2-2 shows that approximately 80% of the model simulations draw down to a water surface elevation of approximately 2,520 ft in January, which is the lowest water surface elevation achievable using the low-level outlet tunnel prior to the historic diversion tunnel opening. However, the reservoir refills in the higher flow months of February through May. There can be large fluctuations in the reservoir water surface levels from March through June. Spillway flows are observed after January for 31% of the simulations.

The reservoir water surface level can rapidly rise in March, April and May resulting from large inflow events. Examples of this are seen in simulation years 1981, 1989, and 1993, where the reservoir water surface level was at approximately 2,520 ft in January but then rapidly rises in response to the high inflows. These inflows may be a function of the refilling of Klamath Lake as described in USBR (2018) or are influenced by the flows from unregulated tributaries entering the Copco No. 1 reservoir.

Figure 2-3 shows the cumulative percent of model simulations and both the date when the reservoir water surface level is at or below the highest water surface elevation at which the historic diversion tunnel can be opened (2,530 ft) and the date when the water surface elevation is sustained below the crest of the historic diversion dam. Currently in the drawdown model, the historic diversion tunnel opens after June 15 once the reservoir water surface elevation is at or below 2,530 ft, which is approximately 20 ft above the top of the historic diversion tunnel intake. Initially, a 5-ft diversion tunnel opening is assumed and once the water surface elevation drops below 2,516 ft, an 18-ft opening is assumed. The drawdown model indicates that approximately 50% of the simulations have reservoir water levels below the 2,530 ft by June 1, with approximately 30% of the simulations achieving this as early as May 1. The drawdown model indicates that 100% of the simulations achieve this by the end of June. There is potential to open the historic diversion tunnel earlier in the year based on the drawdown model results, but this will be dependent on the hydrological conditions in the drawdown year. River forecasting will be required as the reservoir levels need to be maintained below 2,530 ft for 3 weeks, once the historic diversion tunnel is opened, to perform plug removal.

Drawdown is achieved when the water surface elevation is maintained below the crest of the historic cofferdam (2,515 ft) and can only be achieved after the historic diversion tunnel is opened. The drawdown model indicates that approximately 80% of the simulations have reservoir water surface elevations sustained below the crest of the historic diversion dam within a few days (June 19) of the historic diversion tunnel opening on June 15, with 100% of the simulations achieving this by July 2. Note that the water level results shown on Figure 2-3 are based on average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

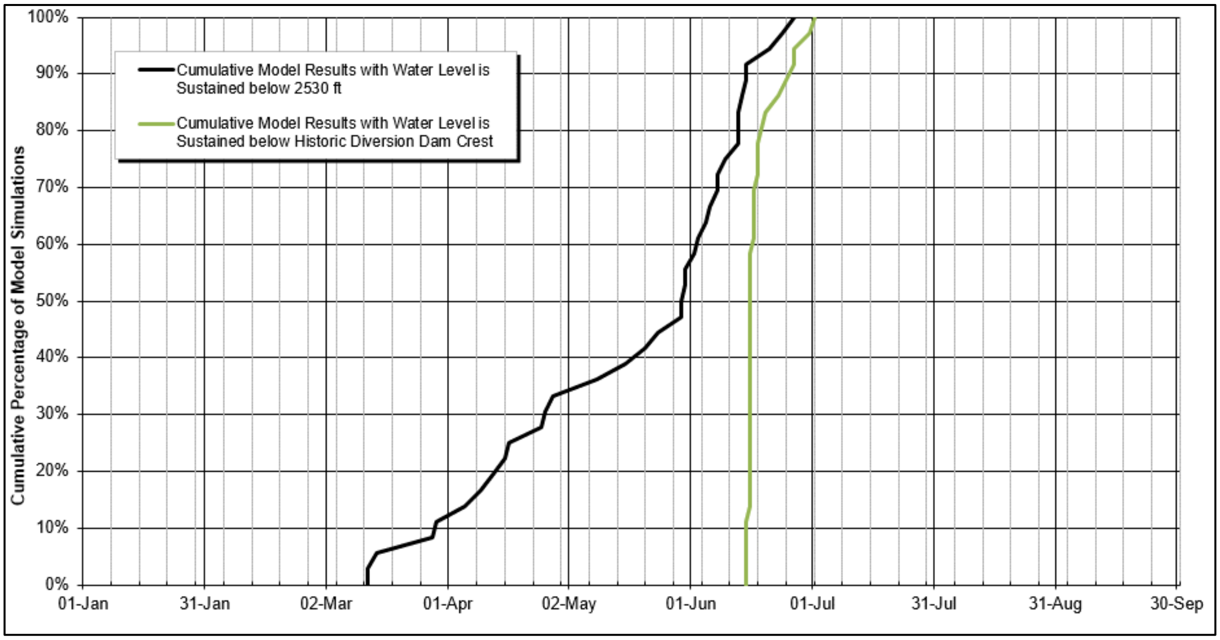

Figure 2-3. Copco No. 1 Reservoir Drawdown Cumulative Model Simulation Dates to Achieve and Sustain Reservoir Water Surface Levels below the 2,530 ft and below the Crest of the Historic Diversion Dam Crest

2.4.1.2 Post-Drawdown/ River Diversion

Bypass through historic diversion tunnel: the historic diversion tunnel can be opened when the reservoir water surface elevation of 2,530 ft is reached on or after June 15 of the drawdown year. The discharge capacity of the tunnel will depend on the opening size and the reservoir water level:

- The diversion tunnel partially opened to elevation 2,505.85 ft has a capacity greater than 1,775 cfs for reservoir level of 2,530 ft.
- The diversion tunnel fully opened (i.e., inlet structure removed to provide inlet conditions at least equal to the nominal tunnel dimensions of 16 ft wide by 18 ft high) has a capacity greater than 3,885 cfs for reservoir level of 2,514 ft, (elevation of the abandoned diversion dam with 1-ft freeboard).
- The fully opened diversion tunnel can bypass all inflows during June 15 to October under all hydrological years evaluated.

At the first opening of the diversion tunnel, outflow of up to 5,675 cfs will occur. The diversion tunnel flow becomes free-flowing, or open channel flow, shortly after opening. The water level upstream of the diversion tunnel intake matches the water surface corresponding to the open channel flow.

River diversion is achieved when all the inflows pass through the diversion tunnel. The outflows are roughly equal to the inflows in the post-drawdown period. The drawdown model as displayed in Figure 2-1 and Figure 2-2 indicate that the post-drawdown water surface levels will range between 2,500 ft and 2,505 ft for average daily conditions evaluated in the drawdown model. These levels do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

2.4.2 Copco No. 2 Development

Operation of the Copco No. 2 reservoir during drawdown and post-drawdown will achieve successful evacuation of the reservoir impoundment. The Renewal Corporation will initiate drawdown of the reservoir by removing Spillway Bay No. 1 in January of the drawdown year.

The drawdown model was developed to assess the reservoir water surface levels during drawdown and post-drawdown under a range of hydrologic conditions. Copco No. 2 is operated as a run-of-river facility with minimal storage volume; therefore, evacuation of the reservoir will occur quickly. During drawdown, the operating characteristics of the reservoir will reflect upstream conditions at Copco No. 1.

2.4.2.1 Reservoir Conditions during Drawdown

Hydrologic simulations of the reservoir drawdown inflows into the Copco No. 2 Reservoir and drawdown regulation and outflows through the Copco No. 2 Dam are included in Appendix G of the 100% Design Report (Knight Piésold 2022a). Appendix G of the 100% Design Report (Knight Piésold 2022a) also shows the hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle, Copco No.1, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

Reservoir water surface levels were simulated in the drawdown model for the full record of inflows available for the 2019 Biological Opinion (2019 BiOp) dataset. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Copco No. 2 Simulated Drawdown. These plots indicate the following:
    - Reservoir water surface levels, and
    - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway and power intake).
- Maximum daily reservoir water surface level daily non-exceedance percentiles (percentiles) are shown on Figure 2-4. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the all the results on any given day of the simulations. These results to not represent a simple simulation and are based on all the model simulations.
- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-5. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

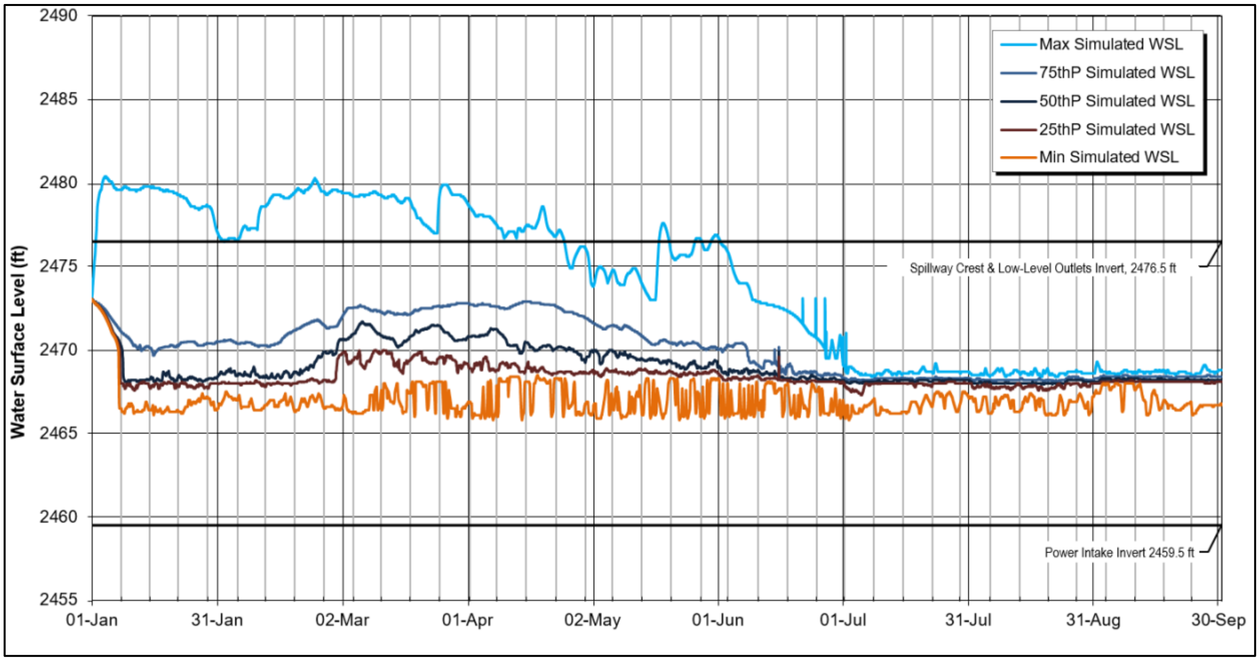

Figure 2-4. Copco No. 2 Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

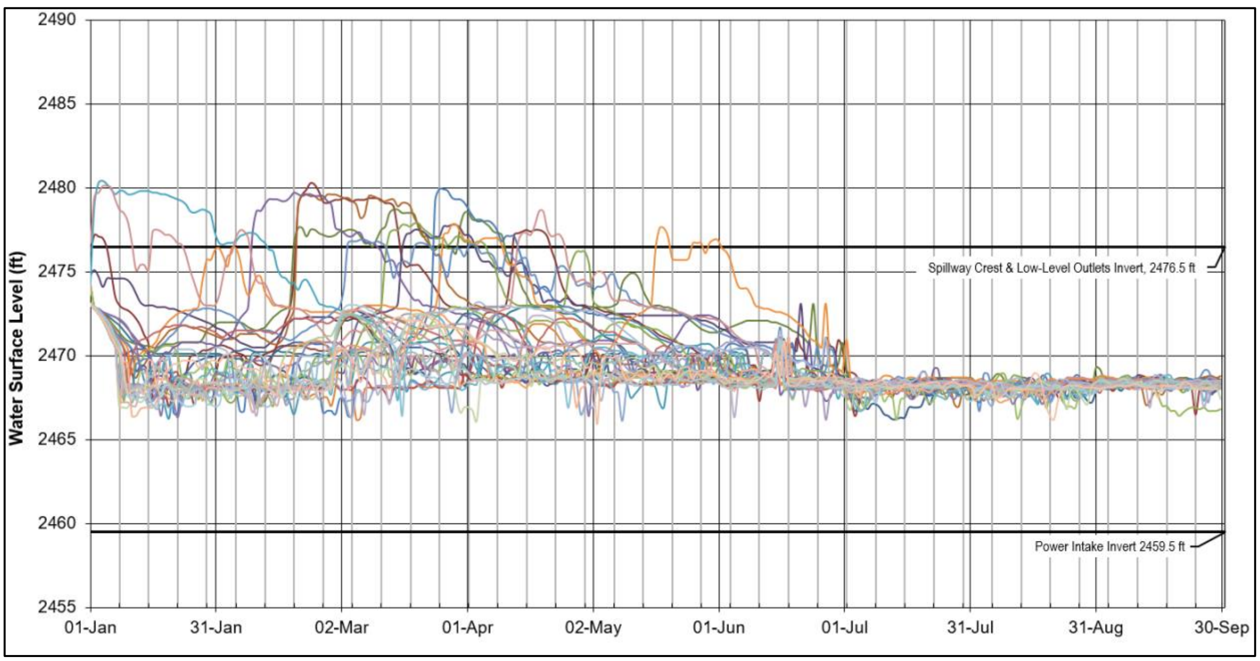

Figure 2-5. Copco No. 2 Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-4 and Figure 2-5 show that there is a reduction in the reservoir water levels in mid-June with the majority of the simulated years achieving sustained low level water levels by the end of July. This is a function of inflow hydrology, which indicates a reduction in streamflow for the second half of June (Appendix A6 of the Design

Report, Knight Piésold 2022a) and the timing of when the historic diversion tunnel is fully opened at Copco No. 1, which is targeted to be around June 15.

Figure 2-4 shows that there are large fluctuations in the reservoir water surface levels from January through June. Copco No. 2 is operated as a run-of-river facility with minimal storage volume; therefore, the reservoir water levels reflect the outflow conditions at Copco No. 1. The drawdown model results show that the flows can be discharged over the Copco No. 2 spillway between January through mid-June.

Lower reservoir levels will be sustained after July 1 depending on the hydrologic conditions and when the Copco No. 1 historic diversion tunnel is opened. The post-drawdown water surface levels are within the range of 2,466.0 ft to 2,469.5 ft for all drawdown model simulations. Note that these water levels are for average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

2.4.3 Iron Gate Development

Hydrologic simulations of the reservoir drawdown inflows into the Iron Gate Reservoir and drawdown regulation and outflows through the Iron Gate Dam are included in Appendix G of the 100% Design Report (Knight Piésold 2022a). Appendix G of the 100% Design Report (Knight Piésold 2022a) also shows the hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle, Copco No.1, and Copco No. 2 Reservoirs and drawdown regulation and outflows from the upstream dam.

The Renewal Corporation will complete reservoir drawdown utilizing the spillway, power intake and turbine/bypass, and the existing outlet control gate in the diversion tunnel. The power intake will be used to assist with reservoir drawdown using the existing turbines or bypass valve. The Renewal Corporation will remove the power intake structure concurrently with embankment removal when the appropriate embankment elevation is reached. The drawdown model was developed to assess the drawdown sequencing in terms of reservoir water surface levels under a range of hydrologic conditions.

Reservoir water surface levels are simulated in the drawdown model for the full record of inflows available for the 2019 Biological Opinion (2019 BiOp) dataset. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Gate Simulated Drawdown. These plots indicate the following:
    - Reservoir water surface levels, and
    - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway, power intake and bypass, and flows through the diversion tunnel).
- Maximum daily reservoir water surface level daily non-exceedance percentiles (percentiles) are shown on Figure 2-6. This figure represents the results from all 36

model simulations as non-exceedance percentiles to summarize the distribution of the all the results on any given day of the simulations. These results do not represent a simple simulation and are based on all the model simulations, and

- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-7. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

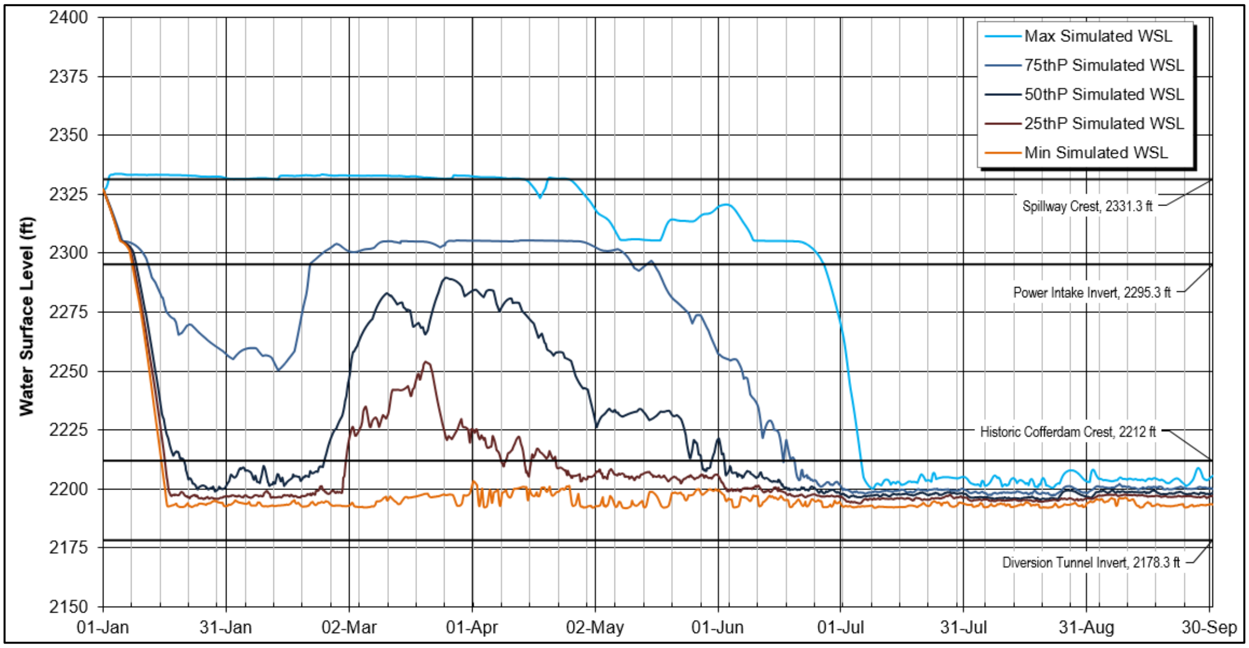

Figure 2-6. Iron Gate Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

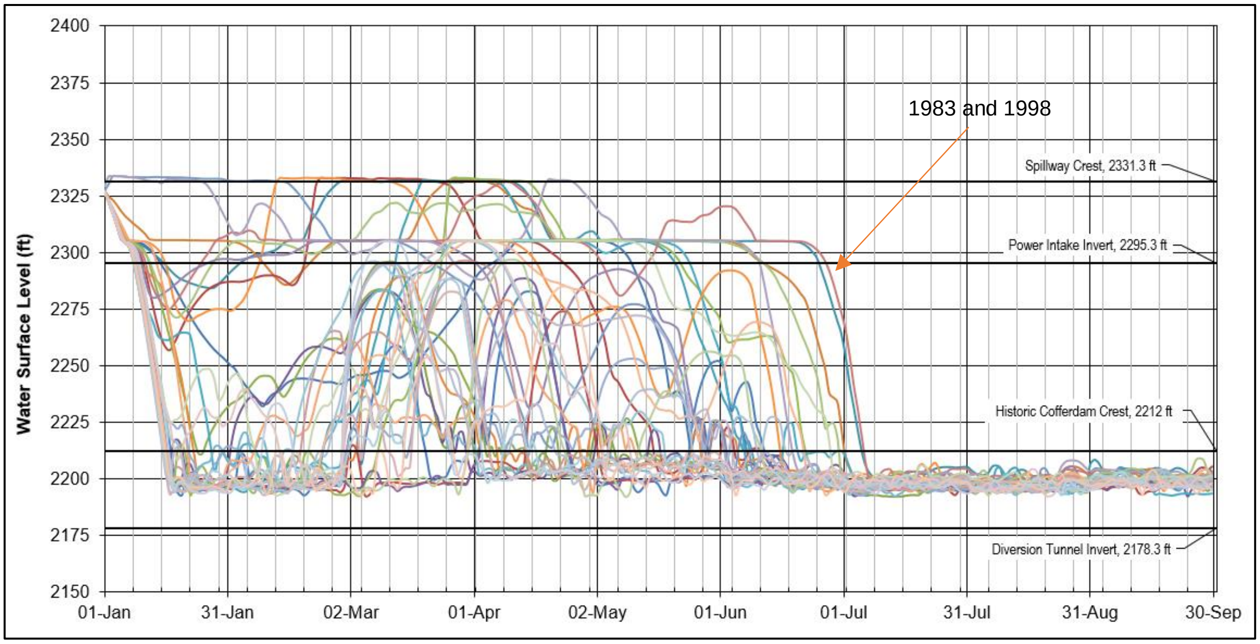

Figure 2-7. Iron Gate Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-6 show that the reservoir water levels drop below the crest of the historic cofferdam in mid-June for the 75th percentile, while the remaining model simulations achieve a lowered reservoir water level in early July. There are two model years (1983 and 1998) indicated on Figure 2-7 that show elevated reservoir water surface levels past July 1. In these years, the reservoir water surface levels drop below the crest of the historic cofferdam prior to July 10.

Figure 2-7 shows that many of the model simulations achieve reservoir drawdown in January; however, the reservoir refills in the higher flow months of February through May. There can be large fluctuations in the reservoir water surface levels from March through June. Spillway flows are observed after January for 28% of the simulations, and for power intake and bypass valve for an additional 25% of the simulations. The reservoir water surface level does not rise above the power intake invert in the remaining 55% of the simulations.

The reservoir water surface level can rapidly rise in March, April and May resulting from large inflow events. Examples of this are seen in simulation years 1981, 1989, and 1993, where the reservoir water surface level was below the historic cofferdam crest in January but then rapidly rises in response to the high inflows. These inflows may be a function of the refilling of Klamath Lake as described in USBR (2018) or are influenced by the flows from unregulated tributaries entering the Iron Gate reservoir, such as Jenny Creek.

Figure 2-8 shows the cumulative percent of model simulations and the date when the reservoir water surface level is lower, and sustained, below the crest of the historic cofferdam. The drawdown model indicates that approximately 40% of the simulations have reservoir water levels sustained below the crest of the historic cofferdam by June 1, with 100% of the simulations by July 7. Note that these water levels are for average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

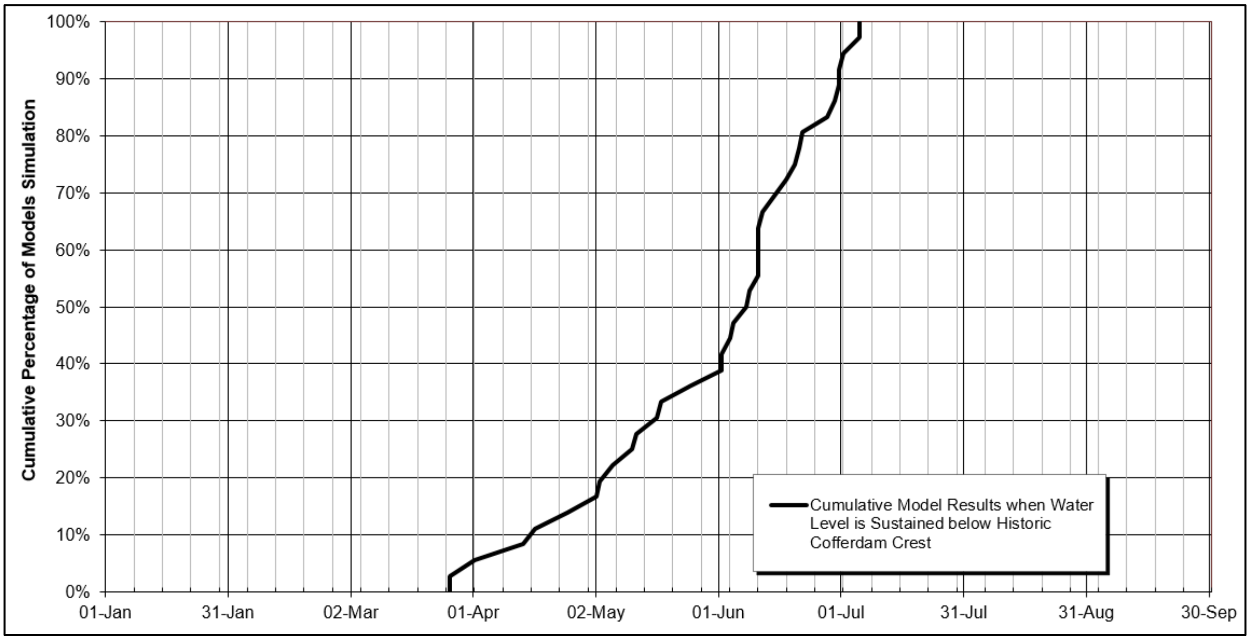

Figure 2-8. Iron Gate Reservoir Drawdown Cumulative Model Simulation Dates to Achieve and Sustain Reservoir Water Surface Levels below the Crest of the Historic Cofferdam Crest

2.4.3.1 Post-Drawdown River Diversion

River diversion is achieved when all the inflows will be passed through the diversion tunnel with negligible attenuation in the post-drawdown period (i.e., the outflows are roughly equal to the inflows). The drawdown model and Figure 2-6 and Figure 2-7 indicate that the post-drawdown water surface levels will range between 2,192 ft and 2,209 ft for average daily conditions evaluated in the drawdown model. These levels do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

2.5 Klamath Irrigation Project Coordination

The Renewal Corporation is coordinating with PacifiCorp and the U.S. Bureau of Reclamation (USBR) for flow management of Keno Dam during pre-drawdown and drawdown construction activities. The primary purpose of this coordination is to manage the Lower Klamath Project in relation to the USBR Klamath Project to provide effective reservoir and river flows to support modifications to the existing dam facilities required to complete the final reservoir drawdown and dam removal effectively, as well as the final dam removal construction work. Planning and preparation of detailed workplans to implement non-routine operations during the pre-drawdown period will be required to complete the construction work activities safely and efficiently while meeting regulatory requirements.

Following the technical coordination with the Renewal Corporation and PacifiCorp, USBR is expected to coordinate with NMFS and the U.S. Fish and Wildlife Service (USFWS) to ensure compliance with USBR's NMFS Biological Opinion (NMFS 2019) and USBR's USFWS Biological Opinion (USFWS 2020)."

3.0 Monitoring Plan

3.1 Reservoir Level Monitoring

Reservoir levels for Iron Gate and Copco No. 1 are currently continuously monitored through the powerhouse control room and the PacifiCorp Hydro Control Center (HCC, PacifiCorp 2015). Flows can increase the amount of debris deposited against facility components during potentially high-flow storm events. Erosion, back cutting, sloughing, or obstruction in the spillway or tailrace channels might occur because of these high-flow conditions. Special attention to these areas is included in the monitoring and surveillance of the facilities during or after high-flow events.

The Renewal Corporation will prepare operational procedures for the pre-drawdown and drawdown periods. If obstructions occur, the Renewal Corporation can implement measures to remove obstructions, such as mechanical means of removal and controlled blasting. The Renewal Corporation will monitor reservoir levels during drawdown by level sensors and staff gauge. If readings are approaching a level that could cause concern regarding stability of the reservoir rim or embankment areas, the Renewal Corporation will, if necessary, take remedial actions described in the Emergency Response Plan (Kiewit 2020) for the Project and the California Slope Stability Monitoring Subplan.

3.2 Embankment and Reservoir Rim Monitoring

Slope stability monitoring for the Iron Gate, Copco No. 1, and Copco No. 2 reservoir rims and applicable embankment structures is addressed in the California Slope Stability Monitoring Subplan.

3.3 Sediment Monitoring

The Renewal Corporation will conduct sediment monitoring as described in the Reservoir Area Management Plan (RAMP). Per the RAMP, the Renewal Corporation will use aerial data capture methods and ground-based surveying to inform design progression following drawdown and assist sediment evacuation at the priority tributary restoration sites. Refer to the RAMP for additional information regarding sediment and vegetation monitoring and associated adaptive management approaches.

4.0 Implementation Plan

4.1 Copco No. 1 Development

The demolition and removal work will include removal of the dam, water conveyance, powerhouse, and electrical infrastructure. It will also involve establishment of the final river channel for volitional fish passage through the former dam and reservoir inundation area. Water surface elevations based on steady state flows and with the low-level outlet tunnel and historic diversion tunnel open, are provided on drawings C2056 and C2057 in Appendix A.

4.1.1 Concrete Dam Removal

When the Klamath River flows are routed through the historic diversion tunnel, the Renewal Corporation can demolish and remove the concrete dam. Dam removal is shown on drawings C2250 and C2255 through C2258 (Appendix A) and is described in the subsections below.

4.1.1.1 Concrete Removal (Crest to Elevation 2,515 ft)

The Renewal Corporation will remove the concrete dam after the historic diversion channel is reopened and the reservoir is lowered. Concrete removal methods include mechanical demolition, drilling and controlled blasting to break up and remove the concrete in lifts from the top down. The blasted concrete rubble will be moved to the downstream face of the spillway and on to the spillway work platform. The concrete will be loaded at the base of the spillway and hauled to the right bank disposal area.

The top-down concrete removal will enable the Renewal Corporation to remove the dam while the work platform level is above the 5% probable flood level.

4.1.1.2 Concrete Foundation Removal (Elevation 2,515 ft to 2,472 ft)

The Renewal Corporation will remove dam concrete to establish the final river channel configuration through the former dam footprint.

The Renewal Corporation proposes to remove the concrete foundation in August or September (depending on the water year) when river flows will be at seasonal lows. Bypass of inflows through the diversion tunnel and seepage reduction at the existing historic cofferdam will limit the need to dewater the work site once the removal line progresses lower than elevation 2,515 ft. However, the Renewal Corporation will conduct pumping as necessary to keep the work site dewatered if seepage were to occur.

The Renewal Corporation will complete this work by constructing work platforms into the former dam footprint area (above the dam foundation) and drilling, blasting, and excavating riverbed concrete. The work platforms will elevate the construction equipment to above water level and allow for much of this work to be conducted in the dry.

4.1.2 Final River Channel

The final river channel will be established through final riverbed and foundation concrete excavation and shaping so future scour and migration of the riverbed will not create a fish barrier at the former Copco No. 1 Dam site. The Renewal Corporation's proposed concrete removal elevation considers historic channel elevations upstream and downstream of the dam site. The Renewal Corporation will line areas along the final river channel that are expected to be inundated during the 1% flood with a layer of bedding material, to provide the appropriate filter relationship with the subgrade material, and rock material to mitigate scour. Required gradations and appropriate thicknesses are detailed in the Design Report (Knight Piésold 2022a), and the final grading plan of the channel through Copco No. 1 and the erosion protection lining is shown on drawing C2230 in Appendix A.

