UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
PacifiCorp	**2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R
100% Design Report
(1 of 12)

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AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R-1
Final Design Report (Public)

TABLE OF CONTENTS

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KLAMATH RIVER RENEWAL PROJECT
100% DESIGN REPORT

Rev	Description	Date
A	Issued in Draft	September 25, 2020
B	Issued in Draft with Client Revisions	October 7, 2020
C	Issued in Draft for Client Review	November 13, 2020

Knight Piésold
CONSULTING

EXECUTIVE SUMMARY

The Klamath River Renewal Project involves the removal of four hydroelectric facilities on the Klamath River basin to restore natural flow and volitional fish passage through the former dam and reservoir reaches. These facilities are J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate. Other Project activities include related works for roads, bridges, and culverts for construction access and/or permanent use, establishment of disposal areas, establishment of the final river channels through the existing dam sites, and demolition of existing recreation sites.

The Project scope is divided into two components: hydropower facilities removal and post-removal reservoir restoration. This report presents the 100% design of the removal of the hydropower facilities and other related works. It is based on continued collaboration with the Restoration Contractor and is built upon the concepts presented in the 90% Design Report (KP, 2020) and the Value Engineering (VE) analyses. Extensive design analyses and collaboration of the multi-disciplinary Project team throughout the design process have targeted reduced costs and construction risks.

Each hydropower facility removal can be categorized into three general periods:

- Pre-drawdown works: the period wherein temporary access, dam and tunnel modifications are constructed to facilitate reservoir drawdown.
- Drawdown: the period wherein reservoirs are lowered to facilitate dam removal works.
- Demolition and removal works: the period when dam and other hydropower facility infrastructure is deconstructed and the final river channels are established.

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Various road, bridge, and culvert improvements will be completed to support construction and long-term access. Temporary bridges and structures, as well as use of private roads, will limit disturbances to public infrastructure.

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TABLES

FIGURES

APPENDICES

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ABBREVIATIONS

ALSA	Amended License Surrender Application
BMP	best management practice
CA FEIR	California Control Board Final Environmental Impact Report
CDFW	California Department of Fish and Wildlife
CFD	computational fluid dynamics
cfs	cubic feet per second
CWA	Clean Water Act
DCD	Design Completion Documents
El.	elevation
FERC	Federal Energy Regulatory Commission
ft	feet, foot
HPU	hydraulic power unit
HVAC	heating, ventilation, and air conditioning
Kiewit	Kiewit Infrastructure West
KP	Knight Piésold Ltd
KRRC	Klamath River Renewal Corporation
KRRP	Klamath River Renewal Project (the Project)
kV	kilovolt
MMRP	Mitigation, Monitoring, and Reporting Plan
MOU	Memorandum of Understanding
NAVD88	North American Vertical Datum 1988
No.	Number
PacifiCorp	PacifiCorp Energy
PFMA	Probable Failure Modes Analysis
RES	Resource Environmental Solutions
RM	River mile
USBR	United States Bureau of Reclamation
VE	Value Engineering
WQC	Water Quality Certifications

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This 100% Design Report is a technical document developed for the Klamath River Renewal Corporation (KRRC), for the purposes of implementing the Klamath River Renewal Project (KRRP). This report is prepared by Knight Piésold (KP), on behalf of The Project Company, Kiewit Infrastructure West Co. (Kiewit), with specific chapter contributions by Kiewit Power and Camas LLC. In addition, there has been significant collaboration with McMillen Jacobs Associates (MJA), the Restoration Contractor, Resource Environmental Services (RES), and other KRRC subcontractors. As the leader of the facilities removal design-build team, Kiewit has provided oversight and guidance in the design process.

The Project Agreement for Preliminary Services presented the Technical Requirements for the Project (in Appendix 4 of the Agreement). Those requirements have since been subject to ongoing informal revision by the KRRP Team and have been captured in this Design Report. The revised requirements were developed in collaboration with the KRRP Team, and communicated to KP by way of Task Force Meetings, a Value Engineering phase, and 30%, 60%, and 90% Design submittal reviews. The revised Technical Requirements for the Project have yet to be captured in a revised Project Agreement.

The Klamath River Renewal Project involves the removal of four hydroelectric facilities on the Klamath River to restore natural flow and volitional fish passage through the former dam and reservoir reaches. These facilities are J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate. Other related works include road, bridge, and culvert improvements for construction access and/or permanent use, establishment of disposal areas, establishment of volitional fish channels through the existing dam sites, and demolition of existing recreation sites.

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Various road, bridge, and culvert improvements will be completed to support construction and long-term access. Temporary bridges and structures, and use of private roads, are incorporated into design to limit disturbances to public infrastructure.

1.2 DRAWINGS AND SPECIFICATIONS

This report refers to the 100% Design Drawings and Project Technical Specifications which, along with this report, form the 100% Design Completion Documents (DCD). These additional documents are issued separately from this report. General drawings are shown in Table 1.1.

Table 1.1 List of General Project Drawings

Drawing Number	Drawing Title
G0001	Title Sheet
G0002	Index of Drawings - (Sheet 1 of 2)
G0003	Index of Drawings - (Sheet 2 of 2)
G0005	Legend, Symbols, and Abbreviations
G0006	General Notes
G0020	Project Location, Vicinity and Access
G0030	General Arrangement Plan - Key Map
G0031	J.C. Boyle Facility - General Arrangement Plan - (Sheet 1 of 2)
G0032	J.C. Boyle Facility - General Arrangement Plan - (Sheet 2 of 2)
G0033	Copco No. 1 and Copco No. 2 Facilities - General Arrangement Plan - (Sheet 1 of 2)
G0034	Copco No. 1 and Copco No. 2 Facilities - General Arrangement Plan - (Sheet 2 of 2)
G0035	Iron Gate Facility - General Arrangement Plan - (Sheet 1 of 2)
G0036	Iron Gate Facility - General Arrangement Plan - (Sheet 2 of 2)
G0050	Earthworks and Demolition - Material Gradations - (Sheet 1 of 2)
G0051	Earthworks and Demolition - Material Gradations - (Sheet 2 of 2)
E0001	General Arrangement - Electrical
E0002	General Transmission Network Diagram

Drawing lists for J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate are provided in Sections 2.1.2, 3.1.2, 4.1.2, and 5.1.2, respectively. Drawing lists for roads, bridges and culverts are presented in Sections 6, and recreation sites demolition are presented in Section 7.

The list of Project Technical Specifications is presented in Table 1.2.

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Table 1.2 List of Technical Specifications

Section Number	Section Title
DIVISION 01	**General Requirements**
01 92 00	Facility Operation
DIVISION 02	**Existing Conditions**
02 41 00	Demolition and Facility Removal
02 41 99	Electrical Distribution System Demolition
DIVISION 03	**Concrete**
03 10 00	Concrete Forming and Accessories
03 20 00	Concrete Reinforcement
03 30 00	Cast-in-Place Concrete
03 37 13	Shotcrete
03 60 00	Grouting
DIVISION 05	**Metals**
05 12 00	Structural Steel
DIVISION 31	**Earthwork**
31 05 00	Materials for Earthwork
31 10 00	Clearing, Grubbing and Stripping
31 23 00	Excavation and Fill Placement
31 25 00	Erosion and Sedimentation Controls
31 60 00	Foundation Preparation
31 71 00	Tunnel Construction
31 80 00	Care of Water
DIVISION 32	**Exterior Improvements**
32 50 00	Roads, Bridges, and Culverts
DIVISION 35	**Waterway and Marine Construction**
35 24 00	Dredging

1.3 EROSION AND SEDIMENT CONTROL

The construction and removal works required for the Project will be conducted in a manner that provides environmental protection and best management practices (BMPs) for erosion and sediment control. Appendix H and the Design Drawings provide the erosion and sediment control design measures for each Project area.

1.4 CONSTRUCTION AND IMPLEMENTATION SCHEDULE

All construction, demolition, and removal activities associated with the Project have been scheduled by Kiewit with consideration of engineering design, permits, and other constraints. The 90% GMP implementation schedule is provided in Appendix I.

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PUBLIC VERSION

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

SECTION 2.0 J.C. BOYLE HYDROPOWER FACILITY REMOVAL

PAGES 4 TO 14

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

SECTION 3.0 COPCO NO. 1 HYDROPOWER FACILITY REMOVAL

PAGES 15 TO 26

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

SECTION 4.0 COPCO NO. 2 HYDROPOWER FACILITY REMOVAL

PAGES 27 TO 35

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

SECTION 5.0 IRON GATE HYDROPOWER FACILITY REMOVAL

PAGES 36 TO 48

6.0 ROADS, BRIDGES, AND CULVERTS

6.1 GENERAL

The scope of work for roads, bridges and culverts consists of two components:

- Mitigation of drawdown effects on permanent bridge and culvert crossings
- Construction access improvements: roads, bridges, and culverts

Reservoir drawdown could potentially affect certain bridges and culverts located on reservoir tributaries by initiating tributary channel incision and headcutting, which could undermine abutments or outlets. Impassable fish barriers could be created where an upstream migrating headcut intersects a crossing-related hard point (i.e. culvert outlet).

The following bridges and culverts have been assessed for drawdown effects and the following mitigation/ designs are developed:

- Camp Creek culvert: to be replaced by a concrete box culvert
- Scotch Creek culvert: to be replaced by a concrete box culvert
- Fall Creek culvert at Daggett Road: to be replaced by a multi-plate arch culvert
- Jenny Creek, Spencer, and Copco bridges: no mitigation designed at this time; to be monitored post-drawdown
- Several culverts: no mitigation designed at this time; to be monitored post-drawdown

6.1.1 TEMPORARY CONSTRUCTION ACCESS IMPROVEMENTS

Temporary construction access improvements are required where existing roads and bridges are not sufficient to handle construction equipment dimensions or loads, or to create new access to certain areas that do not have access now.

The planned construction access improvements are summarized below:

- Temporary strengthening systems will be installed at existing bridges to meet construction load requirements:
  - Fall Creek Bridge
  - Dry Creek Bridge

[redacted]

- Improvement of public roads and culverts, as needed, leaving them in equal or better condition after Project implementation than they are at present:
  - Copco Road – to be repaired and upgraded as required to accommodate Project traffic
- Local construction access – J.C. Boyle:
  - Road realignment at scour hole
  - Road reactivation at lower penstock access road
  - Intersection improvements at the OR66 – JC Boyle intersections
- Local construction access – Copco No. 1:
  - Road improvement of Right Bank access from Copco Road down to Copco No. 1 Powerhouse

[redacted]

- Local construction access – Copco No. 2:
    - New road for Right Bank access to downstream of Copco No. 2 Dam
    - Road improvement of Left Bank utility corridor leading toward Copco No. 2 Dam
- Local construction access – Iron Gate:
    - [redacted]
    - New road for Right Bank access to Iron Gate Dam low-level tunnel outlet
    - [redacted]

The drawings list for the drawdown-affected bridges and culverts (C5000 drawing series), and for the construction access improvements other than local construction access (C6000 drawing series), are presented in Table 6.1. Local construction access improvements at the four hydropower facilities are addressed in the applicable report sections (2 through 5) and Design Drawings.

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7.0 RECREATION SITES DEMOLITION

The recreation site locations were chosen based on the predicted results of Project implementation and return of the river system back to its original location. The recreation site demolition key maps and plans are presented on the C7000 drawing series, as shown on Table 7.1.

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8.0 MANAGEMENT PLANS

The Lower Klamath River Project ("Proposed Action") will require the development of regulatory permit conditions measures incorporated into management plans. The FERC Amended License Surrender Application (ALSA) has established 16 FERC Management Plans to be filed with FERC incorporating the terms and conditions from federal, state, and local permits and/or agreements. The consolidation of plans into the 16 FERC Management Plans is a necessary element to align common resource subject area protection measures into one plan, rather than the multiple plans currently identified in executed governmental approvals. The process of completing these 16 FERC Management Plans will further refine the Proposed Action implementation requirements in consultation with multiple state, federal and local authorities. Once the 16 FERC Management Plans have been finalized, they will be submitted to the FERC for approval. Table 8.1 below identifies the 16 FERC Management Plans as well as their corresponding governmental approval management plans and/or actions.

These 16 FERC Management Plans have incorporated the proposed measures by the following Governmental Approvals:

- Oregon Clean Water Act Section 401 Water Quality Certifications (OR CWA 401)
- California Clean Water Act Section 401 Water Quality Certifications (CA 401 WQC)
- Siskiyou County MOU (draft)
- Klamath County MOU
- California Department of Fish and Wildlife MOU

The California State Water Resource Control Board Final Environmental Impact Report (CA FEIR) provides additional management plan details for incorporation. The FEIR Mitigation, Monitoring, and Reporting Plan (MMRP) provides the specific FEIR measures and their interrelationship to the CA CWA 401 conditions. The MMRP can be found in the McMillen Jacobs Share Point Site. All management plan authors should read through the FEIR MMRP to fully incorporate all elements into their respective management plan drafts.

Table 8.1 Proposed Action Management Plans

FERC Surrender Application Management Plans		Management Plans Identified in CA 401/FEIR/OR 401/Klamath MOU/CDFW MOU	
		Plans identified in Regulatory Approvals and MOU's to be incorporated into FERC Plan	**Governing Document**
1	**Aquatic Resources Management Plan**	**Aquatic Resources Management Plan**	CA 401 WQC-Cond 6
		Plan Subsections	
		Spawning Habitat Availability Report and Plan	
		AR-6 Adaptive Management Plan (Suckers)	
		Fish Presence Monitoring Plan	
		Tributary-Mainstem Connectivity Plan	
		Juvenile Salmonids and Pacific Lamprey Rescue and Relocation Plan	
		AR-6 Adaptive Management Plan (Suckers)	CA 401 WQC-Cond 6
			OR 401 CWA-Cond 4
		Fish Passage	OR 401 CWA-Cond 4

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FERC Surrender Application Management Plans		Management Plans Identified in CA 401/FEIR/OR 401/Klamath MOU/CDFW MOU	
		Plans identified in Regulatory Approvals and MOU's to be incorporated into FERC Plan	**Governing Document**
2	**Construction Management Plan**	**Klamath MOU Traffic Management Plan**	Klamath County MOU
		Plan Subsections	
		Traffic Management Plan	
		Erosion and Sediment Control Drawings	
		Traffic Control Drawings	
		Traffic Study	
		Existing Conditions Summary Report	
		Siskiyou County MOU[1]	Siskiyou County MOU
		Emergency Response Plan[2]	ALSA
3	**Erosion and Sediment Control Plan**	**Erosion, Sediment Control Plan**	OR 401 WQC-Cond 8
		Water Quality Monitoring and Protection Plans	CA 401 WQC-Cond 10
4	**Hatcheries Management and Operations Plan**	**Hatcheries Management and Operations Plan**	CA 401 WQC-Cond 13
		Plan Subsections	
		Hatcheries Management and Operations Plan	
		Bogus Creek Flow Diversions (Iron Gate Hatchery Operations)	
5	**Health and Safety Plan**	**Health and Safety Plan**	ALSA
		Public Safety Plan	
6	**Historic Properties Management Plan**	**Historic Properties Management Plan**	ALSA
		Plan Subsections	
		Historic Properties Management Plan	
		Looting and Vandalism Prevention Plan	
		Inadvertent Discovery Plan	
7	**Interim Hydropower Operations Plan**	**Interim Hydropower Operations Plan**	CA 401 WQC-Cond 20
8	**Recreation Facilities Plan**	**Recreation Facilities Plan**	CA 401 WQC-Cond 19
9	**Remaining Facilities Plan**	**Remaining Facilities Plan**	CA 401 WQC-Cond. 7
			OR 401 WQC-Cond. 7
		Plan Subsections	
		Remaining Facilities (CA)	CA 401 WQC-Cond. 7
		Remaining Facilities Plan and Operations Plan (OR)	OR 401 WQC- Cond 7
10	**Reservoir Area Management Plan**	**Reservoir Area Management Plan**	CA 401 WQC-Cond. 14
			OR 401 WQC-Cond. 6
11	**Reservoir Drawdown and Diversion Plan**	**Reservoir Drawdown and Diversion Plan**	CA 401 WQC- Cond. 3
			OR 401 WQC-Cond. 5
		Slope Stability Monitoring Plan	CA 401 WQC-Cond. 18
			OR 401 WQC-Cond. 5

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FERC Surrender Application Management Plans		Management Plans Identified in CA 401/FEIR/OR 401/Klamath MOU/CDFW MOU	
		Plans identified in Regulatory Approvals and MOU's to be incorporated into FERC Plan	**Governing Document**
12	**Sediment Deposit Remediation Plan**	**Sediment Deposit Remediation Plan**	CA 401 WQC-Cond. 4
13	**Terrestrial and Wildlife Management Plan**	**Amphibian and Reptile Plan**	CA 401 WQC-Cond 16
		Plan Subsections	
		Pond Turtle Mitigation	OR 401 WQC-Cond 4
		Rescue and Relocation Plan	CA 401 WQC-Cond 16
		Bald and Golden Eagle Management Plan	CA 401 WQC-Cond 17
14	**Waste Disposal and Hazardous Management Plan**	**Spill Prevention, Control and Countermeasure Plan**	OR 401 WQC-Cond 10
		Waste Disposal Plan	OR 401 WQC-Cond 9
		(includes Hazardous and Non-Hazardous Materials)	
		Waste Disposal Plan	CA 401 WQC-Cond 11
		Hazardous Materials Management Plan	CA 401 WQC-Cond 12
15	**Water Quality Monitoring Management Plan**	**Water Quality Management Plan**	OR 401 WQC-Cond 1
		Water Quality Monitoring Plan	CA 401 WQC-Cond 1
		Water Quality Monitoring and Protection Plan	CA 401 WQC-Cond 10
16	**Water Supply Monitoring and Management Plan**	**Water Supply Management Plan**	CA 401 WQC-Cond 15
		Plan Subsections	
		Water Supply Management Report (surface water, ground water, fire protection)	CA 401 WQC-Cond 15
		Groundwater Well Management Plan[3]	OR 401 WQC-Cond 11 (g)
		Public Drinking Water Management	CA 401 WQC-Cond 8
		Fire Management Plan	KRRC Commitment
			CA 401 WQC-Cond 15

NOTES:

1. SISKIYOU COUNTY MOU IS IN DRAFT FORM AT THE TIME OF COMPILING THIS TABLE. THE MOU DOES NOT CONTAIN THE PREPARATION OF A SPECIFIC PLAN FOR COUNTY APPROVAL; RATHER IS OUTLINES SPECIFIC COMMITMENTS BETWEEN THE PARTIES. THESE COMMITMENTS WOULD BE SUMMARIZED IN THE CONSTRUCTION PLAN PROVIDED TO FERC.
2. THE CA CWA 401 REFERENCES AS A KRRC "COMMITMENT" FROM THE DEFINITE PLAN, THEREFORE NOT A PERMIT REQUIREMENT. IT IS ASSUMED THAT FERC WILL REQUIRE THIS PLAN. THEREFORE, IT HAS BEEN INCLUDED IN THE CONSTRUCTION MANAGEMENT PLAN.
3. OR CWA 401 DOES NOT REQUIRE A GROUNDWATER WELL MANAGEMENT PLAN. IT RATHER IMPLIES THAT THE KRRC WILL DEVELOP SUCH IN ACCORDANCE TO THE 2018 DEFINITE PLAN REPORT. CONDITION 11 REQUIRES REPORTING BASED ON THE IMPLEMENTATION OF THE PLAN. THEREFORE, BY INFERENCE, THE PLAN IS REQUIRED.

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9.0 LIMITATIONS

This report was prepared by Knight Piésold, with specific chapter contributions by Kiewit Power and Camas LLC, for the account of the Klamath River Renewal Corporation on behalf of Kiewit Infrastructure West Co. Report content reflects the best judgement of the authors, designers, and construction professionals involved based on the available information at the time of preparation. Any use a third party makes of this report, or any reliance on or decisions made based on it is the responsibility of such third parties. Knight Piésold, Kiewit, and other report contributors accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Any reproductions of this report are uncontrolled and might not be the most recent revision.

The Project Agreement for Preliminary Services presented the Technical Requirements for the Project (in Appendix 4 of the Agreement). Those requirements have since been subject to ongoing informal revision by the KRRP Team and have been captured in this Design Report. The revised requirements were developed in collaboration by the KRRP Team, and communicated to KP by way of Task Force Meetings, a Value Engineering phase, and 30%, 60%, and 90% Design submittal reviews. The revised Technical Requirements for the Project have yet to be captured in a revised Project Agreement. KP takes no responsibility for any errors or omissions related to lack of clarity in the Project Technical Requirements.

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10.0 REFERENCES

California Department of Fish and Wildlife (CDFW), 2020. CDFW Memorandum of Understanding. September 2020. California, USA

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11.0 CERTIFICATION

This report is the product of a collaborative effort by several authors and reviewers from the Project Team (Knight Piésold, Kiewit Power, and Camas LLC).

KNIGHT PIÉSOLD

Report Sections 1, 2, 3, 4, 5, 6, and 7 and Appendices A, B, C, D, E, F, and G, were prepared and reviewed by the undersigned.

OREGON – HYDROPOWER FACILITIES

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CALIFORNIA – HYDROPOWER FACILITIES

(Sections 1, 3, 4, and 5; Appendices A, C, D, and E)

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CALIFORNIA – ROADS, BRIDGES, CULVERTS; RECREATION SITES REMOVAL

(Sections 6 and 7; Appendix F)

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Reviewed: ______________________
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Geoserv, Inc.
(Civil Design)

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OREGON – ROADS, RECREATION SITES REMOVAL

(Sections 6 and 7; Appendix F)

Prepared: ______________________

James O'Reilly

Reviewed: ______________________

For: Chuck Schlumpberger, P.E. (OR)
Geoserv, Inc.
(Civil Design)

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Approval that this document adheres to the Knight Piésold Quality System: CN

KIEWIT POWER (KIEWIT INFRASTRUCTURE WEST CO.)

Partial contributions regarding Electrical components in Sections 2, 3, 4, and 5 were prepared and reviewed by the undersigned.

Prepared: Terry.Wolfsen

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Terry Wolfsen

Reviewed: Tawatchai C.

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CAMAS LLC

Section 8 was prepared and reviewed by the undersigned.

Lisa M. DeRose

Prepared: ______________________________
Lisa DeRose

Diane M Barr

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APPENDIX A

Design Criteria

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APPENDIX A1

Project Notation, Units, and Conversion

(Pages A1-1 to A1-2)

APPENDIX A1
PROJECT NOTATION, UNITS, AND CONVERSION

1.0 PROJECT NOTATION

1.1 STANDARD UNITS

The standard units for the design of the project will be the following US Customary Units:

- Length: inch (in), feet (ft) and mile (mi)
- Area: acres
- Volume (reservoir): acre-feet (acre-ft)
- Volume (fluid): US gallons, million US gallons (gal, Mgal)
- Volume (concrete, earthfill): cubic yard (yd3)
- Mass: pound (lb), short tons (tons)
- Density: pounds per cubic foot (pcf)
- Pressure: pound-force per square foot (psf)
- Temperature: degrees Fahrenheit (°F)
- Power: horsepower (hp)
- Flow rate: cubic foot per second (cfs), cubic foot per minute (cfm) gallons per minute (gpm)

1.2 CONVERSIONS TO OTHER US CUSTOMARY UNITS

Other US Customary Units will also be used for preparation of the design. These units and conversion factors from the standard units (unless otherwise indicated) will be the following:

- Length: 1 ft = 12 inches (in)
- Length: 1 yard (yd.) = 3 ft
- Length: 1 mile (mi) = 5,280 ft
- Area: 1 acre = 43,560 square feet (sq. ft)
- Volume: 1 acre-ft = 43,560 cubic feet (ft^3)
- Volume: 1 acre-ft = 1,613 cubic yards (yd^3)
- Fluid volume: 1 Mgal = 1,000,000 gallons (gal)
- Mass: 1 ton = 2,000 pounds (lbs)
- Density: 1 short ton per cubic yard ($tons/yd^3$) = 74 pcf
- Pressure: 1 pound-force per square inch (psi) = 144 psf
- Pressure: 1 kilopound per square inch (ksi) = 1,000 psi

1.3 CONVERSIONS TO INTERNATIONAL SYSTEM OF UNITS (SI)

Typical conversion factors to the International System of Units (SI) from the standard units for the project are the following:

- Length: 1 ft = 0.305 meters (m)
- Length: 1 yd. = 0.914 m

- Length: 1 mi = 1.61 kilometers (km)
- Diameter: 1 in = 25.4 millimeters (mm)
- Area: 1 acre = 4,047 square meters (m^2)
- Area: 1 acre = 0.405 hectare (ha)
- Volume: 1 acre-ft = 1,233 cubic meters (m^3)
- Volume: 1 yd^3 = 0.765 m^3
- Volume: 1 ft^3 = 0.028 m^3
- Fluid volume: 1 gal = 3.785 litres (L)
- Fluid volume: 1 Mgal = 3,785 m^3
- Mass: 1 ton = 907 kilograms (kg)
- Mass: 1 ton = 0.907 tonnes (t)
- Density: 1 pcf = 16 kilograms per cubic meter (kg/m^3)
- Density: 1 pcf = 0.016 tonnes per cubic meter (t/m^3)
- Density: 1 $tons/yd^3$ = 1.19 tonnes per cubic meter (t/m^3)
- Pressure: 1 psf = 0.048 kilopascal (kPa)
- Pressure: 1 psi = 6.89 kilopascal (kPa)
- Power: 1 hp = 746 watts (W)
- Flow rate: 1 gpm = 0.227 cubic meters per hour (m^3/hr)
- Flow rate: 1 gpm = 0.063 litres per second (L/s)

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APPENDIX A2

Mapping, Surveys, and Site Controls

(Page A2-1)

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APPENDIX A2
MAPPING, SURVEYS, AND SITE CONTROLS

1.0 OVERVIEW

Project area mapping to document the existing site conditions across the project site was undertaken by the US Department of the Interior (USDOI) in 2009. LiDAR and 3D break-lines for approximately 170 miles on the Klamath River from Link River Dam, OR to the confluence with Elk Creek south of Happy Camp, CA, and surveys along with above and in-water cross-sections at each of nine bridges, were included in the study area (USDOI, 2010). The map projection for the project is as follows:

- Projection: California State Plane:
  - Zone: 1
  - FIPS zone: 0401
  - Vertical Datum: NAVD 1988
  - Horizontal Datum: NAD83
  - Unit: Feet

Site control will be established and verified by the Contractor. Scale factors will be established for the entire site for use in ground to UTM coordinate conversions if required.

Survey control will be established through surveyed benchmarks across the site. Benchmarks are expected to be established at the intake locations, along the penstock routes and at the powerhouse & switchyard locations. Benchmarks will also be established along the transmission line alignments and at major bridge and road crossings.

The Contractor will establish any other control points and benchmarks necessary to set out and construct the Works.

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APPENDIX A3

Geological Setting

(Pages A3-1 to A3-2)

APPENDIX A3
GEOLOGICAL SETTING

1.0 GENERAL

The Klamath River traverses multiple physiogeographic provinces starting in the Basin and Range Province of Oregon, traversing the High and Western Cascades, Klamath Mountains Province and the Coastal Ranges of northern California, and reaching the Pacific Ocean at Requa, 16 miles south of Crescent City. The Project area is predominantly contained in the Western and High Cascades. The Klamath River pre-dates the formation of the Cascade Mountain Range and maintained a relatively similar course through the mountain building events.

The bedrock of the Project Area comprises volcanic rocks (up to 45 million years old) and includes 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 in present times.

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 sites of the Copco No. 1 and J.C. Boyle Reservoirs when the Klamath River was temporarily ‘dammed’ by volcanic activity.

2.0 J.C. BOYLE HYDROELECTRIC FACILITY

The topography in the area of the J.C. Boyle hydroelectric facility is predominantly a low-gradient bowl with gently rolling terrain. The steepest topography exists in the river canyons upstream and downstream of the reservoir. All the bedrock units in the area are estimated to be younger than 5 million years and associated with High Cascades volcanism from large stratovolcanic complexes and smaller shield volcanoes and vents; these are typically basaltic flows interlayered with volcaniclastics and hydrovolcanic deposits, leading to highly complex geology from a large variety of sources.

Faulting is very prominent in the J.C. Boyle Reservoir area and appears to be associated with extensional tectonics of the Basin and Range Province that began approximately 1.5 to 2.0 million years ago. The bowl topography of the reservoir area likely formed as a dropped-down basin. At least one fault splay is predicted to extend into the dam area (PanGEO, 2008).

The surficial deposits at the reservoir comprise lacustrine deposits as well as river alluvium and local colluvial deposits. The lacustrine deposits comprise older sediments that were laid down in a former lake that was created when the river was temporarily ‘dammed’ by volcanic activity and recent sediments, which were deposited within the reservoir.

3.0 COPCO NO. 1 AND COPCO NO. 2 HYDROELECTRIC FACILITIES

The area surrounding the Copco No. 1 and Copco No. 2 reservoirs is characterized by hillsides comprised of low gradient lava flows from surrounding shield volcanoes. The Copco Basalt (0.14 million years) makes up the vertical upper walls of the canyon in the vicinity of the dam site. The Copco Basalt was created by

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volcanic flows from vents on both sides of the river, which led to damming of the river and the formation of a lake in the same area as the present-day reservoir. The Western Cascades Volcanics underlie most of the slopes on the shoreline of the reservoir. This unit comprises andesite with interstratified tuff-breccia, volcaniclastic sandstone and tuffs.

Small faults that have been historically mapped in the area of the Copco No. 1 and No. 2 hydroelectric facilities typically trend west to northwest south of the river. Limited structural mapping of faults north of the river shows a northward trend.

The surficial deposits at the Copco No. 1 Reservoir comprise lacustrine deposits as well as river alluvium and local colluvial deposits. The lacustrine deposits mainly comprise sediments that were laid down in a former lake that was created when the river was temporarily ‘dammed’ by volcanic activity. Fine sediments, comprising silts and diatomite (siliceous skeletal remains of diatoms) were deposited in the lake. The formation of the lake resulted in fluvial terraces and fans developing further still from the contemporary course of the river. Recent lacustrine deposits have accumulated within the reservoir since its construction. Colluvium occurs locally around the shoreline of the Copco No. 2 Reservoir.

Natural groundwater springs can be observed and typically exist in the tuffaceous layers between impermeable lava flows and along lithological contacts. The rapidly cooled more porous lava flow tops and bottoms are common aquifers in the region.

4.0 IRON GATE HYDROELECTRIC FACILITY

The Iron Gate Dam and its reservoir lie entirely within the Western Cascades Geologic Province. The bedrock around the shoreline comprises andesite and basalt with volcanic breccia, tuff, tuffaceous siltstones, and sandstones. The Western cascades strata dip gently towards the east. Surficial deposits around the reservoir shoreline include colluvium and local alluvial deposits at drainage line intersections.

Natural springs are also found in numerous locations on the valley slopes surrounding the Iron Gate Reservoir.

References:

PanGEO Incorporated (PanGEO), 2008. Geotechnical Report – Klamath River Dam Removal Project. August. Seattle, Washington, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015a. J.C. Boyle Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015b. Copco No. 1 Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015c. Iron Gate Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

APPENDIX A4

Seismicity

(Pages A4-1 to A4-2)

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APPENDIX A4
SEISMICITY

1.0 DESIGN PARAMETERS FOR TEMPORARY STRUCTURES

A standard and guideline review of DSOD, the California Water Code, Caltrans, USACE, ASCE, FEMA, FERC, USBR, and Uniform Building Code documents did not yield clear design criteria for the seismic design of temporary structures. KP has also reviewed the latest Supporting Technical Information Documents (STIDs) provided by PacifiCorp as they pertain to geology and seismicity at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate. It was determined from these documents that the site-specific ground motion parameters for permanent structures were developed by Kleinfelder West Inc. (Kleinfelder) and Black & Veatch using the 2002 United States Geological Survey (USGS) database. The seismic design parameters presented in this appendix have been determined using the updated USGS seismic hazard database in conjunction with a design life equal to or less than one year. The current data provided by the USGS seismic hazard database is based on the 2014 model which incorporates the latest ground motion prediction models for shallow crustal earthquakes (known as the Next Generation Attenuation Models).

The probability of exceedance for the Operating Basis Earthquake (OBE) and Maximum Credible Earthquake (MCE) events were assessed to quantify the risk associated with structures having a design life of 1 year. The probability of exceedance was calculated using the following equation:

$$Q = 1 - e^{-L/T}$$

Where: Q = probability of exceedance

L = design life (years)

T = return period (years)

The resulting probabilities of exceedance are as-follows:

- OBE (1/475-year event): 0.2% probability of exceedance
- MCE (1/2475-year event): 0.04% probability of exceedance

The OBE event was selected for the design of temporary structures having a design life of one year or less. The spectral accelerations corresponding to the OBE event at each site are presented with the OBE PGAs in Table 1.1.

Table 1.1 Selected Seismic Design Parameters for Temporary Structures at Each Site

Site	Return Period (years)	2014 USGS[1] PGA (g)	2014 USGS[1] Sa (0.2 s)	2014 USGS[1] Sa (1.0 s)
J.C. Boyle	475	0.17	0.39	0.14
Copco No. 1	475	0.12	0.26	0.10
Copco No. 2	475	0.12	0.26	0.10
Iron Gate	475	0.11	0.25	0.10

NOTES:

1. PGA AND SPECTRAL ACCELERATION VALUES TAKEN FROM THE USGS UNIFIED HAZARD TOOL DABATASE (USGS).

2.0 DESIGN PARAMETERS FOR PERMANENT SLOPES

Permanent slopes are designed to the MCE values provided in the STIDs for the hydropower facilities. The STIDs are presented in Appendix J.

References:

Black & Veatch, 2010. Copco No. 1 Development Klamath River Hydroelectric Project, FERC Project No. 2082 – Seismic Analysis of Structures. January 12.

Black & Veatch, 2009. Technical Memorandum – Time Histories for J.C. Boyle Dam. September 4.

Black & Veatch, 2004. 5.A Seismicity – Iron Gate. September 15.

Kleinfelder West Inc. (Kleinfelder), 2009a. Geoseismic Evaluation Report – J.C. Boyle Dam. June 19. Salt Lake City, Utah, USA.

Kleinfelder West Inc. (Kleinfelder), 2009b. Geoseismic Evaluation Report – Copco No. 1 Dam. June 19. Salt Lake City, Utah, USA.

Kleinfelder West Inc. (Kleinfelder), 2009c. Geoseismic Evaluation Report – Iron Gate Dam. June 19. Salt Lake City, Utah, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015a. J.C. Boyle Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015b. Copco No. 1 Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

PacifiCorp Energy Inc. (PacifiCorp), 2015c. Iron Gate Development: Supporting Technical Information Document, Section 5 – Geology and Seismicity. April 30. Portland, Oregon, USA.

United States Geological Survey (USGS). Earthquake Hazards Program: Uniform Hazard Tool. (Accessed from: https://earthquake.usgs.gov/hazards/interactive/)

APPENDIX A5

Climate

(Pages A5-1 to A5-8)

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APPENDIX A5
CLIMATE

1.0 OVERVIEW

The Project sites are located in predominantly rural areas of southern Oregon and northern California, along the riparian corridors of the Klamath River and its tributaries. The local climate is characterized by cool, wet winters and warm, dry summers. Cold air temperatures generally occur from November through March and warmer air temperatures and drier conditions occur from April through October with summer air temperatures highest in July, August, and September. The summers are dry with occasional isolated thunderstorms from July to September (Oregon Watershed Enhancement Manual, 2001).

The area is characterized by varying precipitation with a drier climate near Klamath Falls, Oregon and a wetter climate in northern California. Most precipitation occurs in the winter months of November, December and January (Oregon Watershed Enhancement Manual, 2001). Due to generally high elevations, the upper plateau has cool temperatures and receives a substantial amount of snow, which accumulates into moderately deep snowpack (Oregon Watershed Enhancement Manual, 2001). At its higher elevations (above 5,000 feet), the Klamath Basin receives rain and snow during the late fall through to spring.

2.0 AVAILABLE DATA

The National Oceanic and Atmospheric Administration (NOAA) operate several cooperative climate stations in the region. The regional climate datasets most relevant to the Project sites are:

- Keno, Oregon: NCEI COOP #354403 (6 miles from J.C. Boyle facility)
- Copco Dam No. 1, California: NCEI COOP #041990 (located at Copco No. 1 facility)

The location of the regional climate stations and the Project sites are shown on Figure 2.1.

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Figure 2.1 Regional Climate Station Locations and Project Locations

2.1 TEMPERATURE

Data from the regional climate station within the closest proximity to each site was selected to represent the temperatures at that Project site. Available temperature data for the regional climate stations are presented in Table 2.1. The mean annual air temperature range is 44°F to 52°F between Keno, Oregon climate stations and Copco Dam No. 1, California. The months with the highest mean temperatures for the stations are July through September with maximum monthly mean temperatures ranging between 68°F and 75°F. The lowest minimum monthly mean temperatures are in January and December ranging between 29°F and 36°F.

Table 2.1 Measured Regional Temperature Data Summary

Station Details[1]	Unit	Keno, OR	Copco Dam No. 1, CA
Station Number	-	35-4403	04-1990
Latitude	° ' "	42° 7' 46.92" N	41° 58' 46.92" N
Longitude	° ' "	121° 55' 46.92" W	122° 20' 16.08" W
Elevation	ft	4,116	2,703
Distance from Site			
Nearest Project Site(s)	-	J.C. Boyle	Copco No. 1, Copco No. 2, Iron Gate
Distance from Site	mi	6.2	6.0 from Iron Gate
Period of Record[2]	-	1927-2019	1959-2019
Measured Values[3, 4]			
Mean Annual	ºF	44.4	52.1
Mean Annual High	ºF	58.5	65.7
Mean Annual Low	ºF	29.1	38.6
Maximum Monthly Mean	ºF	68.4	75.3
Minimum Monthly Mean	ºF	29.0	35.9
Maximum Recorded Daily	ºF	103	115
Minimum Recorded Daily	ºF	-20	-2

NOTES:
1. DATA OBTAINED FROM NOAA ATLAS 14 – PRECIPITATION-FREQUENCY ATLAS OF THE UNITED STATES (2014).
2. THE PERIOD OF RECORD IDENTIFIES WHEN THE FIRST AND LAST MEASUREMENTS WERE TAKEN AND DOES NOT REPRESENT A CONTINUOUS PERIOD OF DATA COLLECTION.
3. MEASURED TEMPERATURE VALUES OBTAINED FROM NOAA REGIONAL CLIMATE CENTERS (ACIS, 2015).
4. MEASURED TEMPERATURE VALUES REPRESENT RECORDED DATA ONLY.

2.2 PRECIPITATION

Precipitation values for the project sites were derived in a similar manner to the temperature values, with the nearest regional climate station data providing the representative values for each specific project site. The wettest months are November through January. The proportion of precipitation falling as snow is directly correlated to temperature, which varies with each location within the Project region. In the upper watershed, snow is the primary form of precipitation for elevations above 5,000 feet.

The maximum daily rainfall range observed (recorded) at the regional climate stations is 3.0 inches and 6.0 inches for the Copco Dam No. 1 and Keno climate stations, respectively. The daily rainfall was converted to an equivalent 24-hr rainfall using a standard factor of 1.13 (Hershfield, 1961) resulting in maximum 24-hr rainfall of 3.4 inches to 6.8 inches for the Copco Dam No. 1 and Keno climate stations, respectively. The precipitation values are summarized in Table 2.2 and the mean monthly precipitation values are summarized in Table 2.3.

Table 2.2 Measured Regional Precipitation Summary[1, 2]

	Unit	Keno, OR	Copco Dam No. 1, CA
Period of Record[3]	-	1927-2019	1959-2019
Mean Annual Precipitation	in.	18.6	19.7
Mean Total Annual Rainfall	in.	13.4	18.0
Percentage of Annual Precipitation as Rain	%	72%	91%
Mean Total Annual Snowfall	in.	51.5	16.8
Mean Total Annual SWE[4]	in.	5.1	1.7
Maximum Recorded 24-hour Precipitation[5]	in.	6.8	3.4

NOTES:

1. DATA OBTAINED FROM NOAA REGIONAL CLIMATE CENTERS (ACIS, 2015).
2. MEASURED PRECIPITATION VALUES REPRESENT RECORDED DATA ONLY.
3. THE PERIOD OF RECORD IDENTIFIES WHEN THE FIRST AND LAST MEASUREMENTS WERE TAKEN AND DOES NOT REPRESENT A CONTINUOUS PERIOD OF DATA COLLECTION.
4. SWE – SNOW WATER EQUIVALENT. VALUES DETERMINED ASSUMING SNOW WATER EQUIVALENCY CONVERSION FACTOR OF 0.1 (NRCS).
5. MAXIMUM RECORDED 24-HOUR PRECIPITATION WAS DETERMINED BY APPLYING A 1.13 FACTOR (HERSHFIELD, 1961) TO THE MAXIMUM RECORDED DAILY PRECIPITATION.

Table 2.3 Measured Regional Mean Monthly Precipitation

	Keno, OR	Copco No. 1 Dam, CA	Keno, OR	Copco No. 1 Dam, CA	Keno, OR	Copco No. 1 Dam, CA
	Average Precipitation (in)		Average Number of Days with Precipitation >0.5 in		Average Total Snowfall (in)	
Jan	2.9	3.0	4	3	14.8	5.4
Feb	2.0	2.2	3	3	9.8	2.8
Mar	1.9	2.1	4	3	6.1	1.6
Apr	1.3	1.6	3	2	1.9	0.5
May	1.2	1.3	3	2	0.2	-
Jun	0.8	0.8	2	1	-	-
Jul	0.3	0.3	1	1	-	-
Aug	0.5	0.4	1	1	-	-
Sep	0.6	0.6	1	1	-	-
Oct	1.5	1.3	2	2	0.5	-
Nov	2.5	2.9	3	3	5.8	1.7
Dec	3.2	3.4	4	3	12.8	5.1
Mean Annual	18.6	19.7	32	24	51.5	16.8

The intensity duration frequency (IDF) data for the Copco Dam No. 1 climate station were provided by NOAA's Precipitation Frequency Data Server (NOAA, 2017). NOAA provides data for recurrence periods

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from 1 to 1,000 years with durations ranging from 5 minutes to 60 days. The IDF data for the Copco Dam No. 1 climate station is tabulated in Table 2.4 and are representative of the Copco No. 1, Copco No. 2, and Iron Gate Project Sites.

Table 2.4 IDF Data for Copco Dam No. 1 Climate Station (inches)

Duration	Recurrence Interval (yrs)									
	1-yr	2-yrs	5-yrs	10-yrs	25-yrs	50-yrs	100-yrs	200-yrs	500-yrs	1,000-yrs
5-min	0.10	0.14	0.20	0.24	0.31	0.36	0.41	0.47	0.62	0.77
10-min	0.15	0.20	0.28	0.35	0.44	0.51	0.59	0.68	0.89	1.10
15-min	0.18	0.25	0.34	0.42	0.53	0.62	0.72	0.82	1.07	1.33
30-min	0.24	0.33	0.45	0.55	0.70	0.82	0.95	1.09	1.42	1.76
60-min	0.32	0.44	0.60	0.74	0.94	1.10	1.27	1.46	1.91[1]	2.36[1]
2-hr	0.45	0.59	0.77	0.92	1.13	1.30	1.47	1.65	1.93[1]	2.38[1]
3-hr	0.55	0.70	0.90	1.07	1.30	1.47	1.65	1.84	2.09	2.41
6-hr	0.79	0.98	1.23	1.43	1.70	1.91	2.12	2.34	2.63	2.85
12-hr	1.10	1.36	1.70	1.98	2.36	2.66	2.96	3.26	3.68	4.01
24-hr	1.57	1.96	2.47	2.90	3.50	3.98	4.47	4.99	5.70	6.28
2-day	1.98	2.50	3.20	3.78	4.61	5.26	5.94	6.67	7.68	8.50
3-day	2.29	2.91	3.76	4.46	5.46	6.24	7.07	7.94	9.16	10.10
4-day	2.48	3.18	4.11	4.89	5.97	6.83	7.71	8.65	9.95	11.00
7-day	2.90	3.73	4.81	5.69	6.90	7.83	8.78	9.77	11.10	12.10
10-day	3.22	4.15	5.34	6.31	7.61	8.59	9.59	10.60	12.00	13.00
20-day	4.16	5.40	6.98	8.22	9.86	11.10	12.30	13.50	15.10	16.30
30-day	5.07	6.61	8.53	10.00	12.00	13.40	14.90	16.30	18.10	19.50
45-day	6.42	8.36	10.80	12.60	15.10	16.80	18.50	20.20	22.40	24.00
60-day	7.56	9.80	12.60	14.70	17.40	19.40	21.30	23.20	25.60	27.40

NOTES:

1. THE 500-YR AND 1,000-YR 60-MIN AND 2-HR VALUES WERE FLAGGED AS POTENTIALLY ERRONEOUS DUE TO MINIMAL INCREASE IN RAINFALL WITH INCREASE IN STORM DURATION.
2. IDF DATA TAKEN FROM NOAA'S PRECIPITATION FREQUENCY DATA SERVER (NOAA, 2017).

The IDF curves for the Keno climate station were determined using information provided by the Oregon Department of Transportation (ODOT) and supplemented by data available through the Western Regional Climate Center (WRCC). Intensity Duration Recurrence (IDR) information is dictated by the Oregon Rainfall IDR Curve Zone Map as stipulated in the ODOT Hydraulics Manual (ODOT, 2014). The Rainfall IDR Curve Zone Map is shown in Figure 2.2.

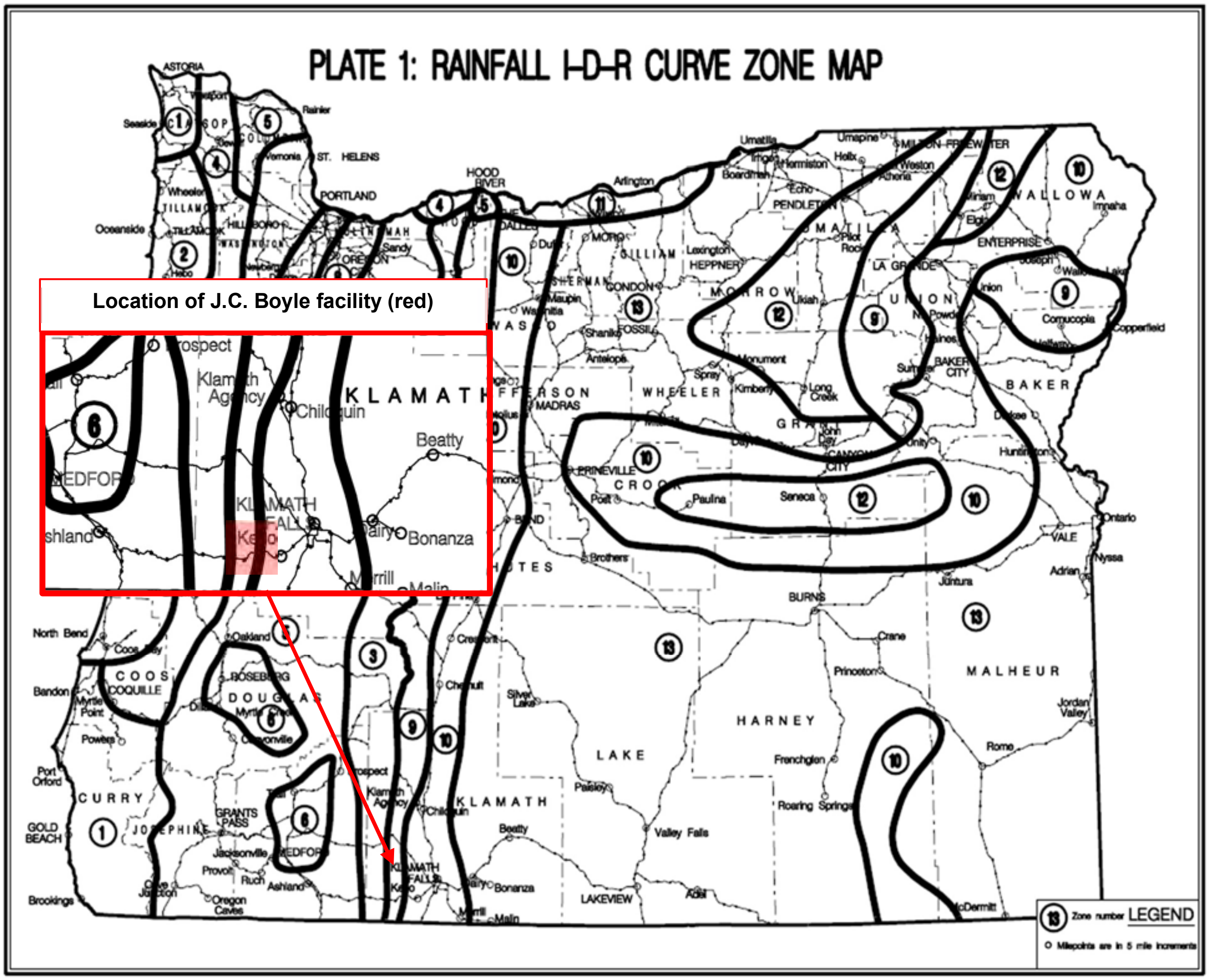

Figure 2.2 ODOT Rainfall IDR Curve Zone Map and Approximate Location of J.C. Boyle (ODOT, 2014)

The zoning map is used to identify which IDR data should be applied to a site. Zone 9 has been selected as representative of the IDR data for the J.C. Boyle project site based on the site location. The IDR rainfall intensity data for Zone 9 is tabulated in Table 2.5.

Table 2.5 IDR Data for Oregon Zone 9 (inches)

Duration	Recurrence Interval (yrs)					
	2-yrs	5- yrs	10-yrs	25-yrs	50-yrs	100-yrs
5-min	0.13	0.18	0.21	0.25	0.29	0.34
10-min	0.19	0.28	0.33	0.40	0.44	0.52
15-min	0.25	0.35	0.41	0.50	0.58	0.66
30-min	0.34	0.48	0.58	0.70	0.80	0.90
60-min	0.44	0.64	0.73	0.88	1.05	1.15
2-hr	0.58	0.82	0.90	1.04	1.20	1.38
3-hr	0.72	0.96	1.08	1.23	1.38	1.59
6-hr	1.02	1.32	1.50	1.62	1.80	2.04
24-hr	2.00	2.50	2.80	3.20	3.80	4.00

NOTES:

1. DATA FOR RECURRENCE PERIODS FROM 2 TO 100 YEARS WITH DURATIONS RANGING FROM 5 MINUTES TO 6 HOURS PROVIDED BY ODOT (ODOT, 2014).
2. 24-HOUR DURATION EVENT DATA PROVIDED BY WRCC PRECIPITATION FREQUENCY MAPS PUBLISHED IN NOAA ATLAS 2 AND REPRESENTS THE IDF DATA FOR THE WHOLE STATE OF OREGON (WRCC, 1973).

2.3 WIND

Regional wind data was not available for the Copco Dam No. 1 and Keno climate stations at the time of the preparation of this report. Wind is a design parameter required for the design of bridges and piers. The American Association of State Highway and Transportation Officials (AASHTO) requires a wind velocity at 30 ft (V_{30}) above low ground/above design water level and recommends the adoption of V_{30} = 100 mph in the absence of site-specific wind data (AASHTO, 2012). This value has been adopted for the design. Alternative wind velocities may be considered to evaluate freeboard requirements specific to wave run-up and set-up considerations.

References

American Association of State Highway and Transportation Officials (AASHTO), 2012. *Load and Resistance Factor Design Bridge Design Specifications.* 6th Edition. Washington, DC, USA.

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APPENDIX A6

Hydrology

(Pages A6-1 to A6-32)

APPENDIX A6
HYDROLOGY

1.0 WATERSHED DESCRIPTION

The Klamath River originates at the outlet of Upper Klamath Lake in southern Oregon and flows approximately 250 miles southwest through the Cascade Mountains of southern Oregon and northern California to the Pacific Ocean. The Upper Klamath Basin has five main lakes: Crater Lake, Upper Klamath Lake, Lower Klamath Lake, Clear Lake, and Tule Lake. The Upper Klamath Basin contains all the hydroelectric developments on the Klamath River, including the Klamath River Renewal Project (KRRP) sites. The Middle Klamath Basin extends 150-miles from Iron Gate Dam downstream to the Trinity River confluence. The Lower Klamath Basin starts at the Trinity River confluence and extends 43 miles downstream to the Pacific Ocean.

The Upper Klamath Basin has broad valleys shaped by volcanoes and active faulting. The fault-bounded valleys contain all the large, natural lakes and large wetlands of the Klamath Basin. The Klamath River flows through mountainous terrain from J.C. Boyle Dam to Iron Gate Dam. Downstream of Iron Gate Dam, and for most of the river's length from there to the Pacific Ocean, the river maintains a relatively steep, high-energy channel (NRC, 2004).

A map of the reach containing the four PacifiCorp dams covered by the KRRP is given on Figure 1.1.

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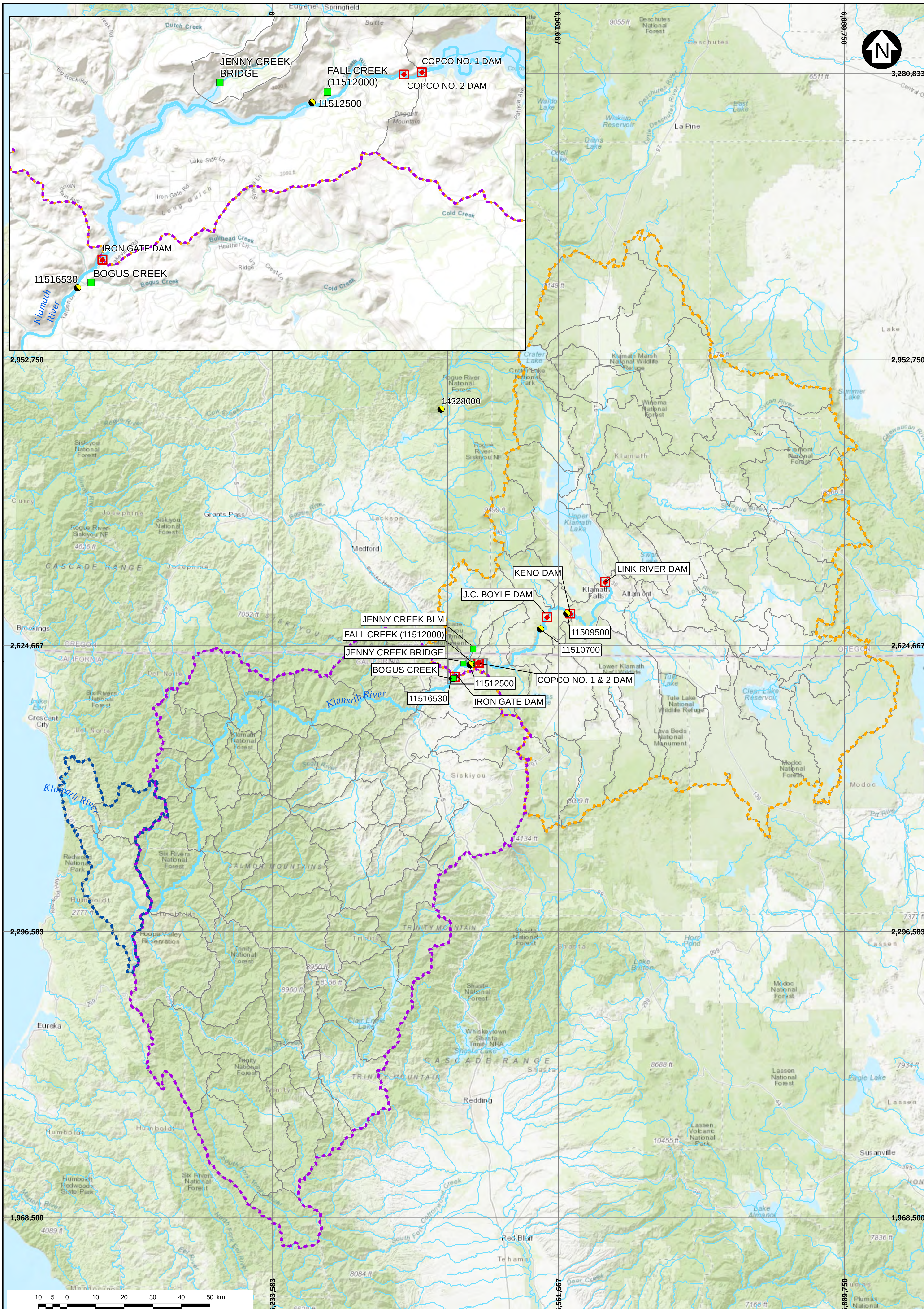

LEGEND:

- ADDITIONAL HYDROLOGY STATION
- USGS STATION
- DAM LOCATION
- KLAMATH RIVER
- LOWER KLAMATH BASIN
- MIDDLE KLAMATH BASIN
- UPPER KLAMATH BASIN
- SUB-CATCHMENT

NOTES:

1. BASE MAP: ESRI ONLINE TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE CALIFORNIA I FIPS 0401 FT US.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:1,250,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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KLAMATH RIVER RENEWAL PROJECT

KLAMATH WATERSHED BASIN

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-640/1	9

FIGURE 1.1 REV C

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
C	12NOV'20	ISSUED WITH REPORT	ELK	KK	AS

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2.0 KLAMATH RIVER AVERAGE MONTHLY FLOW CONDITIONS

The US Bureau of Reclamation (USBR) stores, diverts, and conveys the waters of the Klamath and Lost Rivers to serve authorized Klamath Irrigation Project (Irrigation Project) purposes. The Bureau is required to meet contractual obligations in compliance with state and federal laws and to carry out the activities necessary to maintain the Irrigation Project and maintain its proper long-term functioning and operation. Biological assessments have been prepared to evaluate the potential effects of the continued operation of the Irrigation Project on species listed as threatened or endangered under the Endangered Species Act (ESA). The biological assessments have been prepared pursuant to Section 7(a)(2) of the ESA of 1973, as amended (16 United States Code [USC.] § 1531 et seq.).

Several Section 7 Consultations and Biological Opinions (BiOp's) have governed the operation of Upper Klamath Lake (UKL) and the Irrigation Project since the 1990's (USBR, 2012). The consultations involve the National Marine Fisheries Service (NMFS), also known as NOAA Fisheries, as well as the US Fish and Wildlife Service (FWS) and the USBR. The USBR currently meets its obligations under the ESA by operating the Irrigation Project in accordance with the latest FWS and NMFS BiOp, dated March 29, 2019. This BiOp is based on information provided in the USBR's Final Biological Assessment (USBR, 2018) and is effective April 1, 2019 through March 31, 2029. The latest BiOp operating conditions will govern the Klamath River during the dam removal and reclamation activities of the KRRP.

The USBR uses results generated by the Water Resources Integrated Modeling System (WRIMS) to identify the Klamath River and Upper Klamath Lake hydrographs that are likely to occur as a result of implementing the proposed operations across the full range of reasonably foreseeable annual precipitation and hydrologic patterns. WRIMS is a generalized water resources modeling system for evaluating operational alternatives of large, complex river basins. USBR has developed a WRIMS model specific to the Klamath Basin, which is referred to as the Klamath Basin Planning Model (KBPM). The KBPM incorporates the 2019 BiOp operating conditions and models the Klamath River flows. WRIMS is used to estimate mainstem Klamath River flows at the US Geological Survey (USGS) gages located near the Keno and Iron Gate Dam facilities. While the KBPM captures the hydrology under a wide range of plausible conditions, the unique sequencing and patterns of climatological and hydrological events that will occur in the future cannot be predicted.

There are 36 years (October 1980-November 2016) of daily average flows for the Keno and Iron Gate USGS gages as modeled using the KBPM (USBR, 2018). These daily flows were used to calculate the monthly average inflows for each of the four KRRP facilities. The Keno values were prorated by the ratio of the respective drainage areas to generate values for J.C. Boyle. The Iron Gate values were prorated by drainage area to generate values for Copco No. 1 and Copco No. 2. Area proration is a conventional method to determine flows at ungaged locations, particularly for locations on the same river system (Maidment, 1993). The monthly average flows for the four KRRP sites are shown in Table 2.1 and on Figure 2.1 for each facility. In addition to the monthly average flows for the period of record, Figure 2.1 also includes the range of average monthly flows at each facility for the 36 years of BiOp flows used in the KBPM model. Figure 2.2 is an example ensemble plot of daily average flows at the Iron Gate USGS gage on which each line represents a single year (also referred to as a spaghetti plot). This figure overlaps 36 years of BiOp flows on a common x-axis that spans January 1 to December 31, and highlights the variability of maximum daily flows in each month.

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Table 2.1 Monthly Average Flows at Project Sites

Facility	Keno[1]	J.C. Boyle[2]	Copco No. 1[2,3]	Iron Gate[1]
Drainage Area (mi^2)	**3,920**	**4,080**	**4,370**	**4,630**
Month	**Monthly Average Flow (cfs)**			
January	1,450	1,500	1,910	2,030
February	1,820	1,900	2,360	2,500
March	2,690	2,800	3,230	3,430
April	2,270	2,370	2,790	2,950
May	1,690	1,760	2,110	2,230
June 1 – 15	1,280	1,330	1,620	1,720
June 16 – 30	920	960	1,210	1,280
July 1 – 15	710	740	990	1,050
July 16 – 31	730	760	990	1,050
August	730	760	980	1,040
September 1 – 15	780	810	1,030	1,090
September 16 – 30	760	790	1,030	1,090
October 1 – 15	780	810	1,050	1,120
October 16 – 31	860	890	1,140	1,210
November 1 – 15	940	980	1,230	1,300
November 16 – 30	910	950	1,240	1,310
December	1,070	1,110	1,490	1,580
Average Annual Flow (cfs)	1,330	1,390	1,710	1,820
Average Annual Unit Flow (cfs/mi^2)	0.34	0.34	0.39	0.39

NOTES:

1. 2019 BIOP FLOWS (USBR, 2018) WERE USED AS THE REPRESENTATIVE INCOMING FLOWS TO THE FACILITY BASED ON THE PERIOD OF RECORD FROM 1980 - 2016.
2. J.C. BOYLE INFLOWS WERE CALCULATED USING THE 2019 BIOP FLOWS AT THE USGS KENO GAGE USING LINEAR AREA PRORATION. COPCO NO. 1 INFLOWS WERE CALCULATED USING THE 2019 BIOP FLOWS AT THE USGS IRON GATE GAGE USING LINEAR AREA PRORATION.
3. MONTHLY AVERAGE INFLOWS AT COPCO NO. 2 ARE ASSUMED TO BE THE SAME AS THE MONTHLY AVERAGE INFLOWS AT COPCO NO. 1.

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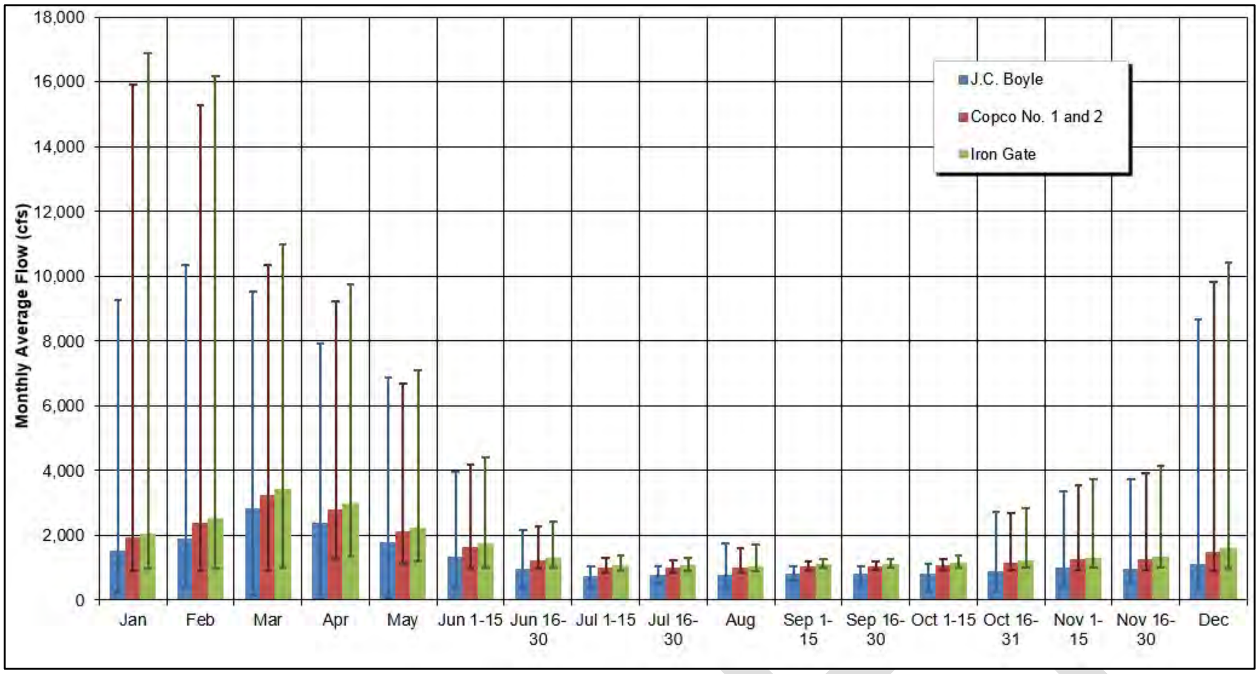

Figure 2.1 Monthly Average BiOp Flows at Project Sites

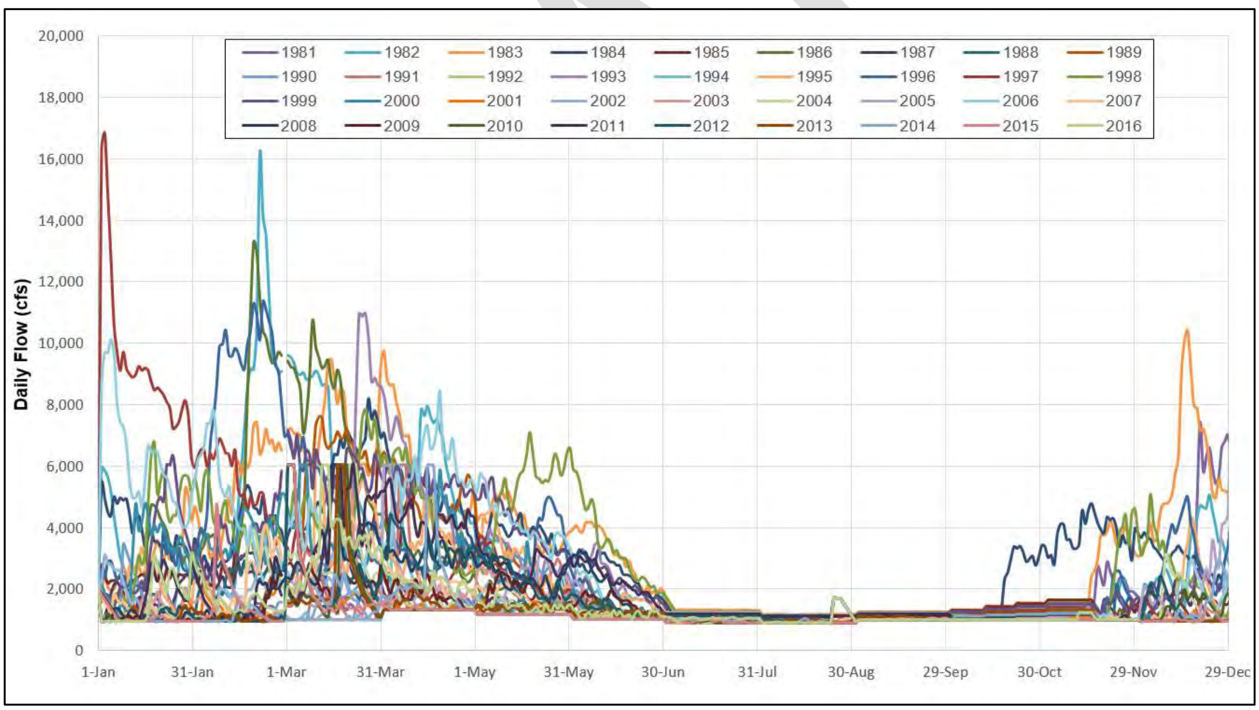

Figure 2.2 Daily Average BiOp Flows at the Iron Gate USGS Gage

The annual patterns of streamflows apparent in the above hydrographs are characterized by the following throughout the Klamath basin:

- High flows in the spring (March and April) due to spring snowmelt runoff (freshet), in the Upper Klamath basin and unregulated tributaries.
- Lower flows in mid-summer to late fall (July through October) due to reduced precipitation during the summer months.
- Increasing flows throughout the winter months (November through February) due to progressively increasing precipitation (which falls as snow in the upper elevations and rain in the lower elevations).

The regulation of Upper Klamath Lake is done with respect to the streamflow patterns seen on Figure 2.1.

- The reservoirs are not designed to mitigate floods and are typically full during the annual peak flows due to the timing of these events and, therefore, attenuation of these storms is limited. During the summer months when the reservoirs have more storage capacity the flood attenuation potential is greater.

The tributary flows contribute high flows during freshet that cannot be mitigated compared to much lower flows during the summer period when flow is mostly from the mainstem. The annual hydrograph on Figure 2.1 indicates that the highest monthly average flows occur in March during spring runoff, but the largest peak flow events generally occur in January and February, as indicated by the maximum range of daily flows shown on Figure 2.1 and Figure 2.2. These peak flows are driven by rain on snow events and govern annual flood events.

The peak floods at Iron Gate can be substantially greater than the peak floods at J.C. Boyle due to the tributaries that enter the Klamath River between the two facilities. The largest tributary between the Keno and Iron Gate facilities is Jenny Creek which contributes a high amount to the flow during the late-winter and spring snowmelt months. The hydrology of Jenny Creek is further described in Section 5.1.