4.1.3 Historic Cofferdam Removal

After the dam foundation is removed at the dam site and the final channel is established downstream, the Renewal Corporation will remove the historic cofferdam to restore flow through the former dam site. The cofferdam will only be accessible in periods of low flow and will be removed by drilling and blasting during the excavation and grading of the upstream portion of the river channel. Concrete and spoil from the cofferdam will be disposed at the disposal area.

4.1.4 Diversion Tunnel Closure

Following removal of the concrete dam and foundation concrete, including the historic cofferdam and diversion tunnel inlet structure, the Renewal Corporation will permanently block the diversion tunnel by backfilling and burying the inlet and outlet portals with earthfill barriers. Blocking the diversion tunnel will prevent access and the possibility of Klamath River flows passing through the historic tunnel. Portal barriers will be comprised of compacted earthfill with sufficient length to prevent piping and downstream erosion of the tunnel plug and erosion protection on the exposed face of the earthfill plug. The outlet portal plug is designed with a filter layer at the base to allow drainage and prevent hydrostatic pressure build-up, as shown on drawing C2175 in Appendix A.

4.2 Copco No. 2 Development

The Renewal Corporation's proposed construction works after the reservoir is drawn down will involve dam removal and other facility removal activities. The subsections below detail the Renewal Corporation's proposed decommissioning and removal activities. Water surface elevations based on variable flow conditions and water years are provided on drawing C3057 in Appendix A.

4.2.1 Dam Removal

The Renewal Corporation will complete dam removal with the river flowing through the removed Spillway Bay No. 1. The Renewal Corporation will construct a temporary work platform to elevation 2,465.0 ft on the spillway apron to elevate the construction equipment above the river diversion flow level. The elevation of the work platform is dependent on the construction of a temporary channel excavation, as shown on drawing C3520 in Appendix A. The base case design of Copco No. 2 involves excavating the downstream river channel to reduce anticipated water levels that will be experienced at the dam during removal. If the temporary channel is not constructed, the work platform elevation may need to be higher to keep the work surface above water. The Renewal Corporation may need to regrade the temporary channel excavation after the dam is removed to maintain the desired final channel geometry.

The Renewal Corporation will remove concrete down to elevation 2,453.5 ft. The excavation will remove the spillway apron, the remaining ogee crest, both abutment wing walls, and part of the intake structure. The limits of the excavation are shown on drawings C3221 and C3232 in Appendix A.

4.2.2 Historic Cofferdam Removal

The Renewal Corporation will complete removal of the historic cofferdam upstream of the Copco No. 2 Dam during the low-flow summer period. An excavator will traverse the river from the right bank and notch out a portion of the left bank side of the historic cofferdam at a natural low point in the riverbed to provide an alternative flow path for river flow. This alternate flow path will allow the current opening to be backfilled to facilitate construction equipment access for the removal of the entire cofferdam (drawing C3240 in Appendix A). The Renewal Corporation will drain the Copco No. 2 reservoir to allow the concrete diversion dam and the historic cofferdam to be removed after the Copco No. 2 reservoir is dewatered, as previously discussed in Section 2.3.2. Another proposed option involves the removal of Copco No. 2 and the historic cofferdam in the pre-drawdown period only. If removal of Copco No. 2 and the historic cofferdam needs to occur during the drawdown year, activities outlined in the design report and drawings will proceed (Knight Piésold 2022a). These activities include, but are not limited to, demolition of a portion of Spillway Bay No. 1 in the pre-drawdown year as in-water work. After drawdown, the Renewal Corporation will remove the remaining Copco No. 2 Dam structure and historic cofferdam, also as in-water work.

4.2.3 Earthfill Embankment Removal

The Renewal Corporation will partially remove the earthfill embankment with 1.5 horizontal to 1 vertical (1.5H:1V) excavation side slopes. Partial removal of the right abutment retaining wall is shown on drawing C3400 in Appendix A. This temporary excavation will be backfilled to the final channel grade. The Renewal Corporation will permanently leave in place the portion of the earthfill embankment and gunite wall that is not within the footprint of the temporary excavation.

4.2.4 Final River Channel

The Renewal Corporation will backfill the final river channel banks with a combination of erosion protection material and riverbed material. The riverbed material specification is unique to Copco No. 2 and will be comprised of a well graded material ranging from 36 inches to the No. 200 Standard sieve with less than 10% fines and is intended to be a visual specification. The material will be similar to the natural material found in the river between Copco No. 1 and Copco No. 2 and can be sourced from in-river, the historic diversion cofferdam, or one of the erosion protection borrow sources at the Copco area. The final grading plan of the channel through the Copco No. 2 dam site is shown on drawing C3234 in Appendix A.

4.3 Iron Gate Development

Demolition and removal work at Iron Gate will involve the decommissioning and removal of the dam and all facility components. The subsections below detail proposed deconstruction activities. Water surface elevations based on steady state flows are provided on drawings C4050 and C4051 in Appendix A.

4.3.1 Embankment Removal

After reservoir water levels have been lowered, the Renewal Corporation will remove the embankment dam at a rate that will provide a required 3 ft of freeboard on the monthly 1% probable flood event until the extended work platform at the upstream toe of the dam is established. Maximum removal limits that provide the required freeboard are shown on the removal sequence drawings C4203 through C4209 in Appendix A. The crest of the extended cofferdam will be established at 3 ft above the controlling 1% probable flood from August 1 to September 15 or until the controlled breach is prepared and implemented during the low flow summer period. The final breach will occur when the reservoir level corresponds to expected average monthly flows. The planned controlled breach avoids downstream flood impacts and public risk. Stability requirements for the embankment through drawdown and embankment removal are provided in Table 2-1.

4.3.2 Final Dam Breach

The Renewal Corporation anticipates that flow rates in the Klamath River will decrease (normal hydrologic cycle) through the dam removal period, which will result in the lowest possible reservoir levels occurring around the time of the final dam breach (August / September). The primary goal of the final breach design is to release the final remaining pond or stored reservoir volume without causing overbank flooding or property damage in the downstream reaches. Based on inundation mapping completed for flood magnitudes of 6,000 cfs and 10,980 cfs (Yurok Tribe / USBR 2020), there is no overbank flooding expected at 6,000 cfs, and limited overbank flooding expected at 10,980 cfs. The monthly 50% probable floods of approximately 6,500 cfs occur in March and December based on observed flows. Therefore, breach peak outflows in the range of 6,000 to 7,000 cfs are considered acceptable for this one-time reservoir release condition, given appropriate planning and advanced warning (and as per the public notice) to protect the safety of the downstream population.

The Renewal Corporation will maintain a minimum of 1,000 cfs, or the flow in the Klamath River if it is less than 1,000 cfs at the time, throughout the final breach. The existing diversion tunnel will remain open and continue to pass flows. As the water level drops and the capacity of the diversion tunnel is reduced, the Renewal Corporation will augment these flows with outflows resulting from the breach formation. Natural flow in the Klamath River will be restored at the completion of the final breach, with all flows diverted through the breach channel, while the remaining embankment materials in the extended cofferdam are removed.

4.3.3 Breach Channel Design

Once the Renewal Corporation establishes the extended cofferdam at elevation 2,228 ft, it will excavate a breach channel along the right rock abutment, with a breach plug retaining the remaining reservoir at the upstream end of the breach channel. The breach channel and plug are designed to initiate progressive erosion once notched, while limiting breach widening and slowing the rate of erosion, so the risk of peak outflows potentially leading to overbank flooding is considered negligible. The Renewal Corporation will employ the following channel design characteristics to achieve this goal, as shown in drawings C4250 and C4255 (Appendix A):

- The breach channel will be excavated along the right abutment of the extended cofferdam to a base channel width of 20 ft. The channel sides will be excavated to a slope of 2H:1V, which are shallower than the slopes typically seen in a breach when a dam fails by overtopping.

- The breach plug will have a crest elevation of 2,202 ft, just above the recommended maximum water surface at the time of breach (elevation 2,201 ft), which is consistent with flows that are exceeded 25% of the time in the first half of September. This plug elevation will limit the amount of stored volume that could possibly be released in the event of an unplanned breach to approximately 516 acre-ft.

- The downstream slope of the breach plug will be excavated, at a slope of 5H:1V, from the native materials within the footprint of the historic cofferdam. This slope is consistent with USBR recommendations (USBR, 1998 and 2010) for downstream embankment slopes where riprap may be considered suitable for overtopping protection. A 5H:1V slope will limit the energy of overtopping flows when compared to more typical embankment slopes of 3H:1V.

- The side boundary of the downstream face of the plug that leads to a 20-ft base width will be protected with riprap (minimum D50 = 34 inches) to limit the breach channel widening beyond 20 ft. This riprap size is consistent with recommended sizes for preventing channel flows from laterally eroding side slopes.

- Once outflows transition into the channel downstream of the plug where the channel gradient is reduced 0.5%, side boundary riprap will reduce in size due to the reduction in local velocities (minimum D50 = 18 inches), but still sufficiently sized to prevent lateral erosion and widening of the breach channel.

- The downstream plug face will be lined with riprap that is sized to be mobile but will also slow the rate of progressive erosion (minimum D50 = 18 inches).

- Once the Renewal Corporation excavates and prepares the breach channel, the remaining plug will be progressively notched, from a safe access point on the right abutment, according to the following sequence:

- The first notch cut will be 1 ft below water surface at the time of breach, and no greater than 10-ft wide, beginning from the rock on the right abutment.

- Outflow behavior will be observed to confirm increasing erosion and notch width, and the plug crest will be evacuated to the extended cofferdam crest. If progressive erosion is not initiated, the notch will be further excavated to 3 ft below the existing water surface at the time.

- The above process will be repeated until progressive erosion is initiated. At no point will cuts be excavated deeper than 3 ft or wider than 20 ft.

4.3.4 Final River Channel

The Renewal Corporation will establish the final river channel through final riverbed excavation and shaping. The final channel has an average slope of 0.7% from where it intersects the reservoir bottom at the upstream end of the excavation to where the excavation daylights naturally near the current powerhouse tailrace. The Renewal Corporation will leave final channel side slopes untreated where embankment excavation is to bedrock. The Renewal Corporation will protect the channel from erosion, when the excavation is bound by fill slopes, with riprap for up to and including the 1% flood event plus 3 ft of freeboard excavation. Additionally, the Renewal Corporation will assess excavated side slopes not in bedrock, or other channel side slopes that put foundation materials for disposal sites at risk once the reservoir is drawn down and native materials can be assessed for erodibility. The final grading plan of the channel through Iron Gate is shown on drawing C4210 in Appendix A.

4.4 Drawdown Implementation Timeline

The following subsections summarize key dates and associated work activities with respect to the drawdown schedule for each facility. A construction implementation schedule was provided to the Commission on June 30, 2022 as part of the Final Construction Documents submittal.[2]

4.4.1 Copco No. 1 Development

The Renewal Corporation determined the earliest proposed dates for key work items in relation to the post drawdown reservoir level and the tailwater level based on the variability of the inflows and assume that work can occur up to the 5% probable inflow with freeboard. Table 4-1 presents the earliest dates.

[2] FERC accession no. 20220630-5018 (https://elibrary.ferc.gov/eLibrary/filelist?accession_num=20220630-5018)

Table 4-1. Copco No. 1 – Key Structure Elevations and Removal Timing

WORK ITEM	LOWEST ELEVATION (FT, NAVD88)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Removal of spillway gates and ancillary items	2,597.1	-	1% max. monthly flood	Spillway gates can be removed in the dry after drawdown is complete to elevation 2,530 ft.
Removal of concrete dam and intake structure	2,472.1	-	5% max. monthly flood	Allow impoundment of the 1% probable flood level with 3 ft freeboard
Removal of gatehouses and intake mechanical items	+/-2,570	After low-level outlet tunnel operation	1% max. monthly flood	Can be removed in the dry after drawdown is complete, 5% probable flood level with 3 ft freeboard after June 1 is 2,534 ft
Removal of penstock #1, #2 and #3	2,575	-	1% max. monthly flood	Can be removed at any time after the flow diversion through the turbine and generator unit is no longer required. Intake gates to be in the closed position and leakage controlled if the removal of the penstock exposes the downstream area to uncontrolled release of water
Re opening of the diversion tunnel	2,488	-	After freshet flows	Final opening to occur when reservoir level is at or below elevation 2,530 ft.
Removal of upstream historic construction spoil materials	+/-2,490	-	-	Will be removed by dredging.
Removal of the powerhouse	2,465	-	-	Can be removed at any time after the flow diversion through the turbine and generator unit is no longer required. In-water work to occur after the California in-water work date (June 1).
Removal of in-river concrete	2,472	June 16	-	Drawdown is complete and all flows are diverted through the diversion tunnel.
Removal of spillway work platform and river channel final grading	2,477	-		In-water work is required, lowest water levels occur during August and September
Construction of tunnel portal plugs	2,494 (inlet) / 2,475 (outlet)	August		In-water work is required, lowest water levels occur during August and September

Notes:

1. Removal of the facility's water retaining structures including the dam, intake gates and the spillway gates before June 1 and when the reservoir water surface level is above elevation 2,538 ft exposes the work site and downstream area to the 1% probable flood.
2. Should the diversion tunnel be reopened before June 15, the design water levels and earliest removal date should be reevaluated.

4.4.2 Copco No. 2 Development

Copco No. 2 has no restrictions regarding drawdown, except that the Renewal Corporation will not initiate drawdown prior to January 1 of the drawdown year. Timing associated with powerhouse operations is tied to demolition of the dam and will be taken offline as soon as is possible. Other removal work items, timing, and elevations are described in Section 4.2 above.

4.4.3 Iron Gate Development

During the pre-drawdown construction period, PacifiCorp will operate the Iron Gate Development at minimum levels. This will be achieved by directing maximum flows through the powerhouse whenever possible. The discharge capacity of the powerhouse is 1,735 cfs (PacifiCorp 2016). The minimum operating water level is 2,327.3 ft. Other removal work items, timing, and elevations are included in Section 4.3 above, and approximate embankment removal volumes by sequence are shown in Table 4-2 below (Knight Piésold 2022a). The removal sequence is governed by the applicable flood probability and the need to maintain a 3-ft freeboard for the associated flood level.

Table 4-2. Iron Gate – Embankment Cut Volumes by Sequence

SEQUENCE DESCRIPTION	DRAWING NUMBER	FLOOD PROBABILITY	START DATE	END DATE	MINIMUM CREST ELEVATION (FT)	APPROXIMATE SEQUENCE CUT VOLUME (CY)
1	C4203	1%	1-Apr	31-May	2,336.3	50,800
2	C4204	1%	1-Jun	15-Jun	2,335.5	5,800
3	C4205	1%	16-Jun	30-Jun	2,308.6	71,000
4	C4206	1%	1-Jul	15-Jul	2,308.1	89,000
5	C4207	1%	16-Jul	31-Jul	2,243	341,000
6	C4208	5%	1-Aug	26-Sept	2,231.2	103,100
7	C4209	5%	Sequence 6 Completion	31-Aug	2.231.2	175,200
Breach Channel	C4250	Not Applicable	Sequence 7 Completion	28-Sept	2,202.0	42,500
Final Grade	C4210	Not Applicable	Breach Completed	4-Oct	Not Applicable	59,300

4.5 Coordination with Agencies and Stakeholders During Drawdown and Removal

Methods used for notification of the Commission; site emergency response personnel; and local, State, and Federal Emergency Response Centers are included in the Emergency Response Plan (Kiewit 2020) for the Project. In addition, the Renewal Corporation will notify the California State Water Resources Control Board and the Commission within 72 hours of an event that may substantially delay drawdown or cause the timeline to complete drawdown to exceed the anticipated schedule.

Any emergency or incident will be immediately communicated to a direct supervisor and, once it is safe to do so, all supervisors will report as outlined in the Emergency Response Plan and Health and Safety Plan for the Project. The Renewal Corporation will implement an alarm system that will sound to alert all personnel in nearby areas of a danger. Emergency Contact Information is included is also included in the Emergency Response Plan, which outline measures for directing emergency responses as well as notifications to the public, as necessary.

5.0 Construction Potential Failure Mode Analysis (cPFMA)

Construction Potential Failure Modes (cPFMs) were determined as part of the December 11 and 14, 2020 informal cPFMA workshop (Kleinschmidt 2021) that included participation by representatives from the Renewal Corporation, Kleinschmidt, the independent Board of Consultants, California Division of Safety of Dams, the FERC, and PacifiCorp. The purpose of the cPFMA workshop was to identify and analyze cPFMs for each of the 4 dams included in the Proposed Action, focusing on the construction phases. As part of the workshop, a range of cPFMs were identified and evaluated in relation to the proposed dam removal design and construction work activities.

All cPFMs identified were fully developed and assigned an appropriate significance category following FERC guidelines. The path to failure was defined, risk reduction measures were listed, and considerations for surveillance and monitoring were discussed and included in the cPFMA report (Kleinschmidt 2021).

5.1.1 Outcomes of cPFMA Workshop for Copco No. 1

A total of 9 cPFMs for Copco No. 1 Dam were identified and analyzed during the cPFMA workshop. Of the 9 cPFMs identified, 3 were not developed or were withdrawn due to design revisions that eliminated the cPFM from consideration. For the remaining 6 cPFMs, surveillance and monitoring actions, as well as opportunities for risk reduction, were identified for Copco No. 1 and are detailed in the cPFMA report (Kleinschmidt 2021). The recommended actions were incorporated into the Project construction document, work sequence, and risk register where appropriate.

5.1.2 Outcomes of cPFMA Workshop for Copco No. 2

A total of 2 cPFMs for Copco No. 1 Dam were identified and analyzed during the cPFMA workshop. For both cPFMs, surveillance and monitoring actions, as well as opportunities for risk reduction, were identified for Copco No. 2 and are detailed in the cPFMA report (Kleinschmidt 2021). The recommended actions were incorporated into the Project construction document, work sequence, and risk register where appropriate.

5.1.3 Outcomes of cPFMA Workshop for Iron Gate

A total of 21 cPFMs for Copco No. 1 Dam were identified and analyzed during the cPFMA workshop. Of the 21 cPFMs identified, 8 were withdrawn due to design revisions that eliminated the cPFM from consideration. For the remaining 13 cPFMs, surveillance and monitoring actions, as well as opportunities for risk reduction, were identified for Iron Gate and are detailed in the cPFMA report (Kleinschmidt 2021). The recommended actions were incorporated into the Project construction document, work sequence, and risk register where appropriate.

6.0 Training and Awareness

Section 6.0 discusses the qualifications required for maintenance personnel including training requirements and documentation. The Renewal Corporation will provide personnel and required training as discussed below.

6.1 Current Responsibilities and Training

PacifiCorp Operations personnel consist of Operators and Foremen, reporting to the Production Manager. The Operators are either journeymen or apprentice, and the Foreman is a General Foreman Hydro. The Foreman is responsible for Operators that perform surveillance duties and read the active instrumentation at the Project (except for the movement surveys). The Foreman and Operators are also responsible for relaying copies of the inspection check lists and sheets to the Dam Safety Engineer. The Foreman is experienced in the safe operation of hydroelectric projects and has participated in all dam safety-related training associated with the execution of dam-specific DSSMPs. The Operators and Foreman are responsible for carrying out surveillance duties and reading active instrumentation at their respective dams. Temporary monument surveys are the responsibility of the Renewal Corporation.

Personnel training in surveillance and monitoring includes review and familiarization of the most current PFMA study and the DSSMP. New personnel at any level of responsibility are trained by experienced personnel at the same or greater level of responsibility. Training includes a review of the surveillance procedures included in the DSSMP and the Daily Log, Weekly Check Sheet, and Annual Engineering Inspection Check Sheets. New PacifiCorp staff review the procedures and accompany an experienced Operators or Foreman to gain an understanding of each aspect of surveillance activities and learn the type of observations and readings needed for valid data input. The Renewal Corporation will implement a training program to train new staff operations after PacifiCorp concedes full control of the Project facilities.

6.2 Training, Awareness, and Competency

Training is required for all personnel prior to commencing work on site. The level of training is commensurate with the level of individual risk their works are likely to entail. Trainings include:

- Environmental and safety policies, site management plans, as well as environmental roles and responsibilities;
- The significance of environmental impacts caused by individual roles and activities;
- Incident management; and
- Potential consequences of non-conformance.

The Renewal Corporation will document training associated with implementation of activities.

6.3 Inductions

All personnel working onsite will undergo mandatory Project training to cover the key requirements of the Workplace Safety Management Plan.

6.3.1 Project Induction

The Project induction will cover an overview and related safety-, environmental-, and community-related risks and responsibilities for the Proposed Action. It is the responsibility of all personnel to adhere to the safety requirements of the Project. The Project induction with respect to reservoir drawdown will include:

- Overview of the California Reservoir Drawdown and Diversion Plan;
- Project contact details;
- Potential Areas of Concern and inaccessible areas;
- Notification procedures; and
- EAP, Emergency Response Plan for the Proposed Action, and other emergency protocols.

6.3.2 Visitor Induction

Visitors must undergo a visitor's induction and their host is responsible for all actions and conduct of the visitor. The Renewal Corporation will restrict visitor access, and personnel who have previously undergone Project induction and safety training will accompany visitors at all times.

7.0 Reporting

The Renewal Corporation will provide an Annual Compliance Report including a summary of drawdown activities and their results to the California State Water Resources Control Board (SWRCB) and the Commission by April 1 and 15, respectively, for the preceding year. During the drawdown phase, the Renewal Corporation will submit monthly progress reports to the SWRCB and the Commission including details regarding drawdown status.

8.0 References

Kiewit Infrastructure West Co. 2020. Emergency Response Plan. Prepared for Klamath River Renewal Corporation.

Kleinschmidt. 2020. Lower Klamath Project, FERC No. 14803, Definite Decommissioning Plan. Prepared for Klamath River Renewal Project. July.

Kleinschmidt. 2021. Construction Potential Failure Mode Analysis Report, Klamath River Renewal Project, FERC No. 14803. Prepared for Klamath River Renewal Project. June.

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Knight Piésold. 2022a. Design Report. Prepared for Klamath River Renewal Project. June.

Knight Piésold. 2022b. 100% Design Completion Drawings. Prepared for Klamath River Renewal Project. June.

National Marine Fisheries Service. 2019. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response: Klamath Project Operations from April 1, 2019 through March 31, 2024. March.

PacifiCorp. 2007. Copco 2 Hydro Plant Klamath River Supporting Technical Information Documents (STID). Revised September 28.

PacifiCorp. 2015. Klamath Hydroelectric Project FERC No. P-2082 Iron Gate Hydroelectric Development, Supporting Technical Information Document (STID). April 30.

PacifiCorp. 2016. Copco 1 Development, Klamath River Project, Supporting Technical Information Document (STID). Updated October 1.

PanGEO. 2008. Geotechnical Report – Klamath River Dam Removal Project – California and Oregon. Project No. 07-153. Prepared for Philip Williams & Associates, Ltd. And California State Coastal Conservancy. August.

U.S. Fish and Wildlife Service (USFWS). 2020. Biological Opinion on the Effects of the Proposed Interim Klamath Project Operations Plan, effective April 1, 2020, through September 30, 2022, on the Lost River Sucker and the Shortnose Sucker (TAILS # 08EKLA00-2020-F-0059). April.

Appendix A

Design Drawings

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

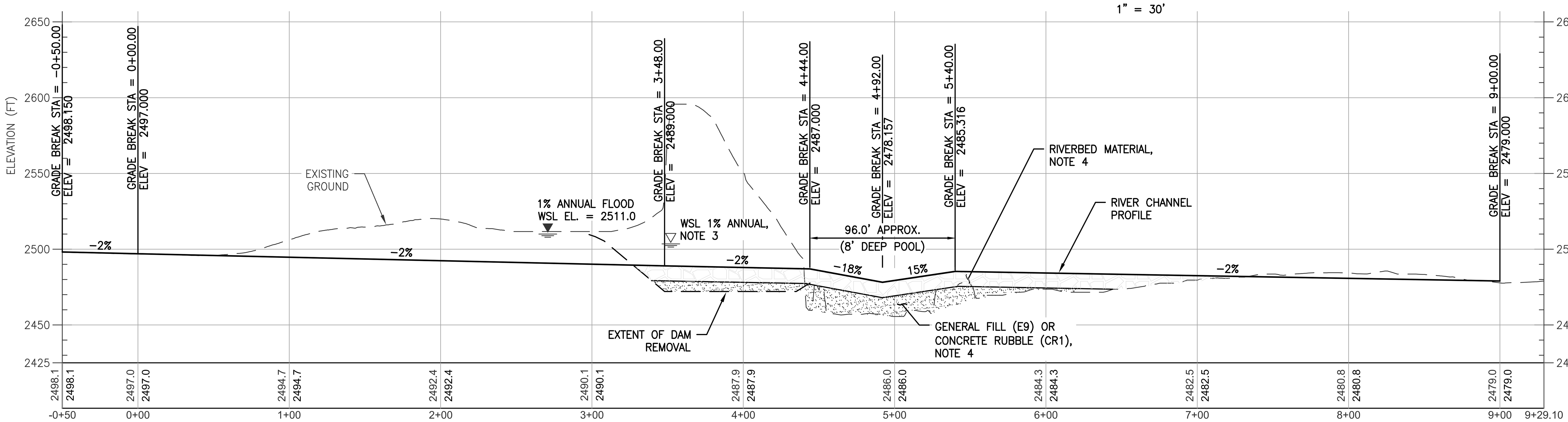
DESIGN SHEETS C2055-C2057: COPCO NO. 1 HYDROLOGIC AND HYDRAULIC INFORMATION

DESIGN SHEETS C2100, C2160, AND C2175: COPCO NO. 1 DIVERSION TUNNEL

DESIGN SHEETS C2205, C2210, AND C2225: COPCO NO. 1 PRE-DRAWDOWN WORKS

PLAN

1" = 30'



PROFILE

1" = 50'

LEGEND:

- LIMITS OF WORK
- EROSION PROTECTION MATERIAL (E7b)
- GENERAL FILL – (E9)
- RIVERBED MATERIAL

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. GROUND CONDITION AND ARRANGEMENT OF FINAL RIVER CHANNEL ARE ASSUMED BASED ON THE HISTORIC PHOTOS AND BATHYMETRY.
3. FINAL CHANNEL DESIGNED FOR THE POST DAM REMOVAL ANNUAL PEAK INSTANTANEOUS FLOOD WITH 1% CHANCE OF EXCEEDANCE = 32,700 cfs (KP REF. VA103-640/1-9). FLOW DEPTH WILL BE APPROXIMATELY 16 ft WITH AVERAGE FLOW VELOCITY OF APPROXIMATELY 22 ft/s AT THE DAM CENTRELINE.
4. MATERIAL STOCKPILED ON THE RIGHT BANK UPSTREAM OF THE COPCO NO. 1 DAM ORIGINATES FROM THE HISTORIC COPCO NO. 1 DAM EXCAVATION AND IS ASSUMED TO BE SUITABLE FOR DIRECT PLACEMENT AS RIVERBED MATERIAL. RIVERBED MATERIAL NOT SOURCED FROM THIS AREA MUST BE WELL GRADED MATERIAL WITH AN UPPER PARTICLE SIZE OF APPROXIMATELY 36 in, AND A 15% MAXIMUM OF MATERIAL SMALLER THAN 6 in (BY VOLUME).
5. HISTORIC SPOIL THAT CONTAINS CONSTRUCTION WASTE MATERIALS (RUBBISH AND DEBRIS) MUST BE REMOVED. REMOVAL MAY EXTEND BEYOND THE EXCAVATION LIMITS SHOWN. SPOIL MATERIAL COMPRISING ONLY LOCALLY EXCAVATED MATERIAL MAY REMAIN IN PLACE. PERMANENT SOIL EXCAVATION SLOPES SHALL NOT BE STEEPER THAN THE INDICATED SLOPES. BEDROCK SURFACES EXPOSED SHALL BE CLEARED OF ALL LOOSE AND UNSTABLE ROCK BY SCALING.