3.0 KLAMATH RIVER PEAK FLOODS

3.1 ANNUAL PEAK FLOODS

3.1.1 METHODOLOGY

Various return period design flood estimates are required for design purposes. Peak flood estimates for the Project area were developed using both the historical USGS gage streamflow data and the developed 2019 BiOp flow data (USBR, 2018). Annual peak flows were determined from both datasets and used to estimate the annual return period peak flows. Flood frequency analyses were performed on the annual peak flow data using the HEC-SSP software, following the Bulletin 17B method for Log-Pearson Type III distribution (USGS, 1982). A detailed description of the analyses for each dataset is outlined in the sections below.

3.1.2 HISTORIC USGS GAGE DATA

The USGS operates several stream gages on the Klamath River within proximity of the Project area. The station details of the regional datasets most relevant to the KRRP are provided in Table 3.1 and shown on Figure 1.1.

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Table 3.1 USGS Regional Streamflow Gaging Stations

USGS Gaging Station No.	Station Name	Drainage Area (mi²)	Longitude	Latitude	Period of Record
11509500	Klamath River at Keno, OR	3,920	42°08'00"	121°57'40"	1905-1913 1930-2017
11510700	Klamath River below John C. Boyle Power Plant near Keno, OR	4,080	42°05'05"	122°04'20"	1959-2017
11512500	Klamath River below Fall Creek near Copco, CA	4,370	41°58'20"	122°22'05"	1923-1961
11516530	Klamath River below Iron Gate Dam, CA	4,630	41°55'41"	122°26'35"	1960-2017

The annual peak flow data for the USGS gages was imported to the United States Army Corps of Engineers' (USACE) HEC-SSP software (V2.1) and used for the flood frequency analyses. A low flow threshold, below which flows did not fit the distribution, were determined by assessing the flood-frequency curves. The data visually fit within the 95 percent confidence limit of the distribution for all locations except J.C. Boyle. Accordingly, the J.C. Boyle data below 3,400 cfs was identified as low flow outliers and the Bulletin 17B procedures were followed to adjust the flood probabilities to account for these low outliers.

The period used for the peak flow analysis is from 1960 onwards. The USGS records for the J.C. Boyle and Iron Gate Dam gages begin after 1960 and account for the effects of many of the reservoirs within the Klamath River basin. This period also includes the flood of record for the Klamath region, which occurred in December 1964 (water year 1965). Copco No. 1 has a peak flow record for the period of 1923 to 1961, which is outside the selected period of analysis. Accordingly, the return period peak flows for Copco No. 1 were calculated by scaling the flood flows at Iron Gate according to the methodology described in "Estimation of Peak discharges for Rural, Unregulated streams in Western Oregon" (USGS, 2005). This approach, which indicates direct linear scaling with an exponent 1.0, results in conservative flood estimates for Copco No. 1 since the peak floods at Iron Gate are substantially greater than the peak floods at J.C. Boyle due to the tributary flows that enter the Klamath River between the two facilities.

Annual peak flood results using the historical USGS data are presented in Table 3.2.

3.1.3 2019 BIOLOGICAL OPINION DATA

The 2019 BiOp flows (USBR, 2018) are comprised of 36 years (1980-2016) of average daily flows for both the USGS gages at Keno and Iron Gate. The daily flows were converted to instantaneous peak floods using conversion factors that were calculated by comparing the annual maximum instantaneous flows to the corresponding daily flows using data available from the USGS gages located downstream of J.C. Boyle (11510700, Klamath River BLW John C Boyle Powerplant, Nr Keno OR) and downstream of Iron Gate Dam (11516530, Klamath River below Iron Gate Dam, CA). The locations of these gages are shown on Figure 1.1. The comparisons indicate that the annual maximum instantaneous floods are approximately 10% higher than the daily flows for the same day. Conversion factors of 1.10 and 1.12 were used to adjust the available 2019 BiOp daily flows into instantaneous peak floods for the Keno and Iron Gate data, respectively. The instantaneous peak flood data at Keno and Iron Gate were used for the flood frequency analyses.

The J.C. Boyle and the Copco No. 1 annual peak floods were calculated using the area proration methodology described in "Estimation of Peak discharges for Rural, Unregulated streams in Western

Oregon" (USGS, 2005), based on the annual BiOp flood frequency results for the Keno and Iron Gate facilities, respectively. The peak flood results from the Iron Gate facility were used in preference to those at Keno to estimate flood values at the Copco No. 1 facility because the Iron Gate flows demonstrate proportionally greater flood flows than the flows at the upstream facility and therefore better represent the effects of the relatively large peak flow contributions from the mostly unregulated tributary creeks and rivers that inflow between the upstream facility and Copco No. 1.

Annual peak flood results using the 2019 BiOp flow data are presented in Table 3.2.

3.1.4 ANNUAL PEAK FLOOD VALUES FOR DESIGN

The historic USGS data and the 2019 BiOp data were both used to estimate annual return period floods at the Klamath River hydroelectric facilities. The 2019 BiOp operating conditions may change the timing and/or volumes of the Klamath River and, therefore, needed to be included in the peak flood analysis in addition to the historical flows seen at the USGS gages. The 2019 BiOp operating conditions are especially important for the monthly peak floods as these floods are more influenced by the regulation of the Klamath River from the upstream facilities. The flood values selected as the recommended design values are the maximum values between these two datasets, as shown in Table 3.2. The annual return period floods at Copco No. 1 are also used as representative of the annual return period floods for Copco No. 2.

Table 3.2 Annual Peak Floods

Location	Drainage Area (mi^2)	Annual Percent Probable Flood (cfs)							
		50%	20%	10%	5%	2%	1%	0.50%	0.20%
Historic USGS Data									
J.C. Boyle	4,080	5,300	8,500	10,300	11,700	13,300	14,200	15,000	15,800
Copco No. 1	4,370	5,600	10,300	14,000	18,200	24,200	29,400	35,000	43,200
Iron Gate	4,630	5,900	10,900	14,900	19,300	25,700	31,200	37,100	45,800
2019 Biological Opinion Data									
J.C. Boyle	4,080	7,000	8,400	9,500	10,400	11,800	12,900	14,100	15,600
Copco No. 1	4,370	7,100	9,400	11,500	14,000	17,800	21,300	25,500	32,100
Iron Gate	4,630	7,500	10,000	12,200	14,800	18,900	22,600	27,000	34,100
Recommended Design Values[1]									
J.C. Boyle	4,080	7,000	8,500	10,300	11,700	13,300	14,200	15,000	15,800
Copco No. 1	4,370	7,100	10,300	14,000	18,200	24,200	29,400	35,000	43,200
Iron Gate	4,630	7,500	10,900	14,900	19,300	25,700	31,200	37,100	45,800

3.1.4.1 ANNUAL FLOWS WITH HIGH PROBABILITY OF EXCEEDANCE

The 2019 BiOp data were used to estimate the annual peak floods at the Klamath River hydroelectric facilities that have high probabilities of exceedance that will occur more frequently. These values were determined as per the methodology described in Section 3.1.1 and are summarized in Table 3.3. The annual percent probable floods at Copco No. 1 are used as representative of the annual percent probable floods for Copco No. 2.

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Table 3.3 Flows with High Probabilities of Exceedance

Location	Drainage Area (mi²)	Annual Percent Probable Flood (cfs)		
		99.9%	80.0%	66.7%
J.C. Boyle[1]	4,080	4,600	5,900	6,400
Copco No. 1[2]	4,370	5,200	5,900	6,400
Iron Gate	4,630	5,500	6,300	6,800

NOTES:

1. CALCULATED BASED ON KENO RESULTS (USING 2019 BIOP FLOWS) USING METHODOLOGY DESCRIBED IN "ESTIMATION OF PEAK DISCHARGES FOR RURAL, UNREGULATED STREAMS IN WESTERN OREGON" (USGS, 2005).
2. CALCULATED BASED ON IRON GATE RESULTS (USING 2019 BIOP FLOWS) USING METHODOLOGY DESCRIBED IN "ESTIMATION OF PEAK DISCHARGES FOR RURAL, UNREGULATED STREAMS IN WESTERN OREGON" (USGS, 2005).

3.2 PEAK FLOODS FOR MONTHLY TIME PERIODS

3.2.1 GENERAL

A flood frequency analysis was performed for monthly periods to better define the risk of flooding events occurring during the dam removal period. The flood frequency analysis used to determine monthly return period peak flows was the same as that used for the annual return period flows, as described in previous sections. The data indicate that the areal extent of freshet snowmelt contributing to peak flows diminishes greatly in the second half of June, and therefore the month of June was divided into two periods for peak flood analysis purposes: June 1 to June 15 and June 16 to June 30. Additional months that were subdivided into two periods include July, September, October, and November. These months were subdivided to support the proposed construction schedule.

3.2.2 HISTORIC USGS GAGE DATA

Daily data for the USGS stations (J.C. Boyle and Iron Gate Dam, Table 3.1) were used to calculate the monthly peak floods. Daily discharge data from January 1960 up until the most recent data available were used for the monthly flood frequency analyses.

The Iron Gate data source was USGS station 11516530. The J.C. Boyle data source was USGS station 11510770 and flows below 3400 cfs were treated as low flow outliers due to the influence of upstream activity. The daily flows of both datasets were converted to equivalent instantaneous 24-hr floods using the conversion factors developed for each site during the annual flood frequency analysis, as discussed above. It is recognized that the instantaneous to daily ratios would tend to vary monthly depending on the source of the flood flows and the amount of upstream flow regulation, but the regulation from upstream reservoirs would tend to limit the size of the ratios to less than the annual peak ratios, so use of annual ratios results in reasonably conservative instantaneous peak flow estimates.

A flood frequency analysis was performed on the monthly peak flows using the HEC-SSP software (V2.1), following the Bulletin 17B method for Log-Pearson Type III distributions (USGS, 1982). The monthly peak floods for Copco No. 1 were calculated using non-linear proration with calculated Iron Gate monthly peak values using the methodology described in “Estimation of Peak Discharges for Rural, Unregulated Streams in Western Oregon” (USGS 2005). Table 3.4 provides the flood frequency results for the specified time periods.

The historic USGS flows are regulated flows and are influenced by the operation of the reservoirs on the Klamath River. This regulation makes it possible for some monthly peak flows to be higher at J.C. Boyle than at Iron Gate.

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TABLE 3.4

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PEAK FLOODS FOR SPECIFIED TIME PERIOD
USING HISTORIC USGS GAGE DATA

Location	Drainage Area (mi^2)	Month	Instantaneous Peak Floods for Specified Time Period (cfs)							
			50% Probable Flood	20% Probable Flood	10% Probable Flood	5% Probable Flood	2% Probable Flood	1% Probable Flood	0.5% Probable Flood	0.2% Probable Flood
		Jan	2,600	4,400	6,000	8,000	11,100	14,000	15,000	15,800
		Feb	2,700	4,900	6,900	9,200	13,000	14,200	15,000	15,800
		Mar	3,500	6,300	8,500	10,900	13,300	14,200	15,000	15,800
		Apr	3,400	5,700	7,400	9,200	11,600	13,600	15,000	15,800
		May	2,600	4,300	5,500	6,800	8,500	9,900	11,300	13,400
		Jun 1 - 15	1,500	2,400	3,200	4,200	5,800	7,300	9,100	12,100
		Jun 16 - 30	1,200	1,700	2,200	2,700	3,400	4,100	4,800	5,900
		Jul 1 - 15	1,000	1,400	1,700	2,100	2,700	3,200	3,900	4,900
J.C. Boyle[1]	4,080	Jul 16 - 31	1,000	1,200	1,400	1,500	1,600	1,700	1,800	2,000
		Aug	1,400	1,500	1,600	1,700	1,800	1,800	1,800	1,900
		Sep 1 - 15	1,400	1,700	1,900	2,100	2,400	2,500	2,700	3,000
		Sep 16 - 30	1,500	1,900	2,200	2,400	2,800	3,000	3,200	3,500
		Oct 1 - 15	1,700	2,200	2,500	2,900	3,400	3,800	4,200	4,700
		Oct 16 - 31	1,700	2,400	2,800	3,300	4,000	4,600	5,200	6,100
		Nov 1 - 15	1,800	2,600	3,200	3,800	4,700	5,500	6,300	7,500
		Nov 16 - 30	2,000	2,900	3,600	4,400	5,400	6,300	7,200	8,500
		Dec	2,500	3,900	5,100	6,300	8,200	9,900	11,700	14,400
		Jan	3,000	5,800	8,400	11,800	17,600	23,400	30,500	42,800
		Feb	3,000	5,800	8,400	11,800	17,600	23,400	30,500	42,800
		Mar	4,100	7,400	10,200	13,000	17,100	20,500	23,900	29,000
		Apr	3,600	6,500	8,900	11,100	14,400	17,000	19,700	23,400
		May	2,600	4,500	5,900	7,400	9,400	11,000	12,700	15,100
		Jun 1 - 15	1,500	2,500	3,400	4,500	6,400	8,200	10,500	14,100
		Jun 16 - 30	1,200	1,800	2,200	2,700	3,500	4,100	4,900	6,100
		Jul 1 - 15	900	1,200	1,600	2,000	2,600	3,200	4,100	5,300
Copco No. 1[2]	4,370	Jul 16 - 31	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600
		Aug	1,100	1,300	1,500	1,600	1,800	2,000	2,100	2,400
		Sep 1 - 15	1,300	1,600	1,800	1,900	2,100	2,200	2,300	2,500
		Sep 16 - 30	1,300	1,600	1,900	2,100	2,400	2,500	2,700	3,000
		Oct 1 - 15	1,500	2,000	2,500	2,900	3,700	4,300	5,100	6,200
		Oct 16 - 31	1,500	2,200	2,700	3,300	4,200	5,100	6,000	7,500
		Nov 1 - 15	1,700	2,500	3,300	4,100	5,400	6,600	7,900	10,000
		Nov 16 - 30	1,900	3,000	4,000	4,900	6,500	7,800	9,300	11,700
		Dec	2,500	5,000	7,400	10,700	16,600	22,600	30,500	43,200
		Jan	3,200	6,100	8,900	12,500	18,700	24,800	32,400	45,400
		Feb	3,200	6,100	8,900	12,500	18,700	24,800	32,400	45,400
		Mar	4,300	7,900	10,800	13,800	18,100	21,700	25,400	30,800
		Apr	3,800	6,900	9,400	11,800	15,300	18,000	20,900	24,800
		May	2,800	4,800	6,300	7,900	10,000	11,700	13,500	16,000
		Jun 1 - 15	1,600	2,600	3,600	4,800	6,800	8,700	11,100	15,000
		Jun 16 - 30	1,300	1,900	2,300	2,900	3,700	4,400	5,200	6,500
		Jul 1 - 15	1,000	1,300	1,700	2,100	2,800	3,400	4,300	5,600
Iron Gate[3]	4,630	Jul 16 - 31	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700
		Aug	1,200	1,400	1,600	1,700	1,900	2,100	2,200	2,500
		Sep 1 - 15	1,400	1,700	1,900	2,000	2,200	2,300	2,400	2,600
		Sep 16 - 30	1,400	1,700	2,000	2,200	2,500	2,700	2,900	3,200
		Oct 1 - 15	1,600	2,100	2,600	3,100	3,900	4,600	5,400	6,600
		Oct 16 - 31	1,600	2,300	2,900	3,500	4,500	5,400	6,400	8,000
		Nov 1 - 15	1,800	2,700	3,500	4,400	5,700	7,000	8,400	10,600
		Nov 16 - 30	2,000	3,200	4,200	5,200	6,900	8,300	9,900	12,400
		Dec	2,700	5,300	7,900	11,300	17,600	24,000	32,400	45,800

M:\1\03\00640\01\A\Data\Task 0900 - 90% Design\08 - Hydrology\2_Flood Frequency Analysis\[Flood Frequency Analysis - Monthly.xlsm]Table - Monthly_USGS_b

NOTES:

1. DATA SOURCE USGS STATION 11510770 "KLAMATH RIVER BLW JOHN C.BOYLE PWRPLNT, NR KENO,OR", PERIOD OF RECORD 1959 TO 2019. PERIOD OF RECORD USED IN ANALYSIS 1960 TO 2019 TO COINCIDE WITH THE IRON GATE PERIOD OF RECORD. FLOWS BELOW 3,400 cfs WERE CENSORED LOW FLOW OUTLIERS DUE TO THE INFLUENCE OF UPSTREAM DAM ACTIVITIES.
2. CALCULATED USING NON-LINEAR PRORATION WITH IRON GATE USING METHODOLOGY DESCRIBED IN "ESTIMATION OF PEAK DISCHARGES FOR RURAL, UNREGULATED STREAMS IN WESTERN OREGON" (USGS, 2005).
3. DATA SOURCE USGS STATION 11516530 "KLAMATH R BL IRON GATE DAM CA", PERIOD OF RECORD 1960 TO 2019. PERIOD OF RECORD USED IN ANALYSIS 1960 TO 2019.
4. ANALYSIS USES HISTORIC USGS GAGE DATA. THESE FLOWS ARE INFLUENCED BY THE OPERATION OF THE RESERVOIRS ON THE KLAMATH RIVER AND ARE, THEREFORE, REGULATED. THE REGULATION MAKES IT POSSIBLE FOR PEAK FLOWS TO BE HIGHER AT J.C. BOYLE THAN AT IRON GATE.
5. THE DATA INDICATE THAT FOR SOME MONTHS THERE IS A TRANSITION IN THE HYDROLOGY IN THE MIDDLE OF THE MONTH. MONTHS WHEN THIS OCCURS INCLUDE JUNE, JULY, SEPTEMBER, OCTOBER, AND NOVEMBER. FOR ANALYSIS PURPOSES THESE MONTHS HAVE BEEN DIVIDED INTO TWO PERIODS: 1st TO 15th AND 16th TO 30th/31st OF EACH MONTH.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	ELK	AS
REV	DATE	DESCRIPTION	PREP'D	RVW'D

3.2.3 2019 BIOLOGICAL OPINION DATA

The 2019 BiOp daily flows for the Keno and Iron Gate facilities were used to estimate the monthly peak floods for the KRRP hydroelectric facilities. The peak daily flow in each specified period was determined and converted to an instantaneous peak flow using the conversion factor of 1.10. A flood frequency analysis was performed on these peak floods using HEC-SSP (V2.1), following the Bulletin 17B method for Log-Pearson Type III distributions (USGS, 1982).

The peak floods for specified time periods at J.C. Boyle and Copco No. 1 were calculated using the methodology described in USGS (2005), based on the results for the Keno and Iron Gate facilities, respectively. The return period floods for specified periods at Copco No. 1 are used as representative for Copco No. 2. Table 3.5 provides the flood frequency results for the specified time periods.

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TABLE 3.5

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

PEAK FLOODS FOR SPECIFIED TIME PERIOD
USING 2019 BIOLOGICAL OPINION DATA[1]

Location	Drainage Area (mi²)	Month	Instantaneous Peak Floods for Specified Time Period (cfs)							
			50% Probable Flood	20% Probable Flood	10% Probable Flood	5% Probable Flood	2% Probable Flood	1% Probable Flood	0.5% Probable Flood	0.2% Probable Flood
Keno[2]	3,920	Jan	2,000	3,700	5,400	7,400	10,600	13,700	17,400	23,500
		Feb	2,200	4,500	6,700	9,300	13,700	18,000	23,100	31,600
		Mar	6,000	7,700	8,400	8,900	9,200	9,400	9,500	9,600
		Apr	4,300	6,500	7,800	9,000	10,500	11,500	12,500	13,700
		May	2,700	4,000	4,800	5,600	6,600	7,300	7,900	8,800
		Jun 1 - 15	1,800	2,800	3,500	4,200	5,300	6,100	7,100	8,400
		Jun 16 - 30	1,300	1,800	2,200	2,700	3,600	4,400	5,300	6,800
		Jul 1 - 15	900	1,100	1,200	1,200	1,300	1,400	1,500	1,600
		Jul 16 - 31	900	1,000	1,100	1,200	1,300	1,400	1,400	1,500
		Aug	1,000	1,200	1,200	1,300	1,400	1,400	1,500	1,600
		Sep 1 - 15	1,000	1,100	1,100	1,200	1,200	1,300	1,300	1,400
		Sep 16 - 30	1,000	1,100	1,100	1,200	1,300	1,300	1,400	1,400
		Oct 1 - 15	1,000	1,100	1,200	1,300	1,400	1,400	1,500	1,600
		Oct 16 - 31	1,000	1,200	1,400	1,700	2,400	3,000	3,900	5,400
		Nov 1 - 15	1,000	1,400	1,800	2,300	3,400	4,400	5,800	8,500
		Nov 16 - 30	1,100	1,800	2,500	3,500	5,300	7,200	9,700	14,400
		Dec	1,800	3,200	4,400	5,800	8,000	10,100	12,500	16,300
J.C. Boyle[3]	4,080	Jan	2,100	3,900	5,600	7,700	11,000	12,900	14,100	15,600
		Feb	2,300	4,700	7,000	9,700	11,800	12,900	14,100	15,600
		Mar	6,300	8,000	8,800	9,300	9,600	9,800	9,900	10,000
		Apr	4,500	6,800	8,100	9,400	10,900	12,000	13,000	14,300
		May	2,700	4,200	5,000	5,800	6,900	7,600	8,200	9,200
		Jun 1 - 15	1,800	2,800	3,500	4,400	5,500	6,400	7,400	8,800
		Jun 16 - 30	1,400	1,800	2,300	2,800	3,600	4,400	5,000	6,300
		Jul 1 - 15	900	1,100	1,300	1,300	1,400	1,500	1,600	1,700
		Jul 16 - 31	900	1,000	1,100	1,200	1,300	1,300	1,300	1,400
		Aug	1,000	1,200	1,200	1,400	1,500	1,500	1,600	1,700
		Sep 1 - 15	1,000	1,100	1,000	1,200	1,200	1,400	1,400	1,500
		Sep 16 - 30	1,000	1,100	1,000	1,200	1,300	1,400	1,500	1,500
		Oct 1 - 15	1,000	1,100	1,300	1,400	1,500	1,500	1,600	1,700
		Oct 16 - 31	1,000	1,200	1,500	1,800	2,500	3,100	3,900	5,300
		Nov 1 - 15	1,000	1,400	1,800	2,300	3,400	4,400	5,900	8,600
		Nov 16 - 30	1,100	1,900	2,600	3,600	5,300	7,200	9,600	14,000
		Dec	1,900	3,300	4,600	6,000	8,300	10,500	13,000	15,600
Copco No. 1[4]	4,370	Jan	2,400	4,500	6,800	9,600	14,600	19,700	25,500	32,100
		Feb	2,900	5,800	8,500	11,800	17,400	21,300	25,500	32,100
		Mar	6,500	8,500	9,200	9,800	10,200	10,400	10,600	10,700
		Apr	4,600	6,900	8,500	10,000	11,900	13,200	14,500	16,100
		May	2,900	4,300	5,400	6,400	7,900	9,000	10,300	11,900
		Jun 1 - 15	1,900	2,900	3,700	4,500	5,600	6,600	7,700	9,400
		Jun 16 - 30	1,400	1,900	2,400	2,900	3,600	4,400	5,100	6,400
		Jul 1 - 15	1,100	1,300	1,500	1,600	1,800	2,000	2,200	2,500
		Jul 16 - 31	1,100	1,200	1,300	1,300	1,400	1,400	1,400	1,500
		Aug	1,200	1,300	1,300	1,400	1,400	1,400	1,500	1,500
		Sep 1 - 15	1,100	1,200	1,300	1,300	1,400	1,400	1,400	1,500
		Sep 16 - 30	1,100	1,200	1,300	1,300	1,400	1,400	1,400	1,500
		Oct 1 - 15	1,200	1,300	1,400	1,500	1,600	1,600	1,700	1,800
		Oct 16 - 31	1,100	1,400	1,600	2,000	2,600	3,200	4,000	5,400
		Nov 1 - 15	1,200	1,500	1,900	2,400	3,500	4,500	6,000	8,700
		Nov 16 - 30	1,300	2,000	2,700	3,700	5,400	7,200	9,700	14,000
		Dec	2,000	3,800	5,700	8,100	12,400	17,100	22,900	32,100
Iron Gate[5]	4,630	Jan	2,500	4,800	7,200	10,200	15,500	20,900	27,000	34,100
		Feb	3,100	6,100	9,000	12,500	18,500	22,600	27,000	34,100
		Mar	6,900	9,000	9,800	10,400	10,800	11,000	11,200	11,300
		Apr	4,800	7,300	9,000	10,600	12,600	14,000	15,400	17,100
		May	3,000	4,600	5,700	6,800	8,400	9,600	10,900	12,600
		Jun 1 - 15	2,000	3,000	3,800	4,600	5,900	7,000	8,200	10,000
		Jun 16 - 30	1,500	2,000	2,500	3,000	3,700	4,400	5,200	6,500
		Jul 1 - 15	1,200	1,400	1,600	1,700	1,900	2,100	2,300	2,600
		Jul 16 - 31	1,200	1,300	1,400	1,400	1,500	1,500	1,500	1,600
		Aug	1,300	1,400	1,400	1,500	1,500	1,500	1,600	1,600
		Sep 1 - 15	1,200	1,300	1,400	1,400	1,500	1,500	1,500	1,600
		Sep 16 - 30	1,200	1,300	1,400	1,400	1,500	1,500	1,500	1,600
		Oct 1 - 15	1,300	1,400	1,500	1,600	1,700	1,700	1,800	1,900
		Oct 16 - 31	1,200	1,500	1,700	2,100	2,700	3,300	4,100	5,500
		Nov 1 - 15	1,300	1,600	2,000	2,500	3,600	4,600	6,100	8,800
		Nov 16 - 30	1,400	2,100	2,900	3,800	5,500	7,300	9,800	14,000
		Dec	2,100	4,000	6,000	8,600	13,200	18,100	24,300	34,100

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NOTES:

1. 2019 BIOLOGICAL OPINION FLOWS (USBR, 2018) WERE PROVIDED FOR THE PERIOD FROM 1981 TO 2016. FLOWS WERE PROVIDED AT KENO (USGS GAGE 11509500) AND IRON GATE (USGS GAGE 11516530).
2. CALCULATED USING 2019 BIOP FLOWS AT KENO. A FACTOR OF 1.10 WAS APPLIED TO ADJUST DAILY AVERAGE FLOW TO DAILY PEAK FLOW.
3. CALCULATED USING NON-LINEAR AREA PRORATION WITH 2019 BIOP FLOWS AT KENO USING METHODOLOGY DESCRIBED IN "ESTIMATION OF PEAK DISCHARGES FOR RURAL, UNREGULATED STREAMS IN WESTERN OREGON" (USGS, 2005).
4. CALCULATED USING NON-LINEAR AREA PRORATION WITH 2019 BIOP FLOWS AT IRON GATE USING METHODOLOGY DESCRIBED IN "ESTIMATION OF PEAK DISCHARGES FOR RURAL, UNREGULATED STREAMS IN WESTERN OREGON" (USGS, 2005).
5. CALCULATED USING 2019 BIOP FLOWS AT IRON GATE. A FACTOR OF 1.12 WAS APPLIED TO ADJUST DAILY AVERAGE FLOW TO DAILY PEAK FLOW.
6. THE DATA INDICATE THAT FOR SOME MONTHS THERE IS A TRANSITION IN THE HYDROLOGY IN THE MIDDLE OF THE MONTH. MONTHS WHEN THIS OCCURS INCLUDE JUNE, JULY, SEPTEMBER, OCTOBER, AND NOVEMBER. FOR ANALYSIS PURPOSES THESE MONTHS HAVE BEEN DIVIDED INTO TWO PERIODS: 1st TO 15th AND 16th TO 30th/31st OF EACH MONTH.
7. THE CEREMONIAL FLOW RELEASES FOR THE YUROK BOAT DANCE CEREMONY WILL BE DEFERRED FOR THE DRAWDOWN YEAR. THESE FLOWS HAVE, THEREFORE, BEEN REMOVED FROM THE DATASET.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	ELK	AS
REV	DATE	DESCRIPTION	PREP'D	RVW'D

3.2.4 MONTHLY PEAK FLOOD RESULTS

The Historic USGS data and 2019 BiOp data were both used to determine the monthly peak floods at the Klamath River reservoirs. The flood values selected as the recommended design values are the maximum calculated values, as shown in Table 3.6 for J.C. Boyle, Copco No. 1 and Iron Gate. An example visual interpretation of Table 3.6 for selected time periods is shown for Iron Gate on Figure 3.1. The monthly return period floods at Copco No. 1 are used as representative of the monthly return period floods for Copco No. 2.

The results show that for all facilities the peak floods for specified time periods decrease from April through to August. The peak flood results then increase from September through to March.

When considering the application of the monthly peak floods in relation to deconstruction activities near the river or reservoirs, embankment dam removal periods, or instream works, the designer/contractor should carefully consider the flows, water levels, and risk levels associated with the probable flood events in the time period that the work will take place or the time period that the structure will remain in place.

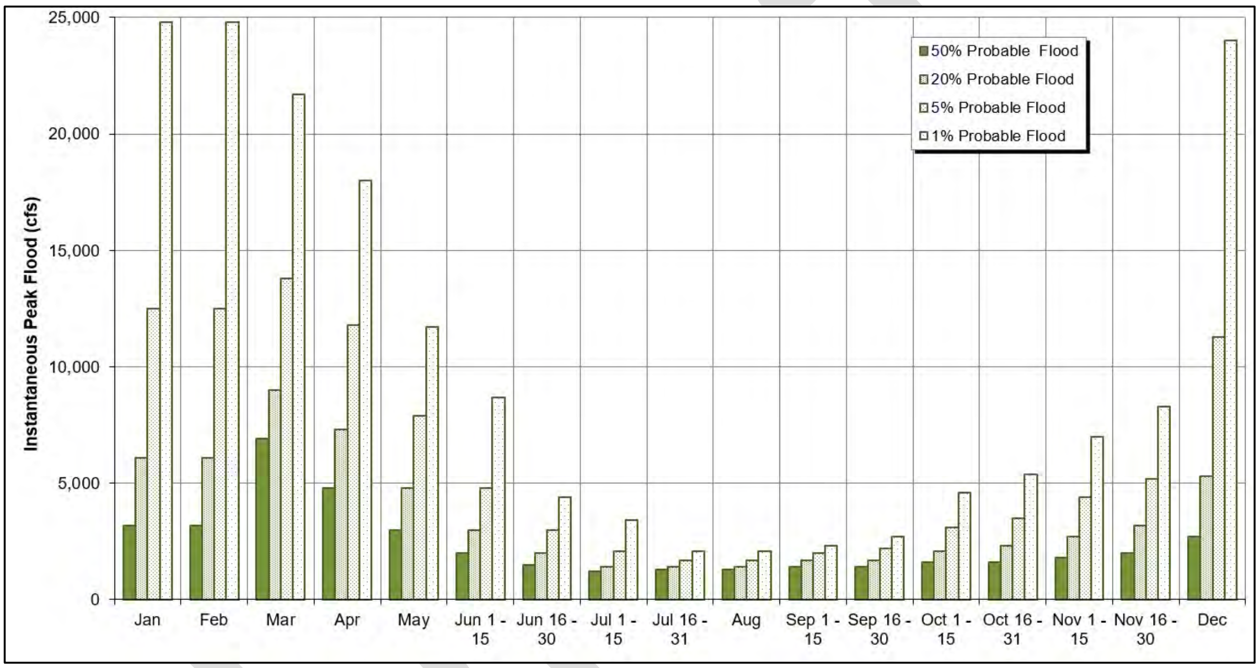

Figure 3.1 Iron Gate Peak Floods per Specified Time Period

Knight Piésold CONSULTING

TABLE 3.6

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

RECOMMENDED DESIGN VALUES OF MONTHLY PEAK FLOODS

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Location	Drainage Area (mi^2)	Month	Instantaneous Peak Floods for Specified Time Period (cfs)								Average Monthly Flow (cfs)
			50% Probable Flood	20% Probable Flood	10% Probable Flood	5% Probable Flood	2% Probable Flood	1% Probable Flood	0.5% Probable Flood	0.2% Probable Flood	
J.C. Boyle	4,080	Jan	2,600	4,400	6,000	8,000	11,100	14,000	15,000	15,800	1,500
		Feb	2,700	4,900	7,000	9,700	13,000	14,200	15,000	15,800	1,900
		Mar	6,300	8,000	8,800	10,900	13,300	14,200	15,000	15,800	2,800
		Apr	4,500	6,800	8,100	9,400	11,600	13,600	15,000	15,800	2,370
		May	2,700	4,300	5,500	6,800	8,500	9,900	11,300	13,400	1,760
		Jun 1 - 15	1,800	2,800	3,500	4,400	5,800	7,300	9,100	12,100	1,330
		Jun 16 - 30	1,400	1,800	2,300	2,800	3,600	4,400	5,000	6,300	960
		Jul 1 - 15	1,000	1,400	1,700	2,100	2,700	3,200	3,900	4,900	740
		Jul 16 - 31	1,400	1,500	1,600	1,700	1,800	1,800	1,800	2,000	760
		Aug	1,400	1,500	1,600	1,700	1,800	1,800	1,800	1,900	760
		Sep 1 - 15	1,400	1,700	1,900	2,100	2,400	2,500	2,700	3,000	810
		Sep 16 - 30	1,500	1,900	2,200	2,400	2,800	3,000	3,200	3,500	790
		Oct 1 - 15	1,700	2,200	2,500	2,900	3,400	3,800	4,200	4,700	810
		Oct 16 - 31	1,700	2,400	2,800	3,300	4,000	4,600	5,200	6,100	890
		Nov 1 - 15	1,800	2,600	3,200	3,800	4,700	5,500	6,300	8,600	980
		Nov 16 - 30	2,000	2,900	3,600	4,400	5,400	7,200	9,600	14,000	950
		Dec	2,500	3,900	5,100	6,300	8,300	10,500	13,000	15,600	1,110
Copco No. 1	4,370	Jan	3,000	5,800	8,400	11,800	17,600	23,400	30,500	42,800	1,910
		Feb	3,000	5,800	8,500	11,800	17,600	23,400	30,500	42,800	2,360
		Mar	6,500	8,500	10,200	13,000	17,100	20,500	23,900	29,000	3,230
		Apr	4,600	6,900	8,900	11,100	14,400	17,000	19,700	23,400	2,790
		May	2,900	4,500	5,900	7,400	9,400	11,000	12,700	15,100	2,110
		Jun 1 - 15	1,900	2,900	3,700	4,500	6,400	8,200	10,500	14,100	1,620
		Jun 16 - 30	1,400	1,900	2,400	2,900	3,600	4,400	5,100	6,400	1,210
		Jul 1 - 15	1,100	1,300	1,600	2,000	2,600	3,200	4,100	5,300	990
		Jul 16 - 31	1,200	1,300	1,500	1,600	1,800	2,000	2,100	2,400	990
		Aug	1,200	1,300	1,500	1,600	1,800	2,000	2,100	2,400	980
		Sep 1 - 15	1,300	1,600	1,800	1,900	2,100	2,200	2,300	2,500	1,030
		Sep 16 - 30	1,300	1,600	1,900	2,100	2,400	2,500	2,700	3,000	1,030
		Oct 1 - 15	1,500	2,000	2,500	2,900	3,700	4,300	5,100	6,200	1,050
		Oct 16 - 31	1,500	2,200	2,700	3,300	4,200	5,100	6,000	7,500	1,140
		Nov 1 - 15	1,700	2,500	3,300	4,100	5,400	6,600	7,900	10,000	1,230
		Nov 16 - 30	1,900	3,000	4,000	4,900	6,500	7,800	9,700	14,000	1,240
		Dec	2,500	5,000	7,400	10,700	16,600	22,600	30,500	43,200	1,490
Iron Gate	4,630	Jan	3,200	6,100	8,900	12,500	18,700	24,800	32,400	45,400	2,030
		Feb	3,200	6,100	9,000	12,500	18,700	24,800	32,400	45,400	2,500
		Mar	6,900	9,000	10,800	13,800	18,100	21,700	25,400	30,800	3,430
		Apr	4,800	7,300	9,400	11,800	15,300	18,000	20,900	24,800	2,950
		May	3,000	4,800	6,300	7,900	10,000	11,700	13,500	16,000	2,230
		Jun 1 - 15	2,000	3,000	3,800	4,800	6,800	8,700	11,100	15,000	1,720
		Jun 16 - 30	1,500	2,000	2,500	3,000	3,700	4,400	5,200	6,500	1,280
		Jul 1 - 15	1,200	1,400	1,700	2,100	2,800	3,400	4,300	5,600	1,050
		Jul 16 - 31	1,300	1,400	1,600	1,700	1,900	2,100	2,200	2,500	1,050
		Aug	1,300	1,400	1,600	1,700	1,900	2,100	2,200	2,500	1,040
		Sep 1 - 15	1,400	1,700	1,900	2,000	2,200	2,300	2,400	2,600	1,090
		Sep 16 - 30	1,400	1,700	2,000	2,200	2,500	2,700	2,900	3,200	1,090
		Oct 1 - 15	1,600	2,100	2,600	3,100	3,900	4,600	5,400	6,600	1,120
		Oct 16 - 31	1,600	2,300	2,900	3,500	4,500	5,400	6,400	8,000	1,210
		Nov 1 - 15	1,800	2,700	3,500	4,400	5,700	7,000	8,400	10,600	1,300
		Nov 16 - 30	2,000	3,200	4,200	5,200	6,900	8,300	9,900	14,000	1,310
		Dec	2,700	5,300	7,900	11,300	17,600	24,000	32,400	45,800	1,580

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NOTES:

1. RECOMMENDED DESIGN VALUES ARE BASED ON THE MAXIMUM VALUES BETWEEN THE ANALYSIS COMPLETED USING THE HISTORIC USGS GAGE DATA AND THE 2019 BIOP FLOW DATA.
2. HISTORIC USGS DATA SOURCE FOR ANALYSIS: USGS STATION 11516530 "KLAMATH R BL IRON GATE DAM CA", PERIOD OF RECORD 1960 TO 2019. PERIOD OF RECORD USED IN ANALYSIS 1960 TO 2019.
3. 2019 BIOP FLOW DATA SOURCE FOR ANALYSIS: 2019 BIOLOGICAL OPINION FLOWS (USBR, 2018) PROVIDED FOR THE PERIOD 1981 TO 2016. FLOWS WERE PROVIDED AT IRON GATE (USGS GAGE 11516530).
4. THE DATA INDICATE THAT FOR SOME MONTHS THERE IS A TRANSITION IN THE HYDROLOGY IN THE MIDDLE OF THE MONTH. MONTHS WHEN THIS OCCURS INCLUDE JUNE, JULY, SEPTEMBER, OCTOBER, AND NOVEMBER. FOR ANALYSIS PURPOSES THESE MONTHS HAVE BEEN DIVIDED INTO TWO PERIODS: 1st TO 15th AND 16th TO 30th/31st OF EACH MONTH.
5. RECOMMENDED DESIGN VALUES FOR THE SECOND HALF OF JULY ARE DICTATED BY THE AUGUST PEAK MONTHLY FLOOD VALUES FOR DAM SAFETY PURPOSES.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	ELK	AS
REV	DATE	DESCRIPTION	PREP'D	RVW'D

4.0 KLAMATH RIVER ANNUAL DAILY FLOW DURATION

Daily flow duration curves show the percentage of time that a flow is likely to equal or exceed a specified value on an annual or monthly basis. The flow duration curves for the KRRP hydroelectric facilities were created with the following inputs:

- Developed using the 2019 Biological Opinion Flows (2019 BiOps) provided by USBR (2018).
- 2019 BiOps for USGS gage 11509500 Klamath River at Keno, OR were translated to the J.C. Boyle facility using linear area proration.
- 2019 BiOps for USGS gage 11516530 Klamath River below Iron Gate Dam, CA were translated to the Copco No. 1 facility using linear area proration. The flows for the Copco No. 1 facility were used for the Copco No. 2 facility.

The annual and monthly daily flow duration curves based on the 2019 BiOp flows are shown below in Tables 4.1 to 4.4 and on Figures 4.1 to 4.3 for the KRRP facilities.

Table 4.1 Flow Duration Flows Based on 2019 BiOp Flows – Annual

% of Time Equaled or Exceeded	Discharge (cfs)			
	Keno	J.C. Boyle	Copco No. 1	Iron Gate Dam
99%	300	320	850	900
95%	500	530	850	900
90%	570	590	900	950
80%	640	660	940	1,000
75%	660	690	940	1,000
70%	690	720	970	1,030
60%	760	790	1,050	1,110
50%	820	860	1,110	1,180
40%	920	950	1,250	1,320
30%	1,130	1,170	1,540	1,630
25%	1,400	1,460	1,780	1,880
20%	1,770	1,840	2,210	2,340
10%	2,860	2,980	3,430	3,630
5%	4,140	4,310	4,780	5,060
1%	6,680	6,960	7,630	8,080

DRAFT

Knight Piésold CONSULTING

TABLE 4.2

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

FLOW DURATION FLOWS BASED ON 2019 BI OP FLOWS
MONTHLY - J.C. BOYLE

Print Nov/13/20 11:24:42

% of Time Equaled or Exceeded	Discharge (cfs)																	
	Monthly																	Annual
	Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec	
99%	360	440	290	230	190	210	250	380	500	460	570	410	240	240	300	510	420	320
95%	470	510	550	770	740	620	590	530	580	550	660	560	610	580	620	560	490	530
90%	520	540	690	890	860	740	660	590	610	590	690	660	690	670	680	590	520	590
80%	580	600	1,060	1,000	940	800	710	640	650	620	720	690	740	740	760	630	570	660
75%	600	630	1,220	1,040	980	820	730	660	670	630	730	710	750	760	790	650	590	720
70%	620	650	1,440	1,120	1,030	860	750	670	690	650	750	720	770	780	820	660	610	720
60%	660	720	1,800	1,450	1,140	940	780	700	730	670	770	760	790	820	870	680	650	790
50%	720	940	2,220	1,870	1,410	1,030	820	740	760	700	800	790	810	850	910	710	680	860
40%	970	1,580	2,650	2,330	1,720	1,170	890	760	790	740	830	810	840	880	940	740	740	950
30%	1,530	2,220	3,350	2,840	2,110	1,440	970	790	820	790	860	860	870	930	990	780	970	1,170
25%	1,850	2,540	3,880	3,390	2,330	1,670	1,020	810	830	810	880	880	890	950	1,030	820	1,240	1,840
20%	2,160	2,980	4,770	3,790	2,530	1,950	1,080	840	850	850	910	900	910	980	1,090	910	1,530	1,840
10%	3,500	4,320	5,840	4,920	3,180	2,490	1,520	900	930	1,000	950	950	1,000	1,120	1,250	1,560	2,350	2,980
5%	4,870	6,010	6,660	5,670	3,870	2,910	1,830	960	980	1,360	1,010	980	1,060	1,220	1,370	3,090	3,250	4,310
1%	8,280	8,880	8,560	6,860	5,290	4,350	2,580	1,120	1,060	1,560	1,070	1,060	1,170	3,090	3,630	3,970	5,640	6,960

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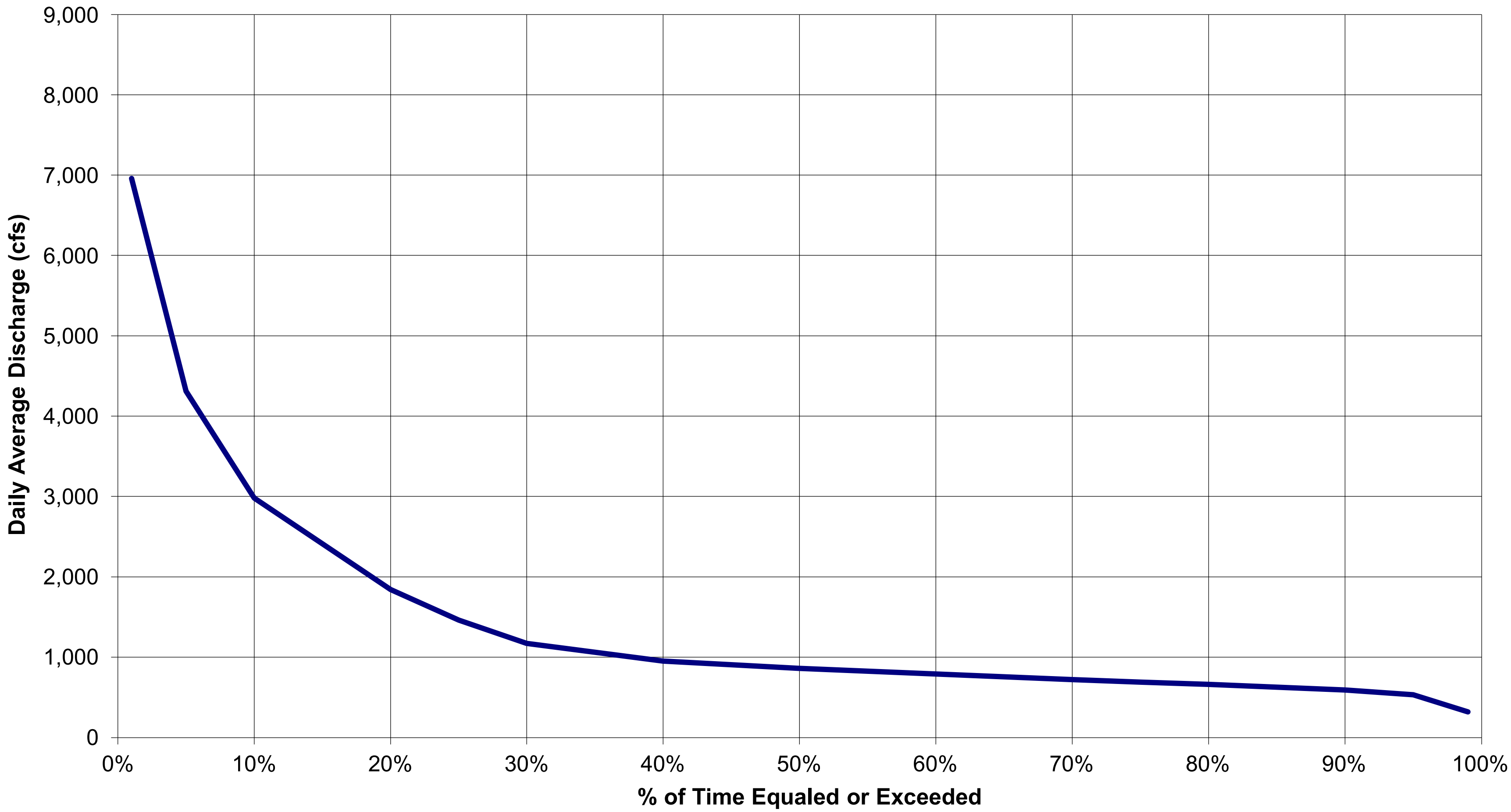
NOTES:

1. J.C. BOYLE FLOWS ARE CALCULATED USING LINEAR AREA PRORATION WITH THE KENO 2019 BIOP FLOWS.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D



NOTES:
1.J.C. BOYLE FLOWS ARE CALCULATED USING LINEAR AREA PRORATION WITH THE KENO 2019 BIOP FLOWS.

C	13NOV'20	ISSUED WITH REPORT	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

J.C. BOYLE
ANNUAL FLOW DURATION CURVE

Knight Piésold CONSULTING

P/A NO. VA103-640/1

REF. NO. 9

FIGURE 4.1

REV C

TABLE 4.3

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

FLOW DURATION FLOWS BASED ON 2019 BI OP FLOWS
MONTHLY - COPCO NO. 1

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% of Time Equaled or Exceeded	Discharge (cfs)																	
	Monthly																	Annual
	Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec	
99%	900	900	940	1,250	1,110	970	960	850	850	850	940	940	940	940	940	940	900	850
95%	900	900	940	1,250	1,110	970	970	850	850	850	940	940	940	940	940	940	900	850
90%	900	900	1,080	1,250	1,110	970	970	850	850	850	940	940	940	940	940	940	900	900
80%	900	900	1,520	1,280	1,240	1,040	970	850	850	850	940	940	940	940	1,000	940	900	940
75%	900	940	1,630	1,410	1,290	1,080	970	860	870	850	940	940	960	990	1,050	940	900	940
70%	900	990	1,800	1,540	1,350	1,130	970	890	900	850	940	940	990	1,020	1,100	940	900	970
60%	970	1,120	2,210	1,810	1,430	1,200	990	930	950	850	940	940	1,030	1,070	1,130	940	900	1,050
50%	1,120	1,390	2,640	2,230	1,700	1,300	1,050	970	990	890	1,010	1,000	1,030	1,090	1,150	940	930	1,110
40%	1,420	1,980	3,120	2,780	2,080	1,480	1,120	1,000	1,000	960	1,070	1,080	1,060	1,110	1,160	940	1,060	1,250
30%	1,930	2,570	3,850	3,320	2,470	1,660	1,190	1,060	1,050	1,040	1,100	1,100	1,080	1,150	1,240	1,020	1,440	1,540
25%	2,280	2,920	4,430	3,920	2,700	1,840	1,230	1,080	1,060	1,050	1,100	1,110	1,100	1,190	1,260	1,080	1,600	1,780
20%	2,580	3,400	5,200	4,270	2,940	2,140	1,410	1,110	1,080	1,060	1,130	1,130	1,130	1,220	1,300	1,220	1,860	2,210
10%	3,980	4,820	6,080	5,260	3,620	2,830	1,770	1,160	1,160	1,110	1,160	1,160	1,200	1,350	1,460	1,960	2,800	3,430
5%	5,340	6,980	7,110	5,750	4,250	3,250	2,050	1,180	1,180	1,460	1,160	1,160	1,250	1,440	1,550	3,300	4,020	4,780
1%	9,070	10,460	8,920	7,220	5,430	4,560	2,780	1,410	1,250	1,600	1,190	1,190	1,350	3,020	3,870	4,070	6,770	7,630

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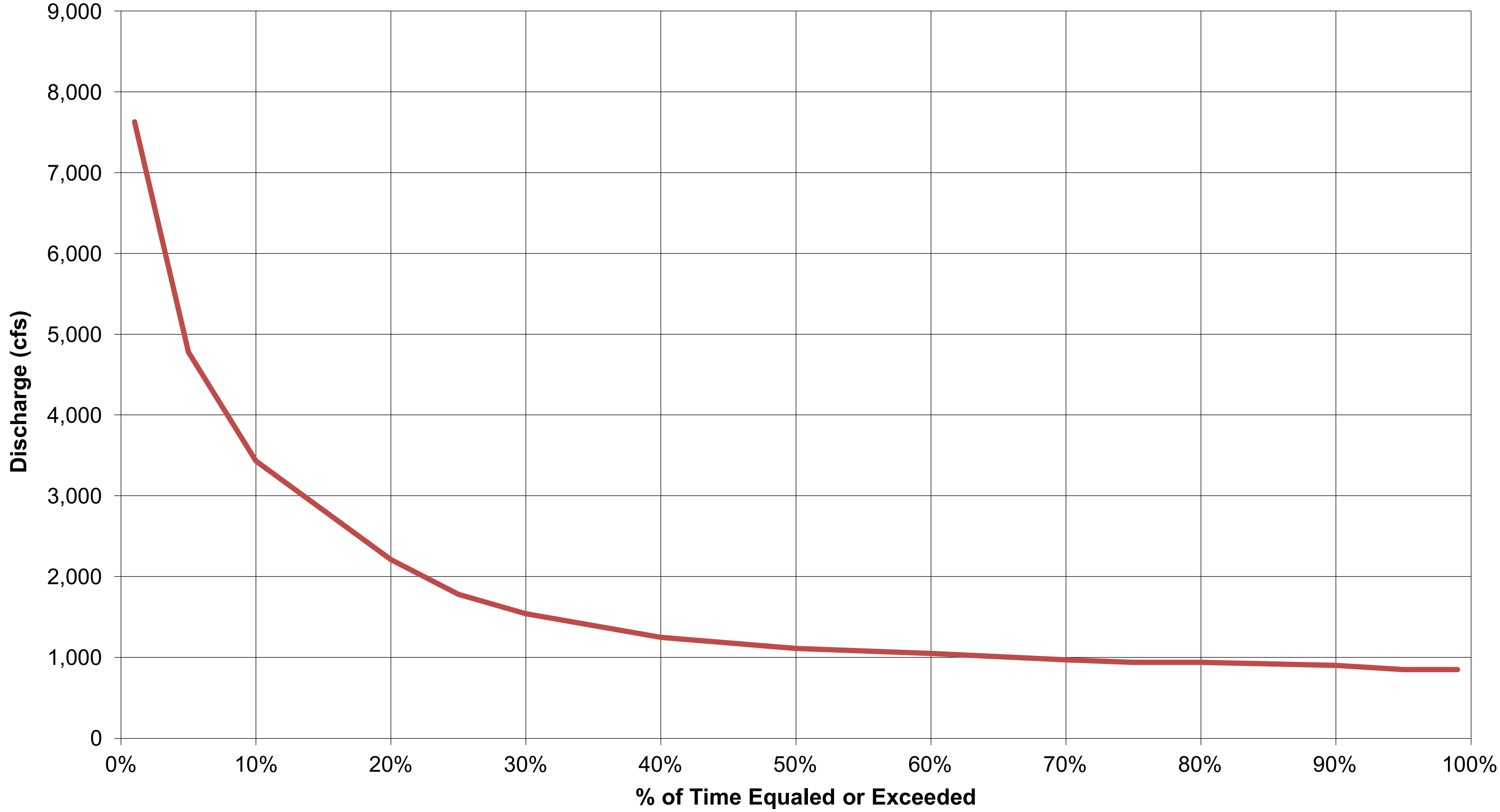
NOTES:

1. COPCO NO. 1 FLOWS ARE CALCULATED USING LINEAR AREA PRORATION WITH THE IRON GATE DAM 2019 BIOP FLOWS.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D



NOTES:
1. IRON GATE DAM FLOWS BASED ON TE 2019 BIOP AVERAGE DAILY FLOWS.
2. COPCO NO. 1 FLOWS ARE CALCULATED USING LINEAR AREA PRORATION WITH THE IRON GATE DAM 2019 BIOP FLOWS.

C	13NOV'20	ISSUED WITH REPORT	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

COPCO NO. 1
ANNUAL FLOW DURATION CURVE

Knight Piésold CONSULTING

P/A NO. VA103-640/1

REF. NO. 9

FIGURE 4.2

REV C

TABLE 4.4

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

FLOW DURATION FLOWS BASED ON 2019 BI OP FLOWS
MONTHLY - IRON GATE DAM

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% of Time Equaled or Exceeded	Discharge (cfs)																	
	Monthly																	Annual
	Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec	
99%	950	950	1,000	1,330	1,180	1,030	1,020	900	900	900	1,000	1,000	1,000	1,000	1,000	1,000	950	900
95%	950	950	1,000	1,330	1,180	1,030	1,030	900	900	900	1,000	1,000	1,000	1,000	1,000	1,000	950	900
90%	950	950	1,150	1,330	1,180	1,030	1,030	900	900	900	1,000	1,000	1,000	1,000	1,000	1,000	950	950
80%	950	950	1,610	1,360	1,320	1,100	1,030	900	900	900	1,000	1,000	1,000	1,000	1,060	1,000	950	1,000
75%	950	1,000	1,730	1,500	1,370	1,150	1,030	910	930	900	1,000	1,000	1,010	1,040	1,110	1,000	950	1,000
70%	950	1,050	1,910	1,640	1,430	1,190	1,030	950	960	900	1,000	1,000	1,050	1,080	1,110	1,000	950	1,030
60%	1,030	1,180	2,340	1,920	1,520	1,270	1,050	980	1,010	900	1,000	1,000	1,090	1,130	1,190	1,000	950	1,110
50%	1,180	1,470	2,800	2,360	1,810	1,380	1,110	1,030	1,040	940	1,070	1,080	1,100	1,160	1,210	1,000	980	1,180
40%	1,500	2,090	3,310	2,950	2,200	1,570	1,180	1,050	1,060	1,020	1,130	1,140	1,120	1,180	1,230	1,000	1,120	1,320
30%	2,040	2,730	4,080	3,520	2,620	1,760	1,260	1,120	1,110	1,100	1,160	1,160	1,150	1,220	1,320	1,080	1,520	1,630
25%	2,420	3,100	4,700	4,150	2,860	1,950	1,300	1,140	1,120	1,110	1,170	1,170	1,170	1,260	1,330	1,150	1,700	1,880
20%	2,730	3,600	5,510	4,530	3,110	2,270	1,490	1,180	1,150	1,130	1,200	1,190	1,200	1,290	1,380	1,300	1,970	2,340
10%	4,220	5,110	6,450	5,570	3,840	2,990	1,870	1,230	1,230	1,180	1,230	1,230	1,270	1,430	1,540	2,070	2,960	3,630
5%	5,650	7,390	7,530	6,090	4,500	3,440	2,180	1,250	1,250	1,550	1,230	1,230	1,330	1,520	1,640	3,500	4,260	5,060
1%	9,600	11,080	9,450	7,650	5,760	4,830	2,950	1,490	1,320	1,700	1,260	1,260	1,430	3,200	4,110	4,310	7,170	8,080

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NOTES:

1. IRON GATE DAM FLOWS BASED ON TE 2019 BIOP AVERAGE DAILY FLOWS.

C	13NOV'20	ISSUED WITH REPORT VA103-640/1-9	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D

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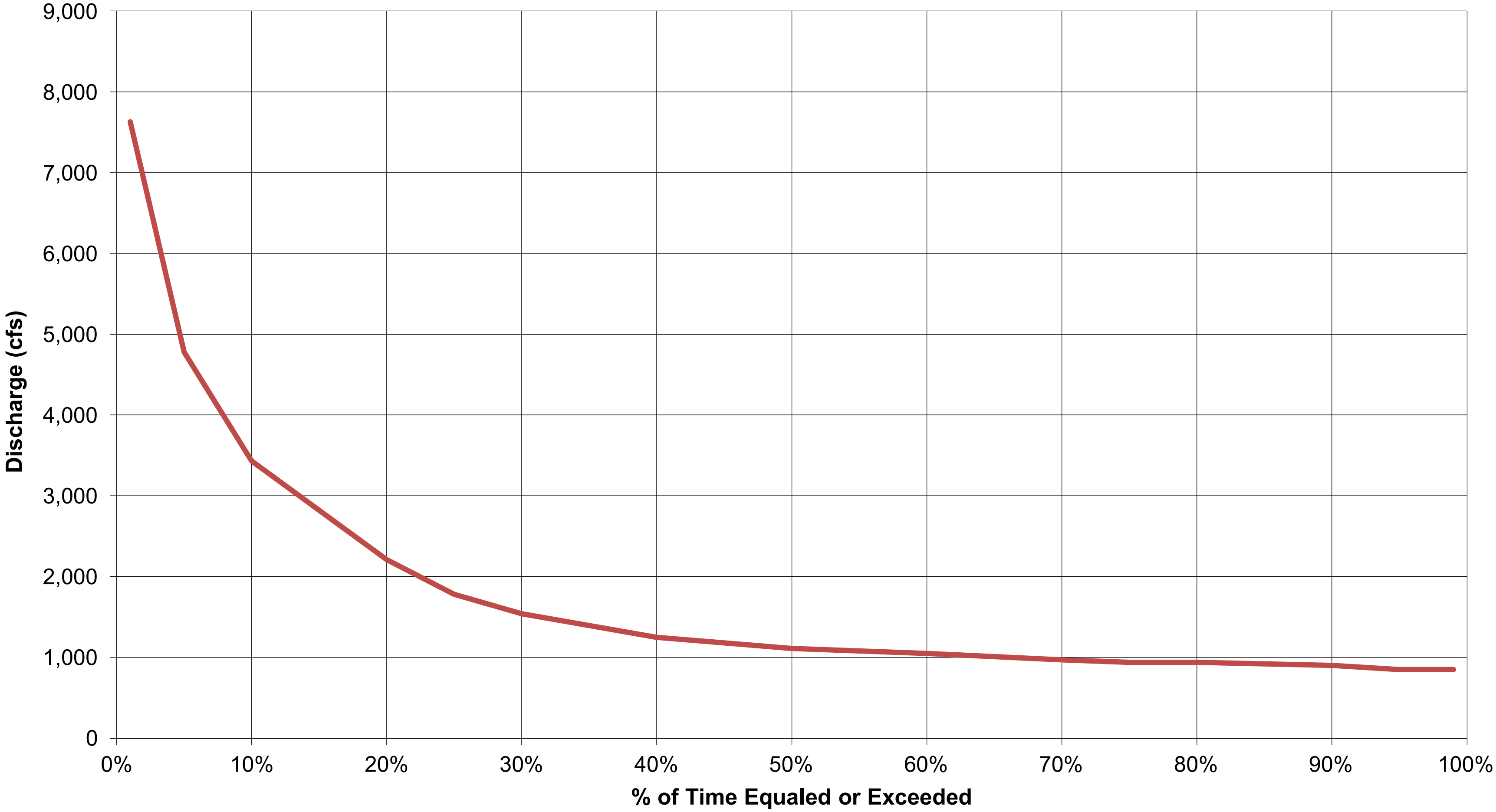


NOTES:
1.IRON GATE DAM FLOWS BASED ON TE 2019 BIOP AVERAGE DAILY FLOWS.
2.COPCO NO. 1 FLOWS ARE CALCULATED USING LINEAR AREA PRORATION WITH THE IRON GATE DAM 2019 BIOP FLOWS.

C	13NOV'20	ISSUED WITH REPORT	AS	ELK
REV	DATE	DESCRIPTION	PREP'D	RVW'D

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

COPCO NO. 2
ANNUAL FLOW DURATION CURVE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA103-640/1	9

FIGURE 4.3 REV C

5.0 FLOWS FOR ROADS AND BRIDGES CROSSINGS

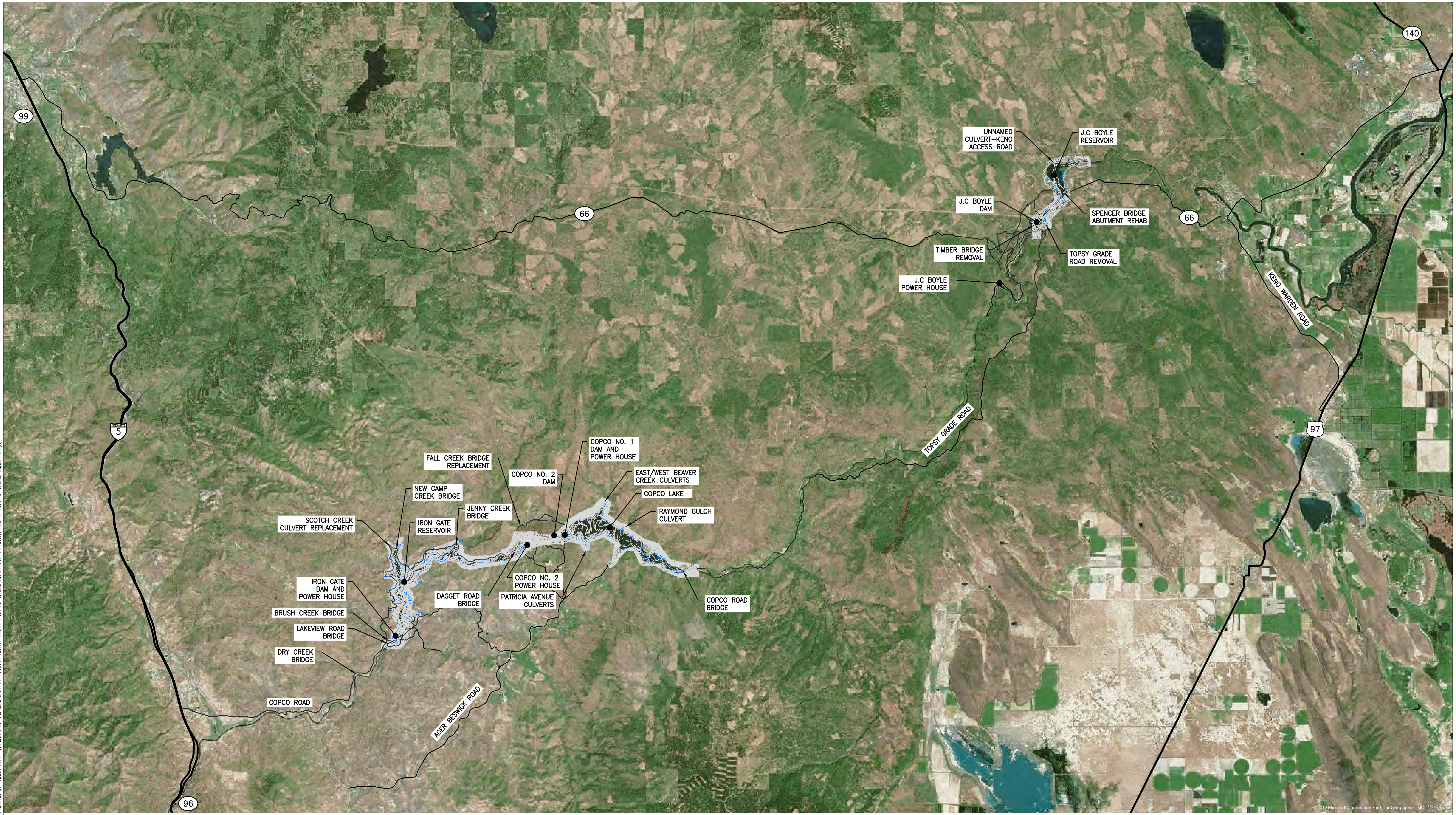
Located within the KRRP area are various roads, bridges, and culvert crossings. The locations of road, bridge, and culvert sites identified for improvement, monitoring, or construction purposes are identified on Figure 5.1.

The primary design goal for the roads, bridges, and culverts component of the KRRP is to modify the existing transport infrastructure to accommodate safe construction access throughout the KRRP site and to maintain existing public access during all stages of the project, from initial construction through to final removal of the hydroelectric facilities, and subsequent restoration. To facilitate this transportation design goal, design flood estimates for ungaged locations within the KRRP area are required.

Most of the transportation points of interest (POIs) are located on tributaries to the Klamath River, with the remaining POIs located directly on the Klamath River. The peak design floods at the ungaged locations were estimated by characterizing the tributary flows within the Klamath Basin between the J.C. Boyle and Iron Gate facilities. The Jenny Creek tributary represents a substantial portion of the incoming flows between the J.C. Boyle and the Iron Gate facilities. While Jenny Creek does have irrigation diversions and the flows are therefore partially regulated, this regulation effect is much smaller than that caused by the reservoirs on the mainstem of the Klamath River, and likely has little impact on the highest peak flows.

Many of the other larger tributary streams to the Klamath River are also regulated with irrigation structures, but as with Jenny Creek, the effects of these regulations on the largest peak flows is likely limited. The return period peak design flows calculated for all tributary streams are based on flow records for unregulated streams.

DRAFT



PLAN
1"= 7500'

0 7500 15000 22500
HORIZ 1" =7500', VERT 1" = 7500'

KIEWIT INFRASTRUCTURE WEST CO.

KLAMATH RIVER RENEWAL PROJECT

LOCATION OF TRANSPORTATION POINTS OF INTEREST (POI)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA103-640/1	9

FIGURE 5.1 REV C

C	12NOV'20	ISSUED WITH REPORT	JCO	ELG/WAL	SRM
REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED

SAVED: \\knightpiesold.local\VA-Prj$\1\03\00640\01\A\acad\FIGS\B03, 11/13/2020 11:19:01 AM, WLAHODA PRINTED: 11/13/2020 11:24:15 AM, Key Plan, WLAHODA ACAD VERSION: 23.1S (LMS TECH)

5.1 JENNY CREEK TRIBUTARY

Jenny Creek is a tributary to the Klamath River that discharges into the Iron Gate reservoir. The flow at Jenny Creek represents approximately 40% of the tributary and overland flow area between J.C. Boyle and Iron Gate facilities. There is an inactive USGS hydrology station located at the outlet of Jenny Creek (USGS Station JENNY C NR COPCO CA, 11516500); however, peak flow data for this gage are only available from 1923 to 1928, and the quality of the data is uncertain. This station has a drainage area of 205 mi^2 (210 mi^2 at the Jenny Creek bridge), and the records indicate annual peak flows ranging from 420 cfs to 1,960 cfs, with a six-year average of about 1,000 cfs. Relative to peak flows recorded at other creeks in the region, these values seem low.

The Bureau of Land Management (BLM) has a hydrology gage on Jenny Creek (located below Spring Creek at UTM 10T 0553140 / 4652570 (Lat/Long: 42.02335, -122.35817) with a drainage area of approximately 195 mi^2. The BLM data consists of average daily flows and annual peak flows for the period of 1998 to 2018. BLM notes that the rating curve may not be applicable and may require updating. The information for this gage has not undergone QA/QC procedures and is therefore provisional. Nonetheless, the data are believed to be the best Jenny Creek specific flow data currently available, and as such, was used to complete a hydrologic analysis for Jenny Creek.

5.1.1 AVERAGE MONTHLY FLOW

The average monthly flows for Jenny Creek at the Jenny Creek Bridge were calculated, as presented in Table 5.1 and on Figure 5.2. These data were prorated from the BLM gage location to the Jenny Creek bridge.