0 50 100 150
1" = 50'

0 30 60 90
1" = 30'

ISSUED FOR CONSTRUCTION

eguevarra May 25, 2022 - 10:32am
M:\1\03\00640\01\A\Acad\DWGS\2000\C2230\C2230.dwg

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

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
FINAL RIVER CHANNEL GRADING
PLAN AND PROFILE

PROJ #	VA103-640/1
DATE	05/27/2022
DWG	C2230

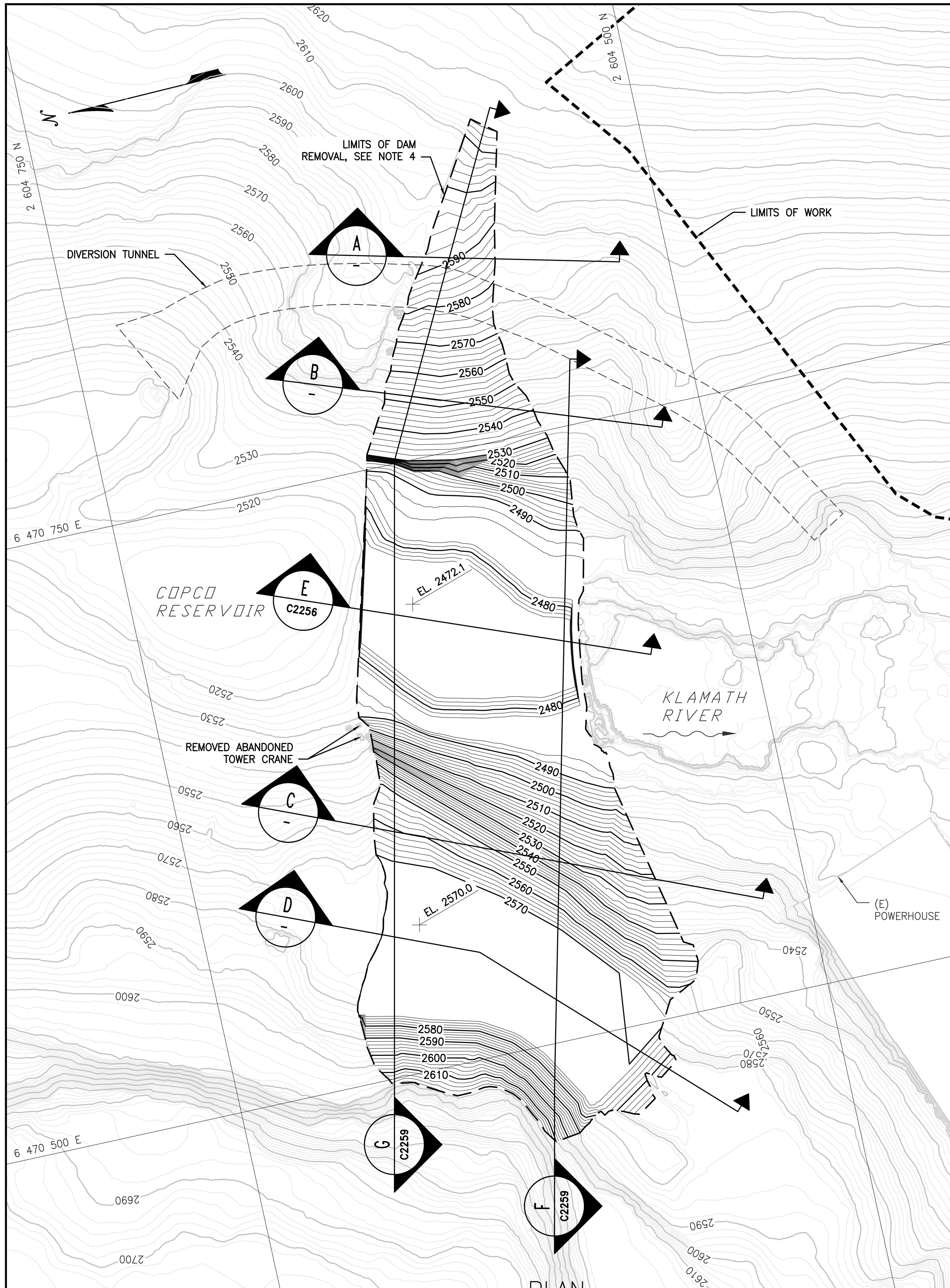
CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

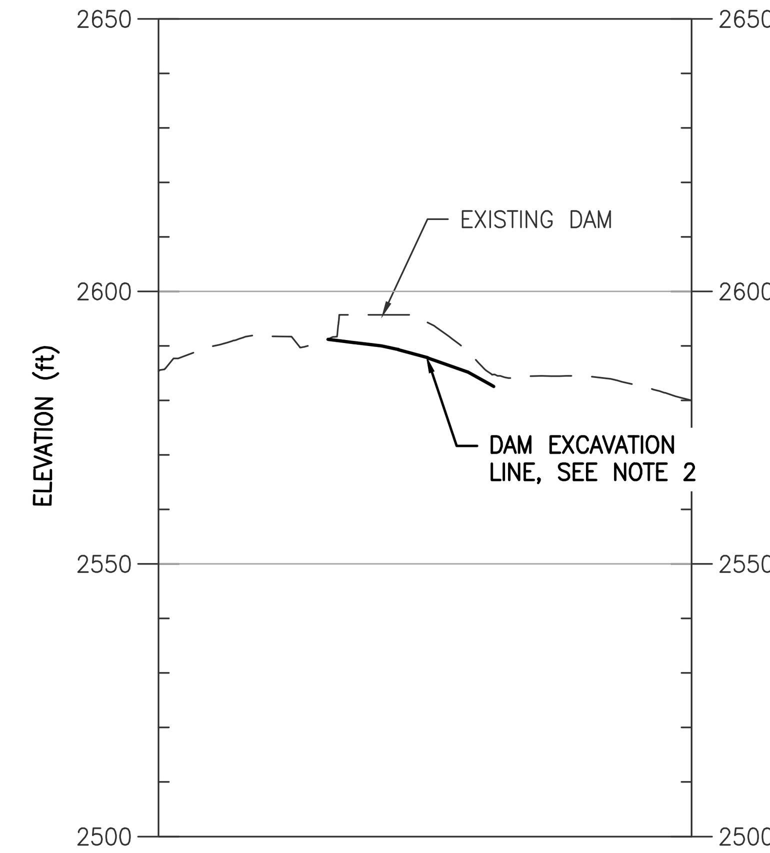
REDACTED

DESIGN SHEETS C2250 AND C2255-C2257: COPCO NO. 1 DAM REMOVAL

PRIVILEGED AND CONFIDENTIAL



PLAN
1" = 30'



SECTION A
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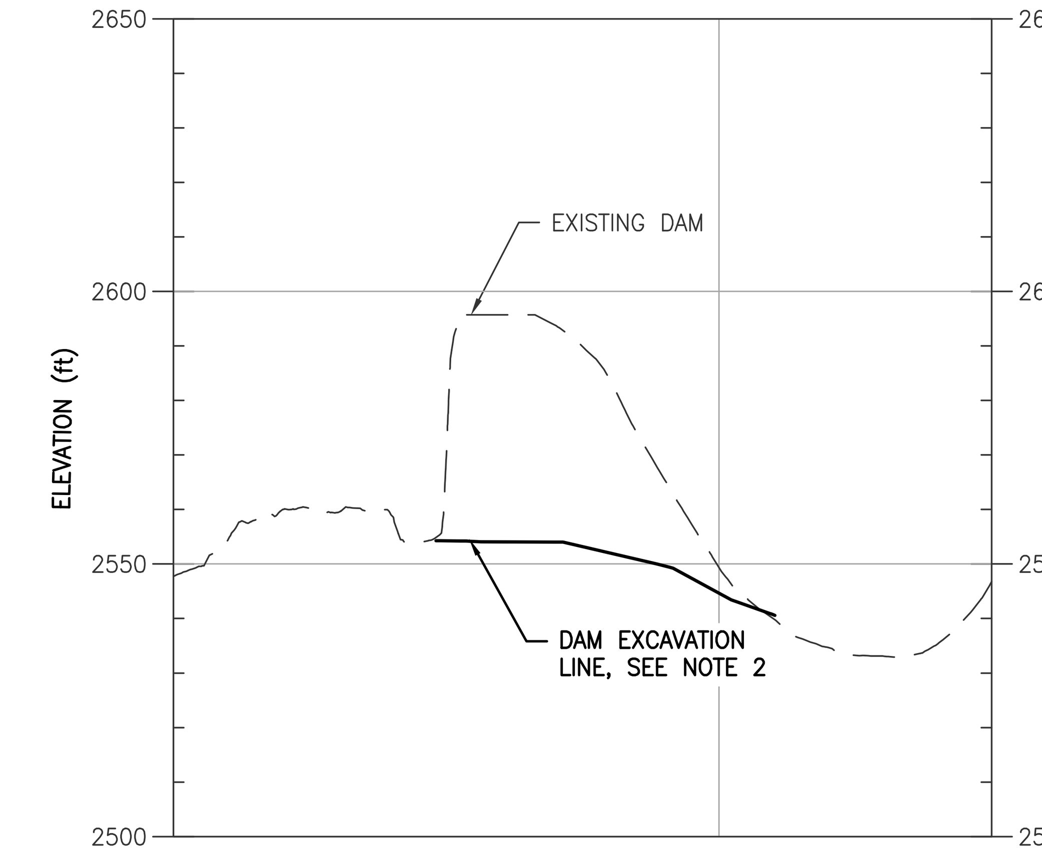
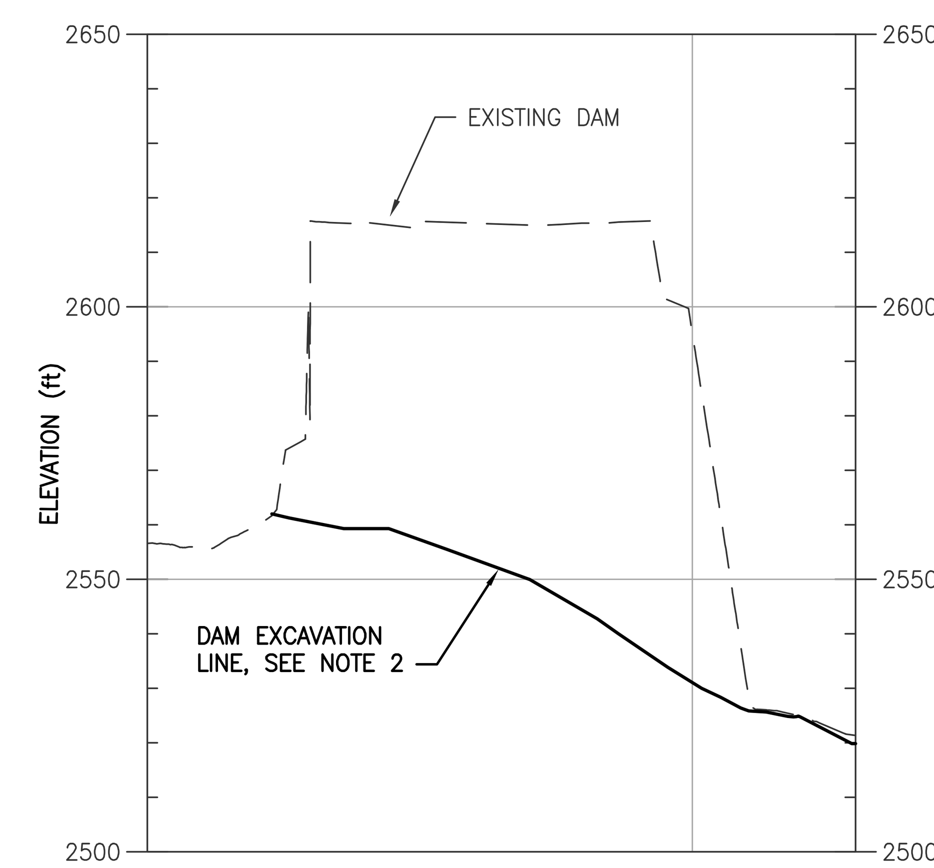
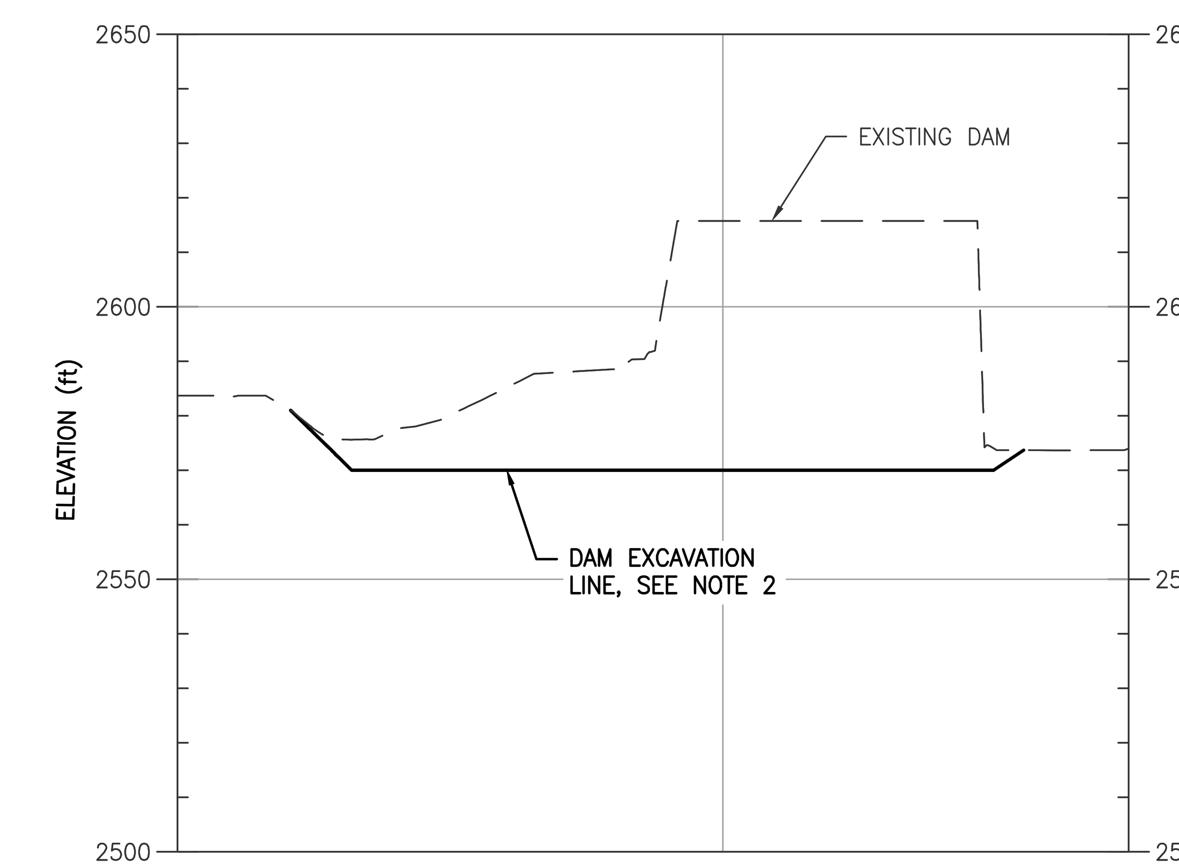


SECTION B
1" = 30'



SECTION C
1" = 30'



SECTION D
1" = 30'

NOTES:

1. REFER TO GENERAL NOTES ON SHEET G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. CONCRETE STRUCTURE TO BE REMOVED TO CURRENT ADJACENT BEDROCK SURFACE. PORTION OF EXISTING CONCRETE MAY BE ABANDONED IN PLACE.
3. CUT REBAR AND ALL EMBEDDED ITEMS EXPOSED BY THE REMOVAL OF CONCRETE TO THE EXCAVATION SURFACE.
4. CONTOURS WITHIN LIMITS OF DAM REMOVAL SHOW FINAL REMOVAL SURFACE.
5. REMOVE ALL LOOSE, UNSTABLE CONCRETE AND ROCK FROM THE SURFACES EXPOSED BY EXCAVATION (SCALING). THE FINAL EXCAVATION SURFACE WITH SCALING MAY EXCEED THE EXCAVATION LIMITS AS SHOWN ON THE DRAWINGS.

LEGEND:

LIMITS OF WORK

ISSUED FOR CONSTRUCTION

0 30 60 90
1" = 30'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	BO	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
DAM REMOVAL - FINAL GRADE
PLAN AND SECTIONS

PROJ # VA103-640/1
DATE 05/27/2022
DWG C2258

eguevara May 24, 2022 - 5:09pm
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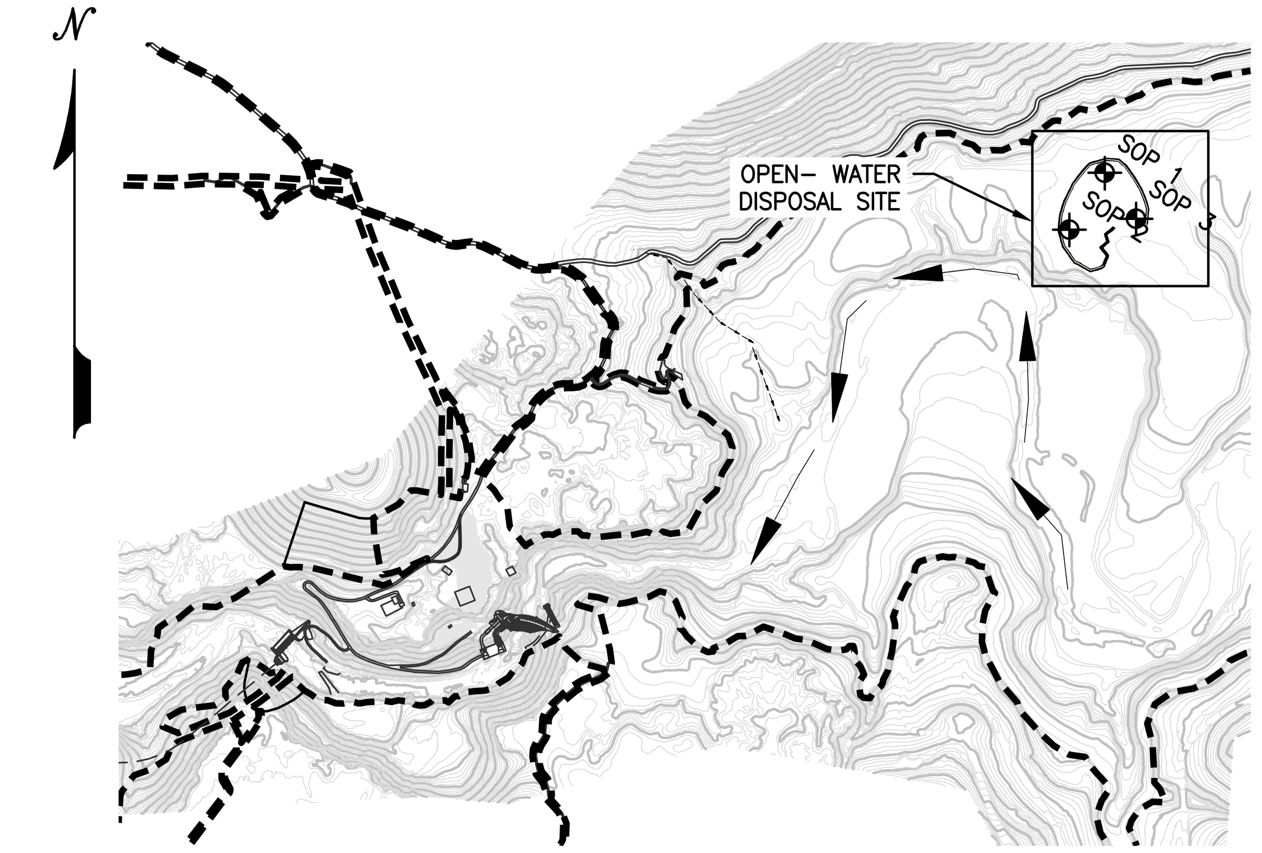
PLAN

1" = 100'



KEY PLAN

NTS

WORK POINTS TABLE		
WORK POINTS	EASTING	NORTHING
SOP 1	6474286.577	2607418.774
SOP 2	6474066.604	2607064.690
SOP 3	6474481.498	2607132.897

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. NORMAL RESERVOIR LEVEL IS 2607 ft. REFER TO C2055 FOR PRE-DRAWDOWN RESERVOIR OPERATION.
3. DISPOSAL SITE WILL BE LOCATED ABOVE KLAMATH RIVER POST DAM REMOVAL.

LEGEND:

- - - - LIMITS OF WORK

ISSUED FOR CONSTRUCTION

0 100 200 300

1" = 100'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	BO	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
OPEN-WATER DISPOSAL SITE
PLAN

PROJ # VA103-640/1
DATE 05/27/2022
DWG C2272

eguevarra May 25, 2022 - 8:39am
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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

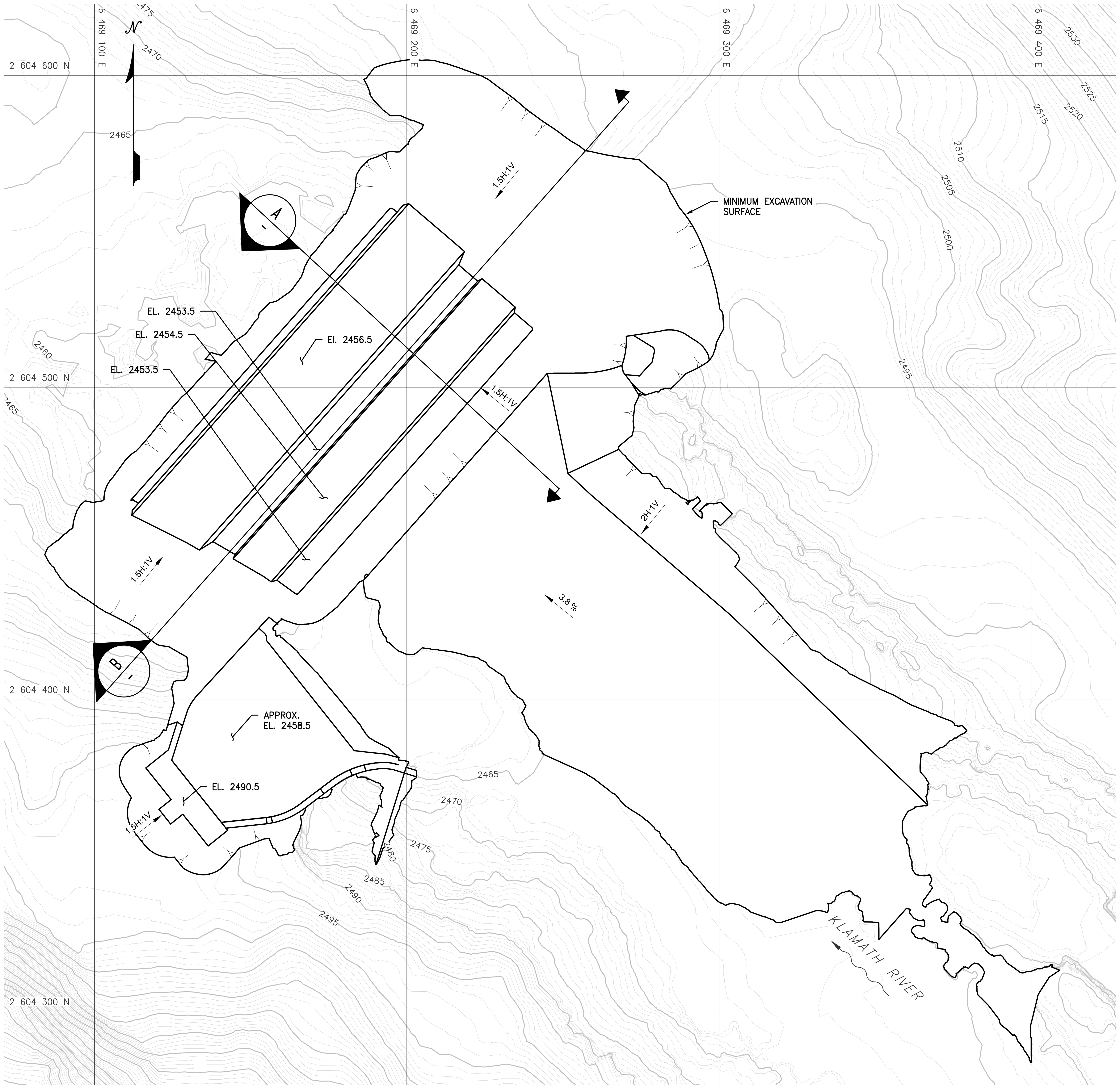
(CEII)

REDACTED

DESIGN SHEET C3057: COPCO NO. 2 HYDROLOGIC AND HYDRAULIC INFORMATION

DESIGN SHEETS C3200 AND C3210: COPCO NO. 2 DAM REMOVAL

PRIVILEGED AND CONFIDENTIAL

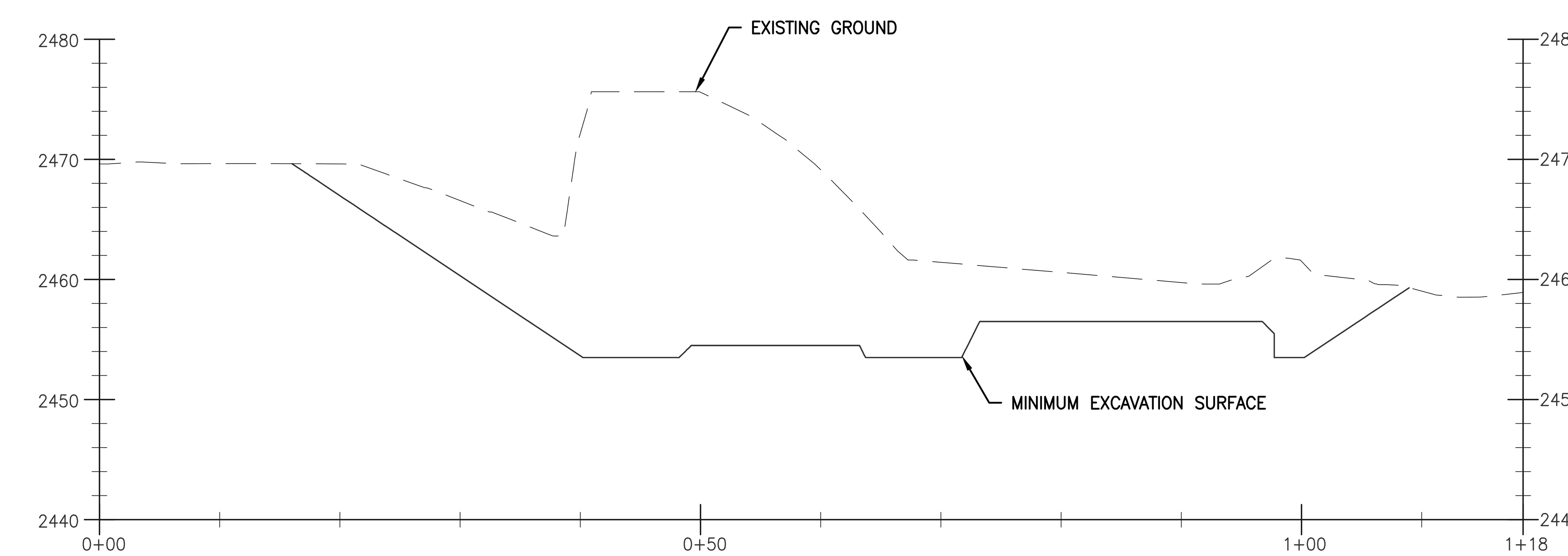


PLAN

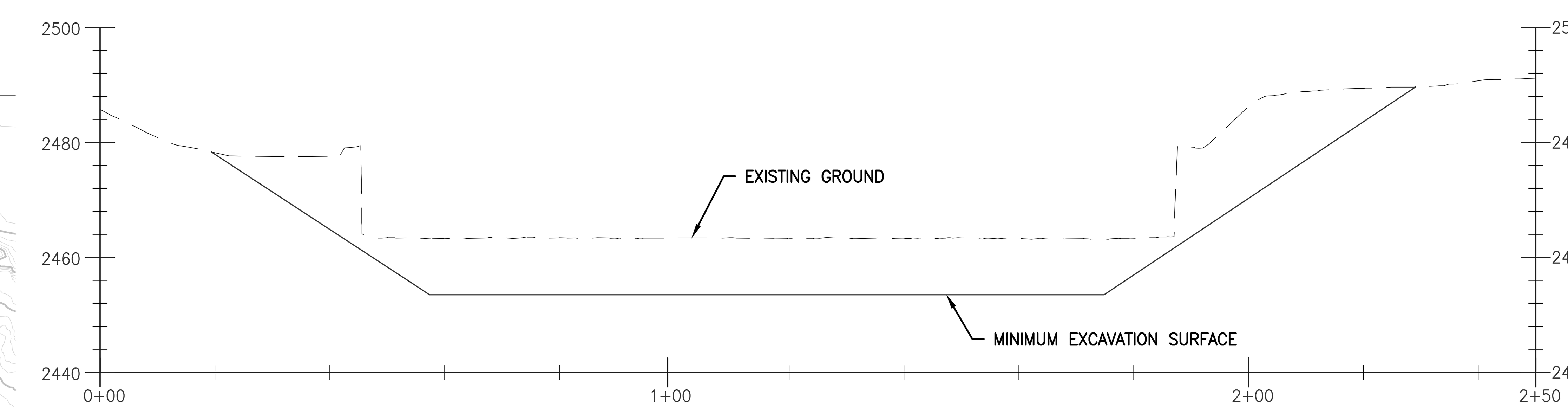
1" = 20'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. CONCRETE RUBBLE TO BE DISPOSED OF IN COPCO NO. 1 DISPOSAL SITE OR COPCO NO. 2 INTAKE STRUCTURE. NATIVE RIVER MATERIAL REMOVED THROUGH EXCAVATION OF DAM TO BE USED FOR BACKFILLING RIVER CHANNEL, SEE DRAWING C3234 FOR SPECIFICATIONS.
3. DIVERSION DAM LOCATION IS APPROXIMATE AND MAY VARY. CONTRACTOR SHALL LOCATE STRUCTURE EXTENTS PRIOR TO REMOVAL.
4. EXCAVATION SLOPES TO BE VERIFIED BY THE ENGINEER. EXCAVATION IN AREAS WITH SATURATED SOILS OR WITH SIGNIFICANT SEEPAGE MAY REQUIRE REDUCED SLOPE ANGLES AND/OR DEWATERING.



A SECTION
1" = 10'



B SECTION
1" = 20'

ISSUED FOR CONSTRUCTION

0 20 40 60
1" = 20'
0 10 20 30
1" = 10'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CAV	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED C. VOS
DRAWN A. NASIRI
REVIEWED S. YONG
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 2 FACILITY
DIVERSION DAM REMOVAL
EXCAVATION PLAN

PROJ # VA103-640/1
DATE 05/27/2022
DWG C3221

anasiri May 19, 2022 - 4:28pm M:\1\01\00640\01\A\Acad\DWGS\3000\C3221\C3221.dwg

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

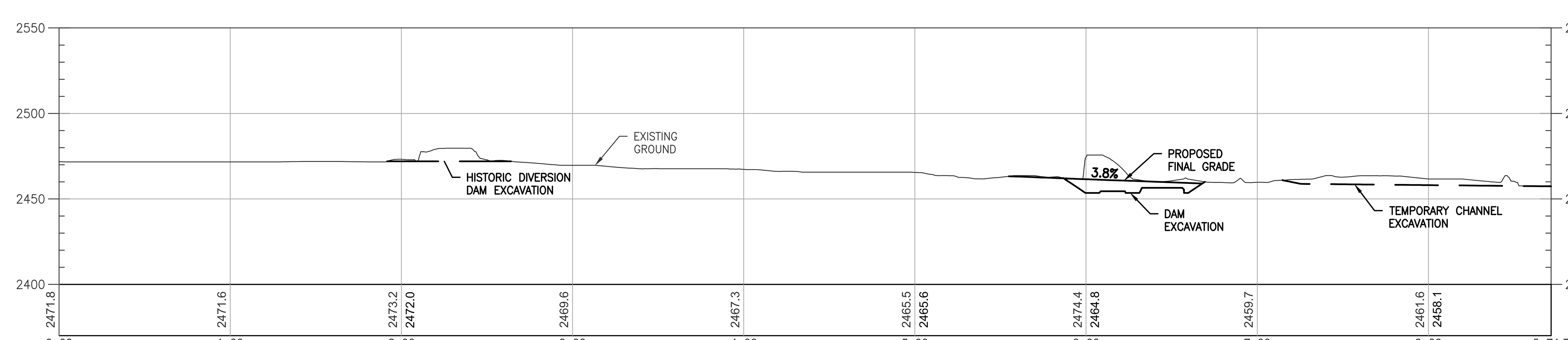
(CEII)

REDACTED

DESIGN SHEET C3232: COPCO NO. 2 INTAKE REMOVAL

PLAN

1" = 40'



PROFILE

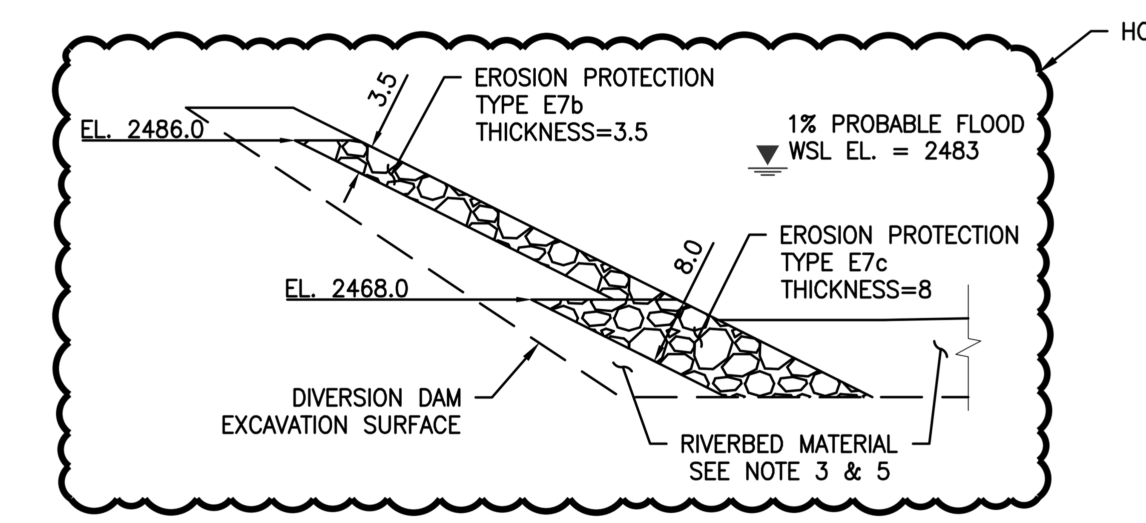
1" = 50'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. THE RIVER CHANNEL SHALL BE BACKFILLED TO THE EXTENTS SHOWN WITH RIVERBED MATERIAL, EXCEPT FOR AREAS THAT ARE SPECIFIED AS EROSION PROTECTION. RIVERBED MATERIAL MAY BE INTERMIXED WITH THE CONCRETE RUBBLE STORED IN THE INTAKE STRUCTURE AT THE DISCRETION OF THE CONTRACTOR, SEE DRAWING C3232.
3. MATERIAL STOCKPILED ON THE RIGHT BANK UPSTREAM OF THE COPCO NO. 1 DAM ORIGINATES FROM THE HISTORIC COPCO NO. 1 DAM EXCAVATION AND IS ASSUMED TO BE SUITABLE FOR DIRECT PLACEMENT AS RIVERBED MATERIAL. RIVERBED MATERIAL NOT SOURCED FROM THIS AREA MUST BE WELL GRADED MATERIAL WITH AN UPPER PARTICLE SIZE OF APPROXIMATELY 36 in, AND A 15% MAXIMUM OF MATERIAL SMALLER THAN 6 in (BY VOLUME).
4. CHANNEL BACKFILL TO BE BLENDED WITH NATURAL RIVER BED AT FILL EXTENTS.
5. PRIOR TO PLACEMENT OF EROSION PROTECTION THE EXCAVATION OR PLACED SUBGRADE SURFACE SHALL BE VISUALLY FREE OF FINES TO ALLOW FOR DIRECT EROSION PROTECTION PLACEMENT.
6. EROSION PROTECTION MATERIAL SHALL BE TAMPED BY THE CONTRACTOR TO INCREASE INTERLOCK AFTER PLACEMENT.
7. SEE DRAWING C3620 FOR SURFACING REQUIREMENTS.