Table 5.1 Monthly Average Flow for Jenny Creek at Jenny Creek Bridge (Provisional)

Month	Monthly Average Flow (cfs)
January	121
February	181
March	305
April	225
May	136
June	41
July	16
August	15
September	16
October	19
November	29
December	87

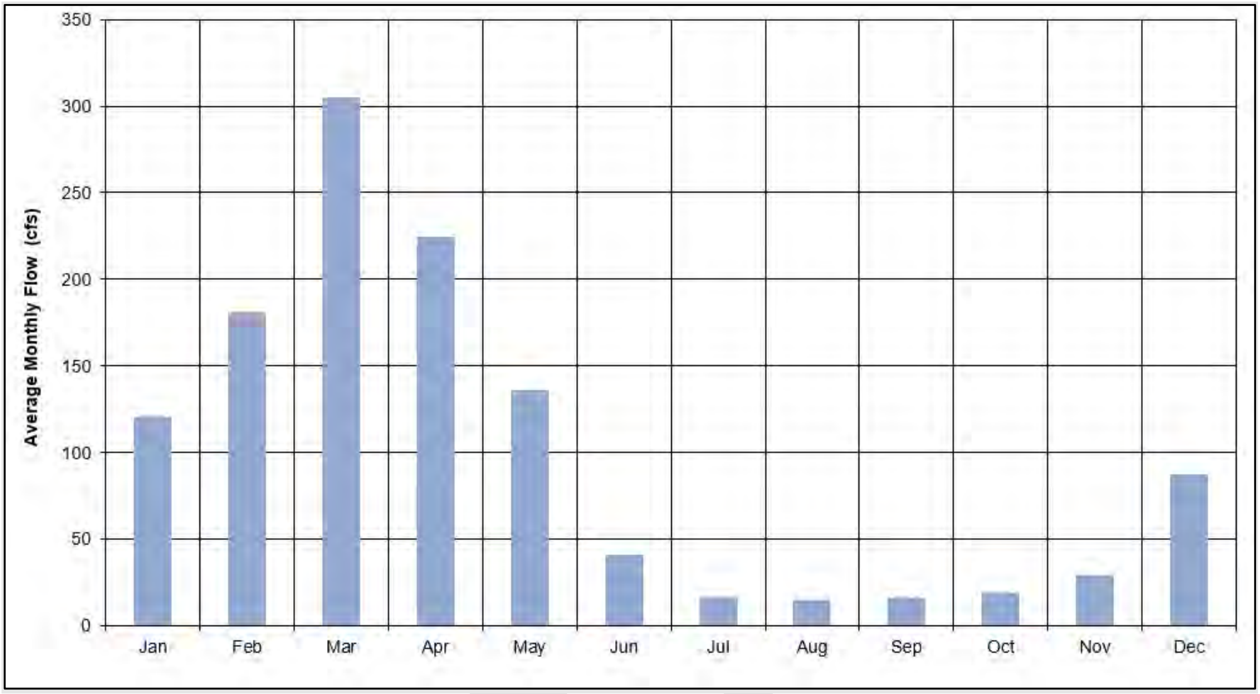


Figure 5.2 Monthly Average Flow for Jenny Creek at Jenny Creek Bridge (Provisional)

5.1.2 ANNUAL PEAK FLOODS

A summary of the available stream gage data used for the regional hydrology assessment of the tributary streams is provided in Table 5.2 below, and the station locations are shown on Figure 5.3.

Table 5.2 Summary of Streamflow Gage Records

Gage	Gage Operator/ Number	Basin Area (mi^2)	Period of Record	Notes
Klamath Tributary near Keno, OR	USGS 11509400	1.02	1964-1981	Annual peak flow estimates only. Includes the 1964 flood.
Fall Creek at Copco CA	USGS 11512000	14.6	1928 - 1959	Peak streamflow available. Does not include 1964 flood.
Fall Creek at Copco CA	PacifiCorp	14.6	2015 - 2017	Hourly data available. Not QA/QC'd. Does not include 1964 flood.
Bogus Creek	PacifiCorp	53.7	2014 - 2018	15-minute data available. Not QA/QC'd. Does not include 1964 flood.
Jenny Creek	BLM	195	1998 - 2018	15-minute data available. Not QA/QC'd. Does not include 1964 flood.
Rogue River above Prospect, OR	USGS 14328000	312	1909 - 2017	15-minute data available. Includes 1964 flood record.

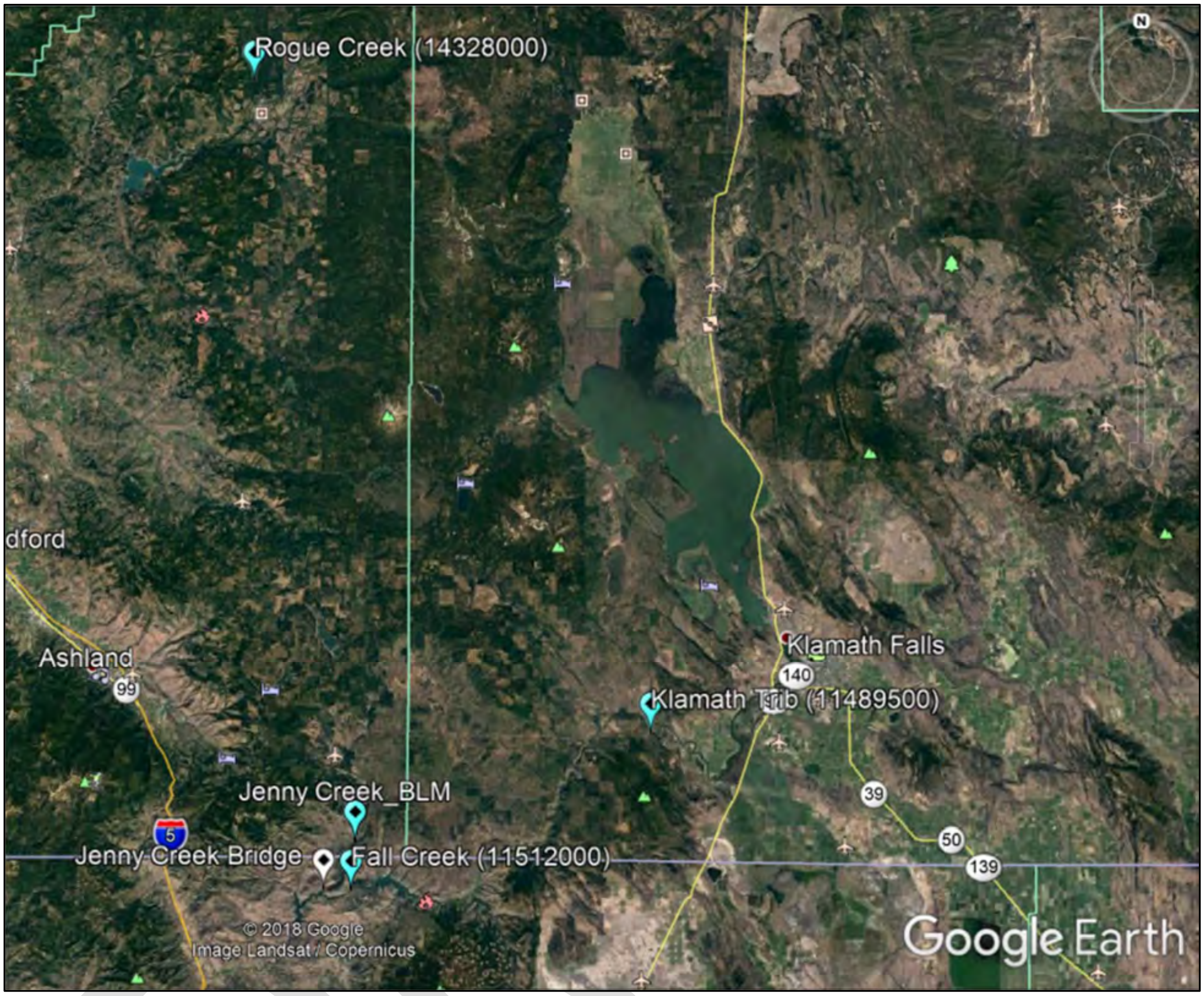


Figure 5.3 Regional Streamflow Gage Locations

A regional flow assessment was performed on available peak flow data for the stream gages listed in Table 5.2. The characteristics of the gaged basins as well as the lengths of available streamflow records were considered when determining the suitability of a gage for estimating flood flows for Jenny Creek. The PacifiCorp gages on Bogus Creek and Fall Creek were excluded due to insufficient stream gage data for the analysis. The USGS gage data for Fall Creek at Copco and the Klamath Tributary near Keno were excluded because their drainage areas are outside of the range of 0.50 to 1.50 times the size of the Jenny Creek drainage area, as recommended by the USGS (2005). Data for the USGS stream gage on Rogue River above Prospect (gage number 14328000) were selected as the most appropriate dataset for calculating return period peak flows for Jenny Creek because of the similarity of Rogue River and Jenny Creek watersheds in terms of drainage area and mean basin elevation. In addition, Rogue River has a lengthy period of record, which dates from 1909 to 2017 and includes the flood of record for the Klamath region (December 1964).

A flood frequency analysis was completed for the entire period of record for the Rogue River using the HEC-SSP (V2.1), following the Bulletin 17B method for the Log-Pearson Type III distribution (USGS, 1982).

The Rogue River flood frequency results were then transposed using the area proration methodology described in "Estimation of Peak discharges for Rural, Unregulated streams in Western Oregon" (USGS, 2005) to calculate the peak flood flows for Jenny Creek at the bridge. A scaling exponent of 1.0 was used for the transposition, as recommended in USGS (2005).

A flood frequency analysis was also performed on the BLM Jenny Creek annual peak flood data using HEC-SSP (V2.1), following the Bulletin 17B method for the Log-Pearson Type III distribution (USGS, 1982). The calculated peak flood values were prorated to the Jenny Creek bridge location using the methods outlined in USGS (2005) and a scaling exponent of 1.0.

The flood frequency analysis results based on both the USGS Rogue River and the BLM Jenny Creek datasets are presented in Table 5.3.

Table 5.3 Flood Frequency Analysis for Jenny Creek Bridge

Percent Probable Flood	Jenny Creek Bridge Peak Floods (cfs)	
	Design Values - Prorated from Rogue River USGS gage, 1909 - 2017	Prorated from Jenny Creek BLM gage, 1998 - 2017
50%	3,100	1,400
20%	5,000	2,700
10%	6,500	4,000
5%	8,000	5,500
2%	10,100	8,000
1%	11,900	10,400
0.5%	13,900	13,200
0.2%	16,600	17,700

The two sets of values agree reasonably well for events greater than the 5% probable flood, while the Rogue River values are higher for events smaller than the 5% probable flood. Flood events greater than the 5% probable flood are typically used for the design of hydraulic structures.

5.2 ANNUAL PEAK FLOODS FOR LOCATIONS OTHER THAN JENNY CREEK

Design flood estimates for ungauged locations for road, bridge, and culvert crossings within the KRRP area were determined by scaling regional peak flows according to the crossing location. For ungaged locations located on the Klamath River, the annual peak floods were determined based on the design flood estimates from the closest appropriate dam facility, which were linearly prorated by the ratio of the respective drainage areas to the location of interest.

For ungaged locations on tributary streams of the Klamath River, the annual peak floods were calculated based on the annual peak flood values for the USGS gage on Fall Creek (gage number 11512000) using non-linear drainage area proration. The Fall Creek stream gage data were selected for the analysis based on drainage area size and mean basin elevation, which are generally representative of the watersheds pertaining to the majority of the POI's that are located on tributary streams much smaller than Jenny Creek. In addition, the Fall Creek record length is reasonably long, at 32 years, and though it is dated (1928 to 1959), it is the most appropriate record available for small streams.

DRAFT

A flood frequency analysis was performed on the Fall Creek annual peak flood data using HEC-SSP (V2.1), following the Bulletin 17B method for the Log-Pearson Type III distribution (USGS, 1982). The calculated peak floods were then non-linearly prorated to the POI locations. The scaling exponent for drainage area was investigated to determine the appropriate value to use for the smaller drainage areas of the POIs. A review of the various USGS regional regression equations for determining peak floods for Oregon and California for the Klamath region indicates scaling exponents ranging from 0.5 to 1.0, although most of the values tend to be towards the upper end of the range, and therefore a value of 0.9 was selected for design purposes.

Preliminary design flood values estimated for roads, bridges, and culverts are provided on a site-by-site basis in Table 5.4.

Table 5.4 Annual Peak Floods for Roads, Bridges, and Culvert Structures

Location	Drainage Area (mi^2)	Annual Percent Probable Flood (cfs)[6]						
		50%	10%	5%	2%	1%	0.5%	0.2%
Scotch Creek Culvert[1]	17.9	170	450	600	850	1,070	1,320	1,710
New Camp Creek Bridge[1]	19.8	180	490	660	930	1,170	1,440	1,870
Jenny Creek Bridge	210	1,400	4,000	5,500	8,000	10,300	13,100	17,700
Timber Bridge Removal[2,3]	4,080	7,000	10,300	11,700	13,300	14,200	15,000	15,800
East/West Beaver Culverts[1]	5.6	60	160	210	300	370	460	600
Raymond Gulch Culvert[1]	2.5	28	80	103	140	180	220	291
Patricia Avenue Culverts[1]	0.4	5	15	20	28	35	43	56
Copco Road Bridge[2,3]	4,340	7,100	13,900	18,100	24,000	29,200	34,800	42,900
Unnamed Culvert Keno Access Road[1]	12.2	120	320	430	600	750	930	1,210
Spencer Bridge[2,3]	4,050	6,900	10,200	11,600	13,200	14,100	14,900	15,700
Topsy Grade Road Culvert[1]	2.2	30	70	90	130	160	200	260
Dagget Road Bridge[2,3,4]	4,370	7,100	14,000	18,200	24,200	29,400	35,000	43,200
Fall Creek Bridge[1]	12.2	120	320	430	600	750	930	1,210
Brush Creek Bridge[1]	5.0	50	140	190	270	340	420	540
Lakeview Road Bridge[2,3,5]	4,630	7,500	14,900	19,300	25,700	31,200	37,100	45,800
Dry Creek Bridge[1]	8.9	90	240	320	450	570	700	910

NOTES:

1. VALUES ARE CALCULATED BASED ON FALL CREEK ANNUAL PEAK FLOOD RESULTS USING NON-LINEAR DRAINAGE AREA PRORATION WITH A SCALING FACTOR OF 0.9 (USGS, 2005).
2. VALUES ARE BASED ON ANNUAL PEAK FLOOD RESULTS FROM THE CLOSEST APPROPRIATE DAM FACILITY, WHICH WERE LINEARLY PRORATED BY THE RATIO OF THE RESPECTIVE DRAINAGE AREAS.
3. THE SITE IS LOCATED ON THE KLAMATH RIVER AND THEREFORE THE FLOW DATA ARE REGULATED.
4. THE DRAINAGE AREA OF THE COPCO NO. 1 FACILITY WAS USED FOR THE DRAINAGE AREA OF POINT OF INTEREST.
5. THE DRAINAGE AREA OF THE IRON GATE FACILITY WAS USED FOR THE DRAINAGE AREA OF POINT OF INTEREST.

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6.0 POST-RIVER DIVERSION PEAK FLOODS

The KRRP dams currently create upstream reservoirs and pass flood flows through spillways. The routing of flows through the reservoirs and over the spillways necessitates a rise in the reservoir levels and the associated temporary storage of flow volumes, which results in an attenuation of flood peak discharges. With the opening of the diversion outlets, the attenuating effects will be negligible. A hydrologic model was developed to estimate the change in magnitude of the peak floods post-river diversion that simulates flows in a reach of the Klamath River from downstream of the Keno Dam to downstream of the Iron Gate Dam. The model was set up using HEC-HMS (v 4.3) to route flows through the Copco No. 1 reservoir and spillway and then the Iron Gate reservoir and spillway. Routing effects from the J.C. Boyle and Copco No. 2 reservoirs and spillways were omitted as these reservoirs have negligible active storage volumes.

Two empirical equations were developed from these results to aid in estimating the effects on peak floods that may result from opening the diversion outlets. Using these empirical equations and the annual peak floods from Table 3.2 (that include attenuation), the post-river diversion annual peak floods were calculated per facility and are shown in Table 6.1. The annual return period floods at Copco No. 1 are used as representative of the annual return period floods for Copco No. 2.

Table 6.1 Post-River Diversion Annual Peak Floods

Location	Drainage Area (mi^2)	Annual Percent Probable Flood (cfs)							
		50%	20%	10%	5%	2%	1%	0.5%	0.2%
J.C. Boyle	4,080	7,000	8,500	10,300	11,700	13,300	14,200	15,000	15,800
Copco No. 1	4,370	11,100	15,400	19,900	24,300	29,400	32,700	36,800	45,400
Iron Gate	4,630	11,600	16,200	20,900	25,400	30,500	33,600	39,000	48,100

The J.C. Boyle Dam reservoir provides minimal attenuation of peak floods, therefore there is negligible increase to the peak flood events and the annual peak floods in Table 3.2 are used to represent the post-attenuation floods.

6.1 MONTHLY PEAK FLOOD RESULTS

The post-river diversion empirical equations are applicable to peak events that result from snowmelt and/or rain-on-snow events, including the annual peak events. When there is less rainfall during the low flow summer months, the monthly peak flood events are primarily driven by releases from Upper Klamath Lake and there is less contribution from tributary and overland sources. Accordingly, peak flows during the summer months tend to be sustained for extended periods and there is little attenuation as these flows pass through the power generation facilities to the downstream. As such, the empirical equations developed for post-river diversion peak flows are not applicable to high flows that occur during the period between June 15 and September 30. The post-river diversion high flows during this period will likely be similar to the existing conditions. The monthly peak floods from Table 3.6 were used to calculate the post-river diversion monthly peak floods per facility by applying the empirical equations to the flows between October 1 to June 14, and by adopting the current values (Table 3.6) for flows from June 15 to September 30. The estimated post-diversion flows are shown in Table 6.2.

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TABLE 6.2

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

POST-RIVER DIVERSION MONTHLY PEAK FLOODS

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Location	Drainage Area (mi^2)	Month	Instantaneous Peak Floods for Specified Time Period (cfs)								Average Monthly Flow (cfs)
			50% Probable Flood	20% Probable Flood	10% Probable Flood	5% Probable Flood	2% Probable Flood	1% Probable Flood	0.5% Probable Flood	0.2% Probable Flood	
		Jan	2,600	4,400	6,000	8,000	11,100	14,000	15,000	15,800	1,500
		Feb	2,700	4,900	7,000	9,700	13,000	14,200	15,000	15,800	1,900
		Mar	6,300	8,000	8,800	10,900	13,300	14,200	15,000	15,800	2,800
		Apr	4,500	6,800	8,100	9,400	11,600	13,600	15,000	15,800	2,370
		May	2,700	4,300	5,500	6,800	8,500	9,900	11,300	13,400	1,760
		Jun 1 - 15	1,800	2,800	3,500	4,400	5,800	7,300	9,100	12,100	1,330
		Jun 16 - 30	1,400	1,800	2,300	2,800	3,600	4,400	5,000	6,300	960
		Jul 1 - 15	1,000	1,400	1,700	2,100	2,700	3,200	3,900	4,900	740
J.C. Boyle	4,080	Jul 16 - 31	1,400	1,500	1,600	1,700	1,800	1,800	1,800	2,000	760
		Aug	1,400	1,500	1,600	1,700	1,800	1,800	1,800	1,900	760
		Sep 1 - 15	1,400	1,700	1,900	2,100	2,400	2,500	2,700	3,000	810
		Sep 16 - 30	1,500	1,900	2,200	2,400	2,800	3,000	3,200	3,500	790
		Oct 1 - 15	1,700	2,200	2,500	2,900	3,400	3,800	4,200	4,700	810
		Oct 16 - 31	1,700	2,400	2,800	3,300	4,000	4,600	5,200	6,100	890
		Nov 1 - 15	1,800	2,600	3,200	3,800	4,700	5,500	6,300	8,600	980
		Nov 16 - 30	2,000	2,900	3,600	4,400	5,400	7,200	9,600	14,000	950
		Dec	2,500	3,900	5,100	6,300	8,300	10,500	13,000	15,600	1,110
		Jan	6,300	9,200	12,900	17,300	23,700	28,800	33,200	44,900	1,910
		Feb	6,300	9,200	13,000	17,300	23,700	28,800	33,200	44,900	2,360
		Mar	10,200	13,000	15,300	18,700	23,200	26,400	29,200	32,500	3,230
		Apr	7,400	10,800	13,500	16,400	20,300	23,100	25,700	28,800	2,790
		May	6,300	7,200	9,300	11,500	14,200	16,300	18,400	21,100	2,110
		Jun 1 - 15	5,900	6,300	6,000	7,200	10,100	12,600	15,600	20,000	1,620
		Jun 16 - 30	1,400	1,900	2,400	2,900	3,600	4,400	5,100	6,400	1,210
		Jul 1 - 15	1,100	1,300	1,600	2,000	2,600	3,200	4,100	5,300	990
Copco No. 1	4,370	Jul 16 - 31	1,200	1,300	1,500	1,600	1,800	2,000	2,100	2,400	990
		Aug	1,200	1,300	1,500	1,600	1,800	2,000	2,100	2,400	980
		Sep 1 - 15	1,300	1,600	1,800	1,900	2,100	2,200	2,300	2,500	1,030
		Sep 16 - 30	1,300	1,600	1,900	2,100	2,400	2,500	2,700	3,000	1,030
		Oct 1 - 15	5,200	6,100	6,400	6,300	6,000	6,900	8,100	9,800	1,050
		Oct 16 - 31	5,200	6,300	6,400	6,000	6,800	8,100	9,500	11,600	1,140
		Nov 1 - 15	5,600	6,400	6,000	6,600	8,600	10,300	12,200	15,000	1,230
		Nov 16 - 30	5,900	6,300	6,500	7,800	10,200	12,000	14,600	19,900	1,240
		Dec	6,400	8,000	11,500	15,900	22,700	28,200	33,200	45,400	1,490
		Jan	6,100	9,600	13,500	18,100	24,800	29,900	34,000	47,700	2,030
		Feb	6,100	9,600	13,700	18,100	24,800	29,900	34,000	47,700	2,500
		Mar	10,800	13,700	16,000	19,700	24,200	27,500	30,300	33,400	3,430
		Apr	7,700	11,300	14,200	17,300	21,300	24,100	26,800	29,900	2,950
		May	6,300	7,700	9,900	12,200	15,000	17,200	19,300	22,100	2,230
		Jun 1 - 15	6,100	6,300	6,200	7,700	10,600	13,300	16,400	21,000	1,720
		Jun 16 - 30	1,500	2,000	2,500	3,000	3,700	4,400	5,200	6,500	1,280
		Jul 1 - 15	1,200	1,400	1,700	2,100	2,800	3,400	4,300	5,600	1,050
Iron Gate	4,630	Jul 16 - 31	1,300	1,400	1,600	1,700	1,900	2,100	2,200	2,500	1,050
		Aug	1,300	1,400	1,600	1,700	1,900	2,100	2,200	2,500	1,040
		Sep 1 - 15	1,400	1,700	1,900	2,000	2,200	2,300	2,400	2,600	1,090
		Sep 16 - 30	1,400	1,700	2,000	2,200	2,500	2,700	2,900	3,200	1,090
		Oct 1 - 15	5,400	6,200	6,400	6,200	6,300	7,400	8,600	10,300	1,120
		Oct 16 - 31	5,400	6,300	6,300	5,700	7,200	8,600	10,100	12,300	1,210
		Nov 1 - 15	5,800	6,400	5,700	7,100	9,000	10,900	12,900	15,800	1,300
		Nov 16 - 30	6,100	6,100	6,800	8,300	10,800	12,700	14,900	19,900	1,310
		Dec	6,400	8,400	12,200	16,700	23,700	29,300	34,000	48,100	1,580

M:\1\03\00640\01\A\Data\Task 1400 - 100% Design\08 - Hydrology\4_Flood Frequency Analysis\[Post-Attenuation Peak Floods - Monthly.xlsm]Table_Post-Dam Removal Monthly

NOTES:

1. PEAK FLOOD CALCULATIONS ARE BASED ON METHODOLOGY PRESENTED IN KP MEMO "EFFECT OF DAM REMOVAL ON KLAMATH RIVER PEAK FLOWS" (VA20-00775, REV A, 20 APRIL 2020).
2. PRE-DAM REMOVAL ANNUAL PEAK FLOOD VALUES WERE REQUIRED FOR CALCULATIONS AND ARE TAKEN FROM TABLE 3.2, APPENDIX A6, 100% DESIGN REPORT (VA103-640/1-9, REV C).
3. THE POST-RIVER DIVERSION MONTHLY PERCENT PROBABLE FLOODS AT COPCO NO. 1 ARE USED AS REPRESENTATIVE OF THE POST-RIVER DIVERSION ANNUAL PERCENT PROBABLE FLOODS FOR COPCO NO. 2.
4. THE PEAK FLOODS HAVE NOT BEEN ADJUSTED FOR THE SUMMER PERIOD BETWEEN JUNE 16 TO SEPTEMBER 30. THE PEAK FLOODS DURING THIS PERIOD ARE ASSUMED TO BE UNAFFECTED POST-RIVER DIVERSION.
5. THE PEAK FLOODS HAVE NOT BEEN ADJUSTED FOR THE J.C. BOYLE FACILITY AS THE RESERVOIR PROVIDES MINIMAL ATTENUATION OF PEAK FLOODS. THE PEAK FLOODS IN TABLE 3.2, APPENDIX A6, 100% DESIGN REPORT (VA103-640/1-9, REV C) ARE ASSUMED TO BE UNAFFECTED POST-RIVER DIVERSION.

C	12NOV'20	ISSUED WITH REPORT VA103-00640/01-9	ELK	JGC
REV	DATE	DESCRIPTION	PREP'D	RVW'D

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A7 Diversion Tunnels – Design Criteria

PAGE A7-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A8 Reservoir Drawdown – Design Criteria

PAGE A8-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A9 Embankment Dam Removal – Design Criteria

PAGE A9-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A10 Concrete Dam & Structures Removal – Design Criteria

PAGE A10-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A11 Roads, Bridges, and Culverts – Design Criteria

PAGES A11-1 to A11-3

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A12 Material Disposal – Design Criteria

PAGE A12-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX A13 Dam Site Permanent Work

PAGE A13-1

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX B J.C. Boyle

PAGES B1-1 TO B2-19

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX C Copco No. 1

PAGES C1-1 TO C3-19

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX D Copco No. 2

PAGES D1-1 TO D2-18

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX E Iron Gate Design Details

PAGES E1-1 TO E2-10

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX F Roads, Bridges, and Culverts Design Details

PAGES F1-1 TO F4.4-91

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX G Reservoir Drawdown Model Report

PAGES G1-1 TO G1-93

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

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APPENDIX H Erosion and Sediment Control – BMP CGP Compliance Evaluation

PAGES H-1 TO H-12

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX I Implementation Schedule (90% GMP, Rev 1)

PAGES I-1 TO I-5

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX J Supporting Technical Information Documents (STID)

PAGES J1-1 TO J4-305

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX K Historic Drawings

PAGES K1-1 TO K4.2-231

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX L KRRP Value Engineering Completion Summary and Advancement to 90% Design

PAGES L1-1 TO L1-329

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION (CEII)

REDACTED

APPENDIX M PacifiCorp Equipment Register

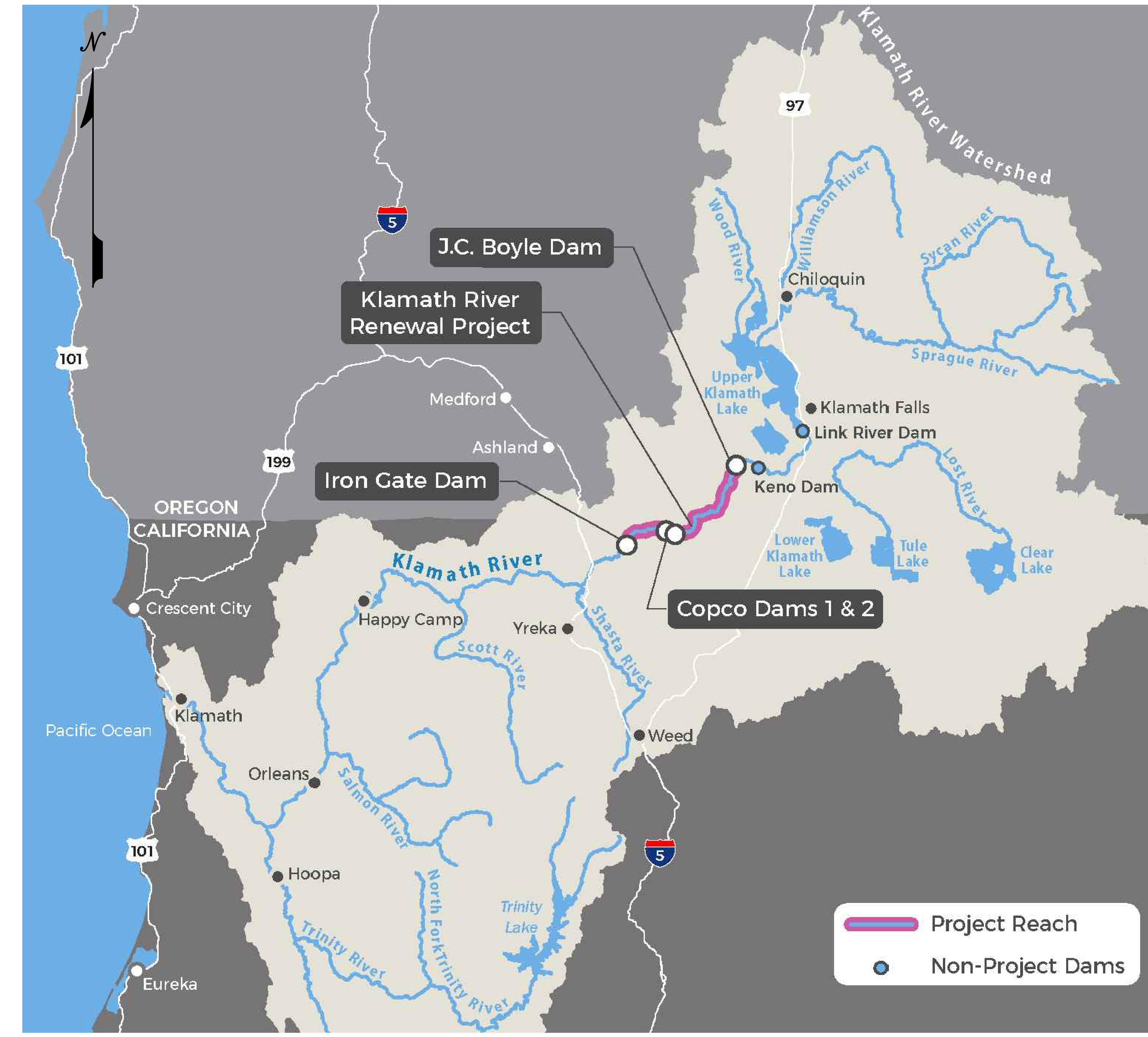
PAGES M1-1 TO M4-1

KLAMATH RIVER RENEWAL PROJECT

KIEWIT CONTRACT #104168

100% DESIGN COMPLETION DRAWINGS

JACKSON COUNTY, OREGON
KLAMATH COUNTY, OREGON
SISKIYOU COUNTY, CALIFORNIA



LOCATION MAP
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PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	CBN	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	CBN	NB	SRM	12/17/19

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

PREPARED BY
Knight Piésold CONSULTING
Kiewit

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PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT	KLAMATH RIVER RENEWAL PROJECT	PROJ #	VA103-640/1
		DATE	11/13/2020
SHEET TITLE	TITLE SHEET	DWG	G0001