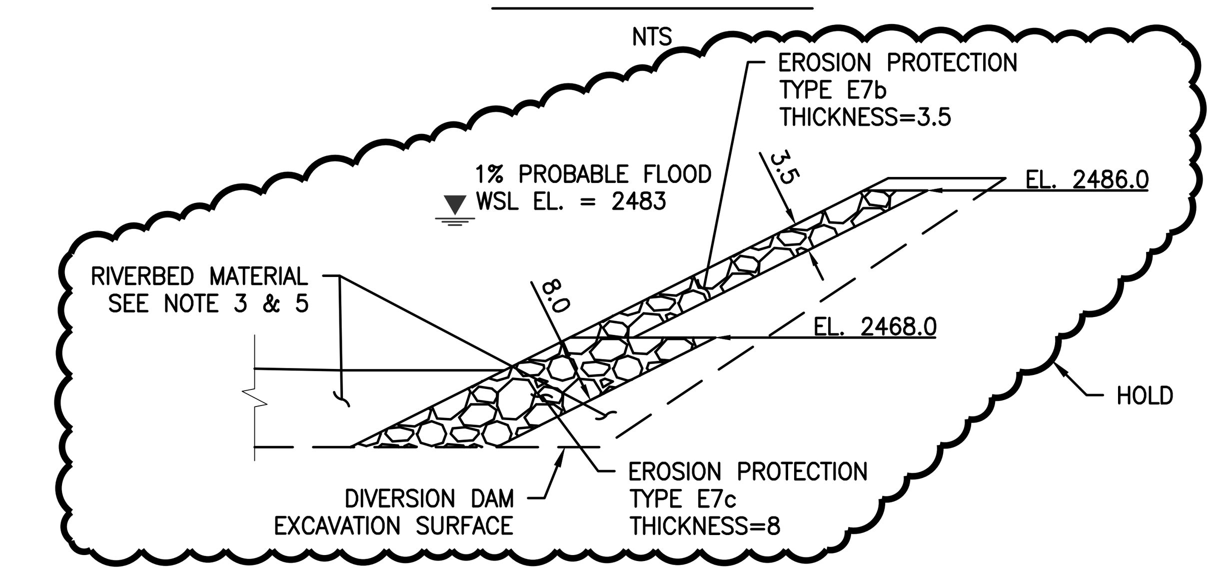
WORK POINTS TABLE

WORK POINTS	EASTING	NORTHING	ELEVATION
DDB-01	6469245.0	2604504.7	2462.0
DDB-02	6469188.3	2604546.9	2459.4
DDB-03	6469222.3	2604369.1	2466.2
DDB-04	6469153.7	2604453.4	2460.7
DDB-05	6469113.6	2604478.6	2459.0



TYPICAL LEFT BANK EROSION PROTECTION DETAIL

NTS



TYPICAL RIGHT BANK EROSION PROTECTION DETAIL

NTS

LEGEND:

EROSION PROTECTION (E7b/E7c)

0 50 100 150
1" = 50'

0 40 80 120
1" = 40'

ISSUED FOR CONSTRUCTION

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CAV	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
Kiewit

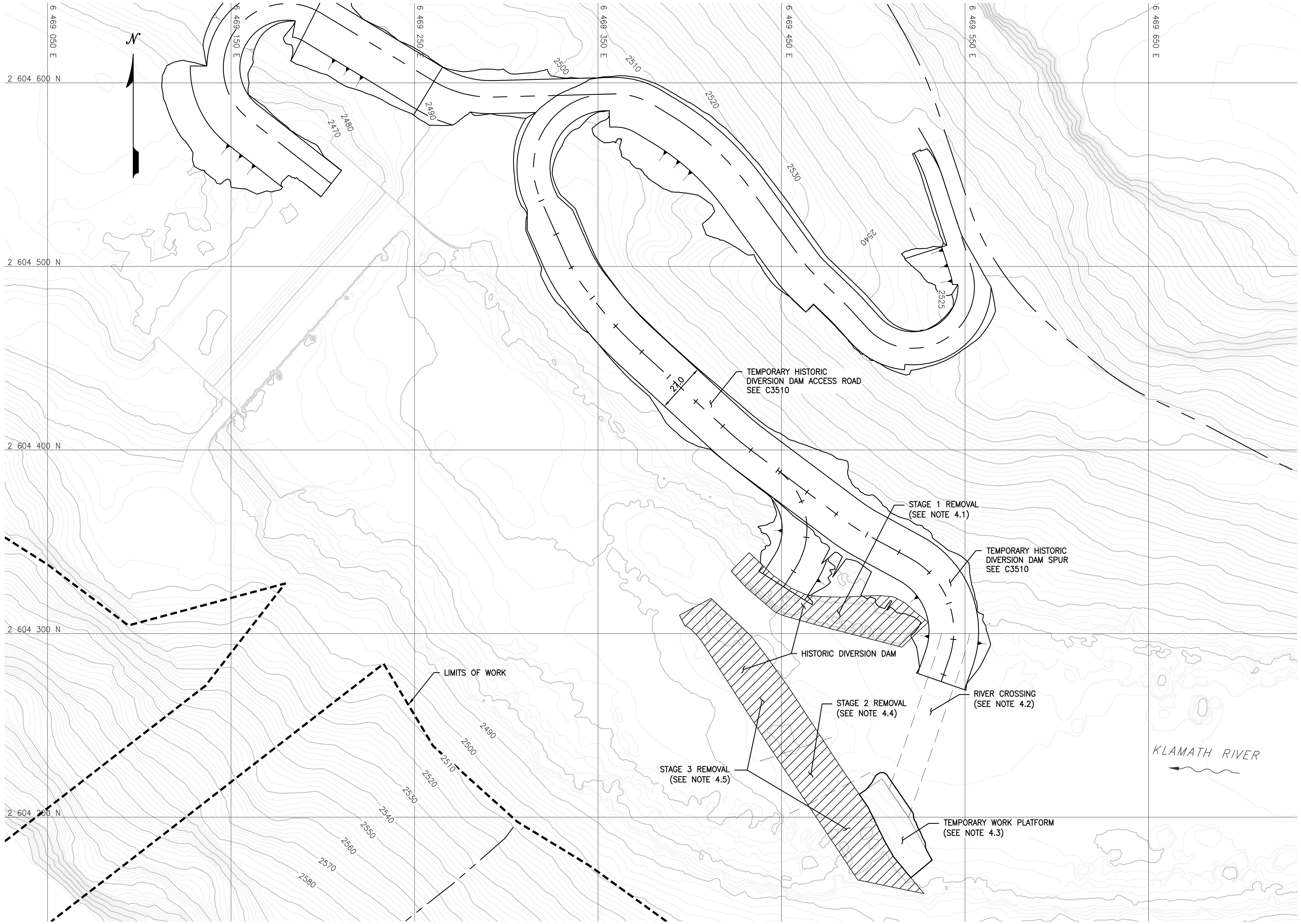
DESIGNED	C. VOS
DRAWN	R. PENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE: COPCO NO. 2 FACILITY DIVERSION DAM REMOVAL CHANNEL GRADING PLAN AND PROFILE

PROJ #: VA103-640/1
DATE: 05/27/2022
DWG: C3234



PLAN

1" = 30'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. REMOVE HISTORIC DIVERSION DAM TO SURROUNDING NATURAL RIVER GRADE.
3. SEE CALIFORNIA OREGON POWER COMPANY COPCO NO. 2 DEVELOPMENT HISTORIC DRAWING E-3290 (DATED 05/27/24) FOR HISTORIC DIVERSION DAM DETAILS.
4. IN THE EVENT THE HISTORIC DIVERSION DAM CANNOT BE REMOVED WHEN THE COPCO NO. 2 REACH IS DEWATERED, THE FOLLOWING ALTERNATIVE REMOVAL METHOD MAY BE EMPLOYED AT THE CONTRACTORS DISCRETION:
   - 4.1. STAGE 1 – REMOVE RIGHT BANK PORTION OF HISTORIC DIVERSION DAM FIRST TO WIDEN THE HISTORIC DIVERSION DAM OPENING AND LOWER THE RIVER LEVEL.
   - 4.2. CONTRACTOR TO CROSS RIVER DURING LOW FLOW MONTHS. SURROUNDING MATERIAL MAY BE USED TO CREATE A PATH THROUGH THE RIVER IF DEPTH OF WATER IS TOO DEEP TO OPERATE THROUGH.
   - 4.3. A TEMPORARY WORK PLATFORM SHALL BE CREATED FROM SURROUNDING MATERIAL AS REQUIRED BY THE CONTRACTOR.
   - 4.4. STAGE 2 – THE PORTION OF THE HISTORIC DIVERSION DAM THAT BLOCKS THE NATURAL LOW POINT IN THE RIVERBED SHALL BE REMOVED TO PROVIDE AN ALTERNATIVE FLOW PATH FOR THE RIVER.
   - 4.5. STAGE 3 – THE REMAINDER OF THE HISTORIC DIVERSION DAM SHALL BE REMOVED USING THE CONTRACTORS PREFERRED SEQUENCE AND HANDLING METHODOLOGY.

LEGEND:

DEMOLITION / REMOVAL

LIMITS OF WORK

ISSUED FOR CONSTRUCTION

0 30 60 90

1" = 30'

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REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CAV	SY	SRM	05/27/22

WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY Knight Piésold CONSULTING Kiewit

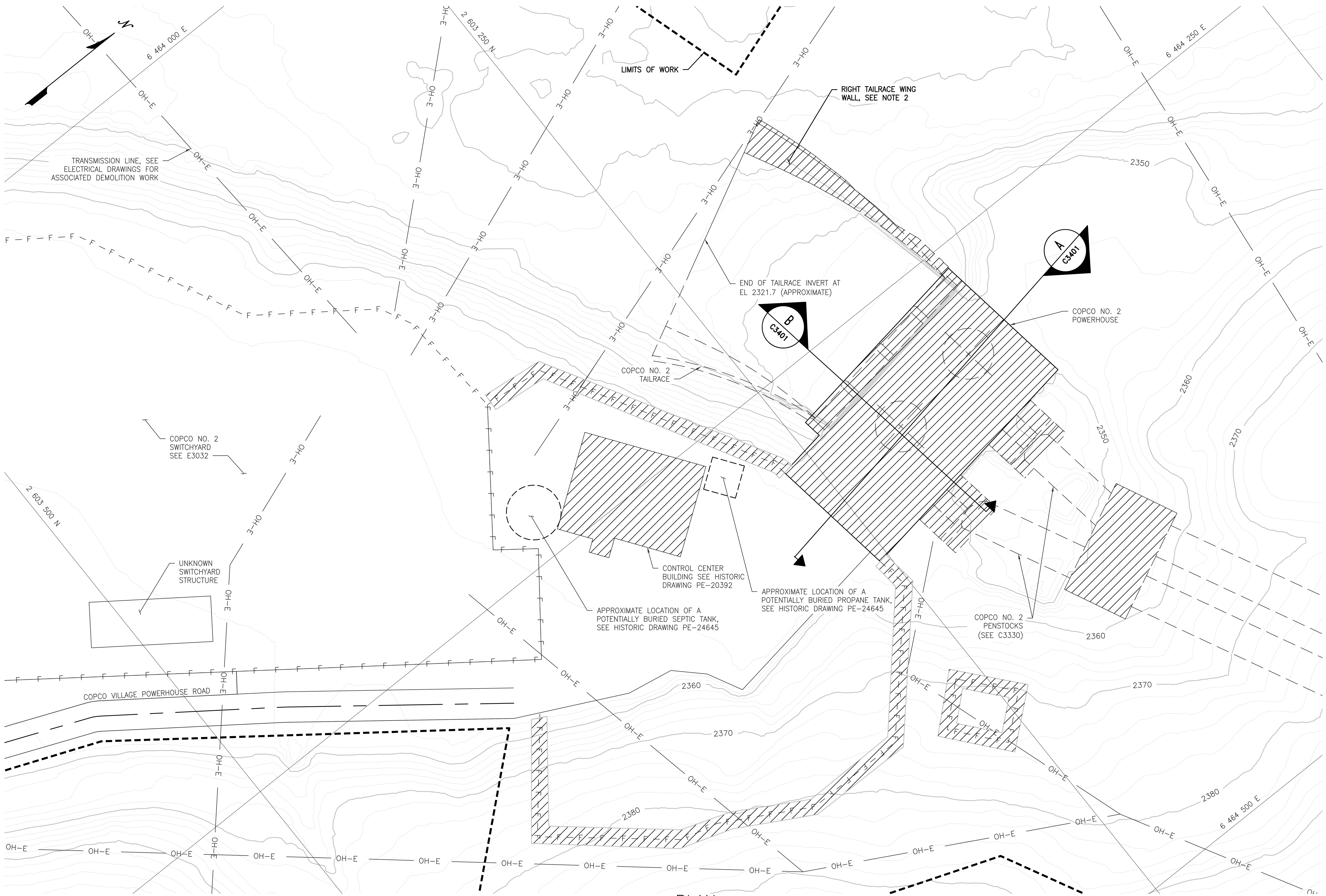
DESIGNED	C. VOS
DRAWN	P. PETKOVIC
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR KLAMATH RIVER RENEWAL CORPORATION

PROJECT KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE COPCO NO. 2 FACILITY HISTORIC DIVERSION DAM REMOVAL PLAN AND REMOVAL NOTES

PROJ #	VA103-640/1
DATE	05/27/2022
DWG	C3240



PLAN
1" = 20'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. RIGHT TAILRACE WING WALL TO BE REMOVED AND PLACED INTO TAILRACE. SEE DRAWING C3332 FOR EXCAVATION DETAILS.
3. TRANSMISSION LINES AND PART OF THE COPCO NO. 2 SWITCHYARD WILL BE SELECTIVELY REMOVED. SEE ELECTRICAL DRAWINGS FOR ASSOCIATED DEMOLITION WORK.

LEGEND:

DEMOLITION / REMOVAL
LIMITS OF WORK

ISSUED FOR CONSTRUCTION

0 20 40 60
1" = 20'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CAV	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY
Knight Piésold CONSULTING
PKS Kiewit

DESIGNED	C. VOS
DRAWN	R. PENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT
PROJ #: VA103-640/1
DATE: 05/27/2022
SHEET TITLE: COPCO NO. 2 FACILITY POWERHOUSE DEMOLITION GENERAL ARRANGEMENT - PLAN
DWG: C3400

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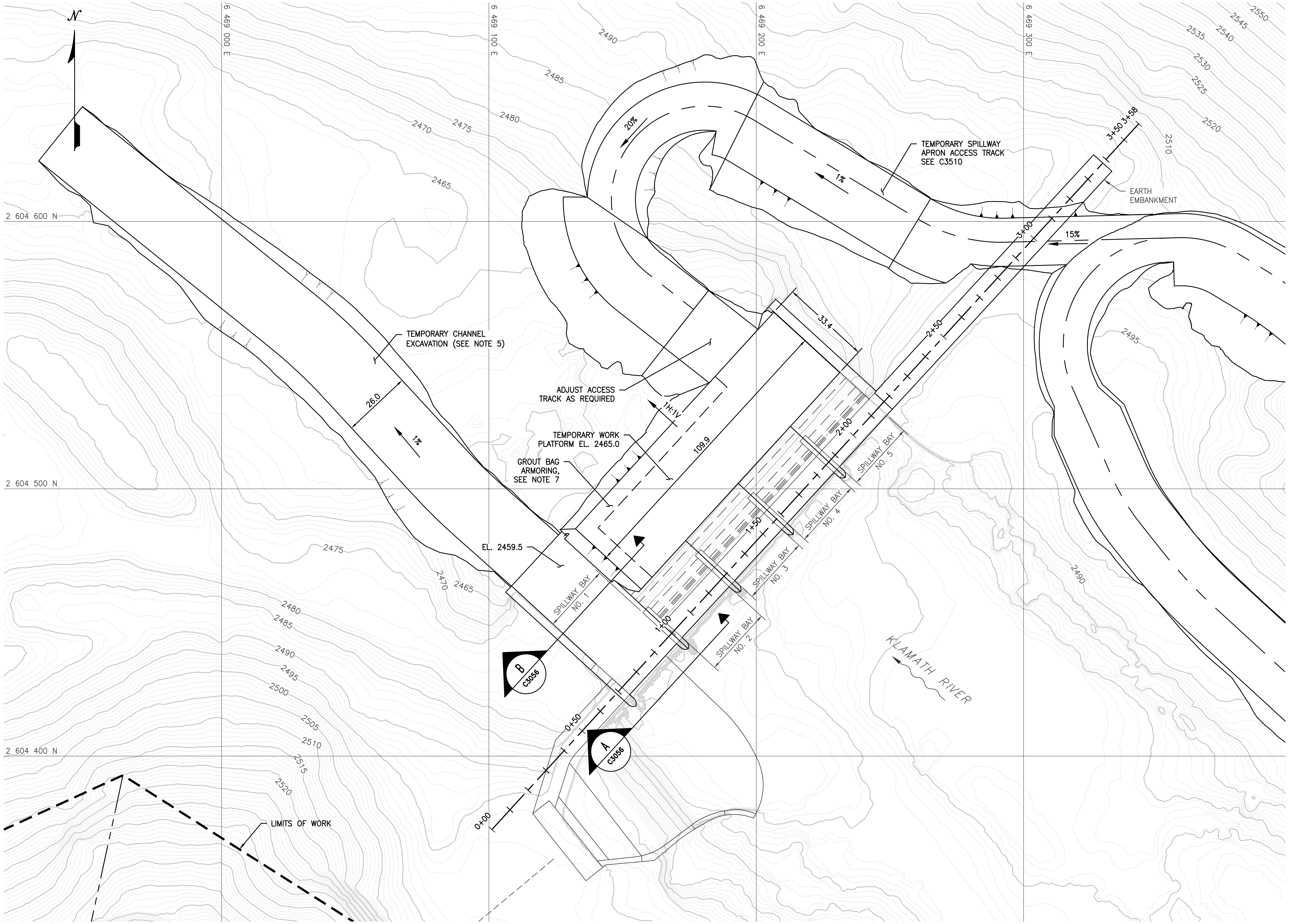

PLAN

SCALE 1" = 20'

NOTES:

1. THE INFORMATION CONTAINED IN THIS DRAWING PERTAINS TO THE COPCO NO. 2 DIVERSION DAM CONTINGENCY REMOVAL METHOD. THE PRIMARY REMOVAL METHOD COMPRISES UTILIZING THE COPCO NO. 1 DAM DURING THE PRE-DRAWDOWN WORKS TO ALLOW THE DIVERSION DAM TO BE REMOVED IN THE DRY TO THE EXTENTS SHOWN ON DRAWING C3220. IF THE CONTRACTOR SELECTS THE PRIMARY REMOVAL METHOD THE WORKS SHOWN ON THIS DRAWING ARE NOT REQUIRED.
2. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
3. LOCATION AND ELEVATION OF EXISTING STRUCTURES TO BE CONFIRMED PRIOR TO DEMOLITION.
4. DAM OUTLINE BASED ON THE CALIFORNIA OREGON POWER COMPANY COPCO 2 DEVELOPMENT HISTORIC DRAWING F-3930 (DATED 05/25/1925).
5. TEMPORARY CHANNEL EXCAVATION DESIGNED TO REDUCE THE RIVER ELEVATION ADJACENT TO THE WORK PLATFORM TO BE CONSTRUCTED AT THE CONTRACTOR'S DISCRETION. WORK PLATFORM MAY NEED TO BE RAISED TO PROVIDE A DRY WORKING SURFACE IN THE EVENT THE TEMPORARY CHANNEL EXCAVATION IS NOT CONSTRUCTED.
6. TEMPORARY CHANNEL EXCAVATION MUST BE BACKFILLED IF EXCAVATED.
7. TEMPORARY WORK PLATFORM TO BE EXCAVATED AS REQUIRED.
8. WORK PLATFORM TO BE ARMORED USING GROUT BAGS OR SIMILAR APPROVED BY ENGINEER.
9. SEE DRAWING C3056 FOR ANTICIPATED WATER LEVELS ALONG SPILLWAY BAY NO. 1 WITH THE TEMPORARY WORK PLATFORM AND TEMPORARY CHANNEL EXCAVATION IN PLACE.

LEGEND:

- - - - - - LIMITS OF WORK

ISSUED FOR CONSTRUCTION

0 20 40 60

1" = 20'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CAV	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY Knight Piésold CONSULTING / Kiewit

DESIGNED	C. VOS
DRAWN	R. PENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT

PROJ # VA103-640/1

DATE 05/27/2022

SHEET TITLE: COPCO NO. 2 FACILITY DIVERSION DAM CONTINGENCY REMOVAL METHOD CONSTRUCTION ACCESS - TEMPORARY SPILLWAY APRON ACCESS TRACK AND WORK PLATFORM

DWG C3520

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEETS C4050 AND C4051: IRON GATE HYDROLOGIC AND HYDRAULIC INFORMATION

DESIGN SHEETS C4203-C4209: IRON GATE EMBANKMENT REMOVAL

PLAN
1" = 80'

NOTES:

1. REFER TO GENERAL NOTES ON G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. CONTOUR INTERVALS ARE 2 ft.
3. ALL CORE ZONE MATERIAL (ZONE III) SHALL BE EXCAVATED TO BEDROCK. ALL OTHER EXCAVATED SURFACE SHALL BE TO BEDROCK OR EXCAVATION EXTENTS SHOWN HERE.
4. FOR FINAL GRADE SURFACE TREATMENT, SEE DRAWING SERIES C4600.
5. NO EROSION PROTECTION REQUIRED WHERE EXCAVATION IS TO BEDROCK.

ISSUED FOR CONSTRUCTION

0 80 160 320
1" = 80'

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	KTW	SY	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER SALINA YONG C 77520 EXP. 06-30-23 CIVIL STATE OF CALIFORNIA

PREPARED BY: Knight Piésold CONSULTING; Kiewit

DESIGNED: K. WECHSELBERGER
DRAWN: A. TSENG
REVIEWED: S. YONG
IN CHARGE: N. BISHOP
APPROVED: S. MOTTRAM

PREPARED FOR: KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT
SHEET TITLE: IRON GATE FACILITY EMBANKMENT REMOVAL GRADING GENERAL ARRANGEMENT PLAN

PROJ #: VA103-640/1
DATE: 05/27/2022
DWG: C4210

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEETS C4250 AND C4255: IRON GATE FINAL BREACH PLAN

DESIGN SHEET G8862: IRON GATE DIVERSION TUNNEL HISTORIC DRAWING

Appendix B

California Slope Stability and Monitoring Plan

Lower Klamath Project
FERC Project No. 14803

California Slope Stability Monitoring Plan

Klamath River Renewal Corporation
2001 Addison Street, Suite 317
Berkeley, CA 94704

Prepared by:
Knight Piésold
LKRP Project Office
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December 2022

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Table of Contents

Attachments

1.0 Introduction

This California Slope Stability Monitoring Plan is a subplan of the Reservoir Drawdown and Diversion Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project.

1.1 Purpose of California Slope Stability Monitoring Plan

This document describes the Klamath River Renewal Corporation's (Renewal Corporation) plan for monitoring slope stability and evaluates practices related to slope stability. The plan identifies reservoir slopes and other areas within the Limits of Work of the Proposed Action prone to instability and describes the Renewal Corporation's measures for monitoring instability during drawdown and dam removal under the Proposed Action. It also describes the Renewal Corporation's measures to address instability and discharges that would violate water quality standards. The Renewal Corporation's slope stability measures are also intended to protect private property, structures, and cultural sites.

The Renewal Corporation will implement the following measures through this California Slope Stability Monitoring Plan or other management plans referenced in this document:

- describe slope stability monitoring, including locations and schedule.
- coordinate with reservoir drawdown to address potential modification of drawdown implementation to control slope instability, if necessary, to protect infrastructure, property, or resources.
- provide a list of measures to be implemented to address erosion and maintain soil stability.
- visually monitor and inspect for evidence of potential slumping, cracking, and other signs of slope instability during drawdown and dam removal and after storm events, and implement necessary repairs, replacements, and/or additional measures to minimize potential slope instability effects on water quality based on information obtained through inspections.
- provide contingency and notification procedures to respond to confirmed or suspected issues related to slope instability or loss of erosion protection.
- submit monthly and annual reports.

1.2 Relationship to Other Management Plans

This California Slope Stability Monitoring Plan is supported by elements of the following management plans to aid in effective implementation: Construction Management Plan, California Reservoir Drawdown and Diversion Plan, and Water Quality Monitoring and Management Plan. So as not to duplicate information, elements from these other management plans are not repeated herein but are, where appropriate, referenced in this plan.

1.3 California Section 401 Water Quality Certificate Condition 18

Under Section 401 of the federal Clean Water Act, the California State Water Resources Control Board (SWRCB) has issued a Section 401 Water Quality Certificate (SWRCB 2020a) that identifies 11 elements for consideration in the Slope Stability Monitoring Plan. These elements are addressed throughout this plan. Modeling for the design (Knight Piésold 2022) showed that dam stability increases during reservoir drawdown and the proposed dam removal for each of the facilities. Therefore, the Renewal Corporation proposes the installation of zero piezometer wells and inclinometers to monitor dam stability. As an alternative, the Renewal Corporation will monitor drainage and make visual observations of the dam faces and reservoir rim during drawdown and dam removal.

1.4 Elevation Datum

All elevations reported in this plan use the North American Vertical Datum of 1988 (NAVD88), which is 3.48 feet (ft) higher than the National Geodetic Vertical Datum of 1929 (NGVD29) at Copco No. 1 and No. 2 and 3.33 ft higher at Iron Gate.

2.0 Supporting Information

2.1 Reservoir Rim

This section is informational and includes excerpts from the Reservoir Rim Stability Report (Knight Piésold 2022); it does not contain specific measures to be implemented by the Renewal Corporation as part of the Proposed Action. *Reservoir rim* is defined as the terrain that lies within the normal operating levels of the reservoir. The terrain downslope and upslope of the rim are defined as *submarine* slopes and *upslope* areas, respectively.

The Reservoir Rim Stability Report summarizes the findings of an evaluation of reservoir rim stability during and following drawdown. The evaluation focused on the potential instabilities that could affect residences and other resources adjacent to the rim, such as transportation infrastructure. The evaluation is consistent with previous evaluations completed by the Renewal Corporation (2019) and PanGeo (2008).

The approach used for the stability analyses (Knight Piésold 2022) commenced with a review of the Renewal Corporation's previous analyses and conclusions (2019). Stability models were then developed based on the interpretation of data and observations collected by the Renewal Corporation, which were influenced by the challenges of gaining site access. Identification and characterization of terrain hazards were completed for each of the reservoir sites and guided the development of slope models. The locations of the features and hazards identified from the terrain analysis are shown in Figures 2-1 and 2-2 (Attachment A). Limit Equilibrium (LE) analyses also allowed for identification of factors that influence slope stability during drawdown of the reservoirs.

The stability models evaluated existing conditions to identify the possible extent of instability during drawdown of the current ground surface as determined by topographic and bathymetric surveys, the assumed geological model, and an established piezometric low (assuming the minimum operating reservoir level represents drawdown conditions). These results provide a framework for judging the results of the drawdown analyses.

2.1.1 Geological Setting

The limits of work are predominantly contained in the Western and High Cascades volcanic regions of the Cascades Geologic Province. The Klamath River predates the formation of the Cascade Mountain Range and maintained a relatively similar course through the mountain-building events. The bedrock within the limits of work comprises volcanic rocks up to 45 million years old as well as basalt and andesite lava flows, tuffs, tuff-breccias, and volcaniclastic sandstone. The volcanic rocks are intruded by numerous dikes and plugs of andesite, rhyolite, and basalt. Many of the volcanoes associated with the Western Cascades have since eroded, but large shield volcanoes and vents of the High Cascades remain and are still active.

Large deposits of coarse alluvium were deposited along the Klamath River during the period of the last glaciation when the river had a higher discharge. Lacustrine deposits were laid down in former temporary lakes that were created at the present-day site of the Copco No. 1 Reservoir when the Klamath River was temporarily “dammed” by volcanic activity. Diatomite deposits surround much of the shoreline of Copco No. 1 Reservoir (PanGeo 2008, as cited in SWRCB 2020b). Diatomaceous deposits and associated fluvio-lacustrine terrace deposits along the rim and below the reservoir water level present the greatest potential for slope instability within the Proposed Action area during drawdown.

2.1.2 Copco No. 1 Reservoir Rim

Residential properties occur locally around the Copco No. 1 Reservoir rim, primarily in the southwestern and eastern sectors of the shoreline. Copco Road follows the north side and Ager Beswick Road follows the south side of the Copco No. 1 Reservoir.

Steep shoreline slopes of weak, white diatomite are a prominent feature along the western part of the rim of Copco No. 1 Reservoir. Shoreline slopes of diatomite are particularly prominent along the south shore of the western part of the reservoir. The presence of diatomaceous deposits and associated fluvio-lacustrine terrace deposits along the rim and below the reservoir water level present the greatest potential for slope instability during drawdown. The shoreline slopes show indications of active erosion undercut by wind-induced reservoir waves, two possible debris slides, a tension crack, slope retrogression, and slumped toe debris.

A natural terrain landslide was identified upslope of Copco No. 1 Reservoir, with the toe located beneath the reservoir shoreline. Past rock falls occur close to Copco No. 1 Reservoir, and two rockslides were identified on a cliff upslope from Ager Beswick Road. Terrain analysis identified three possible debris slides on the downslope side of Copco Road and a possible debris flood deposit within the reservoir (Knight Piésold 2020). Landslides were identified within the cut slopes along Copco Road and Ager Beswick Road, and a rock cut slope alongside Ager

Beswick Road shows evidence of recent rock falls and rockslides. Minor sheet and gully erosion were identified on the natural slopes and south side of the reservoir.

The Klamath River historically followed a meandering path in the western section of the reservoir footprint. Debris slides were identified on the steep slope on the outside of these former meander bends. These landslides occurred in terrace slopes that consist of alluvium and diatomaceous lacustrine deposits. These locations may be possible sites of terrain instability in the post-drawdown condition once the course of the Klamath River is reestablished. Possible relict rockslides were identified in submarine rock slopes close to the dam in the southern part of the reservoir. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

Reservoir drawdown is unlikely to adversely affect relict rockslides mapped on the steep slopes of the narrow canyon upstream of the reservoir. The absence of diatomite and presence of colluvium and weathered bedrock along this slope segment indicates there is a low likelihood that drawdown will adversely affect slope stability. Except for the southwest shoreline, which could be affected, other areas of potential slope instability at Copco No. 1 Reservoir are considered low risk.

2.1.3 Copco No. 2 Reservoir Rim

There are no residential properties adjacent to the Copco No. 2 Reservoir rim. The access roads to the Copco No. 1 powerhouse and Copco No. 2 Reservoir are located adjacent to the rim on the north side of the reservoir.

Two shallow debris slides were identified on a steep slope at the left bank of the rim of Copco No. 2 Reservoir. The columnar jointed basalt cliffs upslope of the reservoir have open sub-vertical discontinuities and are susceptible to toppling, causing rock falls. Talus slopes from past rock falls occur adjacent to the downstream portion of the reservoir. The terrain analysis also identified a debris slide on the cut slope along the access road to the Copco No. 1 powerhouse at a switch-back in the road alignment. The surficial geology at the site of this landslide comprises an unwelded pyroclastic deposit, which developed before 1991, and there appears to have been no significant change between 1991 and 2016.

Copco No. 2 Reservoir is relatively shallow, with valley side slopes intersecting the gently sloping terrain of the former riverbed. The submarine slopes are gently inclined, and no submarine landslides have been identified. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

2.1.4 Iron Gate Reservoir Rim

Copco Road follows the north side of Iron Gate Reservoir. No residential properties were identified adjacent to the rim of the Iron Gate Reservoir in the Reservoir Rim Stability Report (Knight Piésold 2020). One structure was subsequently identified adjacent to the eastern side of the reservoir rim. The terrain hazard analysis completed by Knight Piésold (2020) identified no slope hazards in the area of the structure. Additionally, the slopes below the structure are relatively gentle; therefore, this structure was not included in the stability analysis.

The Klamath River historically followed a meandering path in the footprint area of the reservoir. Over-steepened slope segments are present on the outside of meander bends and are potential sites of terrain instability in the post-drawdown condition once the course of the Klamath River is re-established. Submarine talus slopes have accumulated from rock falls locally around the reservoir rim, particularly in the east part of the south shore of the reservoir. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

At Iron Gate, there is a potential for local instability to affect Copco Road, particularly where possible historic landslides were identified between the road and the reservoir rim and where cracks were identified on the road pavement (Knight Piésold 2020). Previous slope instability was identified at the reservoir rim downslope from Copco Road; however, it was relatively small-scale and did not affect the road. It is likely that any slope instability in these areas caused by drawdown will be similarly small-scale and will not affect Copco Road. The terrain analysis identified previous slope instability in an area between the road and reservoir rim; however, it is unlikely that drawdown will reactivate slope instability in this location (Knight Piésold 2020).

3.0 Proposed Action Areas Potentially Prone to Instability

This section describes slopes and other Proposed Action areas of concern for slope stability.

3.1 Dam Embankments

Stability analyses were conducted for each of the facilities to evaluate the safety of the existing dams and whether dam modifications would result in an unacceptable structural response and risk (Knight Piésold 2022). The analyses focused on the Potential Failure Modes (PFMs) related to the main dam sections where dam modifications could cause adverse effects to the overall stability or structural response of the dams. Stability analyses indicated that during excavation of the low-level outlet and when there is no impoundment, Copco No. 1 Dam would not be unstable, and no monitoring will be undertaken. The Renewal Corporation will monitor the dam earthfill embankments for the following facilities using visual monitoring and other techniques including the use of unmanned aerial vehicles, as described in more detail in Section 4.0:

- Copco No. 2 Dam Embankment: upstream and downstream face and crest of the dam; and
- Iron Gate Dam Embankment: upstream and downstream face and crest of the dam.

3.2 Reservoir Rims

3.2.1 Copco No. 1 Reservoir Rim

For the Copco No. 1 reservoir rim, the LE stability analysis indicates the potential of slope instability impacts from the proposed reservoir drawdown near the southwest shoreline of the reservoir (Knight Piésold 2020). This finding is consistent with the Renewal Corporation study (2019). Specific areas of slope instability are identified below and are shown in Figure 2-1, Sheets 1-8 (Attachment A).

- segments S5, S11a, S12b, and S23 where private properties and residential dwellings are located.
- segments N2, N5, N7, N10, and N11 where potential slope instability impacts to roads were identified.
- segment S1 and the canyon portion of the reservoir rim immediately upstream of the dam where the valley floor is narrow, and instability could result in constricted flow.

3.2.2 Copco No. 2 Reservoir Rim

For the Copco No. 2 reservoir rim, terrain analysis indicates that although there are areas of potentially unstable terrain around the rim of the reservoir, any slope instability is expected to be relatively small due to the interpreted shallow depth of the bedrock and the fact that the colluvium generally comprises coarse talus (Knight Piésold 2020). There is also a potential for local instability of the colluvial slopes in the upstream area at the left bank where the colluvium is finer grained and the two recent debris slides were identified. Based on the low risk associated with the identified potential instability areas, drawdown of the reservoir is not expected to result in large-scale slope instability that could affect adjacent infrastructure or properties.

3.2.3 Iron Gate Reservoir Rim

The terrain analysis confirmed the presence of slope instability at the rim of the Iron Gate Reservoir, as previously identified in both the PanGeo (2008) and the Renewal Corporation (2019) reports. A debris slide was identified at a former meander bend of the Klamath River and a possible relict debris slide upstream of the meander bend. The terrain analysis also identified two recent debris slides in colluvium and/or weathered bedrock at the reservoir rim and two additional debris slides that occurred at the site of a former meander bend of the Klamath River. It is possible that undercutting at the former meander bend contributed to slope instability. The presence of over-steepened bare soil slopes, slumped debris, and inclined trees along the reservoir rim provide evidence of active erosion by wind-generated reservoir waves. Specific areas of potential instability are identified below and are shown in Figure 2-2, Sheets 1-8:

- locations I11, I12a, I12b, and I23 where possible landslides were identified between the road and the reservoir rim and cracks were identified on the road pavement.
- locations I1, I5, and I7 where previous slope instability was identified at the reservoir rim downslope of Copco Road.

- locations I17 and I19 where slope angles show the possibility of slope instability related to the drawdown and where instability could constrict flow due to the narrow valley floor.

3.3 Roads

Improvements to existing roads and development of new temporary access routes are required to support construction activities under the Proposed Action, both to improve access safety and to facilitate movement of construction equipment and traffic. Additional details regarding road improvements and maintenance are included in the Traffic Management Plans, located as appendices to the Construction Management Plan. The Renewal Corporation proposes additional monitoring of areas of potential slope instability, as discussed in Section 4.0.

3.4 Borrow and Disposal Areas

Borrow and disposal areas are required for construction of the Proposed Action. Borrow and disposal sites are designed with stable permanent slopes and suitable drainage requirements using best management practices (BMPs). The Renewal Corporation will place material in the disposal site in layers, track-walk the material, and grade it with a bulldozer to promote surface drainage. The Renewal Corporation will visually monitor slopes during construction and excavation and modify them as needed based on visual observations, as described in the Erosion and Sediment Control Plan and the California Waste Disposal Plan.

4.0 Slope Stability Monitoring

This section discusses monitoring and inspection procedures that the Renewal Corporation will implement to address slope stability concerns. Additional details related to drawdown procedures are included in the California Reservoir Drawdown and Diversion Plan.

4.1 Pre-Drawdown Phase

4.1.1 Property Owner Outreach

No less than six months prior to drawdown, the Renewal Corporation will contact the property owners of parcels in the areas identified in Section 3.2. The Renewal Corporation will send a letter to each property owner, which will include the following information:

- A brief overview of the Proposed Action.
- A schedule for drawdown and the anticipated effects of reservoir drawdown on slope stability.
- A proposal to provide a technical evaluation of the property.
- Contact information for the Renewal Corporation.
- A due date (three months following issuance of letter) for responses to have the participant’s property evaluated.
- Instructions on how and when to initiate communication with the Renewal Corporation to be eligible to receive assistance.

The letter will be printed in English, Spanish, and Hmong.

4.1.2 Dam Embankment Monitoring

In 2017, the Renewal Corporation and PacifiCorp entered into an Operations and Maintenance Agreement. Upon the Renewal Corporation's acceptance of License Transfer, PacifiCorp will continue to operate the Lower Klamath Project under the terms of the Operations and Maintenance Agreement. During the pre-drawdown phase of the Proposed Action, PacifiCorp will continue to monitor the dams and embankments consistent with the requirements of the Supporting Technical Information Document (STID; PacifiCorp 2007, 2015, 2016) for each applicable structure.

Daily and weekly inspections are performed by PacifiCorp Operations personnel as part of their normal duties and per license requirements, and annual inspections are performed by PacifiCorp Dam Safety Engineering staff with the assistance of PacifiCorp Operations personnel.

4.2 Active Drawdown and Dam Removal Phase

Drawdown of the primary reservoirs (i.e., Copco No. 1 and Iron Gate) will take place from January 1 through June 15, depending on the water year type, and drawdown of Copco No. 2 will take place by May 1 of the drawdown year (i.e., within approximately six months of drawdown initiation) or in the pre-drawdown year. The specific schedule for the drawdown and removal of each dam is further described in the California Reservoir Drawdown and Diversion Plan.

The Renewal Corporation will monitor slope stability of dam embankments and reservoir rims during the active drawdown and dam removal phase, and following storm events, for changes in ground conditions, changes in displacement of the ground surface, and changes in the reservoir level. The Renewal Corporation will conduct daily, weekly, and monthly monitoring during active drawdown and dam removal as described below.

4.2.1 Remote Sensing Technology

The Renewal Corporation will visually monitor daily displacements of the ground surface, including reservoir rims and embankments, during the drawdown period using unmanned aerial vehicle flights. This method will provide the greatest spatial coverage for daily evaluation of the response to reservoir drawdown. LiDAR data acquisition will be both airborne and ground-based at Copco No. 1 Reservoir. LiDAR data will be used to create digital elevation models of the reservoir rim and embankments that can be compared through time to identify slope instabilities. The Renewal Corporation will continue monthly monitoring of displacements of the ground surface for six months following the completion of drawdown. The Renewal Corporation will assess conditions after data acquisition and report to the Engineer of Record (EOR) any variations indicating potential displacement.

4.2.2 Visual Inspections

The Renewal Corporation will visually inspect dam embankments (upstream and downstream face and crest) daily for signs of slope instability. Visual inspection locations may be restricted due to safety concerns and challenges to gaining site access, and the Renewal Corporation will adjust these locations to achieve the best vantage point for inspection. The Renewal Corporation will initially use established site access for inspections when possible. If not possible, the Renewal Corporation will use remote monitoring (see Section 4.2.1). Due to safety concerns, some areas on private property may not be accessible for inspection.

4.2.3 Surveillance Monuments

The Renewal Corporation will use existing survey monuments at the dam embankments when accessible during the active drawdown phase until dam removal is complete. Additionally, the Renewal Corporation will establish overall site control through the installation of temporary control points in locations that will not be affected by dam removal activities. The Renewal Corporation will establish temporary monuments on the rock abutments on either side of the dam, as needed.

4.2.4 Other Monitoring

The Renewal Corporation will monitor the reservoirs by level sensors and stream gauges during drawdown. Once the reservoirs drop below their normal operating range, water level gauges will no longer be operational.

At Iron Gate Dam, the Renewal Corporation will continue to collect water level and turbidity readings at Manhole #3 at the toe of the dam during drawdown to monitor changes in seepage through the embankment. Turbidity in the water could indicate seepage erosion occurring through the core if it occurs when turbidity is otherwise low in the tailrace and low-level outlet. Operators will continue to take Secchi tube readings from the reservoir, powerhouse tailrace, and Manhole #3 during drawdown. The manhole will be removed as Iron Gate Dam is demolished.

The Renewal Corporation will perform daily checks of the dams, monitor water levels, and coordinate with the Bureau of Reclamation with respect to potential storm events. Downstream flows will be estimated to provide adequate response time to implement emergency procedures as detailed in the Emergency Response Plan for the Proposed Action (Kiewit 2020). Monitoring requirements for the United States Geological Survey Klamath River stream gauge are included in the California Water Quality Monitoring Plan.

4.3 Post-Drawdown Phase

In the post-drawdown phase, the dam embankments will have been removed so dam embankment monitoring will cease. Reservoir rim instability is limited to the drawdown phase, so daily monitoring of the reservoir rims will cease after drawdown is complete. Post-drawdown monitoring of residual reservoir sediment stability during restoration is addressed in Section 6.2.8 of the Reservoir Area Management Plan.

5.0 Slope Stability Measures

5.1.1 Erosion Protection

The Renewal Corporation will conduct the construction and removal work required for the Proposed Action in a manner that provides environmental protection and follows BMPs for erosion and sediment control, as outlined in the California Stormwater Pollution Prevention Plan. In general, the Renewal Corporation will restore areas disturbed by construction of the Proposed Action components to final lines and grades as soon as practical. The Renewal Corporation will install erosion protection at various locations throughout the limits of work (e.g., river channels, scour hole, volitional fish passage channels, Copco No. 1 diversion tunnel erosion protection plug). The hydraulics of the final channels were modeled to determine the design parameters for the required slope erosion protection and to determine the size and thickness of the erosion protection, as specified in the Design Report (Knight Piésold 2022).

5.1.2 Proposed Measures to Address Instability

If instability issues are confirmed in the areas listed in Section 3.0, the Renewal Corporation will implement the following measures:

- slope monitoring,
- structural slope stability measures, and/or
- local rerouting of Copco Road if the existing road is impacted by slope instability.

As discussed, the Renewal Corporation plans to conduct drone and LiDAR surveys of the reservoir rims during the pre-drawdown period. The primary area of concern is within the Copco No. 1 reservoir where specific geologic conditions and residential property development poses the greatest potential impact for property damage. Several areas within the Iron Gate reservoir were also identified as potential impact areas, though less significant in both probability and impact. Copco No. 2 is not expected to experience slope stability issues. If an area is identified through the Renewal Corporations monitoring measures, additional slope monitoring will be implemented including installation of site-specific monitoring equipment such as surveillance benchmarks, piezometers, and daily site inspections by the Renewal Corporation geotechnical engineering team. The slope monitoring efforts will be designed to provide a clear indication of the severity of the instability including physical extent of the area impacted, degree of instability, the mechanism driving the instability, and potential for significant failures. From these site-specific measures, structural slope stability measures will be evaluated. For all site-specific slope monitoring, access approval by the local landowner will be required to access and conduct the proposed monitoring.

In areas identified with significant slope stability issues where slope failure is imminent, or has occurred with continuing slope movement, the Renewal Corporation geotechnical engineering team will assess the instability area and develop a site-specific plan. Depending on the severity of the instability, the proposed measures could include removal of existing slide material and rerouting drainage paths, installation of toe trains, soils anchors, benching and regarding the embankment section, and/or installation of a buttress wall at the base of the slide. Buttress walls have been used extensively using a variety of design and construction methods including rock toes, retaining walls, sheet pile walls, and natural vegetative stability methods. As noted, the geotechnical team will evaluate the site and determine the optimum approach for structural modifications. It should be noted, that in locations where access is not available, or the major instability has already reached its maximum extent, the recommended action may be to do nothing or a simple cleanup of material.

One area of Copco Road within the Copco No. 1 reservoir was identified as a potential slope instability area. For this specific site, if a significant instability is identified, the Renewal Corporation plans to relocate the existing road. In this case, the Renewal Corporation will move the road away from the reservoir rim crest into more stable material. If instability is identified, the Renewal Corporation geotechnical engineers will conduct a field assessment of the impacted road area, determine the extent of the instability, the provide recommendations for the road re-alignment that will provide a long term, stable road section. The extent of re-alignment will be determined along with the impact to local landowners prior to initiating the final design and construction. The Renewal Corporation contractor will construct the new road section.

5.1.3 Local Impact Mitigation Fund

To address potential impacts to private properties related to slope instabilities during and after reservoir drawdown, the Renewal Corporation will implement the measures stated in this plan. The Renewal Corporation will establish a baseline assessment of slope condition and will monitor changes during and after drawdown. The Renewal Corporation will establish a Local Impact Mitigation Fund (LIMF). For property owners electing to opt into the fund, the LIMF will provide financial resources to such property owners to address the cost of moving or repairing structures damaged by the Proposed Action. The fund will be backstopped by insurance.

The LIMF will include procedures and standards for determining the nature and scope of any impacts, as well as stipulated payments to property owners. Developing this methodology will involve proactive participation and input from key stakeholders. The methodology will be made available for public comment, before being finalized.

Under the LIMF, the Renewal Corporation will not accept responsibility for pre-existing conditions not caused by the Proposed Action. The fund administrator will be supported by a technical team and will ultimately have the discretion to determine the legitimacy of covered claims. Any affected property owners who elect not to participate in the LIMF may, instead, pursue any other remedies available to such property owners under applicable state law.

6.0 Emergency Response

PFMs identified in the STIDs (PacifiCorp 2007, 2015, 2016) have been used to guide previous stability evaluations and are briefly discussed in the California Reservoir Drawdown and Diversion Plan. The dams covered under STIDs will continue their current operations until water levels drop below normal operating elevations during drawdown. PFMs were reevaluated as part of a Construction Potential Failure Mode Analysis (cPFMA) workshop that specifically addressed reservoir drawdown and dam removal (Kleinschmidt 2021). Details concerning the cPFMA workshop are provided in the California Reservoir Drawdown and Diversion Plan.

7.0 Equipment Maintenance Program

This section describes equipment maintenance measures, types of maintenance requirements, and the schedule for and/or frequency of maintenance activities. The Renewal Corporation will monitor equipment to ensure that the desired condition is maintained.

7.1 Survey Monuments

Per the STID for the Iron Gate Hydroelectric Development (PacifiCorp 2015), survey monuments were designed to be permanent. The survey monuments are protected by weatherproof covers and, therefore, require little maintenance. During dam removal activities, the Renewal Corporation will protect survey monuments from movement or damage from vehicles or other equipment traversing the crests. The “permanent” survey monuments will be removed along with the dam embankment, and temporary monuments installed for monitoring dam removal will be also removed once the embankment excavation reaches the monuments.

7.2 Remote Sensing Technology

The Renewal Corporation will establish specific maintenance procedures for remote sensing equipment based on the specific technology.

7.3 Other Instrumentation

Continuous measurements of reservoir levels are made using level sensors. The reservoirs also have a fixed gauge, allowing a comparison of the water levels measured by the level sensors with the levels indicated on the gauges. In the pre-drawdown phase and early in the drawdown phase, these comparisons will be made daily by PacifiCorp operators. Any significant difference in water level readings between these two measurements will initiate work to repair or recalibrate the instruments. Once powerhouse operations cease, the PacifiCorp level sensors will no longer function, and the Renewal Corporation will install and maintain new level sensors to monitor water levels during drawdown and dam removal.

8.0 Reporting

The Renewal Corporation will provide monthly and annual reporting concerning inspections and monitoring conducted during the pre-drawdown phase, active drawdown and dam removal phase, and restoration phase, as described below.

8.1 Monthly Reporting

During the rainy season (October 16 to May 14), beginning before the start of drawdown and ending during reservoir drawdown, the Renewal Corporation will submit monthly reports to the

SWRCB identifying any areas that have experienced slope instability, any actions taken to control and improve slope stability, and an assessment of the success of initial and any ongoing slope stability actions implemented. Monthly reports to the SWRCB will also be submitted during the first rainy season following drawdown.

8.2 Annual Reporting

The Renewal Corporation will provide an annual report describing the results of slope stability monitoring of the dam embankments and reservoir rims to the SWRCB and the Commission by April 1 and 15, respectively, for the preceding year. The annual report will also include a summary of any measures taken to address slope instabilities, including, but not limited to, physical stabilization measures, rerouting of Copco Road, or relocation of residents.

9.0 Management Plan Updates

If additional risk areas are encountered, the Renewal Corporation will revise the monitoring procedures. The Renewal Corporation will document the risk areas and associated amendments to the Management Plan and will submit all changes to the Commission and to the SWRCB.

10.0 References

California State Water Resources Control Board (SWRCB). 2020a. Final Water Quality Certification for Klamath River Renewal Corporation: Lower Klamath Project License Surrender. Federal Energy Regulatory Commission Project No. 14803, Siskiyou County, California. April.

California State Water Resources Control Board (SWRCB). 2020b. Final Environmental Impact Report for the Lower Klamath Project License Surrender. Prepared by Stillwater Sciences, Berkeley, California, for the State Water Resources, Control Board, Sacramento, California.

Kiewit Infrastructure West Co. (Kiewit). 2020. Emergency Response Plan. Prepared for Klamath River Renewal Corporation.

Kleinschmidt. 2021. Construction Potential Failure Mode Analysis Report: Klamath River Renewal Project, FERC No. 14803. Prepared for Klamath River Renewal Project. June.

Knight Piésold. 2020. Reservoir Rim Stability Report. Prepared for Klamath River Renewal Project. February.

Knight Piésold. 2022. Design Report. Prepared for Klamath River Renewal Project. June.

PacifiCorp. 2007. Copco 2 Hydro Plant Klamath River Supporting Technical Information Documents. Revised September 28.

PacifiCorp. 2015. Klamath Hydroelectric Project, FERC No. P-2082: Iron Gate Hydroelectric Development, Supporting Technical Information Document. April 30.

PacifiCorp. 2016. Copco 1 Development, Klamath River Project, Supporting Technical Information Document (STID). Updated October 1.

PanGEO. 2008. Geotechnical Report: Klamath River Dam Removal Project, California and Oregon. Project No. 07-153. Prepared for Philip Williams & Associates, Ltd., and California State Coastal Conservancy. August.

Renewal Corporation. 2019. Geotechnical Data Report. Prepared by Renewal Corporation Technical Representatives: AECOM Technical Services, Inc., and CDM Smith. June.

Attachment A

Figures

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX A: FIGURES

Appendix C

Oregon Reservoir Drawdown and Diversion Plan

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project
FERC Project No. 14803

Oregon Reservoir Drawdown and Diversion Plan

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December 2022

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1.0 Introduction

This Oregon Reservoir Drawdown and Diversion Plan is a subplan of the Reservoir Drawdown and Diversion Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project.

1.1 Purpose of the Oregon Reservoir Drawdown and Diversion Plan

The purpose of the Oregon Reservoir Drawdown and Diversion Plan is to describe the proposed drawdown methods, procedures, schedules, and monitoring measures that the Renewal Corporation will implement on Oregon as part of the Proposed Action.

The Renewal Corporation and PacifiCorp have entered into an Operations and Maintenance Agreement (2017) filed with the Commission. Under the agreement, PacifiCorp will continue to operate the hydroelectric facilities until final drawdown is initiated after the spring freshet when the reservoir levels drop below the power intakes. At that point, the Renewal Corporation will use the low-level outlets at each dam to release water to completely lower the reservoirs.

1.2 Relationship to Other Management Plans

The Oregon Reservoir Drawdown and Diversion Plan is supported by elements of the following management plans for effective implementation: Erosion and Sediment Control Plan, Remaining Facilities Plan, Waste Disposal and Hazardous Materials Management Plan, Health and Safety Plan, and the Reservoir Area Management Plan. So as not to duplicate information, elements from these other management plans are not repeated herein but are, where appropriate, referenced in this Oregon Reservoir Drawdown and Diversion Plan.

1.3 Elevation Datum

All elevations reported within this plan use the North American Vertical Datum of 1988 (NAVD88), which, at the J.C. Boyle location, is 3.71 ft higher than the National Geodetic Vertical Datum of 1929 (NGVD29).

2.0 Drawdown and Diversion Plan

2.1 Drawdown Criteria

Pertinent drawdown criteria for the Proposed Action are summarized in Table 2.1, below, which includes information from the Design Report (Knight Piésold 2022).

Table 2.1. Reservoir Drawdown Design Criteria

FEATURE/CONSIDERATION	CRITERIA	REMARKS	REFERENCE
OPERATING REQUIREMENTS			
Daily Minimum Downstream Flows	Downstream of Iron Gate: • September through November and March - 1,000 cfs • December through February - 950 cfs • April - 1,325 cfs • May - 1,175 cfs • June - 1,025 cfs • July and August - 900 cfs	• Minimum flows will be dictated by USBR requirements which may supersede the biological opinion flows as set out. Minimum flows only applicable up to completion of drawdown. • Operations Flow Parameters meetings are being held to further define the minimum flows in the J.C. Boyle bypass reach and the peaking reach along with the required ramp rates.	• USBR, BiOp 2019
Normal Maximum Operating Surface Elevation (ft NAVD88)	• J.C. Boyle = 3,796.7 ft		FERC License Application - Exhibit A (2004) - NAVD88 Elevations
Normal Minimum Operating Surface Elevation (ft NAVD88)	• J.C. Boyle = 3,791.7 ft		
PRE-DRAWDOWN			
Pre-Drawdown Construction Activities (Downstream of Reservoirs)	• Construction and commissioning to occur prior to January 1 of the drawdown year.		
	• All reservoirs to be operated at or below minimum operating water levels during early works construction; minimum operating water levels are specific to each facility	• Water levels to be defined through consultation with PacifiCorp.	• PacifiCorp STID Section 4 Standard Operations Procedures (PacifiCorp 2015)

FEATURE/CONSIDERATION	CRITERIA	REMARKS	REFERENCE
Pre-Drawdown Flow Regulation	• Regulate project operation flows to keep reservoir levels at or below minimum operating levels to maintain construction safety • The reservoir lowering will begin prior to construction and will be accomplished through project power and water bypass operations on a site-specific basis	• Required for construction staging and work safety.	• PacifiCorp STID Section 4 Standard Operations Procedures (PacifiCorp 2015)
DRAWDOWN			
Initial Drawdown	• To begin on or about January 1 of the drawdown year		
Reservoir Drawdown Rate	• Target drawdown water surface level rate 5 ft/day	• Each facility is unique relative to reservoir area capacity and proposed drawdown. Actual drawdown will be based on the actual water year.	
Drawdown Completion	• Water surface level at or below historic cofferdam level.		• Knight Piésold Memo VA20-01231 - Klamath Drawdown Model
GEOTECHNICAL REQUIREMENTS			
Slope Stability of Reservoir Rim			
Minimum Required FOS	• Drawdown FOS = 1.2	• Reservoir Drawdown criterion applies to existing dam, rim, and embankment slopes.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003
	• Long-term, Post Drawdown FOS = 1.5		• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003

FEATURE/CONSIDERATION	CRITERIA	REMARKS	REFERENCE
Design Earthquake for Temporary Construction	• 10% Probability of Exceeding Operating Basis Earthquake in 50 Years (1/475-Year Event); 0.2% Probability in 1 Year • 2% Probability of Exceeding Maximum Design Earthquake in 50 Years (1/2,475- Year Event); 0.04% Probability in 1 Year		• Appendix A4 of the Design Report
Slope Stability of Temporary Embankment Slopes			
Reservoir Drawdown	• FOS = 1.3	• Reservoir Drawdown criterion applies to temporary embankment slopes during removal.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003

Notes:

BiOp = Biological Opinion
CFS = Cubic feet per second
EM = Engineer Manual
FERC = Federal Energy Regulatory Commission
FOS = Factor of Safety
NAVD88 = North American Vertical Datum of 1988
STID = Supporting Technical Information Document
USBR = United States Bureau of Reclamation
USACE = United States Army Corps of Engineers

2.1.1 Discharge Volumes and Rates

2.1.1.1 J.C. Boyle Facility

Discharges during the drawdown stages will be made through the existing outlets at the intake structure: three spillway bays, the power intake, and the two diversion culverts. The Renewal Corporation will not alter the existing outlets except for the removal of the concrete stop logs upstream of the two diversion culverts. Development of discharge rating capacities for the outlets are outlined in Appendix B of the Design Report (Knight Piésold 2022) and are summarized below. The discharge rating curves for J.C. Boyle are also presented in Appendix B (drawing C1056). Discharge capacities of J.C. Boyle Dam components are presented in Table 2.2, below.