SHEET NO.	GENERAL
G0001	TITLE SHEET
G0002	INDEX OF DRAWINGS – (SHEET 1 OF 2)
G0003	INDEX OF DRAWINGS – (SHEET 2 OF 2)
G0005	LEGEND, SYMBOLS, AND ABBREVIATIONS
G0006	GENERAL NOTES
G0020	PROJECT LOCATION, VICINITY AND ACCESS
G0030	GENERAL ARRANGEMENT PLAN – KEY MAP
G0031	J.C. BOYLE FACILITY – GENERAL ARRANGEMENT PLAN – (SHEET 1 OF 2)
G0032	J.C. BOYLE FACILITY – GENERAL ARRANGEMENT PLAN – (SHEET 2 OF 2)
G0033	COPCO NO. 1 AND COPCO NO. 2 FACILITIES – GENERAL ARRANGEMENT PLAN – (SHEET 1 OF 2)
G0034	COPCO NO. 1 AND COPCO NO. 2 FACILITIES – GENERAL ARRANGEMENT PLAN – (SHEET 2 OF 2)
G0035	IRON GATE FACILITY – GENERAL ARRANGEMENT PLAN – (SHEET 1 OF 2)
G0036	IRON GATE FACILITY – GENERAL ARRANGEMENT PLAN – (SHEET 2 OF 2)
G0050	EARTHWORKS AND DEMOLITION – MATERIAL GRADATIONS – (SHEET 1 OF 2)
G0051	EARTHWORKS AND DEMOLITION – MATERIAL GRADATIONS – (SHEET 2 OF 2)
CIVIL – J.C. BOYLE FACILITY	
C1000	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – KEY MAP
C1001	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 1 OF 5)
C1002	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 2 OF 5)
C1003	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 3 OF 5)
C1004	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 4 OF 5)
C1005	J.C. BOYLE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 5 OF 5)
C1050	J.C. BOYLE FACILITY – DRAWDOWN STAGES – AVERAGE INFLOW – PLAN AND SECTION
C1055	J.C. BOYLE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – POST-DRAWDOWN WATER SURFACE LEVELS
C1056	J.C. BOYLE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – FIGURES
C1210	J.C. BOYLE FACILITY – EMBANKMENT, INTAKE AND FISH LADDER REMOVAL – PLAN AND SECTIONS
C1220	J.C. BOYLE FACILITY – SPILLWAY AND INTAKE REMOVAL – PLAN AND PROFILE
C1221	J.C. BOYLE FACILITY – SPILLWAY AND INTAKE REMOVAL – SECTIONS
C1225	J.C. BOYLE FACILITY – SPILLWAY AND INTAKE REMOVAL – LEFT BANK ACCESS ROAD
C1230	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – PLAN
C1231	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – SECTION AND DETAILS
C1232	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – EXCAVATION SECTIONS
C1234	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 1 OF 6)
C1235	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 2 OF 6)
C1236	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 3 OF 6)
C1237	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 4 OF 6)
C1238	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 5 OF 6)
C1239	J.C. BOYLE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 6 OF 6)
C1240	J.C. BOYLE FACILITY – DISPOSAL SITES – GRADING PLAN
C1241	J.C. BOYLE FACILITY – DISPOSAL SITES – GRADING SECTIONS
C1300	J.C. BOYLE FACILITY – 14' LOW PRESSURE PIPELINE DEMOLITION – PLAN, PROFILE AND DETAIL
C1310	J.C. BOYLE FACILITY – POWER CANAL HEADGATE REMOVAL – PLANS, SECTIONS AND DETAILS
C1311	J.C. BOYLE FACILITY – POWER CANAL HEADGATE REMOVAL – GRADING PLAN AND SECTIONS
C1320	J.C. BOYLE FACILITY – POWER CANAL REMOVAL – PLAN
C1321	J.C. BOYLE FACILITY – POWER CANAL REMOVAL – SECTIONS
C1323	J.C. BOYLE FACILITY – POWER CANAL REMOVAL – TYPICAL ANIMAL CROSSINGS
C1330	J.C. BOYLE FACILITY – FOREBAY DEMOLITION – PLAN
C1331	J.C. BOYLE FACILITY – FOREBAY DEMOLITION – PROFILE, SECTIONS AND DETAILS
C1334	J.C. BOYLE FACILITY – FOREBAY DEMOLITION – GRADING PLAN
C1335	J.C. BOYLE FACILITY – FOREBAY DEMOLITION – GRADING SECTIONS
C1340	J.C. BOYLE FACILITY – SCOUR HOLE REGRADING – GRADING PLAN
C1341	J.C. BOYLE FACILITY – SCOUR HOLE REGRADING – GRADING PROFILE AND SECTIONS
C1350	J.C. BOYLE FACILITY – PENSTOCK DEMOLITION – PLAN AND PROFILES
C1351	J.C. BOYLE FACILITY – PENSTOCK DEMOLITION – SECTION AND DETAIL
C1400	J.C. BOYLE FACILITY – POWERHOUSE DEMOLITION – PLAN
C1402	J.C. BOYLE FACILITY – POWERHOUSE DEMOLITION – PLAN AND SECTIONS
C1410	J.C. BOYLE FACILITY – POWERHOUSE DEMOLITION – GRADING PLAN
C1411	J.C. BOYLE FACILITY – POWERHOUSE DEMOLITION – GRADING SECTIONS
C1500	J.C. BOYLE FACILITY – CONSTRUCTION ACCESS – KEY MAP
C1501	J.C. BOYLE FACILITY – CONSTRUCTION ACCESS – RESERVOIR AREA ROADS
C1511	J.C. BOYLE FACILITY – CONSTRUCTION ACCESS – POWERHOUSE ROAD REALIGNMENT
C1512	J.C. BOYLE FACILITY – CONSTRUCTION ACCESS – PENSTOCK ACCESS ROADS
C1600	J.C. BOYLE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – EMBANKMENT, SPILLWAY, AND INTAKE
C1601	J.C. BOYLE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – FOREBAY AND SCOUR HOLE
C1602	J.C. BOYLE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – PENSTOCK AND POWERHOUSE
C1620	J.C. BOYLE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – DISPOSAL SITES
C1621	J.C. BOYLE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – POWER CANAL
C1622	J.C. BOYLE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – DRAINAGE DETAILS
C1623	J.C. BOYLE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – FOREBAY AND SCOUR HOLE
C1624	J.C. BOYLE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – PENSTOCK AND POWERHOUSE
CIVIL – COPCO NO. 1 FACILITY	
C2000	COPCO NO. 1 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – KEY PLAN
C2001	COPCO NO. 1 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – PLAN
C2010	COPCO NO. 1 FACILITY – EXISTING CONDITION – KLAMATH RIVER CHANNEL – PLAN AND PROFILE
C2055	COPCO NO. 1 FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – WATER SURFACE ELEVATIONS
C2056	COPCO NO. 1 FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – FIGURES
C2057	COPCO NO. 1 FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – TABLES
C2100	COPCO NO. 1 FACILITY – DIVERSION TUNNEL MODIFICATIONS – PLAN AND PROFILE
C2101	COPCO NO. 1 FACILITY – DIVERSION TUNNEL INTAKE REMOVAL – ELEVATION AND PROFILE
C2160	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS – DIVERSION TUNNEL APPROACH CHANNEL EXCAVATION – PLAN, PROFILE AND SECTION
C2175	COPCO NO. 1 FACILITY – DIVERSION TUNNEL PORTAL – PLAN AND SECTIONS
C2200	COPCO NO. 1 FACILITY – DAM MODIFICATIONS – GENERAL ARRANGEMENT – PLAN
C2201	COPCO NO. 1 FACILITY – DAM MODIFICATIONS – GENERAL ARRANGEMENT – PROFILE AND SECTION
C2205	COPCO NO. 1 FACILITY – DRAWDOWN – GENERAL ARRANGEMENT – PLAN AND SECTION
C2210	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS – APPROACH CHANNEL EXCAVATION – PLAN AND SECTIONS
C2225	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS – LOW-LEVEL OUTLET – TUNNEL EXCAVATION – PLAN AND SECTIONS
C2226	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS – LOW LEVEL OUTLET – CONCRETE DETAILS – ELEVATION, SECTIONS AND DETAILS
C2227	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS – LOW-LEVEL OUTLET – OUTLET PIPE – TYPICAL SECTION
C2228	COPCO NO. 1 FACILITY – PRE-DRAWDOWN WORKS LOW-LEVEL OUTLET – PIPE FITTINGS – PLAN, SECTION AND DETAILS
C2230	COPCO NO. 1 FACILITY – FINAL RIVER CHANNEL GRADING – PLAN AND PROFILE
C2231	COPCO NO. 1 FACILITY – FINAL RIVER CHANNEL GRADING – TYPICAL SECTIONS
C2232	COPCO NO. 1 FACILITY – FINAL RIVER CHANNEL GRADING – CROSS SECTIONS
C2250	COPCO NO. 1 FACILITY – DAM REMOVAL – GENERAL ARRANGEMENT – PLAN
C2255	COPCO NO. 1 FACILITY – DAM REMOVAL – SPILLWAY CREST – PLAN, DETAIL AND SECTION
C2256	COPCO NO. 1 FACILITY – DAM REMOVAL – PROFILE AND SECTION
C2257	COPCO NO. 1 FACILITY – DAM REMOVAL – INTAKE – PLAN AND SECTIONS
C2258	COPCO NO. 1 FACILITY – DAM REMOVAL – FINAL GRADE – PLAN AND SECTIONS
C2259	COPCO NO. 1 FACILITY – DAM REMOVAL – FINAL GRADE – SECTIONS
C2260	COPCO NO. 1 FACILITY – DAM REMOVAL – REMOVAL LIFT SEQUENCE – OVERALL ELEVATION AND SECTION
C2261	COPCO NO. 1 FACILITY – DAM REMOVAL – REMOVAL LIFT EL. 2585 FT AND 2569.2 FT – ELEVATION AND SECTIONS
C2262	COPCO NO. 1 FACILITY – DAM REMOVAL – REMOVAL LIFT EL. 2557 FT – ELEVATION AND SECTIONS
C2263	COPCO NO. 1 FACILITY – DAM REMOVAL – REMOVAL LIFT EL. 2525 FT – ELEVATION AND SECTIONS
C2264	COPCO NO. 1 FACILITY – DAM REMOVAL – REMOVAL LIFT EL. 2493 FT – ELEVATION AND SECTIONS
C2265	COPCO NO. 1 FACILITY – REMOVAL OF HISTORICAL COFFERDAM – PLAN AND SECTION
C2270	COPCO NO. 1 FACILITY – DISPOSAL SITE – PLAN AND PROFILE
C2271	COPCO NO. 1 FACILITY – DISPOSAL SITE – SECTIONS
C2272	COPCO NO. 1 FACILITY – OPEN-WATER DISPOSAL SITE – PLAN
C2275	COPCO NO. 1 FACILITY – BORROW SITE – PLAN AND SECTIONS
C2276	COPCO NO. 1 FACILITY – DISPOSAL SITE – COPCO RD REALIGNMENT – PLAN AND PROFILE
C2300	COPCO NO. 1 FACILITY – PENSTOCK REMOVAL – GENERAL ARRANGEMENT – PLAN
C2305	COPCO NO. 1 FACILITY – PENSTOCK REMOVAL – GENERAL ARRANGEMENT – SECTIONS
C2310	COPCO NO. 1 FACILITY – PENSTOCK REMOVAL – FINAL GRADE – PLAN AND SECTION
C2400	COPCO NO. 1 FACILITY – POWERHOUSE REMOVAL – GENERAL ARRANGEMENT – PLAN
C2405	COPCO NO. 1 FACILITY – POWERHOUSE REMOVAL – GENERAL ARRANGEMENT – SECTIONS
C2410	COPCO NO. 1 FACILITY – POWERHOUSE REMOVAL – FINAL GRADE – PLAN
C2411	COPCO NO. 1 FACILITY – POWERHOUSE REMOVAL – FINAL GRADE – SECTIONS
C2500	COPCO NO. 1 FACILITY – CONSTRUCTION ACCESS – KEY PLAN
C2501	COPCO NO. 1 FACILITY – LEFT BANK ACCESS TRACK – PLAN, PROFILE AND TYPICAL SECTION
C2502	COPCO NO. 1 FACILITY – SPILLWAY APRON – PLAN AND TYPICAL SECTION
C2503	COPCO NO. 1 FACILITY – RIGHT BANK ACCESS TRACK TO EL. 2511 FT – PLAN, PROFILE AND TYPICAL SECTION
C2505	COPCO NO. 1 FACILITY – PHASE 1 TO PHASE 3 ACCESS TRACKS – CROSS SECTIONS
C2510	COPCO NO. 1 FACILITY – RIGHT BANK ACCESS ROADS – PLAN
C2511	COPCO NO. 1 FACILITY – RIGHT BANK ACCESS ROADS – PROFILES AND TYPICAL SECTIONS
C2520	COPCO NO. 1 FACILITY – CONSTRUCTION ACCESS – ACCESS RAMP AT EL. 2525 FT – PLAN AND SECTION
C2530	COPCO NO. 1 FACILITY – COPCO ROAD REALIGNMENT – PLAN, PROFILE AND TYPICAL SECTION
C2600	COPCO NO. 1 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – PRE-DRAWDOWN YEAR – PLAN
C2605	COPCO NO. 1 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – DRAWDOWN YEAR – PLAN
C2620	COPCO NO. 1 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – ACCESS ROADS AND DISPOSAL SITE – PLAN
C2621	COPCO NO. 1 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – POWERHOUSE BUTTRESS – PLAN AND TYPICAL SECTION
C2700	COPCO NO. 1 FACILITY – MISCELLANEOUS FACILITY REMOVAL – PLAN
CIVIL – COPCO NO. 2 FACILITY	
C3000	COPCO NO. 2 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – KEY MAP
C3001	COPCO NO. 2 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 1 OF 4)
C3002	COPCO NO. 2 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 2 OF 4)
C3003	COPCO NO. 2 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 3 OF 4)
C3004	COPCO NO. 2 FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 4 OF 4)
C3056	COPCO NO. 2 FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – SPILLWAY BAY NO. 1 REMOVAL – WATER SURFACE LEVELS
C3057	COPCO NO. 2 FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – RESERVOIR AND TAILWATER SURFACE ELEVATIONS – FIGURES AND TABLE
C3200	COPCO NO. 2 FACILITY – DIVERSION DAM AND INTAKE REMOVAL – GENERAL ARRANGEMENT – PLAN AND PROFILE
C3201	COPCO NO. 2 FACILITY – DIVERSION DAM AND INTAKE REMOVAL – GENERAL ARRANGEMENT – SECTIONS
C3210	COPCO NO. 2 FACILITY – PRE-DRAWDOWN WORKS – DIVERSION DAM MODIFICATIONS – PLAN
C3211	COPCO NO. 2 FACILITY – PRE-DRAWDOWN WORKS – DIVERSION DAM MODIFICATIONS – SECTIONS
C3216	COPCO NO. 2 FACILITY – SPILLWAY BAY NO. 1 REMOVAL – PLAN
C3217	COPCO NO. 2 FACILITY – SPILLWAY BAY NO. 1 REMOVAL – SECTIONS
C3220	COPCO NO. 2 FACILITY – DIVERSION DAM REMOVAL – PLAN
C3221	COPCO NO. 2 FACILITY – DIVERSION DAM REMOVAL – EXCAVATION PLAN
C3232	COPCO NO. 2 FACILITY – INTAKE CONCRETE REMOVAL AND BACKFILL LIMITS – PLANS AND SECTIONS
C3234	COPCO NO. 2 FACILITY – DIVERSION DAM REMOVAL – CHANNEL GRADING PLAN AND PROFILE
C3235	COPCO NO. 2 FACILITY – DIVERSION DAM REMOVAL – CHANNEL GRADING SECTIONS
C3240	COPCO NO. 2 FACILITY – HISTORIC DIVERSION DAM REMOVAL – PLAN AND REMOVAL NOTES
C3300	COPCO NO. 2 FACILITY – WOOD-STAVE PENSTOCK DEMOLITION – PLAN AND SECTION
C3303	COPCO NO. 2 FACILITY – WOOD-STAVE PENSTOCK DEMOLITION – GRADING PLAN
C3310	COPCO NO. 2 FACILITY – TUNNEL #1 OUTLET AND TUNNEL #2 INLET PORTALS – CLOSURE BARRIER – SECTION AND DETAILS
C3330	COPCO NO. 2 FACILITY – PENSTOCK DEMOLITION – PLAN
C3331	COPCO NO. 2 FACILITY – PENSTOCK DEMOLITION – PROFILE AND SECTION
C3332	COPCO NO. 2 FACILITY – PENSTOCK AND POWERHOUSE DEMOLITION – EXCAVATION PLAN AND SECTION
C3334	COPCO NO. 2 FACILITY – PENSTOCK DEMOLITION – GRADING PLAN AND SECTION
C3340	COPCO NO. 2 FACILITY – SURGE VENT BARRIER – PLAN AND SECTIONS
C3350	COPCO NO. 2 FACILITY – TUNNEL #2 OUTLET PORTAL – CLOSURE BARRIER – SECTION AND DETAILS
C3360	COPCO NO. 2 FACILITY – OVERFLOW SPILLWAY OUTLET PORTAL – CLOSURE BARRIER – SECTION AND DETAILS
C3400	COPCO NO. 2 FACILITY – POWERHOUSE DEMOLITION – GENERAL ARRANGEMENT – PLAN
C3401	COPCO NO. 2 FACILITY – POWERHOUSE DEMOLITION – SECTIONS
C3420	COPCO NO. 2 FACILITY – TAILRACE DISPOSAL SITE – GRADING PLAN
C3510	COPCO NO. 2 FACILITY – CONSTRUCTION ACCESS – RIGHT BANK ACCESS ROADS – PLAN
C3511	COPCO NO. 2 FACILITY – CONSTRUCTION ACCESS – RIGHT BANK ACCESS ROADS – PROFILES
C3520	COPCO NO. 2 FACILITY – CONSTRUCTION ACCESS – TEMPORARY SPILLWAY APRON – ACCESS TRACK AND WORK PLATFORM
C3530	COPCO NO. 2 FACILITY – OPTIONAL CONSTRUCTION ACCESS – LEFT BANK ACCESS ROAD – PLAN
C3531	COPCO NO. 2 FACILITY – OPTIONAL CONSTRUCTION ACCESS – LEFT BANK ACCESS ROAD – PROFILE AND SECTIONS
C3532	COPCO NO. 2 FACILITY – OPTIONAL CONSTRUCTION ACCESS – LEFT BANK ACCESS ROAD – SECTIONS – (SHEET 1 OF 3)
C3533	COPCO NO. 2 FACILITY – OPTIONAL CONSTRUCTION ACCESS – LEFT BANK ACCESS ROAD – SECTIONS – (SHEET 2 OF 3)
C3534	COPCO NO. 2 FACILITY – OPTIONAL CONSTRUCTION ACCESS – LEFT BANK ACCESS ROAD – SECTIONS – (SHEET 3 OF 3)
C3600	COPCO NO. 2 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – PRE-DRAWDOWN YEAR – DAM REMOVAL
C3601	COPCO NO. 2 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – PRE-DRAWDOWN YEAR – COPCO VILLAGE
C3605	COPCO NO. 2 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – DRAWDOWN YEAR – WOOD-STAVE PENSTOCK REMOVAL
C3606	COPCO NO. 2 FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – DRAWDOWN YEAR – POWERHOUSE AND PENSTOCK REMOVAL
C3620	COPCO NO. 2 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – FINAL RIVER CHANNEL
C3622	COPCO NO. 2 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – WOOD-STAVE PENSTOCK
C3623	COPCO NO. 2 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – POWERHOUSE AND PENSTOCK
C3624	COPCO NO. 2 FACILITY – FINAL EROSION AND SEDIMENT CONTROL – COPCO VILLAGE
C3700	COPCO NO. 2 FACILITY – COPCO NO. 2 VILLAGE REMOVAL – PLAN
CIVIL – IRON GATE FACILITY	
C4000	IRON GATE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – KEY MAP
C4001	IRON GATE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 1 OF 2)
C4002	IRON GATE FACILITY – PROJECT OVERVIEW AND LIMITS OF WORK – (SHEET 2 OF 2)
C4050	IRON GATE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – DRAWDOWN – FIGURES
C4051	IRON GATE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – DRAWDOWN – WATER SURFACE FLOOD LEVELS – RESERVOIR PLAN
C4052	IRON GATE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – DRAWDOWN – WATER SURFACE FLOOD LEVELS – DAM SECTION
C4055	IRON GATE FACILITY – HYDROLOGIC AND HYDRAULIC INFORMATION – TABLES
C4100	IRON GATE FACILITY – PRE-DRAWDOWN WORKS – GENERAL ARRANGEMENT PLAN AND SEQUENCE
C4120	IRON GATE FACILITY – DIVERSION TUNNEL DRAWDOWN MODIFICATIONS – PLAN
C4121	IRON GATE FACILITY – DIVERSION TUNNEL DRAWDOWN MODIFICATIONS – PROFILE, SECTION AND DETAIL
C4122	IRON GATE FACILITY – DIVERSION TUNNEL DRAWDOWN MODIFICATIONS – SECTIONS AND DETAIL
C4123	IRON GATE FACILITY – DIVERSION TUNNEL DRAWDOWN MODIFICATIONS – SECTIONS
C4124	IRON GATE FACILITY – DIVERSION TUNNEL VENTING – PLAN AND PROFILE
C4125	IRON GATE FACILITY – DIVERSION TUNNEL VENTING – SECTION AND DETAILS
C4170	IRON GATE FACILITY – GATE SHAFT – CLOSURE PLAN
C4175	IRON GATE FACILITY – TUNNEL INTAKE – CLOSURE PLAN
C4176	IRON GATE FACILITY – TUNNEL OUTLET – CLOSURE PLAN
C4200	IRON GATE FACILITY – EMBANKMENT AND SPILLWAY – SITE PLAN AND REMOVAL NOTES
C4201	IRON GATE FACILITY – EMBANKMENT AND SPILLWAY – SHEET PILE CREST REMOVAL NOTES
C4203	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 1 OF 7)
C4204	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 2 OF 7)
C4205	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 3 OF 7)
C4206	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 4 OF 7)
C4207	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 5 OF 7)
C4208	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 6 OF 7)
C4209	IRON GATE FACILITY – EMBANKMENT REMOVAL – GENERAL ARRANGEMENT SEQUENCE – (SHEET 7 OF 7)
C4210	IRON GATE FACILITY – EMBANKMENT REMOVAL – GRADING GENERAL ARRANGEMENT PLAN
C4211	IRON GATE FACILITY – EMBANKMENT REMOVAL – GRADING GENERAL ARRANGEMENT SECTIONS
C4212	IRON GATE FACILITY – EMBANKMENT REMOVAL – GRADING CHANNEL PROFILE
C4215	IRON GATE FACILITY – EMBANKMENT REMOVAL – DISPOSAL SITE 1 – HAUL ROADS
C4216	IRON GATE FACILITY – EMBANKMENT REMOVAL – DISPOSAL SITE 1 – HAUL ROAD SECTIONS
C4219	IRON GATE FACILITY – EMBANKMENT REMOVAL – DISPOSAL SITE 1 – FINAL GRADE
C4220	IRON GATE FACILITY – EMBANKMENT AND SPILLWAY – SPILLWAY INFILL – FINAL GRADE AND PROFILE
C4221	IRON GATE FACILITY – EMBANKMENT AND SPILLWAY – SPILLWAY INFILL – FINAL GRADE SECTIONS
C4225	IRON GATE FACILITY – EMBANKMENT REMOVAL – DISPOSAL SITE 2 – FINAL GRADE SITE PLAN
C4226	IRON GATE FACILITY – EMBANKMENT REMOVAL – DISPOSAL SITE 2 – FINAL GRADE TYPICAL SECTION
C4230	IRON GATE FACILITY – ALTERNATE DISPOSAL SITE – GENERAL ARRANGEMENT PLAN AND PROFILE
C4231	IRON GATE FACILITY – ALTERNATE DISPOSAL SITE – SECTIONS
C4250	IRON GATE FACILITY – EMBANKMENT REMOVAL – FINAL BREACH – PLAN, PROFILE AND SECTIONS
C4255	IRON GATE FACILITY – EMBANKMENT REMOVAL – FINAL BREACH – BREACH PLUG DETAILS
C4300	IRON GATE FACILITY – PENSTOCK REMOVAL – REMOVAL NOTES – PLAN AND PROFILE
C4301	IRON GATE FACILITY – INTAKE STRUCTURE REMOVAL – REMOVAL NOTES
C4400	IRON GATE FACILITY – POWERHOUSE AND FISH FACILITIES – REMOVAL AND GRADING – (SHEET 1 OF 2)
C4401	IRON GATE FACILITY – POWERHOUSE AND FISH FACILITIES – REMOVAL AND GRADING – (SHEET 2 OF 2)

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PROJECT
KLAMATH RIVER RENEWAL PROJECT

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(SHEET 1 OF 2)

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C4402	IRON GATE FACILITY – POWERHOUSE AND FISH FACILITIES – FINAL GRADE SECTIONS – (SHEET 1 OF 2)
C4403	IRON GATE FACILITY – POWERHOUSE AND FISH FACILITIES – FINAL GRADE SECTIONS – (SHEET 2 OF 2)
C4405	IRON GATE FACILITY – POWERHOUSE AND FISH FACILITIES – STRUCTURE REMOVAL LIMITS
C4500	IRON GATE FACILITY – CONSTRUCTION ACCESS – DOWNSTREAM TUNNEL PORTAL – OVERVIEW PLAN
C4515	IRON GATE FACILITY – CONSTRUCTION ACCESS – LEFT BANK TUNNEL ACCESS PLAN
C4520	IRON GATE FACILITY – CONSTRUCTION ACCESS – FISH LADDER CROSSING PLAN AND SECTIONS
C4521	IRON GATE FACILITY – CONSTRUCTION ACCESS – FISH LADDER CROSSING CONCRETE AND REINFORCEMENT
C4600	IRON GATE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – PRE-DRAWDOWN YEAR
C4601	IRON GATE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – BERM AND CHECK DAM SECTIONS
C4605	IRON GATE FACILITY – TEMPORARY EROSION AND SEDIMENT CONTROL – DRAWDOWN YEAR
C4610	IRON GATE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – DISPOSAL SITES STABILIZATION PLAN – (SHEET 1 OF 2)
C4615	IRON GATE FACILITY – FINAL EROSION AND SEDIMENT CONTROL – DISPOSAL SITES STABILIZATION PLAN – (SHEET 2 OF 2)
CIVIL – ROADS, BRIDGES, AND CULVERTS – DRAWDOWN IMPROVEMENTS	
C5000	CIVIL – ROADS & CULVERTS – GENERAL NOTES
C5001	CIVIL – ROADS & CULVERTS – ABBREVIATIONS
C5002	CIVIL – ROADS & CULVERTS – LEGEND, SYMBOLS & LINETYPES
C5003	CIVIL – ROADS & CULVERTS – TYPICAL DETAILS – (SHEET 1 OF 2)
C5004	CIVIL – ROADS & CULVERTS – TYPICAL DETAILS – (SHEET 2 OF 2)
C5005	CIVIL – ROADS & CULVERTS – INSPECTION & TESTING
C5200	CAMP CREEK CULVERT – GENERAL ARRANGEMENT
C5201	CAMP CREEK CULVERT – PLAN, PROFILE, AND SECTION
C5202	CAMP CREEK CULVERT – CHANNEL ALIGNMENT – PLAN AND PROFILE
C5203	CAMP CREEK CULVERT – TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
C5204	CAMP CREEK CULVERT – FINAL EROSION AND SEDIMENT CONTROL PLAN
C5205	CAMP CREEK CULVERT – TRAFFIC MANAGEMENT PLAN
C5300	SCOTCH CREEK CULVERT – GENERAL ARRANGEMENT
C5301	SCOTCH CREEK CULVERT – PLAN, PROFILE, AND SECTION
C5302	SCOTCH CREEK CULVERT – CHANNEL ALIGNMENT – PLAN AND PROFILE
C5303	SCOTCH CREEK CULVERT – TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
C5304	SCOTCH CREEK CULVERT – FINAL EROSION AND SEDIMENTATION CONTROL PLAN
C5305	SCOTCH CREEK CULVERT – TRAFFIC MANAGEMENT PLAN
C5400	FALL CREEK CULVERT (DAGGETT ROAD) – GENERAL ARRANGEMENT
C5401	FALL CREEK CULVERT (DAGGETT ROAD) – PLAN, PROFILE, AND SECTION
C5402	FALL CREEK CULVERT (DAGGETT ROAD) – CHANNEL ALIGNMENT – PLAN AND PROFILE
C5403	FALL CREEK CULVERT (DAGGETT ROAD) – TEMPORARY TRAFFIC, EROSION AND SEDIMENT CONTROL PLAN
C5404	FALL CREEK CULVERT (DAGGETT ROAD) – FINAL EROSION AND SEDIMENTATION CONTROL PLAN
CIVIL – ROAD IMPROVEMENTS	
C6000	CIVIL – ROADS & BRIDGES – GENERAL NOTES
C6100	FALL CREEK BRIDGE (COPCO ROAD) – GENERAL ARRANGEMENT
C6101	FALL CREEK BRIDGE (COPCO ROAD) – PLAN, PROFILE, AND SECTION
C6102	FALL CREEK BRIDGE (COPCO ROAD) – DETAILS
C6103	FALL CREEK BRIDGE (COPCO ROAD) – TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
C6104	FALL CREEK BRIDGE (COPCO ROAD) – TRAFFIC MANAGEMENT PLAN
C6200	DAGGETT ROAD BRIDGE – GENERAL ARRANGEMENT
C6201	DAGGETT ROAD BRIDGE – PLAN, PROFILE, AND SECTION
C6202	DAGGETT ROAD BRIDGE – ABUTMENT DETAILS
C6203	DAGGETT ROAD BRIDGE – TEMPORARY TRAFFIC, EROSION AND SEDIMENT CONTROL PLAN
C6204	DAGGETT ROAD BRIDGE – FINAL EROSION AND SEDIMENTATION CONTROL PLAN
C6400	DRY CREEK BRIDGE – GENERAL ARRANGEMENT
C6401	DRY CREEK BRIDGE – PLAN, PROFILE, AND SECTION
C6402	DRY CREEK BRIDGE – DETAILS
C6403	DRY CREEK BRIDGE – TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
C6405	DRY CREEK BRIDGE – TRAFFIC MANAGEMENT PLAN
C6500	LAKEVIEW/AGER BESWICK INTERSECTION IMPROVEMENT – GENERAL ARRANGEMENT
C6600	OR66 INTERSECTION 1 – TEMPORARY IMPROVEMENT – GENERAL ARRANGEMENT
C6610	OR66 INTERSECTION 2 – TEMPORARY IMPROVEMENT – GENERAL ARRANGEMENT
C6720	TRANSPORT – CONSTRUCTION ACCESS – TYPICAL SECTIONS – (SHEET 1 OF 2)
C6721	TRANSPORT – CONSTRUCTION ACCESS – TYPICAL SECTIONS – (SHEET 2 OF 2)
CIVIL – RECREATIONAL FACILITIES	
C7000	J.C. BOYLE RESERVOIR – RECREATION SITE DEMOLITION – KEY MAP
C7005	PIONEER PARK EAST RECREATION FACILITY – DEMOLITION PLAN
C7010	PIONEER PARK WEST RECREATION FACILITY – DEMOLITION PLAN
C7015	TOPSY CAMPGROUND RECREATION FACILITY – DEMOLITION PLAN
C7020	COPCO LAKE – RECREATION SITE DEMOLITION – KEY MAP
C7025	MALLARD COVE RECREATION FACILITY – DEMOLITION PLAN
C7030	COPCO COVE RECREATION FACILITY – DEMOLITION PLAN
C7035	IRON GATE RESERVOIR – RECREATION SITE DEMOLITION – KEY MAP
C7040	FALL CREEK RECREATION FACILITY – DEMOLITION PLAN
C7045	JENNY CREEK RECREATION FACILITY – DEMOLITION PLAN
C7050	WANAKA SPRINGS RECREATION FACILITY – DEMOLITION PLAN
C7055	CAMP CREEK RECREATION FACILITY – DEMOLITION PLAN
C7060	JUNIPER POINT RECREATION FACILITY – DEMOLITION PLAN
C7065	MIRROR COVE RECREATION FACILITY – DEMOLITION PLAN
C7070	OVERLOOK POINT RECREATION FACILITY – DEMOLITION PLAN
C7075	LONG GULCH RECREATION FACILITY – DEMOLITION PLAN
ELECTRICAL – GENERAL	
E0001	GENERAL ARRANGEMENT – ELECTRICAL
E0002	GENERAL TRANSMISSION NEWORK DIAGRAM
ELECTRICAL – J.C. BOYLE FACILITY	
E1015	J.C. BOYLE FACILITY OVERHEAD ELECTRICAL CONDITIONS OF REMOVAL
E1022	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION LINE 59 230KV (SHEET 1 OF 2)
E1023	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION LINE 59 230KV (SHEET 2 OF 2)
E1032	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 1 OF 7)
E1033	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 2 OF 7)
E1034	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 3 OF 7)
E1035	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 4 OF 7)
E1036	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 5 OF 7)
E1037	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 6 OF 7)
E1038	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 7 OF 7)
E1051	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION ONE LINE DIAGRAM (SHEET 1 OF 3)
E1052	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION ONE LINE DIAGRAM (SHEET 2 OF 3)
E1053	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION ONE LINE DIAGRAM (SHEET 3 OF 3)
E1060	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION OIL CONTAINMENT PLAN
E1072	J.C. BOYLE FACILITY ELECTRICAL DEMOLITION DISTRIBUTION
ELECTRICAL – COPCO NO. 1 FACILITY	
E2015	COPCO NO. 1 FACILITY OVERHEAD ELECTRICAL CONDITIONS OF REMOVAL
E2022	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION LINE 3 FALL CREEK 69KV
E2023	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION LINE 15
E2033	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 1 OF 4)
E2034	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 2 OF 4)
E2035	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 3 OF 4)
E2036	COPCO NO. 1 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 4 OF 4)
E2051	COPCO NO. 1 ELECTRICAL DEMOLITION ONE LINE DIAGRAM
ELECTRICAL – COPCO NO. 2 FACILITY	
E3015	COPCO NO. 2 FACILITY OVERHEAD ELECTRICAL CONDITIONS OF REMOVAL
E3022	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION IRON GATE–COPCO 2 69KV (SHEET 1 OF 2)
E3023	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION IRON GATE–COPCO 2 69KV (SHEET 2 OF 2)
E3032	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 1 OF 4)
E3033	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 2 OF 4)
E3034	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 3 OF 4)
E3035	COPCO NO. 2 FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 4 OF 4)
E3051	COPCO NO. 2 ELECTRICAL DEMOLITION ONE LINE DIAGRAM
ELECTRICAL – IRON GATE FACILITY	
E4015	IRON GATE FACILITY OVERHEAD ELECTRICAL CONDITIONS OF REMOVAL
E4032	IRON GATE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 1 OF 3)
E4033	IRON GATE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 2 OF 3)
E4034	IRON GATE FACILITY ELECTRICAL DEMOLITION PLAN & ELEVATION OF SUBSTATION (SHEET 3 OF 3)
E4051	IRON GATE FACILITY ELECTRICAL DEMOLITION ONE LINE DIAGRAM
E4061	IRON GATE FACILITY ELECTRICAL DEMOLITION PRODUCTION POLE P514
SECURITY	
S1000	J.C. BOYLE FACILITY – SECURITY – GENERAL LAYOUT
S2000	COPCO NO. 1 FACILITY – SECURITY – GENERAL LAYOUT
S3000	COPCO NO. 2 FACILITY – SECURITY – GENERAL LAYOUT
S4000	IRON GATE FACILITY – SECURITY – GENERAL LAYOUT

FOR INFORMATION ONLY

PRELIMINARY DESIGN (NOT FOR CONSTRUCTION)

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	CBN	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	CBN	NB	SRM	12/17/19

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 W. LAHODA
REVIEWED S. YONG
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT KLAMATH RIVER RENEWAL PROJECT
SHEET TITLE INDEX OF DRAWINGS (SHEET 2 OF 2)
PROJ # VA103-640/1
DATE 11/13/2020
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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

100% DESIGN COMPLETION DRAWINGS

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
PacifiCorp	**2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R-2
Final Design Drawings (Public)

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

100% DESIGN COMPLETION DRAWINGS

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
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AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R-3
Technical Specifications (Public)

Knight Piésold CONSULTING

TABLE 1

KIEWIT INFRASTRUCTURE WEST CO.
KLAMATH RIVER RENEWAL PROJECT

TECHNICAL SPECIFICATIONS LIST

Print Nov-16-20 13:35:57

2016 CSI Numbering	2016 CSI Specification	KP Ref. No.	90% Design Rev. (05AUG'20)	100% Design Rev. (13NOV'20)	100% Signatures	
					Prep	Rev
Division 01 - General Requirements						
01 92 00	Facility Operation	T19	C	G	BO	NB
Division 02 - Existing Conditions						
02 41 00	Demolition and Facility Removal	T3	D	H	BO	CBN
02 41 99	Electrical Distribution System Demolition	T6	C	D	TW (Kiewit)	TC (Kiewit)
Divison 03 - Concrete						
03 10 00	Concrete Forming and Accessories	T14	D	F	BO	KTW
03 20 00	Concrete Reinforcement	T15	C	F	BO	KTW
03 30 00	Cast-in-Place Concrete	T16	D	H	BO	KTW
03 60 00	Grouting	T17	D	G	BO	KTW
Divison 05 - Metals						
05 12 00	Structural Steel	T18	B	E	BO	KTW
Division 31 - Earthwork						
31 05 00	Materials for Earthwork	T2	D	H	CBN	CAV
31 10 00	Clearing, Grubbing and Stripping	T23	C	G	CBN	BO
31 23 00	Excavation and Fill Placement	T24	C	G	CBN	CAV
31 25 00	Erosion and Sedimentation Controls	T25	C	G	LB	CBN
31 60 00	Foundation Preparation	T26	C	G	CBN	BO
31 71 00	Tunnel Construction	T11	D	H	BO	KTW
31 80 00	Care of Water	T32	-	D	CBN	BO
Division 32 - Roads and Site Improvements						
32 50 00	Roads, Bridges, and Culverts	T29	C	F	JOR	BO
Divison 35 - Marine Construction						
35 24 00	Dredging	T31	A	D	LB	BO
Count		**17**				

\\KPL\VA-Prj$\1\03\00640\01\A\Correspondence\1_Transmittal\2020\VA20-02XXX - Technical Specifications List (Rev G)\[Technical Specifications List (Rev G).xlsx]Specs List

G	16NOV'20	ISSUED WITH TRANSMITTAL VA20-02465	CBN	CJN
REV	DATE	DESCRIPTION	PREP'D	RVW'D

01 92 00 FACILITY OPERATION

Prepared by:

Benoit Otis
Knight Piésold

Reviewed by:

Norm Bishop
Knight Piésold

Approved by:

Craig Nistor
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01 92 00 FACILITY OPERATION

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
	Prepared by	Reviewed by	Approved by			
A	Benoit Otis	Norm Bishop	Craig Nistor	020720	-	-
B	Benoit Otis	Norm Bishop	Craig Nistor	072920	-	-
C	Benoit Otis	Norm Bishop	Craig Nistor	080520	-	-
D	Benoit Otis	Norm Bishop	Craig Nistor	092520	-	-
E	Benoit Otis	Norm Bishop	Craig Nistor	100720	-	-
F	Benoit Otis	Norm Bishop	Craig Nistor	103020	-	-
G	Benoit Otis	Norm Bishop	Craig Nistor	111320	-	-

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01 92 00 FACILITY OPERATION

TABLE OF CONTENTS

PAGES

DRAFT

01 92 00 FACILITY OPERATION

SECTION 01 92 00 FACILITY OPERATION

Part 1 - GENERAL

1.1 SUMMARY

A. The Work specified in this Section includes the coordinated operation of the Facilities with KRRC, PacifiCorp and the Contractor after the FERC Surrender Order for the Facilities and up to the decommissioning of the Facilities. It is recognised that further development of specific responsibilities and requirements for facility operation and systematic decommissioning remain to be agreed and developed between KRRC, PacifiCorp and the Contractor.

1. General permitting and procedural requirements applicable to the operations of the Facilities between the Project Start until their decommissioning.
2. Compliance with FERC License Surrender Order requirements and other regulatory agency requirements.
3. Collecting, recording, and reporting of Facilities operation data.

1.2 DEFINITIONS

A. Pre-Drawdown – Period between the FERC Licence Surrender Order and the commencement of the reservoir drawdown during which pre-reservoir drawdown preparation, equipment and material procurement and construction improvements are executed.

B. Reservoir Drawdown – Period when the Contractor will make control discharges to lower the reservoir's water level and flush reservoir sediment.

C. Operator – The party engaged by the KRRC to operate the Facilities between the date of the FERC Licence Surrender Order and until their decommissioning.

1.3 RESPONSIBILITY

A. Operate the Facilities safely within the requirements applicable to all phases of the Work.

B. Abide by all PacifiCorp and Contractor Lockout Tagout procedures.

C. Contractor will maintain safety throughout its work and coordinate closely with the Operator.

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01 92 00 FACILITY OPERATION

D. [redacted]

1. [redacted]
2.
3.
4.
5.
6.

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works.

1. Prepare facility operation plan for periods where the Works are affected by reservoir water level and downstream discharges.

B. Iron Gate Facility: [redacted].

1.5 MONITORING

A. Operation Monitoring: KRRC or their designee will Submit daily reservoir water levels and unit flows and spillway flows at each Facility to the Contractor.

1.6 NORMAL OPERATING INSTRUCTIONS

A. [redacted].

B. [redacted]

C. [redacted]

DRAFT

01 92 00 FACILITY OPERATION

D. Notify the Contractor of any unplanned work or maintenance resulting in potential impact to the operations of the Facilities.

E. Maintain the reservoir water level at the following elevations to allow downstream work:

1. [redacted]
2. [redacted]
3. [redacted]
4. Operations Parameters remain to be agreed with the USBR and PacifiCorp (if applicable) per following table.

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01 92 00 FACILITY OPERATION

Table 1 – Facility Operations Parameters

No.	Description of Parameter	Target Flow	Purpose	Start Date	End Date	Proposed Action	Priority
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	

01 92 00 FACILITY OPERATION

1.7 EMERGENCY OPERATING INSTRUCTIONS

A. Prepare emergency operating instructions including safety procedure for all gates, valves, piping, and operating equipment used for water passage required for emergency operation.

B. When reservoir water levels indicate spilling will occur, notify the Contractor of the emergency operating procedures affecting the Contractor's work areas.

1.8 POST-OPERATION

A. Cessation of power generation: to be coordinated with the Reservoir Drawdown schedule. Bypass of flows through turbine-generators at the Facilities shall be terminated during the Reservoir Drawdown.

B. Facility decommissioning: complete all post-operation and isolations required to safely de-energize the equipment within the Facilities in accordance with the Contractor's schedule. Perform lockout tagout process as isolations are needed.

Part 2 - PRODUCTS – NOT USED

Part 3 - EXECUTION – NOT USED

END OF SECTION 01 92 00

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02 41 00 DEMOLITION AND FACILITY REMOVAL

Prepared by:

Benoit Otis
Knight Piésold

Reviewed by:

Cyrus Niamir
Knight Piésold

Approved by:

Craig Nistor
Knight Piésold

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02 41 00 DEMOLITION AND FACILITY REMOVAL

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
	Prepared by	Reviewed by	Approved by			
A	Chuck McDonald	Marko Barisic	Craig Nistor	120219	-	-
B	Benoit Otis	Cyrus Niamir	Craig Nistor	020720	-	-
C	Benoit Otis	Cyrus Niamir	Craig Nistor	072920	-	-
D	Benoit Otis	Cyrus Niamir	Craig Nistor	080520	-	-
E	Benoit Otis	Cyrus Niamir	Craig Nistor	092520	-	-
F	Benoit Otis	Cyrus Niamir	Craig Nistor	100720	-	-
G	Benoit Otis	Cyrus Niamir	Craig Nistor	103020	-	-
H	Benoit Otis	Cyrus Niamir	Craig Nistor	111320	-	-

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02 41 00 DEMOLITION AND FACILITY REMOVAL

TABLE OF CONTENTS

PAGES

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

SECTION 02 41 00 DEMOLITION AND FACILITY REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section applies to the demolition, removal and disposal of existing structures, buildings, miscellaneous items identified for removal in whole or in part, including but not limited to the following:

1. Diversion dams, embankment and concrete dams, water conveyance structures, powerhouses and switchyards and related facilities.
2. Operator's buildings, residences, and related facilities.
3. Fish hatchery structures and related facilities.
4. Electric, water, communication, sewerage, and gas utilities.
5. Excavation, removal and disposal of historical construction debris and sediment upstream of the Facilities and within the riverbed.

1.2 RELATED SECTIONS

A. Section 31 05 00 – Materials for Earthwork.

B. Section 31 10 00 – Clearing, Grubbing, and Stripping.

C. Section 31 23 00 – Excavation and Fill Placement.

D. Section 31 25 00 – Erosion and Sedimentation Controls.

E. Section 31 80 00 – Care of Water.

1.3 REFERENCE STANDARDS

A. The latest edition of Reference Standards shall govern, unless otherwise specified.

B. American National Standards Institute (ANSI)/ American Society of Safety Professionals (ASSP):

1. ANSI/ASSP - A10.6, Safety & Health Program Requirements for Demolition Operations.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

C. National Fire Protection Association (NFPA) 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

D. OSHA Construction Safety Orders.

E. State of California:

1. California Health and Safety Code Section 25117.

F. Resource Conservation and Recovery Act (RCRA).

1.4 GENERAL REQUIREMENTS

A. Obtain Authorizations before the commencement of any demolition or removal activities.

B. Confirm and coordinate with the Owner the extent of salvaged materials and special procedures for protection of articles indicated to be salvaged.

1.5 SUBMITTALS

A. Submit in accordance with the Contract Documents and FERC surrender order articles.

B. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

C. Demolition and Removal Plan indicating the following:

1. Method statement shall comply with ANSI/ASSP - A10.6 and NFPA 241 and schedule of demolition activities.
2. Description and schedule of materials to be disposed on site and their disposal location.
3. Protection of items to be salvaged, in accordance with the salvage list shown on Table 1, the Fall Creek Hatchery Project Specification and as agreed with the Owner.
4. Inventory of all hazardous and/or contaminated materials existing on site.
5. Methods for abatement, removal, handling, and transportation of all hazardous and/or contaminated materials identified in the inventory.
6. Methods for managing and monitoring dust generation and stormwater runoff to satisfy local authorities and in accordance with Section 31 25 00 - Erosion and Sedimentation Controls.
7. Submit disposal plan including name and location of off-site disposal facility.
8. Care of Water including Storm Water Pollution Prevention Plan (SWPPP).

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

D. Waste Materials Management Plan:

1. Submit a Construction/Demolition Waste Materials Management Plan. Identify requirements for hazardous and non-hazardous construction/demolition waste Materials.

E. Blasting plans in accordance with the applicable federal, State, and local codes and regulations, indicating the following:

1. Name, qualification, and references of the proposed blaster-in-charge and personnel responsible for blast design.
2. Method and mitigation to control noise, air blast, ground vibration, fly rock, and dust control.
3. Explosives transportation plan including handling, storage, and security.
4. Safety plan and fire prevention plan.

1.6 SITE CONDITIONS

A. Locate existing services and underground structures that may affect the Work or may be damaged during demolition. Drawings or descriptions, verbal or otherwise, of existing structures or their location that are given are intended only as an aid to the location of these structures. Measurements and locations of the existing underground structures shown on the Drawings are not guaranteed to be accurate and must be verified by the Contractor prior to proceeding with demolition.

B. Unknown Conditions:

1. Material, debris, and soils may be contaminated by hazardous substances including but not limited to transformers, batteries, insulation, and petroleum products not indicated on the Drawings or Contract Documents. Conduct an assessment to classify the extent of contaminated materials.

C. Lead-based paint and asbestos:

1. Structures, equipment, and buildings to be removed may include lead-based paint and asbestos.

D. Petroleum, oil, and lubricants (POL):

1. Equipment indicated for removal will require the removal of petroleum, oil, and lubricant products not indicated on the Drawings or Contract Documents.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Confirm the location and extent of all structures and items indicated for demolition, salvage, or removal. Identify any special requirements that may be necessary to perform this work.

B. Confirm the location of all utilities and coordinate all utility disconnection with the utility owner.

3.2 ITEMS TO REMAIN IN PLACE

A. Protect items to remain in place from damage. In the event of damage to items indicated to remain in place, immediately notify the Owner.

3.3 ENVIRONMENTAL CONSIDERATIONS

A. Dust and Debris Control:

1. Dust from demolition and removal operations shall be controlled so as not to adversely affect people and equipment, including Others.
2. Keep the site free of debris and control water runoff. Discharge water runoff such that suspended materials or other harmful substances in accordance with the requirements of local authorities. Prevent erosion and sedimentation at and downstream of the discharge locations, in accordance with Section 31 25 00 - Erosion and Sedimentation Controls.

B. Properly remove and dispose of hazardous materials including dust, fibrous materials (insulation), contaminated or dangerous materials.

3.4 REMOVAL OF STRUCTURES AND FACILITIES

A. Comply with ANSI/ASSP A10.6 and NFPA 241.

B. Proceed with demolition work in accordance with the Demolition and Removal Plan and in accordance with the Drawings.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

C. Demolition limits are based on the conditions reported on the historic drawings. Where unanticipated conditions or unknow elements are encountered contact the Engineer for evaluation.

D. Site access and temporary safety controls of the work site area are to be established and monitored by the Contractor.

E. Do not damage components indicated to remain or to be salvaged.

F. Comply with the Waste Materials Management Plan, Federal, State, and Local Authorities regarding waste material transport.

G. Excavations:

1. Excavation required for demolition must comply with Section 31 23 00 – Excavation and Fill Placement.

H. Removal of Structures:

1. Remove structures and associated facilities to the lines and limits as indicated on the Drawings.
2. Remove structures in a manner that ensures structural stability during the demolition and removal work.
3. Provide any temporary shoring, support, and work platforms required to ensure structural stability during the demolition and removal process.
4. Remove and separate hazardous or contaminated materials from the demolition waste and dispose of as per the Waste Materials Management Plan.
5. The exposed portion of the structures left in place shall be free of jagged edges and/ or exposed rebar. Rebar shall be cut flush with the lines and grade as shown on the Drawings.
6. Exposed concrete surfaces after demolition works shall be free of any loose material or exposed partially detached aggregates.

I. Underground Structures:

1. Underground structures shall be abandoned in place unless indicated otherwise.
2. Underground storage tanks abandoned in place shall be pumped out and filled with General Fill - Type E9 with or without concrete as indicated on the Drawings.
3. All underground storage tank containing petroleum products shall be removed.

J. Utilities and Related Equipment:

1. Electrical distribution system shall be removed or modified as per Section 02 41 99 – Electric Distribution System Demolition.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

2. Ensure that all utilities including electric, water, communication, gas, and sewage connection to the structures, indicated to be removed or modified, are disconnected in conformance with Federal, State and Local regulations.
3. Do not interrupt utilities serving facilities used by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   a. Notify the Owner not less than 7 days in advance of proposed utility interruptions.
   b. Do not proceed with utility interruptions without the Owner's written permission.
4. Piping, ducts, and conduits will be removed to the lines and limits as indicated on the Drawings.
   a. Flush piping to be abandoned in place.
   b. Abandoned piping remaining in place will be capped or covered with a minimum of 2 feet with General Fill - Type E9 or as indicated on the Drawings.

K. Mechanical Equipment:

1. Where removal of mechanical equipment is required for demolition or indicated on the Contract Documents or Drawings, ensure that the equipment is de-energized.
2. Flush abandoned piping.
3. Identify any hazardous waste materials and decontamination required to prepare the equipment for disposal in accordance with the Demolition and Removal Plan indicating the following:
   a. Means and method statement.
   b. Construction staging in accordance with OSHA Construction Safety Orders.
   c. Description and schedule of materials to be disposed and their disposal location.
   d. Method for removal, handling, and transportation of hazardous or contaminated materials.
   e. Name and location of off-site disposal facility.
   f. Care of Water details.
   g. Waste Materials Management Plan.

L. Pavement Removal:

1. Cut out with saw and remove asphalt and road toppings pavement to the limits shown on the Drawings, dispose of all loose pavement, or as agreed between Contractor and local counties, per Memorandum of Understanding.

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02 41 00 DEMOLITION AND FACILITY REMOVAL

M. Recreation Site Demolition:

1. Septic tanks located at recreation facilities shall be removed and backfilled. Septic tanks may also be left in place and backfilled. The bottom of the tank and at least one side shall be crushed so as to prevent subsurface water collection in the tank.
2. Water wells located at recreation facilities shall be abandoned and backfilled with a impervious fill material and as approved by the appropriate jurisdictional agency.
3. Any above ground service or utilities shall be removed and severed with subsurface utilities to a level of 1 feet below ground. Subsurface utilities and components shall remain in place.
4. All existing asphalt and gravel surfaces shall remain in place.
5. Utilities shall be confirmed to be ‘out of service’ prior to removal.
6. Removal of surface structures (i.e. vaulted toilets, sheds, structures with lead-based paint etc.) shall be completed as approved by the appropriate jurisdictional agency.
7. Boat docks, boat ramps, ADA platforms shall be removed and disposed of as required.

3.5 PACIFICORP EQUIPMENT TO BE SALVAGED

A. Check equipment salvage list shown in Table 1 and record the conditions of items to be salvaged as per the Contract Documents.

B. Protect all items indicated to be salvaged as per the Contract Document. Refer to salvage list in Table 1 and the Fall Creek Hatchery Project Specification (Iron Gate).

3.6 BACKFILL

A. All backfill materials and fill placement required at the demolition Worksite will be as per Section 31 05 00 – Materials for Earthwork and Section 31 23 00 – Excavation and Fill Placement.

3.7 DRILLING AND BLASTING

A. Drill blasting holes as required to complete desired construction results. Review the blasting performance and adjust the blast design to achieve the requirements as per the Drawings.

B. Where control blasting is required, blasting to be performed using perimeter-controlled blasting techniques including presplitting and trim (cushion) blasting adjacent to the minimum line of excavation.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

C. Design the blast to comply with safe peak particle velocity (PPV) for all structures within and in the vicinity of the blast area and other locations.

D. Take necessary precautions to protect the structures, buildings and equipment not intended to be removed from blast induced damage, including protection from fly rock, protection from vibrations and air blasts.

E. Coordinate blasting and notify the Owner, Other Contractors and personnel working on site or near site.

F. Remove unstable material and scale base surface as shown on the Drawings and as required to provide a stable surface.

3.8 DISPOSAL OF PETROLEUM, OIL AND LUBRICANTS (POL)

A. After de-energizing the facilities, all POL shall be removed, transported, and disposed of off-site in accordance with Clause 3.9 of this Section.

3.9 DISPOSAL OF REMOVED MATERIALS

A. Dispose of all removed materials.

B. Temporary waste material stockpiles shall be placed and graded to prevent any water accumulation on their surfaces and erosion of the slope. If necessary, direct any water accumulation away from the stockpile in accordance with Section 31 25 00 - Erosion and Sedimentation Controls.

C. Place contaminated materials in separate stockpiles, provide containment and protection of stormwater from seepage in accordance with Section 31 25 00 - Erosion and Sedimentation Controls. Remove contaminated materials from the Project site and dispose in a licensed, approved off-site disposal site.

D. On-Site Disposal:

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

1. Develop Disposal Sites as designated on the Drawings. All non-hazardous materials removed from the site and surplus materials from the excavations at the (separate) locations shown on the Drawings shall be disposed in the disposal sites shown on the Drawings. The disposal sites shall be stable within themselves, shall not cause instability of adjacent natural slopes or any parts of the Work and shall be graded as shown on the Drawings, to provide free draining surfaces which do not detract from the general appearance of the area. The Disposal Sites shall be established and maintained in a manner that meets the requirements of the Drawings, Section 31 05 00 – Materials for Earthwork, Section 31 23 00 – Excavation and Fill Placement and Section 31 25 00 – Erosion and Sedimentation Controls.

E. Off-Site Disposal:

1. Obtain all haul route permits for waste material transport operations.

F. Hazardous and Contaminated Waste Disposal:

1. This applies to materials and substances as defined under CERCLA, "hazardous waste" as defined under RCRA and in California Health and Safety Code Section 25117, "hazardous material" as defined under US DOT regulations (49 CFR Parts 100–180), and "hazardous material" as defined in Oregon Administrative Rules 340-142-0001.
2. Dispose of hazardous materials and waste in accordance with the Federal, State and Local regulations.
3. Dispose of unused contaminated debris, soils and other materials resulting from the demolition or removal of the facility in accordance with the Waste Materials Management Plan.
4. Comply with all other applicable local, state, and federal hazardous waste material regulations not specifically contained in this section.

3.10 CLEAN-UP

A. At the end of each shift, ensure that the excavations and structures are safe, clean, solid, and stable.

B. Trim demolition surfaces to match the conditions of adjacent, undisturbed areas.

C. At completion and during progress of the Work, maintain premises in a neat and orderly manner. Dispose of rubbish, construction debris and surplus materials at least on a weekly basis.

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

3.11 SECURITY

A. Partially demolished structures or buildings shall be protected from unauthorized entry.

B. Access to site is to be restricted to authorized entry points as shown on the Drawings.

Table 1 – Equipment Salvage List (12-09-2019)

PacifiCorp Equipment to be Salvaged – J.C. Boyle		
Functional Location	Equipment	Description
JCB1 - Exciters	10012357	Exciter
JCB2 - Exciters	10012358	Exciter
JCBC - Controls/Instrumentation	10012389	Controls/Instrumentation
JCBC - Electrical Systems	10012400	JC Boyle 1 GEN BREAKER 5L51
JCBC - Electrical Systems	10012401	JC Boyle 2 GEN BREAKER 5L52
JCBC - Electrical Systems	10012402	Transformer - GSU - JB2 sn C660427
JCBC - Electrical Systems	10012403	Transformer - GSU - JBC SPARE sn C660426
JCBC - Cranes/Hoists	10050475	JCB Powerhouse Stop Log Crane
JCB1 - Governor System	10050564	Governor - JCB Unit 1
JCB2 - Governor System	10050567	Governor - JCB Unit 2
JCBC - Electrical Systems	10052841	Transformer - GSU - JB1 sn G1150-01
JCBC - PROTECTIVE RELAYS	10075565	JCB1 REL-P GEN 12Y-1 overspeed - Airpax
JCBC - PROTECTIVE RELAYS	10075566	JCB2 REL-P GEN 12Y-2 overspeed - Airpax
JCBC - WECC RELAYS	10075588	JCB1 REL-W SWGR ARC FLASH MONITOR
JCBC - WECC RELAYS	10075589	JCB2 REL-W GSU ARC FLASH MONITOR
JCBC - WECC RELAYS	10075637	JCB1 REL-W GEN 11 - 3425A-1
JCBC - WECC RELAYS	10075638	JCB1 REL-W GEN 11 - 3425B-1
JCBC - WECC RELAYS	10075639	JCB1 REL-W GEN 64F-1 field ground detect
JCBC - WECC RELAYS	10075640	JCB1 REL-W GSU 11 - 3311-1
JCBC - PROTECTIVE RELAYS	10075641	JCB1 REL-P GEN 25 sync check 188A-1
JCBC - PROTECTIVE RELAYS	10075642	JCB1 REL-P GEN 25-1 syncrocloser 193B-1
JCBC - PROTECTIVE RELAYS	10075643	JCB1 REL-P GEN 25-1 gen control 194-1
JCBC - WECC RELAYS	10075644	JCB2 REL-W GEN 11 - 3425A-2
JCBC - WECC RELAYS	10075645	JCB2 REL-W GEN 11 - 3425B-2
JCBC - WECC RELAYS	10075646	JCB2 REL-W GEN 64F-2 field ground detect
JCBC - WECC RELAYS	10075647	JCB2 REL-W GSU 11 - 3311-2 multi-funct
JCBC - PROTECTIVE RELAYS	10075648	JCB2 REL-P GEN 25 sync check 188A-2

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

PacifiCorp Equipment to be Salvaged – J.C. Boyle		
Functional Location	Equipment	Description
JCBC - PROTECTIVE RELAYS	10075649	JCB2 REL-P GEN 25-2 syncrocloser 193B-2
JCBC - PROTECTIVE RELAYS	10075650	JCB2 REL-P GEN 25-2 gen control 194-2
JCBC - Electrical Systems	10083827	JC Boyle Station Battery System - 125 V
JCBC - Electrical Systems	10083829	JC Boyle Dam Battery System - 125 V
JCBC - Electrical Systems	10083830	JC Boyle Station Batteries - 125 VDC
JCBC - Electrical Systems	10083834	JC Boyle Stn Battery Charger - 125 VDC
JCBC - Electrical Systems	10083839	JC Boyle Stn Battery Inverter - 125 VDC
JCBC - Electrical Systems	10083840	JC Boyle Dam Batteries - 125 VDC
JCBC - Electrical Systems	10083841	JC Boyle Dam Battery Charger - 125 VDC
JCBC - Electrical Systems	10083842	JC Boyle Dam Battery Inverter - 125 VDC
JCBC - WECC RELAYS	10085257	JC BOYLE 1 REL-W GEN WECC RELAYS - 10 YR
JCBC - WECC RELAYS	10085258	JC BOYLE 1 REL-W GSU WECC RELAYS - 10 YR
JCBC - WECC RELAYS	10085259	JC BOYLE 2 REL-W GEN WECC RELAYS - 10 YR
JCBC - WECC RELAYS	10085260	JC BOYLE 2 REL-W GSU WECC RELAYS - 10 YR
JCBC - WECC RELAYS	10085261	JC BOYLE PLANT REL-W SS WECC RELAYS-10 Y
JCBC - Electrical Systems	10099298	JC Boyle Plant Energy Meters

PacifiCorp Equipment to be Salvaged – Copco 1		
Functional Location	Equipment	Description
C11 - Exciters	10011707	Exciter
C12 - Exciters	10011708	Exciter
C1C - Electrical Systems	10011757	Emergency Generator
C1C - Electrical Systems	10011763	Copco 1 Station Battery System - 120VDC
C11 - Governor System	10050469	Governor - Copco 11
C12 - Governor System	10050470	Governor - Copco 12
C1C - Electrical Systems	10084172	Copco 11 generator energy meter
C1C - Electrical Systems	10084173	Copco 12 generator energy meter
C1C - Electrical Systems	10084279	Copco 1 Station Batteries - 120VDC
C1C - Electrical Systems	10084280	Copco 1 Station Battery Charger

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

PacifiCorp Equipment to be Salvaged – Copco 2		
Functional Location	Equipment	Description
C21 - Exciters	10011839	Exciter
C22 - Exciters	10011840	Exciter
C2C - Controls/Instrumentation	10011868	Controls/Instrumentation
C2C - Electrical Systems	10011878	Copco 21 unit breaker 6G21
C2C - Electrical Systems	10011879	Copco 22 unit circuit breaker 6G22
C2C - Electrical Systems	10011880	Transformer - Miscellaneous
C2C - Electrical Systems	10011886	Plant Emergency Generator
C2C - Electrical Systems	10011891	Dam Emergency Generator
C21 - Governor System	10050543	Governor - Copco 21
C22 - Governor System	10050544	Governor - Copco 22
C2C - Electrical Systems	10084174	Copco 2 station service energy meter
C2C - Electrical Systems	10084175	Copco 21 generator energy meter
C2C - Electrical Systems	10084176	Copco 22 generator energy meter
C2C - Electrical Systems	10084282	Copco 2 Station Batteries - 130 VDC
C2C - Electrical Systems	10084283	Copco 2 Station Battery Charger -130 VDC
C2C - Electrical Systems	10084508	Copco 2 station service breaker 6G9
C2C - Electrical Systems	10084513	Copco 21 station service breaker 6G36
C2C - Electrical Systems	10084514	Copco 22 station service breaker 6G37
C2C - Communication Site	10086912	C2C - Communication Site - Hilltop

PacifiCorp Equipment to be Salvaged – Iron Gate		
Functional Location	Equipment	Description
IGC - Controls/Instrumentation	10012136	Controls/Instrumentation
IGC - Electrical Systems	10012147	Irongate Station Battery System - 130VDC
IG1 - Governor System	10050555	Governor - Iron Gate
IGC - Cranes/Hoists	10050558	Iron Gate Powerhouse Stop Log Hoist
IGC - Electrical Systems	10084182	Irongate generator energy meter
IGC - Electrical Systems	10084344	Irongate Station Batteries - 130VDC
IGC - Electrical Systems	10084345	Irongate Station Battery Charger
IGC - Electrical Systems	10099297	Irongate Plant Energy Meters
IGC - Controls/Instrumentation	10012136	Controls/Instrumentation
IGC - Electrical Systems	10012147	Irongate Station Battery System - 130VDC
IG1 - Governor System	10050555	Governor - Iron Gate

DRAFT

02 41 00 DEMOLITION AND FACILITY REMOVAL

PacifiCorp Equipment to be Salvaged – Iron Gate		
Functional Location	Equipment	Description
IGC - Cranes/Hoists	10050558	Iron Gate Powerhouse Stop Log Hoist
IGC - Electrical Systems	10084182	Irongate generator energy meter
IGC - Electrical Systems	10084344	Irongate Station Batteries - 130VDC
IGC - Electrical Systems	10084345	Irongate Station Battery Charger
IGC - Electrical Systems	10099297	Irongate Plant Energy Meters
IGC - Controls/Instrumentation	10012136	Controls/Instrumentation
IGC - Electrical Systems	10012147	Irongate Station Battery System - 130VDC
IG1 - Governor System	10050555	Governor - Iron Gate

END OF SECTION 02 41 00

DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

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02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

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D	Terry Wolfsen	Tawatchai Chaipaisan	Craig Nistor	100720	All	Issued for 100% Design

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DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

TABLE OF CONTENTS

PAGES

DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

SECTION 02 41 99 – ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work includes removal of the associated utility lines at the J.C. Boyle powerhouse, the Copco No. 1 powerhouse, the Copco No. 2 powerhouse, the Iron Gate powerhouse and area outbuildings and village areas.

1.2 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal.

1.3 REFERENCES

A. Drawings and general provisions of the Contract, including general and supplementary conditions, apply to this section.

1.4 WORK INCLUDED

A. The Contractor shall furnish all labor, equipment, and materials necessary to remove, salvage, and dispose of, abandon, or reset existing power lines and conduits, communication lines and facilities, and/or miscellaneous structures of all types and as required for the demolition of the proposed dam, powerhouse, fish facilities and village installations.

1.5 SUBMITTALS

A. Submit in accordance with the Contract Documents and FERC surrender order articles.

B. Provide the following submittals before starting any work, in accordance with Section 02 41 00 – Demolition and Facility Removal.

1. Demolition and Removal Plan indicating the following:

DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

a. Description and schedule of materials to be disposed on site and their disposal location.
b. Description and schedule of materials to be disposed off site and their disposal location.
c. Submit Utility Interruption Plan and utility service disconnection schedule.

1.6 WORKSITE CONDITIONS

A. Contractor to provide record of lockout tagout.

B. Equipment identified to be salvaged shall be inspected and designated for salvage or disposal in accordance with Section 02 41 00 or as shown on the Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Confirm the location of all structures and equipment to be removed.

B. Confirm the location and condition of all structures and equipment to be salvaged in accordance with Section 02 41 00 – Demolition and Facility Removal.

3.2 POWER/COMMUNICATION AERIAL LINE REMOVAL/ABANDONMENT

A. [redacted]

DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

B. [redacted]

C. The Contractor is responsible for any necessary lock out/tag out procedures as required prior to performing any work.

D. The end of line runs to remain shall be suitably determined from the plans. All poles, guy wires, guy poles, transformers and associated equipment, pole lights, and conduit/riser equipment shall be removed by the Contractor. Refer to specification 02 41 00 for a list of salvage materials, applicable to this demolition scope of work.

E. Foundations shall be buried unless regrading of the area results in removal. The Contractor shall provide two (2) feet of cover material over any remaining structure base/foundation. Any removal resulting in two (2) foot or less of structure base shall be totally removed. Ground rods shall be cut off one (1) foot below the finished ground elevation. Transmission, distribution, communication, and production poles that are to be removed may be cut two (2) feet below ground line and back-filled with native soil. Should wood pole removals reveal any contamination from test and treat procedures, the entire pole length must be removed from the ground.

F. [redacted]

G. The Contractor shall load, haul away, and dispose of in an approved location any debris, trash, structures, etc. removed from the worksite in accordance with all applicable codes and regulations.

3.3 CABLE/CONDUIT REMOVAL/ABANDONMENT

A. The Contractor shall be responsible for removal of any cable line shown on the Contract Drawings that are to be abandoned or removed. Buried conduit may be abandoned in place.

B. [redacted]

DRAFT

02 41 99 ELECTRICAL DISTRIBUTION SYSTEM DEMOLITION

C. The Contractor is responsible for any necessary lock out/tag out procedures as required prior to performing any work.

D. The ends of conduit runs to remain shall be suitably determined from the plans. [redacted]

E. Foundations shall be buried unless regrading of the area results in removal. Removal or demolishing shall be at the Contractors discretion; however, the Contractor shall provide two (2) feet of cover material over any remaining structure base/foundation. Any removal resulting in two (2) foot or less of structure base shall be totally removed. Ground rods shall be cut off one (1) foot below the finished ground elevation.

F. [redacted]

G. The Contractor shall follow all applicable codes and regulations for removal of hazardous materials and dispose of in a legal and proper manner.

H. The Contractor shall load, haul away, and dispose of in an approved location any debris, trash, structures, etc. removed from the worksite in accordance with all applicable codes and regulations.

3.4 MISCELLANEOUS STRUCTURE REMOVAL/RESET

A. The Contractor shall be responsible for removal of any miscellaneous structure that as indicated on the Contract documents and/or drawings.

B. Where miscellaneous structures are to be removed, the Contractor shall remove the structure, with their attached parts and connections, from supports/foundation, excavate the supports/foundation, and backfill the void with approved material; the backfill shall be E9.

C. The Contractor shall load, haul away, and dispose of in an approved location any debris, trash, structures, parts, connections, etc. removed from the worksite in accordance with all applicable codes and regulations.

END OF SECTION 02 41 99

DRAFT

03 10 00 CONCRETE FORMING AND ACCESSORIES

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03 10 00 CONCRETE FORMING AND ACCESSORIES

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F	Benoit Otis	Katrina Wechselberger	Craig Nistor	111320	-	-

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03 10 00 CONCRETE FORMING AND ACCESSORIES

TABLE OF CONTENTS

PAGES

DRAFT

03 10 00 CONCRETE FORMING AND ACCESSORIES

SECTION 03 10 00 – CONCRETE FORMING AND ACCESSORIES

Part 1 - GENERAL

1.1 SUMMARY

A. This Section applies to design, construction, erection, use and removal of forms, formwork and falsework required for Cast-In-Place Concrete shown or indicated on the Drawings or in the Specifications.

1.2 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcement.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 03 37 13 – Shotcrete.

1.3 REFERENCE STANDARDS

A. Applicable Federal or State Building Code.

B. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 347 - Guide to Formwork for Concrete.
3. ACI SP-4 - Formwork for Concrete.

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works.

B. Submit formwork/lift drawings and structural design calculations for all formwork and falsework for which engineering design is required by a civil engineer registered in the applicable State. In general, the lift drawings should show:

1. Type of forming materials.
2. Falsework and formwork support system details.

DRAFT

03 10 00 CONCRETE FORMING AND ACCESSORIES

3. Maximum permitted vertical pour rate for the various concrete mixes.
4. Methods of fixing reinforcing and conduit.
5. Direction of form material.
6. Location of tie rods and tie cones.
7. Form joints, construction joints, blockouts, bulkheads.
8. Locations of embedded plates and anchor bolts cast into concrete.
9. Location of reveals, rustication strips and method of fixing to formwork.
10. Form connection and corner details including sealing forms between construction joints.
11. Locations and sizes of blockouts for mechanical ducts, sleeves, chases, etc.

C. Review of formwork drawings will be for information and general conformance to the design intent and construction sequences only and will not constitute acceptance of structural adequacy of formwork. It is the sole responsibility of the Contractor to ensure the forms are designed and built to provide adequate strength, rigidity, and safety.

1.5 QUALITY ASSURANCE

A. Formwork and Falsework Design:

1. Design formwork and falsework in accordance with ACI 347 and ACI SP-4.
2. Design and engineering of formwork, shoring and falsework is the responsibility of the Contractor. Retain a civil engineer registered in the applicable State to provide complete designs, drawings and instructions for forms, falsework, shoring and re-shoring for the project.
3. Make due provisions for the effects of various concrete mixes, in particular the effects for admixtures such as retarders, accelerators and plasticizers.

Part 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 301, ACI 347 to conform to the design and applicable Code and Building Code requirements to achieve concrete shape, line, and dimension as indicated on Drawings.

2.2 FORMWORK MATERIALS

A. Formwork Materials: shall be approved for the intended use.

DRAFT

B. Use a compatible forming hardware system to maintain specified tolerances for finished surfaces.

2.3 FORMWORK ACCESSORIES

A. Form Ties:

1. Designed to prevent form deflection and to prevent spalling concrete surfaces upon form removal.
2. Tie cones for exposed finishes: Plastic tapered cones 2 1/2 inch deep and 1 1/2 inch face.
3. The portion of ties remaining in concrete after removal (if any) to be at least 1 1/2 inch from the outer concrete surface. Fill resulting recesses as specified in Section 03 30 00 – Cast-in-Place Concrete.
4. Tie hole plugs for concealed finishes, including foundation walls and other elements below grade: For permanent concrete works, remove tie cones and patch tie holes flush with surrounding surface as specified in Section 03 30 00 – Cast-in-Place Concrete.

B. Form Release Agent:

1. Form Release Agent: Chemical non-staining release agent not affecting the concrete surface and not affecting the application of finish treatment. Use in strict accordance with the manufacturer's recommendations.

Part 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork.

3.2 FORMWORK AND FALSEWORK

A. Construct forms complying with ACI 347 to the exact sizes, shapes, lines, and dimensions shown and as required to obtain accurate alignment, location, grades, level and plumb work in finish structure.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

DRAFT

03 10 00 CONCRETE FORMING AND ACCESSORIES

C. Construct forms and falsework with sufficient strength to structurally support the Work, and withstand the pressure resulting from placement and vibration of the concrete and maintain them rigidly in position during concrete placement.