Table 2.2. J.C. Boyle Total Discharge Capacity and Drawdown Operations Plan

RESERVOIR WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)					
	SPILLWAY ONLY (CFS)	POWER INTAKE ONLY (CFS)	ONE CULVERT - NO POWER (CFS)	ONE CULVERT - WITH POWER (CFS)	TWO CULVERTS (CFS)	TWO CULVERTS PLUS SPILLWAY (CFS)
3,801.7	30,402	2,850	3,786	6,636	7,572	37,974
3,800.7	27,680	2,850	3,740	6,590	7,480	35,160
3,799.7	25,045	2,850	3,694	6,544	7,388	32,433
3,798.7	22,500	2,850	3,647	6,497	7,294	29,794
3,797.2	20,046	2,850	3,599	6,449	7,198	27,244
3,796.7	17,690	2,850	3,550	6,400	7,100	24,790
3,795.7	15,433	2,850	3,501	6,351	7,002	22,435
3,794.7	13,282	2,850	3,451	6,301	6,902	20,184
3,793.7	11,241	2,850	2,915	5,765	5,830	17,071
3,791.7	9,265	2,850	2,868	5,718	5,736	15,001
3,791.7	7,433	2,850	2,820	5,670	5,640	13,073
3,790.7	5,752	2,850	2,772	5,622	5,544	11,296
3,789.7	4,233	2,850	2,723	5,573	5,446	9,679
3,788.7	2,887	2,805	2,674	5,479	5,348	8,235
3,787.7	1,733	2,531	2,623	5,154	5,246	6,979
3,786.7	801	2,269	2,572	4,841	5,144	5,945
3,785.7	153	2,020	2,520	4,540	5,040	5,193
3,785.2	–	1,784	2,494	4,278	4,988	4,988
3,784.7	–	1,561	2,467	4,028	4,934	4,934
3,783.7	–	1,351	2,414	3,765	4,828	4,828

RESERVOIR WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)					
	SPILLWAY ONLY (CFS)	POWER INTAKE ONLY (CFS)	ONE CULVERT - NO POWER (CFS)	ONE CULVERT - WITH POWER (CFS)	TWO CULVERTS (CFS)	TWO CULVERTS PLUS SPILLWAY (CFS)
3,782.7	–	1,155	2,359	3,514	4,718	4,718
3,781.7	–	973	2,303	3,276	4,606	4,606
3,780.7	–	805	2,240	3,045	4,480	4,480
3,779.7	–	651	2,187	2,838	4,374	4,374
3,778.7	–	512	2,128	2,640	4,256	4,256
3,777.7	–	388	2,066	2,454	4,132	4,132
3,776.7	–	279	2,003	2,282	4,006	4,006
3,775.7	–	187	1,939	2,126	3,878	3,878
3,774.7	–	111	1,872	1,983	3,744	3,744
3,773.7	–	54	1,803	1,857	3,606	3,606
3,772.7	–	15	1,731	1,746	3,462	3,462
3,771.7	–	–	1,657	1,657	3,314	3,314
3,770.7	–	–	1,578	1,578	3,156	3,156
3,769.7	–	–	1,496	1,496	2,992	2,992
3,768.7	–	–	1,409	1,409	2,818	2,818
3,767.7	–	–	1,316	1,316	2,632	2,632
3,766.7	–	–	1,135	1,135	2,270	2,270
3,765.7	–	–	1,098	1,098	2,196	2,196
3,764.7	–	–	868	868	1,736	1,736
3,763.7	–	–	735	735	1,470	1,470
3,762.7	–	–	609	609	1,218	1,218
3,761.7	–	–	491	491	982	982
3,760.7	–	–	382	382	764	764
3,760.2	–	–	331	331	662	662
3,760.0	–	–	312	312	624	624
3,759.7	–	–	283	283	566	566
3,758.7	–	–	194	194	388	388
3,757.7	–	–	117	117	234	234
3,756.7	–	–	54	54	108	108
3,755.7	–	–	10	10	20	20

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix B2 of the Design Report (Knight Piésold 2022).

2.2 Drawdown and Diversion Procedures

The Renewal Corporation will initiate the release of sediment to the Klamath River from the three larger reservoirs (J.C. Boyle, Copco No. 1, and Iron Gate) with reservoir drawdown. Initial reservoir releases will be accomplished with the facilities' existing structures to bring the reservoirs at or near their minimum allowable operating levels, which will occur prior to January 1st. Starting January 1st, Stage 1 of 4 stages will commence, allowing for regulated releases to draw down the reservoirs and release associated sediment in a controlled manner. Drawdown will continue until removal of the dams. The following reservoir drawdown and diversion approach described in this section is from the Design Report (Knight Piésold 2022). Drawdown and diversion procedures for Copco No. 1, Copco No. 2, and Iron Gate Developments is detailed in the California Reservoir Drawdown and Diversion Plan.

2.2.1 Existing Facility Components

The J.C. Boyle Development construction is well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report (Knight Piésold 2022). The Supporting Technical Information Document (STID) is provided in Appendix J of the Design Report.

2.2.2 Pre-Drawdown Works

The Renewal Corporation will utilize existing facility features to assist with pre-drawdown and drawdown at the J.C. Boyle Development. The Renewal Corporation will use two existing diversion culverts under the current spillway to facilitate reservoir drawdown and flow passage during dam removal. The historic cofferdam and earthfill dam embankment divert water into the diversion culverts. No new cofferdams will be installed.

The dam site is accessible without additional access improvements. The Renewal Corporation can commence site preparation, equipment mobilization, and construction access improvements to other parts of the facility after drawdown is complete.

The J.C. Boyle Reservoir operation during the pre-drawdown period will follow the PacifiCorp STID operating levels (PacifiCorp 2015). The reservoir operation elevations are defined as follows:

- Normal maximum reservoir operation level: 3,796.7 ft
- Normal minimum reservoir operation level: 3,791.7 ft

2.2.3 Reservoir Operation

The Renewal Corporation will lower the reservoir and maintain it at a targeted level just below the spillway crest by using normal power operations or controlled spillway releases prior to the commencement of drawdown (January 1 of the drawdown year).

2.2.4 Drawdown Works

The Renewal Corporation will commence drawdown operation at J.C. Boyle on or about January 1 of the drawdown year. No special provisions for pre-drawdown are needed for J.C. Boyle; however, PacifiCorp will lower the reservoir to the normal minimum operating level prior to January 1 using normal power operations or controlled spillway releases, as inflows allow. The proposed drawdown occurs in four stages; the first utilizes the spillway gates, the second utilizes the power facilities, and the third and fourth utilize a sequenced removal of the diversion culvert stoplogs (shown on drawing C1050 in Appendix B).

The Renewal Corporation will maintain a reservoir water surface level of 3,783.2 ft (NAVD88; 2 ft below the spillway crest) to initiate both Stage 3 and Stage 4. This level allows workers to access the downstream side of the diversion culverts safely. River forecasting and coordination with the United States Bureau of Reclamation (USBR), operator of Link River Dam and Upper Klamath Lake, is required so the reservoir water level will remain below the spillway crest while crews are actively working on the downstream side of the diversion culverts. The maximum rate of drawdown varies from stage to stage due to inflow, the geometry of the reservoir, and the nature of the outflow (free-flowing) through the diversion culverts.

The design analysis completed to support the Design Report (Knight Piésold 2022) compared steady-state inflows to culvert rating curves to determine the maximum flow allowable for crews to access the downstream side of the diversion culverts safely. These are presented in the Stage 2 and Stage 3 drawdown sections below. The United States Bureau of Reclamation (USBR) controls Link River Dam releases, which therefore has the capacity to regulate flows into JC Boyle. For safety of working crews, during Stage 2 and Stage 3, flow coordination with the USBR will be finalized when climatic information is available and flow forecasts are prepared by the USBR to keep J.C. Boyle Reservoir below the spillway crest.

Steady state water surface elevations are provided on drawing C1055 in Appendix B.

2.2.4.1 Stage 1 Drawdown

The Renewal Corporation will direct PacifiCorp to commence Stage 1 drawdown no earlier than January 1 of the drawdown year, with the reservoir at or above the minimum operating elevation of 3,791.7 ft. This stage of drawdown will be achieved by using the gated spillway bays and/or power intake to lower reservoir levels at a target rate of 5 ft per day, controlling the rate by varying spillway openings according to actual reservoir inflow rates.

The Renewal Corporation will direct PacifiCorp to undertake Stage 1 drawdown within 48 to 72 hours of commencement, when the water level in the reservoir has stabilized above the spillway crest (spillway crest El. 3,785.2 ft). The stabilized elevation marking completion of Stage 1 may depend on the reservoir inflows at the time of drawdown.

2.2.4.2 Stage 2 Drawdown

The Renewal Corporation may direct PacifiCorp to initiate Stage 2 drawdown by continued power operations once Stage 1 is completed, and with the use of the spillways during wet year inflows. With power operations, outflow rates will initially increase and then quickly subside as water levels recede (ranging up to 2,850 cfs). The diversion culverts may remain closed during Stage 2.

Stage 2 drawdown will be complete when the water level in the reservoir has stabilized at least 2 ft below the spillway crest (spillway crest El. 3,785.2 ft). The stabilized elevation marking completion of Stage 2 may depend on the reservoir inflows at the time of drawdown. A reservoir water level which is 2 ft below the spillway crest is associated with a reservoir inflow of 1,260 cfs and may require river forecasting and coordination with the USBR, operator of Link River Dam and Upper Klamath Lake, to achieve this flow release.

2.2.4.3 Stage 3 Drawdown

The Renewal Corporation will initiate Stage 3 drawdown once Stage 2 is completed by removing one of the diversion culvert concrete stoplogs. The Renewal Corporation will remove the diversion culvert #1 stoplog by controlled blasting. The explosives required to remove the culvert stoplog and initiate Stage 3 can only be set when there is no flow coming over the spillway. Diversion culvert #1 is located below the gated spillways and provides a 9.5 ft by 10 ft opening with an invert elevation of 3,755.2 ft. With diversion culvert #1 opened, outflow rates will initially increase and then subside as reservoir water levels recede (ranging up to 3,786 cfs). The Renewal Corporation will close the power intake wheel gate simultaneously with (or immediately prior to) the removal of the diversion culvert #1 stoplog. Once the power intake is closed, it will remain closed for the duration of the drawdown period.

The J.C. Boyle reservoir is narrow and does not have a large storage capacity below the spillway crest elevation. As a result, the culvert outflow rate will quickly equalize with the reservoir inflow rates over a 48- to 72-hour period. The maximum anticipated drawdown rate for Stage 3 is 10 ft per day. The stabilized elevation marking completion of Stage 3 will depend on the reservoir inflows at the time of drawdown. Similar to Stage 2, a reservoir water level that is 2 ft below the spillway crest is required for access to the downstream side of diversion culvert #2 to prepare for Stage 4. While water is flowing from diversion culvert #1, the Renewal Corporation will cut an access hole in the roof of diversion culvert #2 to gain access to the diversion culvert #2 stoplog. This process will allow the Renewal Corporation to conduct diversion culvert #2 concrete stoplog demolition work in the dry (i.e., isolated from diversion culvert #1 outflows to the greatest extent possible). This reservoir elevation is associated with a reservoir inflow of about 2,120 cfs and may require river forecasting and coordination with the USBR, operator of Link River Dam and Upper Klamath Lake, to achieve this flow release.

2.2.4.4 Stage 4 Drawdown

The Renewal Corporation will initiate Stage 4 drawdown on or about June 10 of the drawdown year by removing the diversion culvert #2 concrete stoplog. The exact timing of the removal of the stoplog for Stage 4 may be adjusted to best accommodate the inflow rates and water levels at the time.

The Renewal Corporation will remove the diversion culvert #2 stoplog by controlled blasting, if required. Diversion culvert #2 is located below the gated spillways and provides a 9.5 ft by 10 ft opening with an invert elevation of 3,755.2 ft. The outflow rate will initially increase and then equalize with the reservoir inflow rates over approximately 12 to 24 hours, as the reservoir water level drops (ranging up to 7,572 cfs). The maximum anticipated drawdown rate for Stage 4 is 10 ft per day. Completion of the Stage 4 drawdown may provide the lowest possible drawdown of the reservoir based on reservoir inflow.

The drawdown will be complete when both diversion culverts are operating, the J.C. Boyle reservoir has been substantially dewatered, and reservoir inflows and outflows equalize (water levels are relatively stable). The diversion culverts will remain open and will pass all river flows until the historic cofferdam breach is conducted.

2.3 Flood Frequency and Hydrological Evaluation

This Section 2.3 of the Oregon Reservoir Drawdown and Diversion Plan is informational and discusses the results of the drawdown model and implications to the Proposed Action. This section does not contain specific measures to be implemented by the Renewal Corporation as part of the Proposed Action.

Operation of the J.C. Boyle reservoir during drawdown and post-drawdown will lower the reservoir impoundment and provide the required flood control. The Renewal Corporation will complete the reservoir drawdown sequencing over four stages as described in the previous section and as outlined in detail in the Design Report (Knight Piésold 2022) and on drawing C1050 in Appendix B. The drawdown model was developed to assess the drawdown sequencing in terms of reservoir water surface levels under a range of hydrologic conditions.

2.3.1 Reservoir Conditions During Drawdown

Hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle Reservoir and drawdown regulation and outflows through the J.C. Boyle Dam are included in Appendix G of the Design Report (Knight Piésold 2022). Appendix G of the Design Report (Knight Piésold 2022) also shows the hydrologic simulations of the reservoir drawdown inflows into the Copco No.1, Copco No. 2, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

Reservoir water surface levels were simulated in the drawdown model for the full record of inflows available for the 2019 Biological Opinion (2019 BiOp [NMFS 2019]) dataset. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the J.C. Boyle Simulated Drawdown. These plots indicate the following:
  - Reservoir water surface levels.
  - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway, power intake, and flows through the diversion culverts).
- Maximum daily reservoir water surface level daily non-exceedance percentiles (percentiles) are shown on Figure 2.1, and on drawing C1056 in Appendix B. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the results on any given day of the simulations. These results do not represent a simple simulation and are based on all the model simulations.
- Ensemble figures, Figure 2.2, with each line representing a single model simulation for a different year. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

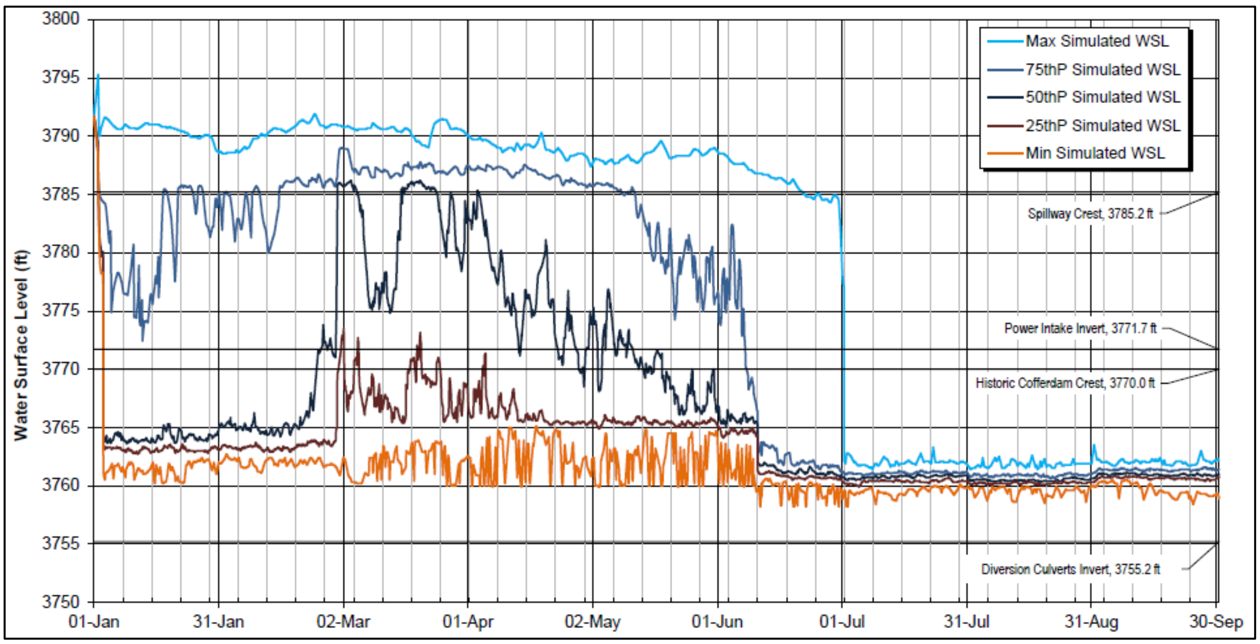

Figure 2.1. J.C. Boyle Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

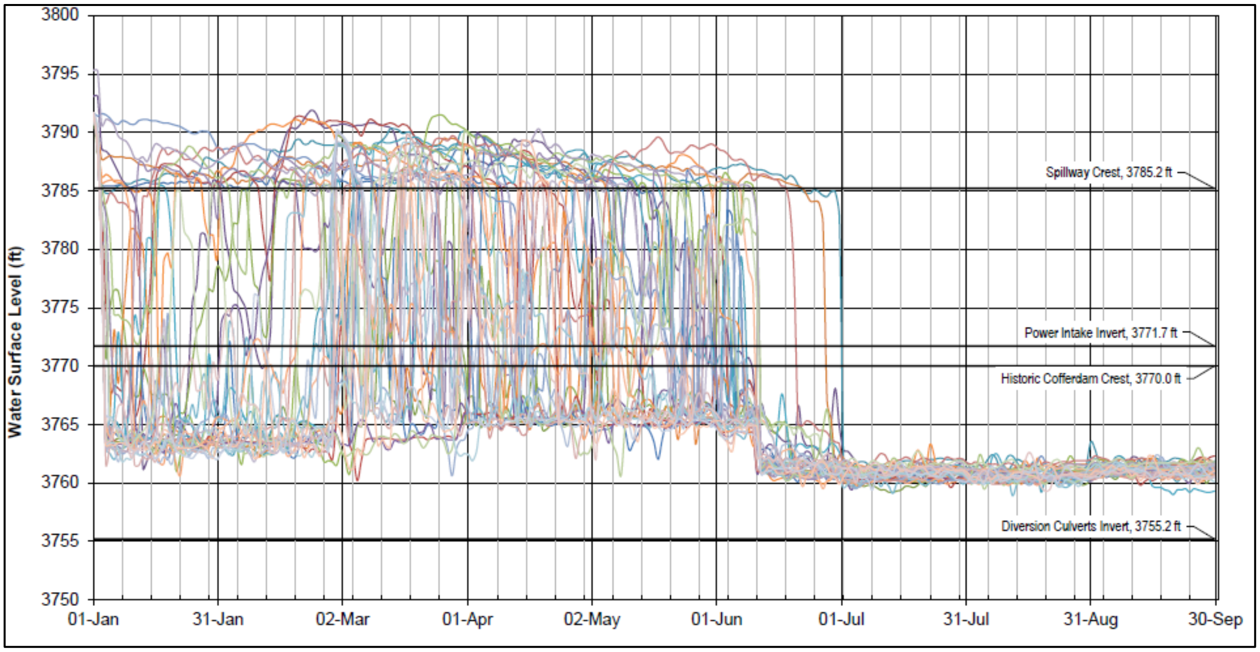

Figure 2.2. J.C. Boyle Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2.1 and Figure 2.2 show that there is a substantial reduction in the reservoir water levels in mid-June with the majority of the simulated years achieving sustained water levels below the historical cofferdam crest in early June. This is a function of initiating Stage 4 of drawdown on June 10 and the inflow hydrology, which indicates a reduction in streamflow for the second half of June (Appendix A6 of the Design Report [Knight Piésold 2022]). There are three model years (1983, 1984, and 1998) that show elevated reservoir water surface levels past June 15. However, in these years, the reservoir water surface levels do drop below the crest of the historic cofferdam prior to July 1.

Figure 2.2 shows that there are large fluctuations in the reservoir water surface levels from January through June as a function of the inflow hydrology into the J.C. Boyle reservoir. The J.C. Boyle reservoir has a small storage capacity, and the reservoir can refill quickly during the higher flow months, typically in January through May, resulting in spillway flows. Lower reservoir levels will be sustained below the crest of the historic cofferdam after June 1 depending on the hydrologic conditions and throughout Stage 4.

Figure 2.3 shows the cumulative percent of model simulations and the date when the reservoir water surface level is lower, and sustained, below the crest of the historic cofferdam. The drawdown model indicates that approximately 50% of the simulations have reservoir water levels sustained below the crest of the historic cofferdam by June 1, with 100% of the simulations by July 1. Note that these water levels are for average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

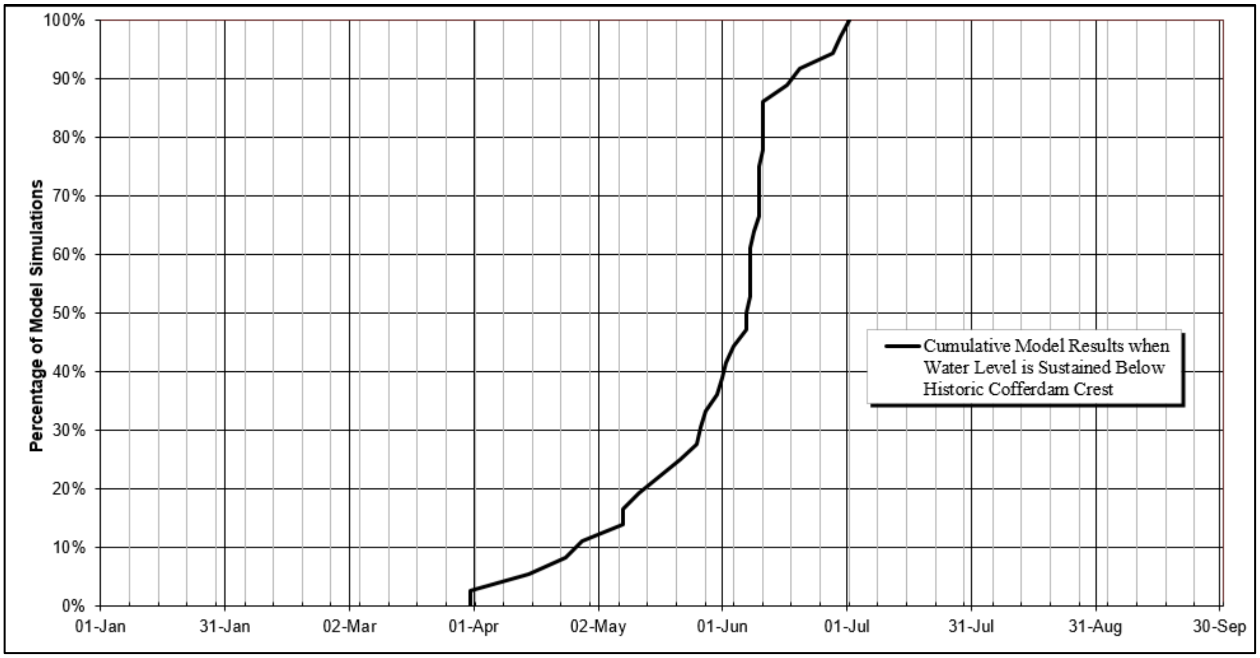

Figure 2.3. J.C. Boyle Reservoir Drawdown Cumulative Model Simulation Dates to Achieve and Sustain Reservoir Water Surface Levels below the Crest of the Historic Cofferdam

The results of the reservoir drawdown model are outlined below for each stage of drawdown.

- Stage 1 - Spillway Gates:
    - The spillway gates and/or power intake are used to target a drawdown of 5 ft/day, and drawdown occurs over one day.
- Stage 2 - Power Intake is Opened:
    - The reservoir water levels are controlled by the discharge capacity of the power intake and are dependent on the reservoir inflows.
    - Outflows through the power intake are limited to 2,850 cfs. The total outflow can be higher if the spillway is still engaged.
    - The reservoir can lower up to 5 ft when the power intake is initially opened in drier climatic conditions, as seen in the simulated results for 1990 and 2015.
    - The drop in reservoir water surface levels is not as large in wetter climatic conditions, and may be maintained above the spillway crest, as seen in simulated results for 1984 and 1997.
    - The duration of Stage 2 is determined by the hydrologic conditions and when the downstream diversion culverts can be accessed to remove the stoplogs successfully. Approximately 75% of the simulations indicate that the duration of Stage 2 is limited to less than a week under the simulated drawdown methodology. Years with much higher-than-average inflows (wet years) indicate that Stage 2 can be sustained for many weeks and beyond April 1. This is observed in less than 15% of the simulated years (1983, 1984, 1985, 1997, and 2006). In approximately 10% of simulations, Stage 2 was limited to 2 weeks (1982, 1996, 1998, and 2002).

  - River forecasting and coordination with the upstream refilling of Upper Klamath Lake may be used to limit the duration of Stage 2. Reduced inflows to the reservoir will result in lower reservoir water levels, therefore, allowing for safe access to the downstream end of the diversion culverts. The steady-state inflow to the reservoir to maintain a water level 2 ft below the spillway crest with the power intake is 1,250 cfs for Stage 2. Alterations to the flow releases from refilling of Upper Klamath Lake outside of the 2019 BiOp flows were not simulated with the drawdown model.
- Stage 3 – Diversion Culvert #1 is Opened:
  - A temporary drop in reservoir water surface level and an increase in outflow is observed when the diversion culvert is opened. The reservoir water surface levels can drop below 3,765 ft under most hydrologic conditions when the diversion culvert is opened. Wetter hydrologic conditions will result in a lesser drop in the reservoir level (e.g., 1998 drops to approximately 3,770 ft as there is an increase in reservoir inflows shortly after removing the diversion culvert stoplogs).
  - After removal of the diversion culvert #1 concrete stoplog, the power tunnel intake will be permanently closed.
  - Outflows through the diversion culvert are limited to approximately 2,400 cfs prior to the spillway being engaged. Total outflows in Stage 3 can be higher if the spillway is still engaged.
  - The reservoir water surface level is likely to increase periodically after opening Diversion Culvert #1. Nearly 90% of the model simulations indicate that the spillway will be reengaged during Stage 3.
  - The drawdown model report notes that under the drawdown operating criteria evaluated for the drawdown model, in some years both diversion culverts open on the same date (June 11). Under these hydrologic conditions, coordination with the refilling of Upper Klamath Lake will be required to permit the opening of diversion culvert # 1 on an earlier date, therefore initiating Stage 3 of drawdown prior to June 10.
- Stage 4 – Diversion Culvert #2 is Opened:
  - Stage 4 represents the final stage of drawdown.
  - Stage 4 is initiated on or after June 10 and when the reservoir water surface level is 2 ft below the spillway crest, or lower. The steady-state inflow to the reservoir to maintain a water level 2 ft below the spillway crest with diversion culvert #1 open is 2,120 cfs.
  - Over 90% of the drawdown model simulations indicate that diversion culvert #2 is opened on June 10. Under wet hydrologic conditions, such as those in simulation years 1983, 1984, and 1998, the opening on the diversion culvert is delayed – the latest date resulting from the simulations is June 29.
  - The reservoir water surface levels can drop below 3,763 ft under most hydrological conditions when diversion culvert #2 is opened. Wetter hydrologic conditions will result in a lesser drop in the reservoir level (e.g., 1993, 1998, 1999

and 2011 drops to approximately 3,765 ft with the initial opening of the diversion culvert).

After the diversion culvert has been opened, and after July 1, the reservoir water surface levels remain low and are within the range of 3,758.0 to 3,763.5 ft for all the model simulations.

3.0 Monitoring Plan

3.1 Reservoir Level Monitoring

Reservoir levels for J.C. Boyle are currently continuously monitored through the powerhouse control room and Hydro Control Center (PacifiCorp 2015). Flows can increase the amount of debris deposited against facility components during high-flow storm events. Erosion, back cutting, sloughing, or obstruction in the spillway or tailrace channel might occur because of these high-flow conditions. Special attention to these areas is included in the monitoring and surveillance of the facility during or after high-flow events. The Proposed Action will comply with high-flow event monitoring. If obstructions occur, the Renewal Corporation can implement measures to remove obstructions, such as mechanical removal or controlled blasting.

The Renewal Corporation will monitor reservoir levels during drawdown by level sensors and staff gauge. If readings are approaching a level that could cause concern regarding stability of the reservoir rim or embankment areas, the Renewal Corporation will, if necessary, take remedial actions described in the Emergency Response Plan (Kiewit 2020) for the Project and Appendix A (Oregon Slope Stability Monitoring Plan) to this plan.

3.2 Flow Monitoring

The Renewal Corporation will continue to monitor USGS stream gages (11509500 below Keno Reservoir and 11510700 below J.C. Boyle Reservoir) as described in the Oregon Water Quality Management Plan.

3.3 Embankment and Reservoir Rim Monitoring

Slope stability monitoring for the J.C. Boyle Reservoir rim and embankment structures is addressed in the Oregon Slope Stability Monitoring Plan (Appendix A). The Oregon Slope Stability Monitoring Plan presents the Renewal Corporation's proposed monitoring and evaluates practices to avoid and minimize potential impacts related to slope stability. The appendix proposes measures to address instability and discharges that may impact water quality.

4.0 Implementation Plan

4.1 J.C. Boyle Development

This section describes the post-drawdown decommissioning and removal measures for the J.C. Boyle Development. The demolition and removal work will include removal of the dam, water conveyance, powerhouse, and electrical infrastructure. It will also involve establishment of the final river channel for volitional fish passage through the former dam and reservoir inundation area. Drawing C1055 (Appendix B) presents water surface elevations based on steady state flood flows and with both low-level outlets (diversion culverts #1 and #2) open. The drawdown modeling provides simulated water surface levels through to October 1 of the drawdown year. Additional information is provided in the design drawings provided in Appendix B and supporting details of the Design Report (Knight Piésold 2022).

4.1.1 Dam and Intake Concrete Removal

With the diversion culverts operating as described above, the Renewal Corporation will remove the concrete components at the dam and intake. Dam and intake structure removals are shown on drawings C1210 and C1220 (Appendix B) and are described in the subsections below.

4.1.1.1 Concrete Removal

The Renewal Corporation will remove spillway gates and hoisting equipment after drawdown is complete. Partial removal of the concrete spillway may occur in the low-flow summer period coinciding with the decline in flood water surface elevations. The Renewal Corporation will remove the fish ladder, concrete cut-off wall and power intake concrete in conjunction with dam embankment removal. The phased removal elevations are shown on drawings C1234 and C1239 (Appendix B). Removal methods include dam embankment excavation, mechanical demolition, drilling, and controlled blasting. The final removal elevation at the intake is approximately 3,785.2 ft. Following use as an access road to the left bank, the Renewal Corporation will bury in place any concrete below this elevation. The Renewal Corporation will place excavated concrete rubble in the scour hole. The top-down concrete removal process will confirm structural stability criteria are met throughout the entire concrete structure removal process.

4.1.2 Earthfill Embankment Removal

The Renewal Corporation will commence embankment removal and demolition work following reservoir drawdown. The removal plan allows for most of the dam removal to occur in the dry, by leaving the upstream portion of the dam embankment and historic cofferdam in place and removing the dam embankment in phases (as shown in Table 4.1). The Renewal Corporation will remove the embankment in Phases 1 to 7, remove the historic cofferdam in Phase 8, and bury the diversion culvert channel and remaining concrete in Phase 9. Additional detail is provided in the following subsections.

Proposed stability requirements for the embankment through drawdown and embankment removal are provided in Table 3.1, and embankment removal drawings (C1230 to C1232, and C1234 to C1239) are included in Appendix B.

4.1.2.1 Stability, Freeboard, and Removal Phases

Removal of the J.C. Boyle earthfill dam embankment and concrete structures is planned and proposed in a manner that maintains the current stability criteria. This is achieved by removing the embankment in a sequence that does not result in narrowing of the crest or steepening of the downstream embankment slopes (drawing C1050 in Appendix B). Appendix B of the Design Report provides a description of the geotechnical, civil, and hydrotechnical details proposed for the phased dam embankment removal. The embankment removal work is broken into multiple phases related to flood water surface elevations. The phased embankment removal, historic cofferdam removal, and downstream rockfill grading, including historic cofferdam breach and removal are shown on the design drawings in Appendix B.

In addition to meeting the stability criteria discussed above, the Renewal Corporation will remove the dam in a manner that provides a 3-ft freeboard for a reservoir water level corresponding to a 1% flood event (100-year instantaneous flood flow), as shown on the design drawings in Appendix B.

4.1.2.2 Final Embankment Removal

The Phase 5 embankment crest will be at El. 3,770.7 ft. The Renewal Corporation will complete the majority of embankment dam fill removal in the dry, as the historic cofferdam upstream is anticipated to route flows to the diversion culverts. The Renewal Corporation will excavate the final river channel footprint to approximately 3,739 ft at the dam embankment centerline based on the anticipated bedrock depth. This river bottom elevation is lower than the diversion culvert invert elevation of 3,755.2 ft. The Renewal Corporation will complete visual inspection of the historic cofferdam and remaining sediment prior to removal of the Phase 6 embankment. The Renewal Corporation will complete the removal of the Phase 6 embankment in conjunction with the riverbank slope protection installation, as shown on drawing C1230 in Appendix B.

4.1.3 Historic Cofferdam and Sediment Removal

The Renewal Corporation will use the historic cofferdam that is located approximately 450 ft upstream of the dam embankment centerline. No historic design or construction cofferdam details are available. The Renewal Corporation will assess the condition of the historic cofferdam after the reservoir is lowered and make any repairs needed for the cofferdam to function as originally intended. This may include:

- Adding earthfill to the crest to restore original crest elevation and freeboard.
- Lining the upstream portion of the cofferdam with impervious material.
- Mechanically removing sediment from the diversion culvert approach channel.

Following use of the historic cofferdam to divert flows to the diversion culverts, the Renewal Corporation will remove the cofferdam as well as accumulated sediment between the embankment dam and the cofferdam. This is required to restore the river channel and achieve volitional fish passage.

The Renewal Corporation will cut the cofferdam embankment back towards the river right bank (drawing C1239, Appendix B). Once the cofferdam is breached, flow will naturally erode and remove portions of the historic cofferdam. The Renewal Corporation will remove material remaining and place this material in the disposal area. This removal will return flows to the historic channel and allow for in-water removal of the remaining fill.

4.1.4 Final River Channel

The Renewal Corporation will remove the embankment, historic cofferdam, and soft sediment to an elevation that provides channel width and grade suitable for volitional fish passage as described in the Reservoir Area Management Plan Section 5.1.2.1. No bedrock or rockfill will be excavated. The Renewal Corporation will install erosion protection prior to historic cofferdam breach. The Renewal Corporation will line areas along the final river channel that are expected to be inundated during the 1% flood with a layer of bedding material to provide the appropriate filter relationship with the subgrade material, and rock material to mitigate scour. Proposed gradations and appropriate thicknesses are detailed in the Design Report (Knight Piésold 2022), and the final grading plan of the channel through the J.C. Boyle site is shown on drawing C1230 (Appendix B).

4.2 Drawdown Implementation Timeline

Table 4.1 summarizes key dates and associated work activities for the drawdown of the J.C. Boyle Reservoir. A construction implementation schedule was provided to the Commission on June 30, 2022 as part of the Final Construction Documents submittal.[1]

Table 4.1. Key Intake and Embankment Elevations and Removal Timing

REMOVAL ITEM	ELEVATION (FT NAVD88)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Spillway Gates and Trunnions	3,790.0	January 1	-	Once the drawdown is initiated, spillway control is no longer required, so the spillway gates and trunnions can be removed.
Diversion Culvert #1 (Drawdown Stage 3)	3,755.2	Varies	-	See drawdown section (Stage 3).
Embankment Removal **Phase 1**	-	March 15	1% Probable Flood + 3ft freeboard	Remove erosion protection material from downstream face of the dam.
Embankment Removal **Phase 2**	3792.1	June 1	1% Probable Flood + 3ft freeboard	Remove embankment to June 1 1% probable flood with 3 ft freeboard.

[1] FERC accession no. 20220630-5018 (https://elibrary.ferc.gov/eLibrary/filelist?accession_num=20220630-5018)

REMOVAL ITEM	ELEVATION (FT NAVD88)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Diversion Culvert #2 (Drawdown Stage 4)	3,755.2	Varies	-	See drawdown section (Stage 4).
Embankment Removal **Phase 3**	3,784.7	June 15	1% Probable Flood + 3ft freeboard	Remove embankment to June 15 1% probable flood with 3 ft freeboard.
Spillway Structure	3785.2	July 1	1% Probable Flood + 3ft freeboard	Remove spillway and intake structure to max removal elevation – maintain 15 ft width for access to left bank.
Abutment Left Wall Phase 1	3,785.2	July 1	1% Probable Flood + 3ft freeboard	Match left wall elevation to spillway and elevation.
Embankment Removal **Phase 4**	3,776.7	July 1	1% Probable Flood + 3ft freeboard	Remove embankment to July 1 1% probable flood with 3 ft freeboard.
Embankment Removal **Phase 5**	3,770.4	July 15	1% Probable Flood + 1ft freeboard	Criteria changes from 1% probable flood with 3 ft freeboard to 1% probable flood with 1 ft freeboard. Remove embankment to July 15 1% probable flood with 1 ft freeboard.
Embankment Removal **Phase 6** and Erosion Protection Installation	-	Aug 1	1% Probable Flood + 1ft freeboard	Remove remaining embankment and silt. Excavate final channel to lines and grades shown on C1230, followed by installation of erosion protection and bedding material. Stockpile material for eventual placement in diversion culvert channel and to bury intake concrete (Phase 9).
Evaluate/Grade Downstream Rockfill **Phase 7**	3770.0	Aug 1	1% Probable Flood + 1ft freeboard	Evaluate rockfill for use in final channel following removal Phase 6 and grade as required.
Historic Cofferdam Breach **Phase 8**	3,755.2 (min)	September 1	-	To start no earlier than September 1 and be completed no later than September 30. Breaching of the historic cofferdam must take place after the final channel excavation is substantially complete.

REMOVAL ITEM	ELEVATION (FT NAVD88)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Intake Cover **Phase 9**	-	September 1	-	To occur after cofferdam breach and substantial completion of the Final River Channel. Place material in diversion culvert channel and bury intake concrete.

4.3 Coordination with Agencies and Stakeholders During Drawdown and Removal

Methods used for notification of the Commission; site emergency response personnel; and local, State, and Federal Emergency Response Centers are included in the Emergency Response Plan (Kiewit 2020) for the Project. In addition, the Renewal Corporation will notify the Oregon Department of Environmental Quality (ODEQ) and the Commission within 72 hours of an event that may substantially delay drawdown or cause the timeline to complete drawdown to exceed the anticipated schedule.

Any emergency or incident will be immediately communicated to a direct supervisor and, once it is safe to do so, all supervisors will report as outlined in the Emergency Response Plan and Health and Safety Plan for the Project. The Renewal Corporation will implement an alarm system that will sound to alert all personnel in nearby areas of a danger. Emergency Contact Information is included is also included in the Emergency Response Plan, which outline measures for directing emergency responses as well as notifications to the public, as necessary.

5.0 Construction Potential Failure Mode Analysis (cPFMA)

Construction Potential Failure Modes (cPFMs) were determined as part of the December 11 and 14 2020 informal cPFMA workshop (Kleinschmidt 2021) that included participation by representatives from the Renewal Corporation, Kleinschmidt, the independent Board of Consultants, California Division of Safety of Dams, the FERC, and PacifiCorp. The purpose of the cPFMA workshop was to identify and analyze cPFMs for each of the 4 dams included in the Proposed Action, focusing on the construction phases. As part of the workshop, a range of cPFMs were identified and evaluated in relation to the proposed dam removal design and construction work activities.

All cPFMs identified were fully developed and assigned an appropriate significance category following FERC guidelines. The path to failure was defined, risk reduction measures were listed, and considerations for surveillance and monitoring were discussed and included in the cPFMA report (Kleinschmidt 2021).

5.1 Outcomes of cPFMA Workshop for J.C. Boyle

A total of 16 cPFMs for J.C. Boyle Dam were identified and analyzed during the cPFMA workshop. Of the 16 cPFMs identified, eight were not developed or were withdrawn due to design revisions that eliminated them from consideration. For the remaining eight cPFMs, surveillance and monitoring actions as well as opportunities for risk reduction were identified for J.C. Boyle; these are detailed in the cPFMA report (Kleinschmidt 2021). The recommended actions were incorporated into the Project construction document, work sequence, and risk register where appropriate.

6.0 Training and Awareness

Section 6.0 discusses the qualifications required for maintenance personnel including training requirements and documentation. The Renewal Corporation will provide personnel and required training as discussed below.

6.1 Current Responsibilities and Training

PacifiCorp Operations personnel consist of Operators and Foremen, reporting to the Production Manager. The Operators are either journeymen or apprentice, and the Foreman is a General Foreman Hydro. The Foreman is responsible for Operators that perform surveillance duties and read the active instrumentation at the Project (except for the movement surveys). The Foreman and Operators are also responsible for relaying copies of the inspection check lists and sheets to the Dam Safety Engineer. The Foreman is experienced in the safe operation of hydroelectric projects and has participated in all dam safety-related training associated with the execution of dam-specific Dam Safety Surveillance and Monitoring Plan (DSSMPs). The Operators and Foreman are responsible for carrying out surveillance duties and reading active instrumentation at their respective dams. Temporary monument surveys are the responsibility of the Renewal Corporation.

Personnel training in surveillance and monitoring includes review and familiarization of the most current PFMA study and the DSSMP. New personnel at any level of responsibility are trained by experienced personnel at the same or greater level of responsibility. Training includes a review of the surveillance procedures included in the DSSMP and the Daily Log, Weekly Check Sheet, and Annual Engineering Inspection Check Sheets. New PacifiCorp staff review the procedures and accompany an experienced Operators or Foreman to gain an understanding of each aspect of surveillance activities and learn the type of observations and readings needed for valid data input. The Renewal Corporation will implement a training program to train new staff operations after PacifiCorp concedes full control of the Project facilities.

6.2 Training, Awareness, and Competency

Training is required for all personnel prior to commencing work on site. The level of training is commensurate with the level of individual risk their works are likely to entail. Trainings include:

- Environmental and safety policies, site management plans, as well as environmental roles and responsibilities;

- The significance of environmental impacts caused by individual roles and activities;
- Incident management; and
- Potential consequences of non-conformance.

The Renewal Corporation will document training associated with implementation of activities.

6.3 Inductions

All personnel working onsite will undergo mandatory Project training to cover the key requirements of the Workplace Safety Management Plan.

6.3.1 Project Induction

The Project induction will cover an overview and related safety-, environmental-, and community-related risks and responsibilities for the Proposed Action. It is the responsibility of all personnel to adhere to the safety requirements of the Project. The Project induction with respect to reservoir drawdown will include:

- Overview of the Oregon Reservoir Drawdown and Diversion Plan,
- Project contact details;
- Potential Areas of Concern and inaccessible areas;
- Notification procedures; and
- EAP, Emergency Response Plan for the Proposed Action, and other emergency protocols.

6.3.2 Visitor Induction

Visitors must undergo a visitor's induction and their host is responsible for all actions and conduct of the visitor. The Renewal Corporation will restrict visitor access, and personnel who have previously undergone Project induction and safety training will accompany visitors at all times.

7.0 Reporting

The Renewal Corporation will provide an Annual Compliance Report including a summary of drawdown activities and their results to ODEQ and the Commission by April 1 and 15, respectively, for the preceding year. During the drawdown phase, the Renewal Corporation will submit monthly progress reports to ODEQ and the Commission including details regarding drawdown status.

8.0 References

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Appendix A

Oregon Slope Stability Monitoring Subplan

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project
FERC Project No. 14803

Oregon Slope Stability Monitoring Plan

J.C. Boyle

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December 2022

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Table of Contents

List of Figures

1.0 Introduction

This Oregon Slope Stability Monitoring Plan is an appendix to the Oregon Reservoir Drawdown and Diversion Plan, which is a subplan of the Reservoir Drawdown and Diversion Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project.

1.1 Purpose of Oregon Slope Stability Monitoring Plan

This document describes the Klamath River Renewal Corporation's (Renewal Corporation) plan for monitoring slope stability and evaluates practices related to slope stability. The plan identifies reservoir slopes and other areas within the Limits of Work of the Proposed Action prone to instability and describes the Renewal Corporation's measures for monitoring instability during drawdown and dam removal under the Proposed Action. It also describes the Renewal Corporation's measures to address instability and discharges that would violate water quality standards. The Renewal Corporation's slope stability measures are also intended to protect private property, structures, and cultural sites.

The Renewal Corporation will implement the following measures through this Oregon Slope Stability Monitoring Plan or other management plans referenced in this document:

- Describe proposed survey monuments to monitor slope stability during and following drawdown.
- Visually monitor for evidence of potential slumping, cracking, or slope failure of dam embankment during dam removal.
- Monitor J.C. Boyle Reservoir elevation and stream flow at the United States Geological Survey (USGS) gauge 11509500 below Keno Reservoir and 11510700 below J.C. Boyle powerhouse during drawdown.
- Provide contingency and notification procedures to respond to confirmed or suspected issues for slope instability or loss of erosion protection.
- Submit monthly and annual reports.

1.2 Relationship to Other Management Plans

This Oregon Slope Stability Monitoring Plan is supported by elements of the following management plans to aid in effective implementation: Construction Management Plan, Erosion and Sediment Control Plan, Oregon Reservoir Drawdown and Diversion Plan, and Water Quality Monitoring and Management Plan. So as not to duplicate information, elements from these other management plans are not repeated herein but are, where appropriate, referenced in this plan.

1.3 Oregon Section 401 Water Quality Certificate Condition 5

Under Section 401 of the federal Clean Water Act, the Oregon Department of Environmental Quality has issued a Section 401 Water Quality identifies several elements for consideration in the Reservoir Drawdown and Diversion Plan, including the location, schedule, and installation procedures for piezometer wells proposed for the upstream shell and core of J.C. Boyle Dam and procedures to monitor water levels and pore pressure at these locations (Condition 5(b)(i), ODEQ 2018). These elements are addressed throughout this plan. Modeling for the design (Knight Piésold 2022) showed that dam stability increases during reservoir drawdown and the proposed dam removal for each of the facilities. Therefore, the Renewal Corporation proposes the installation of zero piezometer wells and inclinometers to monitor dam stability. As an alternative, the Renewal Corporation will monitor drainage and make visual observations of the dam faces and reservoir rim during drawdown and dam removal.

1.4 Elevation Datum

All elevations reported in this plan use the North American Vertical Datum of 1988 (NAVD88), which is 3.71 ft higher than the National Geodetic Vertical Datum of 1929 (NGVD29) at J.C. Boyle.

2.0 Supporting Information

2.1 Reservoir Rim

This section is informational and includes excerpts from the Reservoir Rim Stability Report (Knight Piésold 2020); it does not contain specific measures to be implemented by the Renewal Corporation as part of the Proposed Action. *Reservoir rim* is defined as the terrain that lies within the normal operating levels of the reservoir. The terrain downslope and upslope of the rim are defined as *submarine* slopes and *upslope* areas, respectively.

The Reservoir Rim Stability Report summarizes the findings of an evaluation of reservoir rim stability during and following drawdown. The evaluation focused on the potential instabilities that could affect residences and other resources adjacent to the rim, such as transportation infrastructure. The evaluation is consistent with previous evaluations completed by the Renewal Corporation (2019) and PanGeo (2008).

The approach used for the stability analyses (Knight Piésold 2020) commenced with a review of the Renewal Corporation’s previous analyses and conclusions (2019). Stability models were then developed based on the interpretation of data and observations collected by the Renewal Corporation, which were influenced by the challenges of gaining site access. Identification and characterization of terrain hazards were completed for each of the four reservoir sites and guided the development of slope models. The analysis for JC Boyle established that there were no hazards identified. In addition, Limit Equilibrium (LE) analyses also allowed for identification of factors that influence slope stability during drawdown of the reservoir.

The stability models evaluated existing conditions to identify the possible extent of instability during drawdown of the current ground surface as determined by topographic and bathymetric surveys, the assumed geological model, and an established piezometric low (assuming the minimum operating reservoir level represents drawdown conditions). These results provide a framework for judging the results of the drawdown analyses.

2.1.1 Geological Setting

The limits of work are predominantly contained in the Western and High Cascades volcanic regions of the Cascades Geologic Province. The Klamath River predates the formation of the Cascade Mountain Range and maintained a relatively similar course through the mountain-building events. The bedrock within the limits of work comprises volcanic rocks up to 45 million years old as well as basalt and andesite lava flows, tuffs, tuff-breccias, and volcaniclastic sandstone. The volcanic rocks are intruded by numerous dikes and plugs of andesite, rhyolite, and basalt. Many of the volcanoes associated with the Western Cascades have since eroded, but large shield volcanoes and vents of the High Cascades remain and are still active.

Large deposits of coarse alluvium were deposited along the Klamath River during the period of the last glaciation when the river had a higher discharge. Lacustrine deposits were laid down in former temporary lakes that were created at the present-day site of the J.C. Boyle Reservoir when the Klamath River was temporarily “dammed” by volcanic activity. Diatomite deposits surround much of the shoreline of the J.C. Boyle Reservoir (PanGeo 2008, as cited in SWRCB 2020). The presence of diatomaceous deposits and associated fluvio-lacustrine terrace deposits along the rim and below the reservoir water level present the greatest potential for slope instability.

2.1.2 J.C. Boyle Reservoir Rim

There are no residential properties adjacent to the J.C. Boyle Reservoir rim. A bridge crossing on Highway 66 separates the broad north part of the reservoir from the south part, which is mainly confined within a canyon.

Undercutting has been identified at one location around the J.C. Boyle Reservoir rim. There is an approximately 15 ft-high, steep shoreline slope, comprised of diatomite, in the north part of the reservoir approximately 0.4 miles west of Spencer Creek that has been undercut by wave action (Figure 2.1, Figure 2.2; Knight Piésold, 2020). No submarine landslides were identified in the terrain analysis. The soft sediment that has accumulated on the floor of the reservoir will be highly susceptible to erosion upon drawdown.

The lower slopes of the southwest oriented bedrock canyon, south of the road crossing, are comprised of geological materials that are not expected to be prone to slope instability during the drawdown.

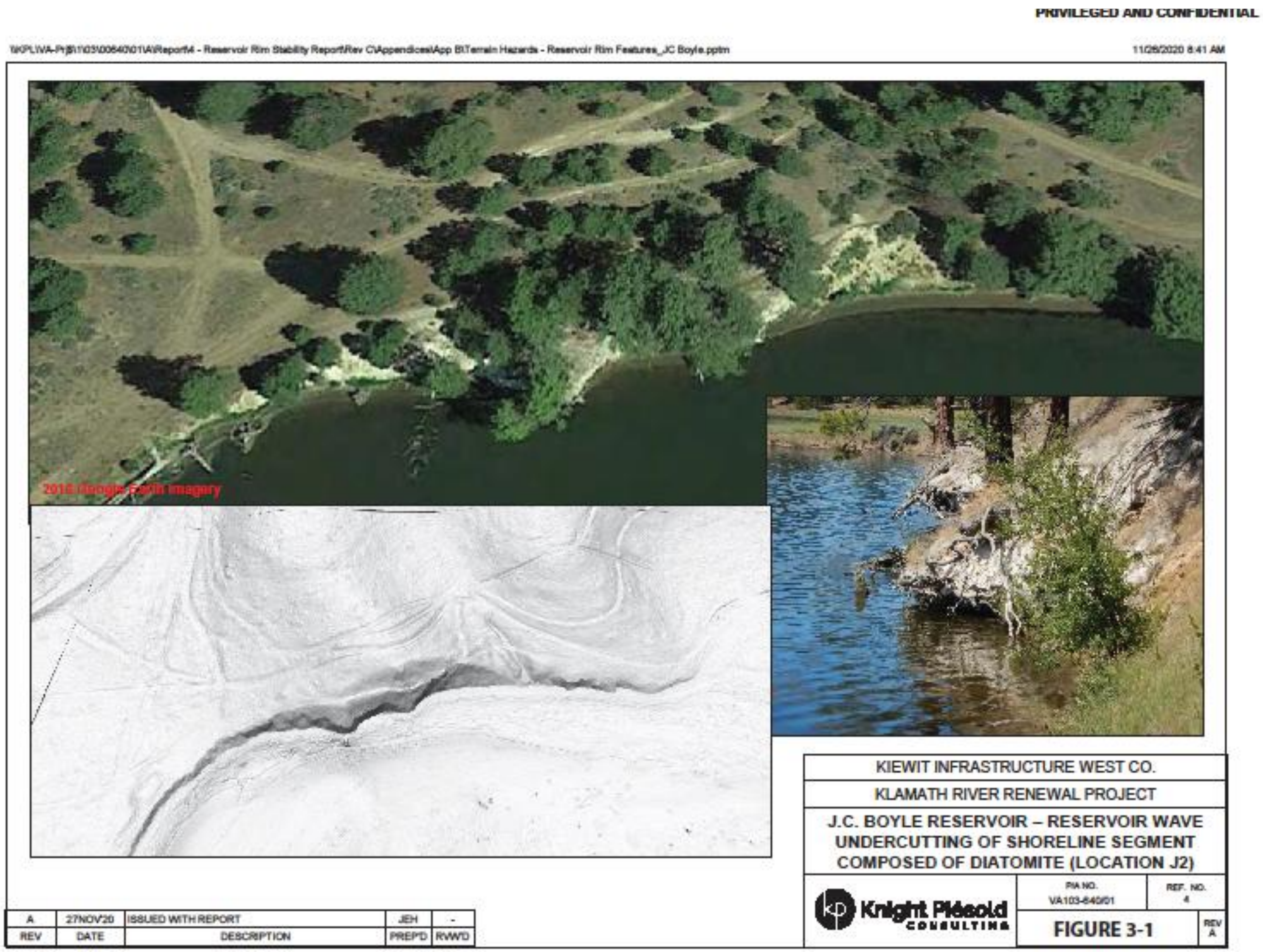


Figure 2.1. J.C. Boyle Reservoir – Reservoir Wave Undercutting of Shoreline Segment Composed of Diatomite (Location J2)

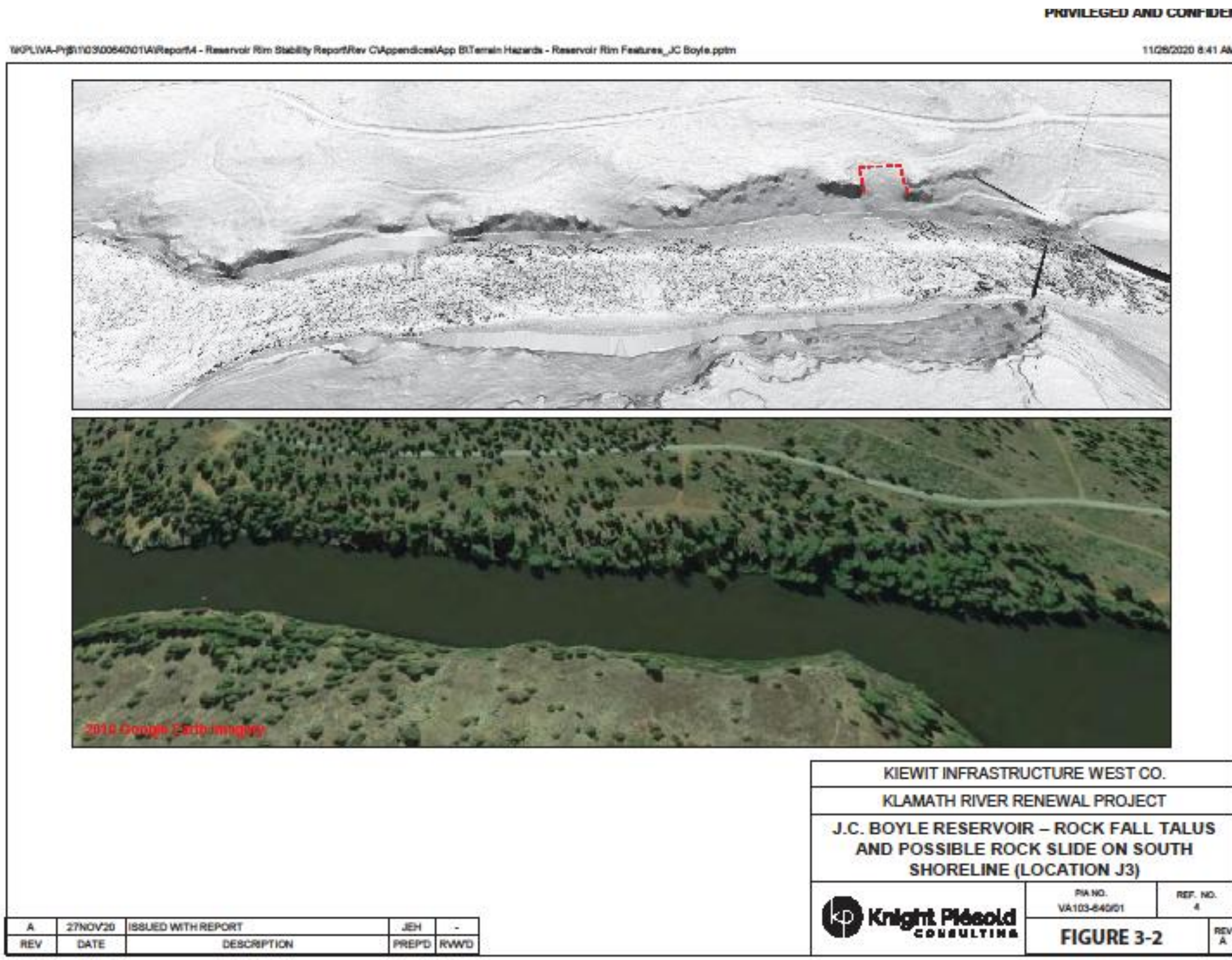


Figure 2.2. J.C. Boyle Reservoir – Rock Fall Talus and Possible Rock Slide On South Shoreline (Location J3)

3.0 Proposed Action Areas Potentially Prone to Instability

This section describes slopes and other Proposed Action areas of concern for slope stability.

3.1 Dam Embankments

Stability analyses were conducted for each of the facilities to evaluate the safety of the existing dams and whether dam modifications would result in an unacceptable structural response and risk (Knight Piésold 2022). The analyses focused on the Potential Failure Modes (PFMs) related to the main dam sections where dam modifications could cause adverse effects to the overall stability or structural response of the dams. The Renewal Corporation will monitor the upstream and downstream face and crest of the J.C. Boyle Dam earthfill embankment.

3.2 J.C. Boyle Reservoir Rim

Previous studies completed by PanGeo (2008) and the Renewal Corporation (2019) and supported by a recent study by Knight Piésold (2020), indicate that drawdown of the J.C. Boyle Reservoir will not result in large-scale slope instability effecting adjacent infrastructure or properties. Undercutting has been identified at one location around the J.C. Boyle Reservoir rim. There is an approximately 15 ft-high, steep shoreline slopes, comprised of diatomite, in the north part of the reservoir approximately 0.4 miles west of Spencer Creek that has been undercut by wave action (Figure 2.1, Figure 2.2; Knight Piésold, 2020). However, the occurrence of gentle slopes beneath the diatomite cliff will render the possibility low. No submarine landslides were identified in the terrain analysis. The soft sediment that has accumulated on the floor of the reservoir will be highly susceptible to erosion upon drawdown.

3.3 Roads

Improvements to existing roads and development of new temporary access routes are required to support construction activities under the Proposed Action, both to improve access safety and to facilitate movement of construction equipment and traffic. Additional details regarding road improvements and maintenance are included in the Traffic Management Plans, located as appendices to the Construction Management Plan. The Renewal Corporation proposes additional monitoring of areas of potential slope instability, as discussed in Section 4.0.

3.4 Borrow and Disposal Areas

Borrow and disposal areas are required for construction of the Proposed Action. Borrow and disposal sites are designed with stable permanent slopes and suitable drainage requirements using best management practices (BMPs). The Renewal Corporation will place material in the disposal site in layers, track-walk the material, and grade it with a bulldozer to promote surface drainage. The Renewal Corporation will visually monitor slopes during construction and excavation and modify them as needed based on visual observations, as described in the Erosion and Sediment Control Plan and the Oregon Waste Disposal and Hazardous Materials Management Plan.

4.0 Slope Stability Monitoring

This section discusses monitoring and inspection procedures that the Renewal Corporation will implement to address slope stability concerns. Additional details related to drawdown procedures are included in the Oregon Reservoir Drawdown and Diversion Plan.

4.1 Pre-Drawdown Phase

In 2017, the Renewal Corporation and PacifiCorp entered into an Operations and Maintenance Agreement. Upon the Renewal Corporation's acceptance of License Transfer, PacifiCorp will continue to operate the Lower Klamath Project under the terms of the Operations and Maintenance Agreement. During the pre-drawdown phase of the Proposed Action, PacifiCorp will continue to monitor the dam and embankment consistent with the requirements of the Supporting Technical Information Document for J.C. Boyle Dam (STID; PacifiCorp 2015). Daily and weekly inspections are performed by PacifiCorp Operations personnel as part of their normal duties and per license requirements, and annual inspections are performed by PacifiCorp Dam Safety Engineering staff with the assistance of PacifiCorp Operations personnel.

4.2 Active Drawdown and Dam Removal Phase

Drawdown of the J.C. Boyle reservoir is proposed to take place from January 1 through June 15, depending on the water year type. The specific schedule for the drawdown and removal of the dam is further described in the Oregon Reservoir Drawdown and Diversion Plan.

The Renewal Corporation will monitor slope stability of the dam embankment and reservoir rim during the active drawdown and dam removal phase, and following storm events, for changes in ground conditions, changes in displacement of the ground surface, and changes in the reservoir level. The Renewal Corporation will conduct daily, weekly, and monthly monitoring during active drawdown and dam removal as described below.

4.2.1 Remote Sensing Technology

The Renewal Corporation will visually monitor daily displacements of the ground surface, including reservoir rims and embankments, during the drawdown period using unmanned aerial vehicle flights. This method will provide the greatest spatial coverage for daily evaluation of the response to reservoir drawdown. LiDAR data acquisition will be both airborne and ground-based at J.C. Boyle Reservoir. The Renewal Corporation will continue monthly monitoring of displacements of the ground surface for six months following the completion of drawdown. The Renewal Corporation will assess conditions after data acquisition and report to the Engineer of Record (EOR) any variations indicating potential displacement.

4.2.2 Visual Inspections

The Renewal Corporation will visually inspect dam embankments (upstream and downstream face and crest) daily for signs of slope instability.

4.2.3 Surveillance Monuments

The Renewal Corporation will use existing survey monuments at the dam embankments when accessible during the active drawdown phase until dam removal is complete. Additionally, the Renewal Corporation will establish overall site control through the installation of temporary control points in locations that will not be affected by dam removal activities. The Renewal Corporation will establish temporary monuments on the rock abutments on either side of the dam, as needed.

4.2.4 Other Monitoring

The Renewal Corporation will monitor the reservoir by level sensors and stream gauges during drawdown. Once the reservoir drops below its normal operating range, water level gauges will no longer be operational. The USGS stream gauge monitoring requirements (11509500 below Keno Reservoir and 11510700 below J.C. Boyle powerhouse) are included in the Oregon Water Quality Management Plan.

The Renewal Corporation will perform daily checks of the dam, monitor water levels, and coordinate with the Bureau of Reclamation with respect to potential storm events. Downstream flows will be estimated to provide adequate response time to implement emergency procedures as detailed in the Emergency Response Plan for the Proposed Action (Kiewit 2020).

4.3 Post-Drawdown Phase

In the post-drawdown phase, the dam embankment will have been removed so dam embankment monitoring will cease. Reservoir rim instability is limited to the drawdown phase, so daily monitoring of the reservoir rims will cease after drawdown is complete. Post-drawdown monitoring of residual reservoir sediment stability during restoration is addressed in Section 6.2.8 of the Reservoir Area Management Plan.

5.0 Slope Stability Measures

5.1.1 Erosion Protection

The Renewal Corporation will conduct the construction and removal work required for the Proposed Action in a manner that provides environmental protection and follows BMPs for erosion and sediment control, as outlined in the Erosion and Sediment Control Plan. In general, the Renewal Corporation will restore areas disturbed by construction of the Proposed Action components to final lines and grades as soon as practical. The Renewal Corporation will install erosion protection at various locations throughout the limits of work (e.g., river channels, scour hole, and volitional fish passage channels).

5.1.2 Proposed Measures to Address Instability

If instability issues are confirmed in the areas listed in Section 3.0, the Renewal Corporation will implement the following measures:

- slope monitoring,
- structural slope stability measures, and/or
- local rerouting of roads.

As discussed, the Renewal Corporation plans to conduct drone and LiDAR surveys of the reservoir rims during the pre-drawdown period. If an area of instability is identified through the Renewal Corporations monitoring measures, additional slope monitoring will be implemented including installation of site-specific monitoring equipment such as surveillance benchmarks, piezometers, and daily site inspections by the Renewal Corporation geotechnical engineering team. The slope monitoring efforts will be designed to provide a clear indication of the severity of the instability including physical extent of the area impacted, degree of instability, the mechanism driving the instability, and potential for significant failures. From these site-specific measures, structural slope stability measures will be evaluated. For all site-specific slope monitoring, access approval by the local landowner will be required to access and conduct the proposed monitoring.

In areas identified with significant slope stability issues where slope failure is imminent, or has occurred with continuing slope movement, the Renewal Corporation geotechnical engineering team will assess the instability area and develop a site-specific plan. Depending on the severity of the instability, the proposed measures could include removal of existing slide material and rerouting drainage paths, installation of toe trains, soils anchors, benching and regarding the embankment section, and/or installation of a buttress wall at the base of the slide. Buttress walls have been used extensively using a variety of design and construction methods including rock toes, retaining walls, sheet pile walls, and natural vegetative stability methods. As noted, the geotechnical team will evaluate the site and determine the optimum approach for structural modifications. It should be noted, that in locations where access is not available, or the major instability has already reached its maximum extent, the recommended action may be to do nothing or a simple cleanup of material.

5.1.3 Local Impact Mitigation Fund

To address potential impacts of slope instabilities related to reservoir drawdown, the Renewal Corporation will implement the measures stated in this plan, as required in the License Surrender Order. In order to address potential damage claims involving private properties, the Renewal Corporation will establish a Local Impact Mitigation Fund (LIMF), to be administered outside of the License Surrender Order. For property owners electing to opt into the fund, the LIMF will provide financial resources to such property owners to mitigate displacement costs and impacts to residential properties that are determined to be caused by the Proposed Action. The fund will be backstopped by insurance.

The LIMF will establish procedures and standards for determining the nature and scope of any impacts, as well as stipulated payments to affected property owners. Developing the standards and procedures will involve proactive participation and input from key stakeholders. The draft methodology for the LIMF program will be made available for public comment through townhalls and other meetings.

Under the LIMF, the Renewal Corporation will not accept responsibility for pre-existing conditions not caused by the Proposed Action. The fund administrator will be supported by a technical team but will ultimately have the discretion to determine the legitimacy of covered claims. Any affected property owners who elect not to participate in the LIMF may, instead, pursue any other remedies available to such property owners under applicable state law.

6.0 Emergency Response

PFMs identified in the STID (PacifiCorp 2015) have been used to guide previous stability evaluations and are briefly discussed in the Oregon Reservoir Drawdown and Diversion Plan. The dams covered under STIDs will continue their current operations until water levels drop below normal operating elevations during drawdown. PFMs were reevaluated as part of a Construction Potential Failure Mode Analysis (cPFMA) workshop that specifically addressed reservoir drawdown and dam removal (Kleinschmidt 2021). Details concerning the cPFMA workshop are provided in the Oregon Reservoir Drawdown and Diversion Plan.

7.0 Equipment Maintenance Program

This section describes equipment maintenance measures, types of maintenance requirements, and the schedule for and/or frequency of maintenance activities. The Renewal Corporation will monitor equipment to ensure that the desired condition is maintained.

7.1 Survey Monuments

Survey monuments are protected by weatherproof covers and, therefore, require little maintenance. During dam removal activities, the Renewal Corporation will protect survey monuments from movement or damage from vehicles or other equipment traversing the crests. The “permanent” survey monuments will be removed along with the dam embankment, and temporary monuments installed for monitoring dam removal will be also removed once the embankment excavation reaches the monuments.

7.2 Remote Sensing Technology

The Renewal Corporation will establish specific maintenance procedures for remote sensing equipment based on the specific technology.

7.3 Other Instrumentation

Continuous measurements of reservoir levels are made using level sensors. The reservoirs also have a fixed gauge, allowing a comparison of the water levels measured by the level sensors with the levels indicated on the gauges. In the pre-drawdown phase and early in the drawdown phase, these comparisons will be made daily by PacifiCorp operators. Any significant difference in water level readings between these two measurements will initiate work to repair or recalibrate the instruments. Once powerhouse operations cease, the PacifiCorp level sensors will no longer function, and the Renewal Corporation will install and maintain new level sensors to monitor water levels during drawdown and dam removal.

8.0 Reporting

The Renewal Corporation will provide an Annual Compliance Report describing the results of slope stability monitoring of the dam embankments and reservoir rims to ODEQ and the Commission by April 1 and 15, respectively, for the preceding year. The Annual Compliance Report will also include a summary of any measures taken to address slope instabilities, including, but not limited to, physical stabilization measures. During the drawdown phase, the Renewal Corporation will submit monthly progress reports to ODEQ and the Commission including details regarding any identified slope instabilities and actions taken to address such instabilities.

9.0 Management Plan Updates

If additional risk areas are encountered, the Renewal Corporation will revise the monitoring procedures. The Renewal Corporation will document the risk areas and associated amendments to the Management Plan and will submit all changes to the Commission and to ODEQ.

10.0 References

California State Water Resources Control Board (SWRCB). 2020. Final Environmental Impact Report for the Lower Klamath Project License Surrender. Prepared by Stillwater Sciences, Berkeley, California, for the State Water Resources, Control Board, Sacramento, California.

Kiewit Infrastructure West Co. (Kiewit). 2020. Emergency Response Plan. Prepared for Klamath River Renewal Corporation.

Kleinschmidt. 2021. Construction Potential Failure Mode Analysis Report: Klamath River Renewal Project, FERC No. 14803. Prepared for Klamath River Renewal Project. June.

Knight Piésold. 2020. Reservoir Rim Stability Report. Prepared for Klamath River Renewal Project. February.

Knight Piésold. 2022. 100% Design Report. Prepared for Klamath River Renewal Project. June.

Oregon State Department of Environmental Quality (ODEQ). 2018. Final Clean Water Act Section 401 Certification for the Klamath River Renewal Corporation License Surrender and Removal of the Lower Klamath Project (FERC No. 14803) Klamath County, Oregon. September 7.

PacifiCorp. 2015. J.C. Boyle Development, Klamath River Project, Supporting Technical Information Document (STID). April.

PanGEO. 2008. Geotechnical Report: Klamath River Dam Removal Project, California and Oregon. Project No. 07-153. Prepared for Philip Williams & Associates, Ltd., and California State Coastal Conservancy. August.

Renewal Corporation. 2019. Geotechnical Data Report. Prepared by Renewal Corporation Technical Representatives: AECOM Technical Services, Inc., and CDM Smith. June.

Appendix B

Design Report Drawings

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

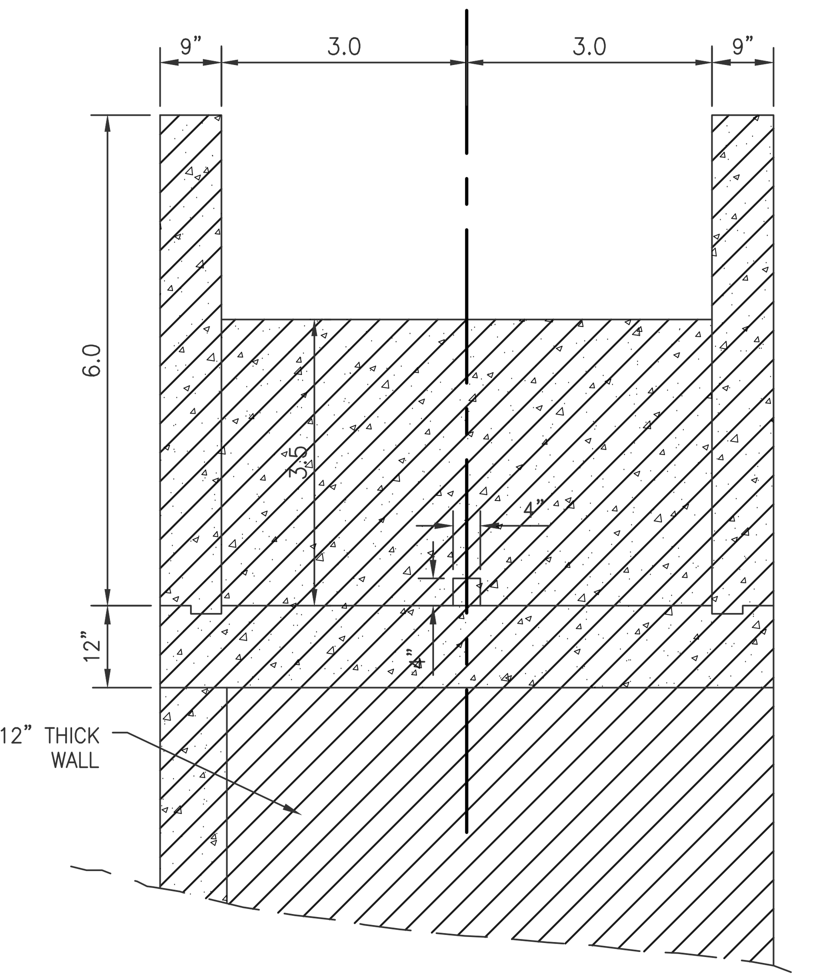
DESIGN SHEETS

C1050 J.C. BOYLE DRAWDOWN STAGES

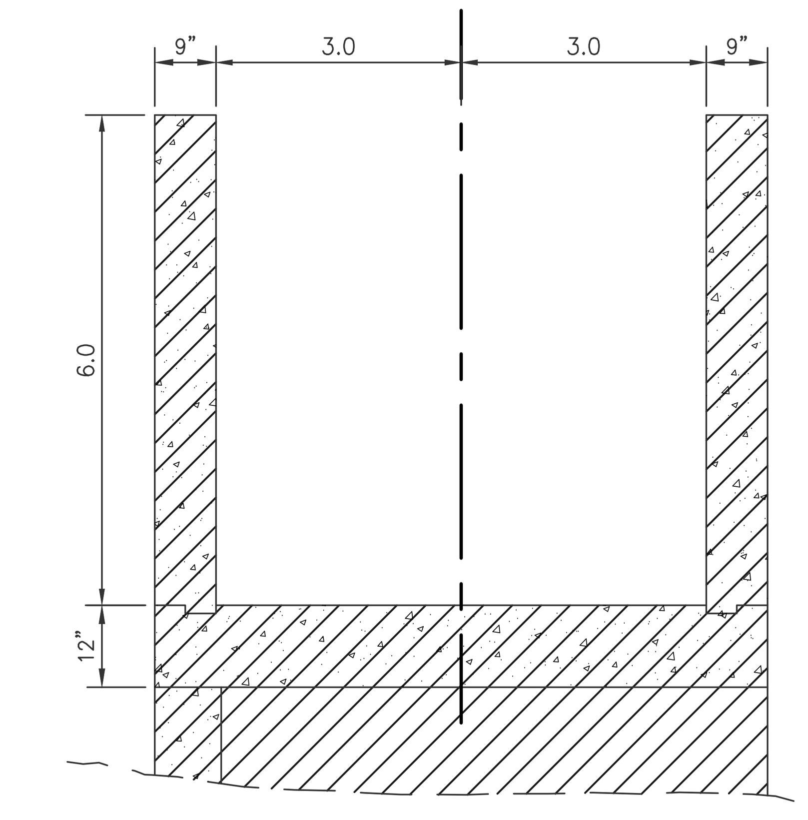
C1055 J.C. BOYLE HYDROLOGIC AND HYDRAULIC INFORMATION

C1056 J.C. BOYLE HYDROLOGIC AND HYDRAULIC INFORMATION

PLAN
1" = 50'

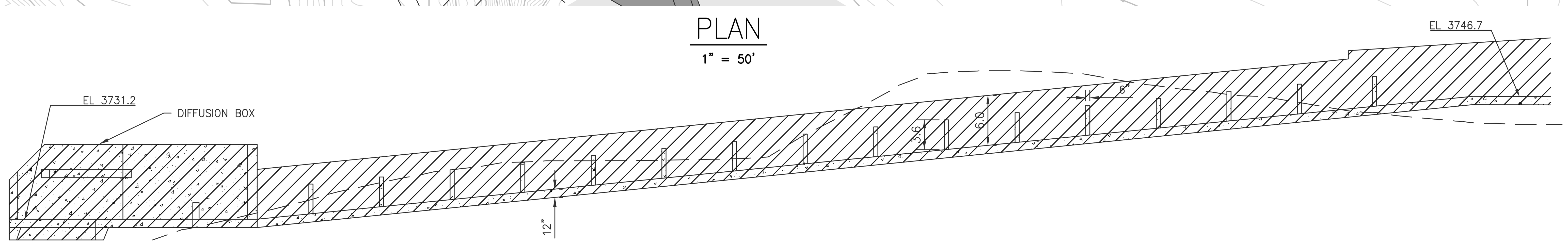


SECTION – FISH LADDER (C)
1" = 2'



SECTION – FISH LADDER (D)
1" = 2'

BORROW SOURCES WORK POINTS TABLE			
WORK POINTS	EASTING	NORTHING	ELEVATION
SOP-1	6,548,227.6	2,656,860.8	3735.0
SOP-2	6,548,312.3	2,656,964.8	3778.0
SOP-3	6,548,553.2	2,656,914.0	3762.0
SOP-4	6,548,529.0	2,656,696.3	3766.5
SOP-5	6,548,475.1	2,656,853.6	3735.5
SOP-6	6,548,133.5	2,656,618.4	3731.0
SOP-7	6,548,261.3	2,656,756.7	3736.0
SOP-8	6,548,277.2	2,656,619.1	3734.0
SOP-9	6,548,145.0	2,656,491.0	3728.0
SOP-10	6,548,298.4	2,656,557.9	3736.5
SOP-11	6,548,219.7	2,656,517.9	3730.5
SOP-12	6,548,249.2	2,656,330.5	3723.0



SECTION – FISH LADDER (A)
1" = 10'

LEGEND:

- (E) CONCRETE
- DEMOLITION / REMOVAL
- – F – F – FENCE
- EXTENT OF EMBANKMENT
- BORROW SOURCE LIMITS
- ○ TO BE REMOVED
- 1 FISH LADDER
- 2 EMBANKMENT CREST
- 3 DIVERSION CULVERTS
- 4 GATED SPILLWAY
- 5 INTAKE STRUCTURE
- 6 DAM COMMUNICATIONS BLDG
- 7 14' PIPELINE

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. LOCATION AND EXTENT OF HISTORIC COFFERDAM IS BASED ON HISTORIC PHOTOS AND MAY VARY. THE CONTRACTOR SHALL LOCATE AND ASSESS THE HISTORIC COFFERDAM PRIOR TO COMMENCING EXCAVATION SO EXCAVATION LIMITS CAN BE UPDATED AS REQUIRED.
3. POTENTIAL BORROW SOURCE LOCATED IN CULTURALLY SENSITIVE AREA.
4. REMOVE FISH LADDER COMPLETELY.
5. DIMENSIONS BASED ON HISTORIC DRAWING 78112.

0 2 4 6 — 1" = 2'
0 10 20 30 — 1" = 10'
0 50 100 150 — 1" = 50'

REGISTERED PROFESSIONAL ENGINEER 96150PE OREGON MAY 12, 2020 CYRUS NIAMIR
EXPIRES: 06/30/2024

ISSUED FOR CONSTRUCTION

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CBN	HE	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: Knight Piésold CONSULTING; Kiewit

DESIGNED	C. NIAMIR
DRAWN	A. NASIRI
REVIEWED	H. ELWIN
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR: KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE: J.C. BOYLE FACILITY EMBANKMENT, INTAKE AND FISH LADDER REMOVAL PLAN AND SECTIONS

PROJ # VA103-640/1
DATE 05/27/2022
DWG C1210

dhawkins May 24, 2022 - 9:54am
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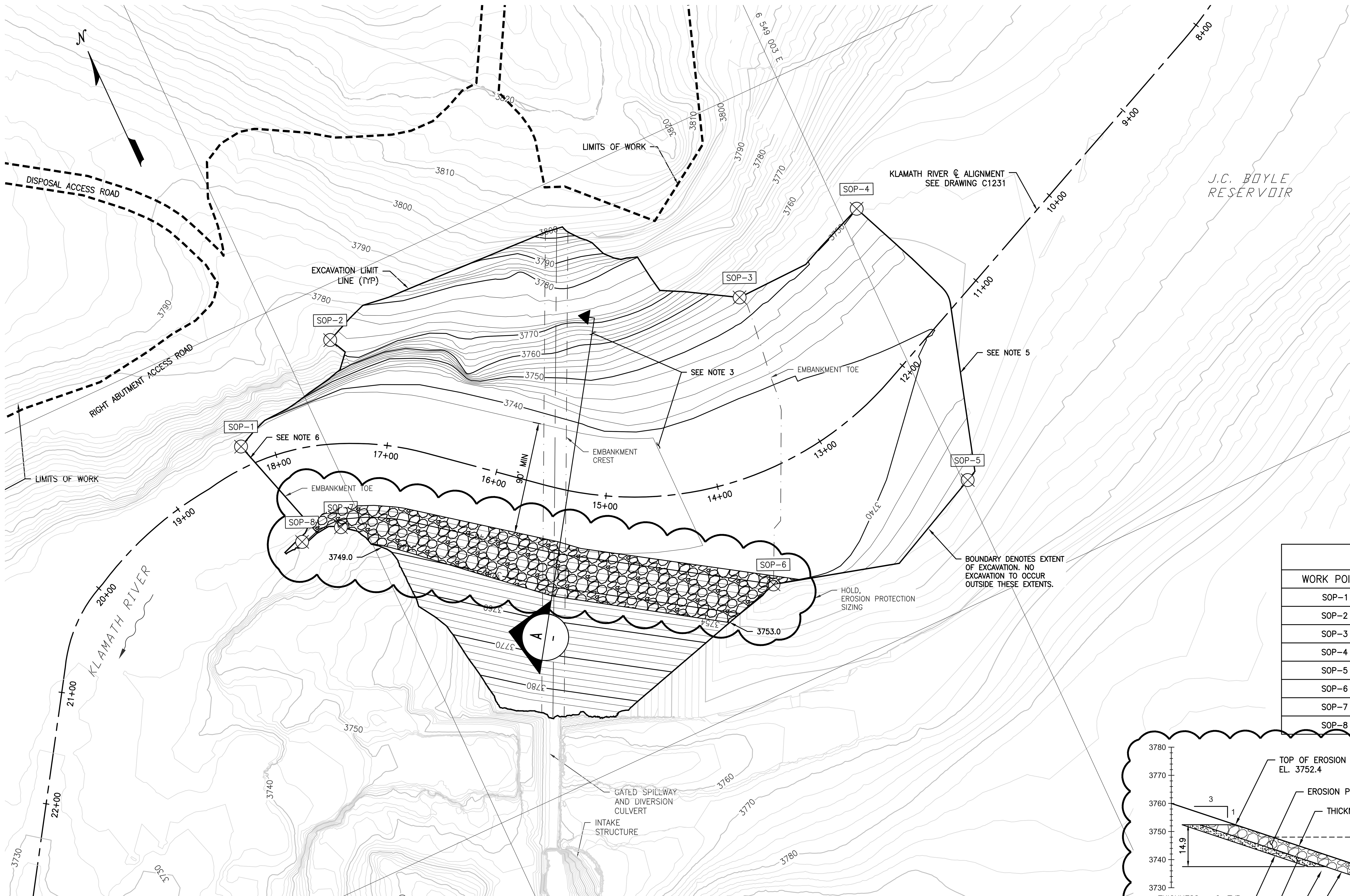
CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEET
C1220 J.C. BOYLE SPILLWAY AND INTAKE REMOVAL



PLAN
1" = 50'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. REMOVE DAM EMBANKMENT FILL TO LINES AND GRADES SHOWN. EROSION PROTECTION AND BEDDING MATERIALS TO BE PLACED PRIOR TO COFFERDAM BREACH.
3. FINAL RIVER CHANNEL EXCAVATED TO BEDROCK ALONG THE RIGHT BANK AND BOTTOM. DO NOT EXCAVATE INTO BEDROCK SURFACE EXCEPT AT EROSION PROTECTION KEY IN.
4. EXCAVATED FILL TO BE PLACED IN DISPOSAL AREAS SHOWN ON C1240 OR USED AS COVER MATERIAL.
5. EXTENT OF REMAINING SEDIMENT AND DEBRIS TO BE EVALUATED FOLLOWING DRAWDOWN. REMOVAL LIMIT CORRESPONDS TO HISTORIC COFFERDAM UPSTREAM TOE. ADDITIONAL SEDIMENT AND DEBRIS REMOVAL MAY BE NECESSARY TO ACCESS THIS POINT. REMOVAL OF MATERIAL UPSTREAM OF THIS POINT, UNLESS TO ACCESS TO THE HISTORIC COFFERDAM TOE, WILL BE COMPLETED BY OTHERS AND IS OUTSIDE THE SCOPE OF THIS DESIGN.
6. FOLLOWING EMBANKMENT REMOVAL, EVALUATE ROCKFILL AT DOWNSTREAM TOE AND GRADE AS REQUIRED.
7. CHANNEL SECTIONS BY STATION SHOWN ON C1233.
8. THE ANTICIPATED WATER SURFACE LEVELS AT SECTION A, FOR VARIOUS FLOW CONDITIONS DURING CONSTRUCTION, ARE SUMMARIZED IN APPENDIX B1.
9. THE FINAL CHANNEL BOTTOM WILL NOT REQUIRE DENTAL CLEANING BETWEEN THE ROUGH ROCK RIDGES.
10. EXCAVATION EXTENTS ARE INTERPRETED BASED ON THE HISTORIC DRAWINGS AND ARE INTENDED TO ILLUSTRATE THE BEDROCK SURFACE ONCE THE EMBANKMENT IS REMOVED. BEDROCK DEPTH MAY VARY.
11. EROSION PROTECTION TO EXTEND INTO NON-ERODIBLE BEDROCK. KEY IN REQUIRED TO PREVENT SLIDING.

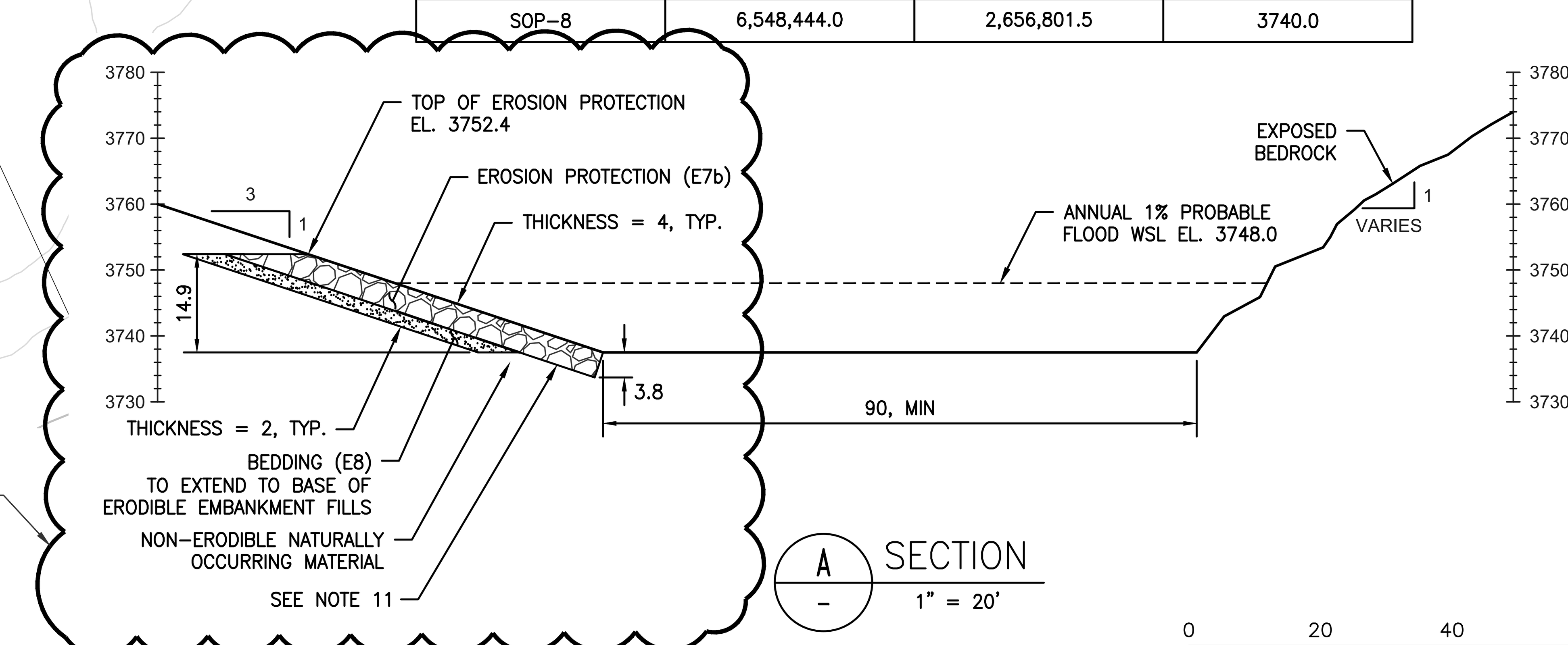
LEGEND:

- EROSION PROTECTION (E7b)
- BEDDING (E8)
- WATER SURFACE LEVEL
- LIMITS OF WORK

HOLD, EROSION PROTECTION SIZING

WORK POINTS TABLE

WORK POINTS	EASTING	NORTHING	ELEVATION
SOP-1	6,548,430.0	2,656,901.0	3736.5
SOP-2	6,548,542.0	2,656,954.0	3773.0
SOP-3	6,548,888.5	2,656,835.5	3774.5
SOP-4	6,549,016.0	2,656,864.0	3777.5
SOP-5	6,549,004.5	2,656,603.0	3770.5
SOP-6	6,548,808.5	2,656,591.5	3765.0
SOP-7	6,548,480.7	2,656,798.9	3744.0
SOP-8	6,548,444.0	2,656,801.5	3740.0



HOLD, EROSION PROTECTION SIZING

A SECTION
1" = 20'

0 20 40 60
1" = 20'

0 50 100 150
1" = 50'

REGISTERED PROFESSIONAL ENGINEER
09963PE
OREGON
MAY 29, 2019
E. HARVEY ELWIN
EXPIRES: 12/31/2023

ISSUED FOR CONSTRUCTION

REV	DESCRIPTION	BY	CHK	APP	DATE
0	ISSUED FOR CONSTRUCTION	CBN	HE	SRM	05/27/22

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: Knight Piésold CONSULTING / Kiewit

DESIGNED: C. NIAMIR
DRAWN: R. McLELLAN
REVIEWED: H. ELWIN
IN CHARGE: N.BISHOP
APPROVED: S. MOTTRAM

PREPARED FOR: KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT
SHEET TITLE: J.C. BOYLE FACILITY EMBANKMENT REMOVAL PLAN

PROJ #: VA103-640/1
DATE: 05/27/2022
DWG: C1230

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEETS

C1231 - C1239 J.C. BOYLE EMBANKMENT REMOVAL SECTIONS

Appendix D

Consultation Record

Consultation Record

Reservoir Drawdown and Diversion Plan			
Sub-Plan	**Agency**	**Date of Agency Plan Submittal**	**Agency Comments Received Date**
Oregon Reservoir Drawdown and Diversion Plan	Oregon Department of Environmental Quality	January 20,2021 August 11, 2021 August 23, 2022	February 5, 2021 August 31, 2021 October 14, 2022 (DEQ Conditional Approval)
	Oregon Department of Fish and Wildlife	January 20,2021 August 11, 2021	February 6, 2021 September 7, 2021
	Bureau of Land Management – Klamath Falls	February 25, 2021 August 11, 2021	April 15, 2021 No Comments Received
California Reservoir Drawdown and Diversion Plan	California State Water Resources Control Board	January 20,2021 August 11, 2021 July 28, 2022	February 5, 2021 August 25, 2021 September 20, 2022
	California Department of Fish and Wildlife	January 20,2021 August 11, 2021	April 16, 2021 August 25, 2021
	California Department of Water Resources	August 11, 2021	September 9, 2021
California Slope Stability and Monitoring Plan	California State Water Resources Control Board	January 20,2021 August 11, 2021 July 14, 2022	February 5, 2021 August 25, 2021 September 20, 2022
	California Department of Fish and Wildlife	January 20,2021 August 11, 2021	No Comments Received August 25, 2021
	California Department of Water Resources	August 11, 2021	September 9, 2021