D. Construct forms sufficiently tight to prevent loss of mortar from the concrete.

E. Corner treatment:

1. Form corners accurately to produce uniformly straight lines and tight edge joints on exposed concrete. Tape or caulk joints to prevent leakage at corners of walls, columns, and beams.
2. All concrete corners (exposed, permanent works only) shall have a 1-inch chamfer formed from a 1 x 1 inch triangular timber, plastic or other approved material unless specified otherwise on the Drawings.

F. The Contractor shall inspect formwork prior to placing concrete for purpose of reviewing cleanliness, and for general conformance with the Drawings. Third party inspection will not relieve the Contractor of his responsibility to construct and erect forms safely.

3.3 CONSTRUCTION JOINTS

A. Locate construction joints only where shown and as detailed or where pre-approved by the Engineer.

3.4 INSERTS, BLOCKOUTS, CONDUIT AND OPENINGS

A. Provide all openings and blockouts shown or otherwise required by civil, mechanical, electrical, and other trades.

B. Openings not shown on the Drawings must be pre-approved by the Engineer. Approval of the size, type and position of any holes required by the Contractor must be obtained prior to installation of such items.

C. Unless otherwise specified or approved, form all holes at the time of placing concrete. No part of the concrete walls or slabs may be drilled or cut away without prior approval by the Engineer.

3.5 EMBEDDED ITEMS

A. Set all embedded items such as anchor bolts, and other such items required to be anchored in the concrete before the concrete is placed.

DRAFT

03 10 00 CONCRETE FORMING AND ACCESSORIES

3.6 FORMWORK REMOVAL

A. Do not remove formwork and falsework supporting concrete, such as slabs and beams unless:

1. The concrete has attained at least 70% of the specified compressive strength as verified by testing field cured concrete cylinders.
2. The concrete has attained a compressive strength twice that which will be induced in any part of the structure due to self-weight and construction loads.

B. Remove form ties carefully to avoid marking concrete and allow for patching or filling with tie plugs.

3.7 REUSE OF FORMS

A. When forms are reused for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints.

B. Replace split, frayed, de-laminated or otherwise damaged form facing material.

3.8 TOLERANCES

A. The forms constructed tolerance and surface tolerances shall be in compliance with the requirements of Section 03 30 00 – Cast-in Place Concrete.

3.9 PROTECTION AND CLEAN-UP

A. At completion and during progress of the work maintain premises in a neat and orderly manner. Dispose of all rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage by work of other sections.

C. Protect the work of other sections from damage resulting from the work of this section.

END OF SECTION 03 10 00

DRAFT

03 20 00 CONCRETE REINFORCEMENT

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03 20 00 CONCRETE REINFORCEMENT

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03 20 00 CONCRETE REINFORCEMENT

TABLE OF CONTENTS

PAGES

DRAFT

03 20 00 CONCRETE REINFORCEMENT

SECTION 03 20 00 – CONCRETE REINFORCEMENT

Part 1 - GENERAL

1.1 SUMMARY

A. This Section describes the reinforcement steel for concrete shown or indicated on the Drawings.

B. This specification applies to:

1. Design, supply, fabrication, installation of reinforcing steel.
2. Dowels and anchors.

1.2 RELATED SECTIONS

A. Section 03 10 00 – Concrete Forming and Accessories.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 03 37 13 – Shotcrete.

D. Section 03 60 00 – Grouting.

1.3 REFERENCE STANDARDS

A. Applicable Federal or State Building Code.

B. American Concrete Institute (ACI):

1. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
2. ACI SP-66 - ACI Detailing Manual.

C. ASTM International (ASTM):

1. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

DRAFT

03 20 00 CONCRETE REINFORCEMENT

D. Concrete Reinforcing Steel Institute (CRSI):

1. CRSI 10-MSP - Manual of Standard Practice.
2. CRSI 10-PLACE - Placing Reinforcing Bars.

1.4 REINFORCEMENT DETAILING

A. Detailing of reinforcement and preparing shop drawings, comprising bar schedules and placement drawings, is the responsibility of the Contractor. Not withstanding the review of these shop drawings by the Engineer and site inspections of reinforcing performed by the Engineer, the design Drawings will govern.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works.

B. Provide shop/placing drawings in conformance with ACI SP-66 or CRSI 10-MSP detailing:

1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel.
2. Lists and quantities of reinforcement.
3. Bar bending details.
4. Placing drawings, indicating sizes, spacings, locations and quantities of reinforcement.

C. Materials Certificate: Certify that products meet or exceed specified requirements, mill test report.

Part 2 - PRODUCTS

2.1 REINFORCEMENT

A. Deformed Reinforcing Steel conforming with ASTM A615, Grade 60.

B. Welded wire fabric conforming with ASTM A1064.

C. Plain Dowels: ASTM A615/A615M, round, smooth surface, Grade 40.

DRAFT

03 20 00 CONCRETE REINFORCEMENT

D. Reinforcement Dowels: ASTM A615/A615M, deformed, new billet steel, Grade 60.

E. Surface Coatings: unfinished, unless otherwise indicated.

F. All reinforcement shipped on site shall be identified.

G. Use new reinforcement, free from loose scale, rust, oil, or other coatings which will decrease the bond to concrete at the time of placing concrete.

H. Bending of reinforcement:

1. All steel reinforcement shall be bent cold using purpose-made equipment to the recommended dimensions shown in ACI 318.
2. Do not bend partially embedded bars without the prior approval of the Engineer.
3. Do not straighten or re-bend in a manner which will damage the reinforcement bars.
4. Bars showing cracks (metal fatigue) shall be rejected and remedial measures carried out the Contractor to replace the damaged bars.

2.2 REINFORCEMENT ACCESSORIES

A. Chairs, bolsters, bar supports, spacers: Use only non-rusting, galvanized, plastic coated steel, or plastic supports and accessories. Use chairs of sufficient strength to suit construction activities.

B. Wire for tying reinforcement: No. 16 AWG or heavier black soft-annealed wire.

Part 3 - EXECUTION

3.1 INSTALLATION

A. Accurately place reinforcement steel in position and adequately secure in position using chairs or spacers. Reinforcement placement must meet the requirements of CRSI 10-PLACE.

B. Bracing Reinforcement: All reinforcement shall be placed in accordance with Plans for Construction and shall be held so securely in position by wiring and blocking from the forms and by wiring together at intersections that it will not be displaced during the depositing and compacting of the concrete. Tack welding of bars will not be permitted.

DRAFT

03 20 00 CONCRETE REINFORCEMENT

C. Support of the Work: Piping and conduits shall not be supported or tied directly to the steel. They shall be supported by bar chairs or support bars provided for piping or conduits only.

D. Ensure that concrete cover is not reduced by reinforcement, embedded items, anchor bolts and tie wires.

E. Maintain minimum concrete cover around reinforcement according to ACI 301 and ACI 350 or, as shown on Drawings.

1. Concrete cast on/against soil, rock, or concrete blinding: 3 inch.
2. Concrete exposed to flowing water: 3 inch.
3. Concrete exposed to weather, standing water and soil backfill:
    a. Primary reinforcement: 2 inches.
    b. Stirrups, ties, and spirals: 1-1/2 inches.
4. Concrete exposed to air and standing water: 1-1/2 inch.

3.2 FIELD QUALITY CONTROL

A. Reinforcement as indicated on the Drawings may be checked and approved by the Engineer before closing of forms and concrete placement.

3.3 TOLERANCES

A. Install reinforcement within following tolerances for flexural members, walls, and compression members:

1. On concrete cover: -0 Inch, +3/8 inch.
2. On embedment and splice length: -0 inch, No upper limit.
3. On standard hook dimensions: -0 inch, No upper limit.
4. On lateral spacing of reinforcement: ± 1/2 inch.
5. On rebar dimension length: ± 1 inch.

3.4 PROTECTION AND CLEAN-UP

A. At completion and during progress of the Work maintain premises in a neat and orderly manner. Dispose of all rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage by Work of other sections.

DRAFT

03 20 00 CONCRETE REINFORCEMENT

C. Protect the Work of other sections from damage resulting from the work of this section.

END OF SECTION 03 20 00

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

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DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
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DRAFT

Approval that this document adheres to the Knight Piésold Quality System: CN

03 30 00 CAST-IN-PLACE CONCRETE

TABLE OF CONTENTS

PAGES

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers the requirements for supply, placement, finishing and curing installation of cast-in-place concrete as indicated on the Drawings.

1.2 RELATED SECTIONS

A. Section 03 10 00 – Concrete Forming and Accessories.

B. Section 03 20 00 – Concrete Reinforcement.

C. Section 03 60 00 – Grouting.

D. Section 31 60 00 – Foundation Preparation.

1.3 REFERENCE STANDARDS

A. The latest edition of Reference Standards shall govern, unless otherwise specified.

B. American Concrete Institute (ACI):

1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 304.2R - Guide to Placing concrete by Pumping Methods.
4. ACI 305R - Guide to Hot Weather Concreting.
5. ACI 306.1 - Standard Specification for Cold Weather Concreting.
6. ACI 308.1 - Specification for Curing Concrete.
7. ACI 318 - Building Code Requirements for Structural Concrete.
8. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.

C. ASTM International:

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
5. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
8. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
9. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
10. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
11. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
12. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
13. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
14. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
15. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Ready-mix concrete from a ready-mix plant: Submit for review and approval documentation demonstrating that the concrete materials achieve the project requirements indicating the following:

1. Petrographic analysis of concrete aggregate (fine and coarse).
2. Aggregate size and gradation.
3. Test results for alkali-aggregate reaction.
4. Cement and supplementary cementitious materials chemical composition.
5. Product Data: Submit Manufacturer’s information on all concrete additives and admixtures to be used.

C. Mix design data, submit for review and approval the following:

1. Concrete ingredients and proportion, including admixtures for each strength and type of concrete.

DRAFT

2. Compressive strength results at 7, and 28-days of each type of concrete demonstrating that each class of concrete will achieve the required strength and performance requirements either evaluated by concrete trial mixes or based on tests conducted within the previous 12 months.
3. Cold weather mixing procedure and methods for protection from freezing during placing and curing in accordance with ACI 306 if work is expected to occur when atmospheric temperatures are expected to be below 40 °F.
4. Hot weather procedure in accordance with ACI 305 when atmospheric temperatures are expected to exceed 85°F.

D. Quality Control Plan.

E. For bridges and culvert structures, see submittal requirements in Section 32 50 00.

F. Field Quality-Control Submittals:

1. Ready-mix delivery tickets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cementitious Materials:

1. Portland Cement: Comply with ASTM C150, Type I.

B. Aggregate:

1. Concrete aggregate to conform to ASTM C33. Aggregates not complying with ASTM C33, but which have shown by test and actual service to produce concrete of adequate strength and durability may be submitted for approval.
2. Aggregates shall be nonreactive for alkali-silica reactivity (ASR) and shall be washed before use.
3. Do not use aggregates containing soluble salts or other substances which cause stains on exposed concrete surfaces.
4. Fine aggregates and coarse aggregates shall be regarded as separate ingredients.
5. Fine aggregate shall not exceed 40 percent by weight of the combined aggregate total.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

C. Water:

1. Comply with ACI 301, ASTM C94 and ASTM C1602.
2. Be clean and free from objectionable quantities of silty organic matter, oils, acids, alkali, salts, organics, and other impurities.

D. Admixtures:

1. Air Entrainment: Comply with ASTM C260, be compatible with water reducing and any other admixture, and shall be subject to tests in accordance with ASTM C233. If air entraining cement is used, any additional air entraining admixture shall be of the same type as that in the cement. Air-entraining admixtures shall be added to the concrete mixture in the form of solutions rather than solids. The manufacturer's storage recommendations shall be followed.
2. Water reducing and set retarding admixtures shall conform to ASTM C260, Types A or D and conform to ASTM C494, Type A with not more than 0.1 percent chloride ions. Use water reducing admixture to increase workability of mix.
3. High range, water reducing admixtures used for slowing concrete cure and retarders: shall conform to ASTM C1017, Type 1.

E. Miscellaneous Materials:

1. Waterstops:
   a. Hydrophilic waterstop, swellable strip type with delayed action coating meeting shall be used where specified. Apply hydrophilic waterstop as per Manufacturer’s recommendations.
2. Curing and Sealing Compounds:
   a. Liquid membrane forming, curing compound meeting requirements of ASTM C309, clear type.
3. Polystyrene Joint Filler/Bond Breaker: Rigid closed-cell extruded polystyrene foam panels; ASTM C578, Type VI, density 1.8 pcf minimum, 2-inch thick or as required.
4. Bond Breaker: Asphalt impregnated felts, 15 pounds, polyethylene tape, coated paper, metal foil, or other approved material.

F. Grout:

1. Nonshrink grout: in accordance with ASTM C1107.
2. Epoxy grout: in accordance with ASTM C881.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

2.2 CONCRETE MIX

A. Mix Designs: Contractor shall be responsible for mix designs and related testing to the mix designs, which shall conform to the following requirements:

B. All materials used in the work shall be subject to inspection and tests at the batch plant and at the job site.

C. All concrete mixes shall be designed using the minimum water possible subject to workability requirements.

D. Select proportions for normal weight concrete according to ACI 301.

E. Performance and Design Criteria:

1. All cast-in-place concrete, shall meet the following proportioning and design requirements without the use of an ASTM C494, Type F, high range water reducing admixture:
2. Compressive Strength: 28-day strength as indicated in Drawings.
   a. Provide concrete as indicated on the Drawings meeting the following requirements:

Table 1 – Concrete Requirements

28-Day Compressive Strength	Maximum w/cm (%)	Air Content (%)	Slump (inch)
4,000 psi	0.45	4 - 7	up to 5
5,000 psi	0.42	5 - 8	up to 5

   b. ASTM C494, Type F, high range water reducing admixture may be used to improve consistency and workability, for pumping concrete.
   c. Slump specified prior to the addition of superplasticizers.

2.3 SUPPLY OF PRE-CAST CONCRETE ITEMS

A. Concrete requirements of pre-cast concrete items shall be in compliance with the requirements of this Section.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare previously placed concrete by roughening surface of existing concrete to an amplitude of approximately 1/4 inch to remove laitance, coatings, and unsound materials.

B. Preparation of soil and rock foundations shall meet the requirements stated in Section 31 60 00 – Foundation Preparation.

C. Verify before placing concrete that reinforcement is placed to meet the requirements stated in Section 03 20 00 - Concrete Reinforcement and that all reinforcing steel is free of oil or other coatings that might impair bond with the concrete.

D. Verify that castings, anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, clean, and free of oil or loose coatings of paint, rust or scale, and will not interfere with placing concrete.

E. Apply bonding agent in accordance with manufacturers recommendations.

F. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels, and completely fill the grout hole with non-shrink grout as specified in Section 03 20 00 - Concrete Reinforcement and Section 03 60 00 – Grouting or as specified on the Drawings.

G. Concrete shall not be placed in formwork which has collected water, snow, or ice, in any form or manner.

H. Preheat forms to maintain temperature at 40 °F or above.

I. Formwork shall be cleaned of all tie wire off-cuts, nuts, bolts, rebar off-cuts, timber, Snow, ice, chips, dirt, and other debris before fresh concrete is placed inside forms. Formwork shall be completed and checked to be watertight and to the proper lines. Thoroughly wet the forms (except in freezing weather), or oil them; and remove all standing water.

J. Thoroughly saturate existing concrete one hour before placing new concrete against existing concrete. Maintain surface of existing concrete in a moist condition until new concrete is placed.

K. Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3.2 PRODUCTION OF CONCRETE

A. Mix and deliver concrete according to ASTM C94, ACI 301, and ACI 318.

B. Start agitation of concrete immediately after the pre-mixed concrete is placed in the concrete mixing truck and continue without interruption until discharged.

C. Concrete may be furnished by batch mixing at or near the site or by ready mix methods.

D. Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transportation of aggregates shall be such to avoid contamination, excessive breakage, or segregation.

3.3 WATERSTOPS

A. Install waterstops in accordance with manufacturer's recommendations.

B. Support and protect waterstops during construction.

C. Splice waterstops using manufacturer’s approved splicing procedures to form a continuous watertight joint.

3.4 CONCRETE PLACEMENT

A. Place concrete according to ACI 301, ACI 304.2R, and ACI 318.

B. Discharge concrete at the placing site prior to any set up of the mix.

C. Do not place concrete for slabs or other visually exposed horizontal surfaces when rain is forecast during the placing and finishing time period unless protective enclosures are provided to prevent damage to surface of concrete from rain.

D. Provide such equipment and place concrete as close as possible to its final position to avoid segregation of the mix.

E. Ensure that reinforcement, inserts, embedded parts, formed expansion and contraction joints, and forms are not disturbed during concrete placement.

F. Do not drop concrete a free distance of more than 5 feet. For vertical drops exceeding this height, such as in walls, columns, and piles, use a tremie or other suitable approved placement method.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

G. Concrete shall be conveyed from mixer to forms as rapidly as practicable, by methods that will prevent segregation of aggregates or loss of mortar.

H. Place concrete so that uniform appearance of visually exposed surface will be obtained.

I. Place concrete in continuous operation for each panel or section as determined by predetermined joints proceeding at a uniform rate so that cold joints between layers are not created. Keep the pour surface of concrete within walls generally level.

J. Carry out placing as a continuous operation until placement of the panel or section is complete. Do not deposit fresh concrete on concrete, which has hardened sufficiently that a vibrator will not easily penetrate.

K. Elapsed Time for Placing Concrete: Concrete shall be delivered to any monolithic unit of a structure at a rate which will permit proper handling, placing, and finishing of the concrete.

L. Regulate the maximum interval between the placing of batches at the work site to avoid the development of cold joints. If concrete placement is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead or finished to a horizontal surface. New concrete shall not be placed until the hardened concrete has cured at least 12 hours and the construction joint has been prepared in accordance with Clause 3.8.

3.5 CONCRETING IN COLD WEATHER

A. When the atmospheric temperature may be expected to drop below 40°F at the time concrete is delivered to the work site, during placement, or any time during the curing period, the following provisions also shall apply:

1. Protect concrete work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.
2. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcement, and adjacent concrete surfaces are entirely free of frost, now or ice before placing concrete.
3. The temperature of the concrete at the time of placing shall not be less than 50°F nor more than 85°F. The temperature of neither aggregates nor mixing water shall be more than 100°F just prior to mixing with the cement.
4. When the daily minimum temperature is less than 40°F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3.6 CONCRETING IN HOT WEATHER

A. When climatic or other conditions are such that temperature of concrete may be expected to exceed 85°F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions also shall apply:

1. Maintain the temperature of the concrete below 85°F during mixing, conveying, and placing. Methods used shall conform to ACI 305. Cool ingredients before mixing to maintain concrete temperature at time of placement. Mixing water may be chilled or chopped ice may be used to control temperature provided water equivalent of ice is calculated in total amount of mixing water.
2. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected, as directed by the Engineer, from drying during the time between placement and finishing, and after finishing.
3. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.
4. Concrete surfaces exposed to the air shall be covered as soon as the concrete has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period and for the entire curing period unless curing compound is applied.
5. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied.
6. If moist curing is discontinued before the end of the curing period, curing compound shall be applied immediately, according to manufacturer's recommendations.

3.7 CONSOLIDATION

A. Consolidate concrete by means of hand-tamping tool, vibrators, or finishing machines.

B. Manipulate vibrators so as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Supplement vibrating by hand spading with suitable tools to assure proper and adequate consolidation.

C. Maintain at least one spare (standby) vibrator on site during concrete placement.

D. Employ sufficient number of vibrators so that, at the required rate of placement, vibration is maintained throughout the entire volume of each layer of concrete and complete consolidation is secured.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

E. Location, manner, and duration of application of vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface.

F. Vibration shall be applied in the freshly deposited concrete by inserting and removing vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to ensure effective bond between layers.

G. Vibration shall not be applied directly to reinforcement steel or forms, or to concrete that has hardened to the degree that it does not become plastic when vibrated.

H. Use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

3.8 CONSTRUCTION JOINTS

A. Locate and install construction joints at locations shown and as specified below. Contractor may submit alternate, additional, or the elimination of joint locations for Engineer's approval.

B. Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than six inches.

C. Provide keyways at least 1-1/2 inch deep in construction joints in walls, slabs and between walls and footing; bulkheads designed for this purpose may be used for slabs.

D. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.

E. Surfaces of concrete to be joined shall be clean, rough, and moist when new-cast-in-place concrete is applied. Clean joint surfaces to remove all unsatisfactory concrete, laitance, coatings, stains, or debris by high pressure washing or scrubbing with a wire brush or wire broom.

F. Prepare surfaces of existing or hardened concrete by wet or dry sandblasting, water blasting with approved equipment, bush hammering, grinding, or other approved method. Clean surfaces by air/water jets and allow to dry thoroughly; drying may be accomplished by air jets. Compressed air used in cleaning and drying operations shall be free from oil or other contaminating materials.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

G. Joints shall be thoroughly moistened prior to placing concrete. Surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

3.9 CONTRACTION AND EXPANSION JOINTS

A. Locate and install contraction and expansion joints shall be made only at locations shown on the Drawings.

B. Apply a waxed based curing compound or bituminous paint to old concrete surface prior to concrete placement to provide a bond breaker between concrete placements. Curing compound or bituminous paint shall not be removed but shall remain on these joints and be kept intact until adjoining concrete is placed.

C. Waterstops and dowels shall be protected during application of bond breaking material to prevent them from being coated.

3.10 JOINT SEALANT

A. Apply joint sealant to horizontal and vertical contraction joints as shown on the Drawings. Comply with manufacturer's instructions.

B. Provide information on sealant testing.

C. Installation of field molded sealants, joint shall be cleaned of all debris and further cleaned using water, chemical solvents or other means as recommended by sealant manufacturer.

1. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.11 REMOVAL OF FORMS

A. Forms shall be removed in accordance with the requirements of Section 03 10 00.

B. Form removal shall be performed sequentially such that completion of finishing operations can be accomplished within four hours of form removal.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3.12 SURFACE FINISH FOR FORMED SURFACES

A. Formed Surfaces: in accordance with Section 03 10 00 – Concrete Forming and Accessories.

B. Concrete formed surfaces shall be true and even, and shall be free from open or rough spaces, depressions, projections, or other defects in the specified surface finish or alignment.

C. After removing forms, patch all tie holes (except where noted otherwise).

D. All form bolts and ties shall be removed to a depth at least one inch below surface of concrete. Cavities produced by form ties and other holes of similar size and depth shall be thoroughly cleaned and, after interior surfaces have been kept continuously wet for at least three hours, shall be carefully packed with a dry patching mortar (pre shrunk) mixed not richer than one part cement to three parts sand.

1. Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.
2. Patching mortar shall be thoroughly compacted into place to form a dense, well bonded unit, and the in place mortar shall be sound and free from shrinkage cracks. Cure patched areas as specified.

E. Unexposed Finished Surfaces: Provide standard rough finish to formed surfaces to be concealed in finish work, by earth or rock fill, or by other construction, unless otherwise designated. Standard rough form finish shall be the concrete surface having texture imparted by form facing material. Repair defective concrete, fill form tie holes and surface depressions deeper than one inch and remove or smooth fins and abrupt projections which exceed 1/4 inch.

F. Exposed Finish Surfaces: Provide standard smooth finish to formed surfaces exposed to view or surfaces that convey water. Standard smooth finish shall be the as-cast concrete surface obtained with form facing material.

G. For permanent concrete works, repair defective concrete, fill all form tie holes, remove, or smooth all abrupt irregularities greater than 1/4 inch in depth or projection, and treat all depressions such that they do not exceed 1/4 inch in depth.

H. Related Unformed Surfaces: At top of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3.13 SURFACE FINISH FOR UNFORMED SURFACES

A. Check and level surface plane with a straight edge. Cut high spots and fill low spots.

B. Float and steel trowel finish required for permanent exposed surfaces.

C. Broom finish by roughening the surface in a direction perpendicular to the direction of traffic: roughening the surface immediately after trowelling with a fibre bristle broom Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Do not work surface until surface has hardened sufficiently to prevent an excess of fine material from being drawn to the surface. Begin floating when surface water has disappeared, and concrete has stiffened sufficiently to permit operation of power-driven float. Excessive floating while concrete is soft will not be permitted. Consolidate surface with power-driven floats, or by hand floating using bull floats or darbies if area is small or inaccessible to power units.

E. Tool joints and edges using molding tools on unformed surfaces that will be exposed to view that are not to be left square or have been chamfered.

3.14 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Curing period and moisture retention to comply with ACI 301. Unhardened concrete shall be protected from heavy rains and flowing water. All concrete shall be adequately protected from damage.

C. Moist Curing: Concrete shall be moist cured by maintaining all surfaces continuously (not periodically) wet for the duration of the entire curing period. Water for curing shall be clean and free from any elements which will cause staining or discoloration of the concrete. Where forms of wood are used and left in place during curing, the wood shall be kept wet at all times.

D. Membrane Curing: apply curing compound to surfaces, as per the manufacturer's recommendation.

3.15 NON-CONFORMING CONCRETE

A. This section shall apply to the permanent concrete works.

DRAFT

B. Repair of formed surfaces shall be started within 48 hours after removal of the forms. All new concrete shall be secured with keys, dovetails, or anchors.

C. Repair of non-conforming concrete shall include any poor joints, voids, honeycomb, stone pockets, or other defective areas. Where necessary, cut out and chip defective areas to a depth of not less than one inch, with the edges perpendicular to the surface.

D. Contractor shall apply bonding agent to areas to be patched with care to keep bonding agent off of areas to remain exposed. Contractor shall apply bonding agent in accordance with manufacturer's printed instructions.

E. Place mortar thoroughly into place and screed off so as to leave the patch slightly higher than the surrounding surface. The patch shall be left undisturbed for a period of one to two hours to permit initial shrinkage before beginning final finishing. The patch should be finished in such a manner as to match the adjoining surface. All patches shall be finished and cured in accordance with requirements for surface in which the patch occurs. The patch shall be kept moist for not less than three days after installation.

F. Tie-holes left by withdrawal of rods, or holes left by removal of ends of ties shall be filled solidly with mortar after first being wet thoroughly. For holes passing entirely through a wall, a plunger-type grout-gun shall be used to force the mortar through the wall, starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside; and when the hole is completely filled, the excess mortar shall be struck off flush with the surface. Holes not passing entirely through the walls shall be filled with a small tool that will permit packing of the hole solidly with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth.

G. Patching:

  1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

H. Honeycombing or Embedded Debris in Concrete:

  1. Notify Engineer upon discovery.

I. Patch imperfections according to ACI 301 or as directed by the Engineer.

J. Defective Concrete:

  1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.

K. Repair or replacement of defective concrete will be approved by Engineer.

DRAFT

03 30 00 CAST-IN-PLACE CONCRETE

3.16 TOLERANCES

A. Variation in dimensions and locations shall be in accordance with ACI 117.

B. Concrete work shall meet the tolerance limits shown on the Drawings.

3.17 FIELD QUALITY CONTROL

A. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.

B. Inspection and Testing: Performed by Contractor supplied testing laboratory according to ASTM C31, ASTM C172, ACI 308, and ACI 318.

C. Sample concrete in accordance with and make one set of three cylinders in accordance with for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area for slabs and walls.

D. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch if less than five batches are used.

E. Make one additional cylinder during cold weather concreting and field cure.

F. Measure slump, temperature, and air content for each sample according to ASTM C143, ASTM C173, and ASTM C1064.

3.18 PROTECTION AND CLEANUP

A. At completion and during progress of the work maintain premises in a neat and orderly manner. Dispose of all rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage including water leakage onto curing concrete.

C. Protect the work of other sections from damage resulting from the work of thissection.

END OF SECTION 03 30 00

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03 60 00 GROUTING

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03 60 00 GROUTING

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B	Benoit Otis	Katrina Wechselberger	Craig Nistor	020720	-	-
C	Benoit Otis	Katrina Wechselberger	Craig Nistor	072920	-	-
D	Benoit Otis	Katrina Wechselberger	Craig Nistor	080520	-	-
E	Benoit Otis	Katrina Wechselberger	Craig Nistor	100720	-	-
F	Benoit Otis	Katrina Wechselberger	Craig Nistor	103020	-	-
G	Benoit Otis	Katrina Wechselberger	Craig Nistor	111320	-	-

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03 60 00 GROUTING

TABLE OF CONTENTS

PAGES

DRAFT

03 60 00 GROUTING

SECTION 03 60 00 - GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section applies to the Work that requires grout and includes:

1. Supply, mixing, placement and curing of grout.
2. Supply, mixing, placement and curing of Low Density Cellular Concrete Grout (LDCC).

1.2 RELATED SECTIONS

A. Section 03 10 00 – Concrete Forming and Accessories.

B. Section 03 20 00 – Concrete Reinforcing.

C. Section 03 30 00 – Cast-in-Place Concrete.

D. Section 31 70 00 – Tunnel Construction.

1.3 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. ACI 301 - Specifications for Structural Concrete for Buildings.

B. ASTM International (ASTM):

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
3. ASTM C150 - Standard Specification for Portland Cement.
4. ASTM C191 - Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
5. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.

DRAFT

03 60 00 GROUTING

6. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
7. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.
8. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
9. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
10. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Grout from pre-mix materials: Product Data: Submit manufacturer product data and information.

C. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and non-shrink grouts.

D. Contractor shall submit for review and approval a mix design meeting the project criteria stated in this Section, including proportions, weighs, w/c ratio, admixture use, brands and types of products, compressive strengths (7, 14, 28 day) etc.

E. Contractor provide details for placing of grout materials.

1.5 QUALITY ASSURANCE

A. Perform Work according to the ACI standards.

B. Certified/accredited lab performing testing of materials and expertise in the material type.

C. Certifications that admixtures are compatible within the proposed design.

D. Make test cylinders for every 100 cubic yards of material placed.

DRAFT

03 60 00 GROUTING

1.6 DELIVERY, STORAGE, AND HANDLING

A. Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: Comply with ASTM C150 Type I and II.

B. Nonshrink grout: Comply with ASTM C1107.

C. Silica fume: in accordance with ASTM 1240.

D. Water: comply with ACI 301 and ASTM A1602. clean and free from objectionable quantities of silty organic matter, oils, acids, alkali, salts, organics, and other impurities.

E. Fine Aggregate: Comply with ASTM C33.

F. Adhesive anchoring system: epoxy-type, as indicated on the drawings or approved by the Engineer.

2.2 GROUT MIX

A. Pre-mixed and ready-for-use formulation requiring only addition of water.

B. Do not use ferrous aggregate or staining ingredients in grout mixes.

C. Include a non-shrink admixture or use a prepackaged non-shrink material.

D. Performance and Design Criteria:

1. Mix design by the Contractor as to produce the compressive strength and properties as indicated on the Drawings.

DRAFT

2. Minimum compressive strength: 6,000 psi.

2.3 FORMWORK

A. As specified in Section 03 10 00 - Concrete Forming and Accessories.

PART 3 - EXECUTION

3.1 PREPARATION PER MANUFACTURER'S RECOMMENDATIONS

A. Execution and Closeout Requirements: Requirements for installation preparation.

B. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by brushing, hammering, chipping, or other similar means until sound and clean concrete surface is achieved.

C. Roughen concrete lightly, but not to interfere with placement of grout.

D. Remove foreign materials from metal surfaces in contact with grout.

E. Align and maintain final positioning of components to be grouted.

F. Saturate concrete surfaces with clean water, and then remove excess water.

3.2 INSTALLATION

A. Formwork:

1. Install formwork with clearances to permit proper placement of grout.
2. As specified in Section 03 10 00 - Concrete Forming and Accessories.

B. Mixing:

1. Portland Cement Grout:
    a. Use proportions of two parts sand and one-part cement, measured by volume or as described by the manufacturer for prepackaged mixtures.
    b. Prepare grout with water to obtain consistency to permit placing and packing.
    c. Mix water and grout as per the mix design.
    d. Mix only quantities of grout capable of being placed within 30 minutes after mixing.

DRAFT

03 60 00 GROUTING

   e. Do not add additional water after grout has been mixed.
2. Rapid-Curing Epoxy Grout:
   a. Mix and prepare according to manufacturer instructions.
   b. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.
3. Nonshrink Cementitious Grout:
   a. Mix and prepare according to manufacturer instructions.
4. Mix grout components in proximity to Work area and transport mixture quickly and in manner not permitting segregation of materials.

C. Placing of Grout per Manufacturer's Recommendations:

1. Place grout material quickly and continuously.
2. Provide equipment, pumps, and pressure vessels capable of delivering the grout at the recommended rate and pressure.
3. Do not use dry-packing methods.
4. Apply grout from one side only to avoid entrapping air.
5. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
6. Thoroughly compact final installation and eliminate air pockets.
7. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap method or maintaining end form placement where possible.
2. Control ground water or other seepage to prevent erosion of the grout material.
3. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
4. After grout has attained its initial set, keep damp for minimum three days (if applicable).

3.3 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS AND ANCHOR BOLTS

A. Hole Preparation:

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4 inch greater than the diameter of the outer surface of the reinforcing bar deformations.
2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

DRAFT

03 60 00 GROUTING

3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.
4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling, and the location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.
5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

B. Embedment:

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole.
2. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets.
3. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.
4. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy.
5. The bar shall be inserted slowly enough to avoid developing air pockets.
6. The bars shall be supported to avoid movement during the curing process.

C. Anchor bolt installation shall comply with the following:

1. Anchor diameter and grade of steel shall be per the Drawings or per equipment supplier specifications. Anchor shall be threaded or deformed full length of embedment and shall be free of rust, scale, grease, and oils.
2. Embedment depth shall be as specified. Adhesive capsules of different diameters may be used to obtain proper volume for the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. Any extension or protrusion of the capsule from the hole is prohibited.
3. All installation recommendations by the anchor system manufacturer shall be followed carefully, including maximum hole diameter.
4. Holes shall have rough surfaces, such as can be achieved using a rotary percussion drill.
5. Holes shall be blown clean with compressed air and be free of dust or standing water prior to installation.
6. Anchor shall be left undisturbed and unloaded for full adhesive curing period.
7. Concrete temperature (not air temperature) shall be compatible with curing requirements of adhesives per adhesive manufacturer. Anchors shall not be placed in concrete below 25 degrees F.

DRAFT

03 60 00 GROUTING

3.4 FIELD QUALITY CONTROL

A. Quality Requirements: Requirements for inspecting and testing.

B. Inspection and Testing:

1. Comply with ACI 301 and as specified in Quality Requirements.
2. Submit proposed mix design of each class of grout to Engineer for review and approval prior to commencement of Work.
3. Tests of grout components may be performed to ensure compliance with specified requirements.

3.5 PROTECTION AND CLEANUP

A. At completion and during progress of the work maintain premises in a neat and orderly manner. Dispose of all rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage including water leakage onto curing concrete.

C. Protect the work of other sections from damage resulting from the work of this section.

END OF SECTION 03 60 00

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05 12 00 STRUCTURAL STEEL

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05 12 00 STRUCTURAL STEEL

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E	Benoit Otis	Katrina Wechselberger	Craig Nistor	111320	-	-

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05 12 00 STRUCTURAL STEEL

TABLE OF CONTENTS

PAGES

DRAFT

05 12 00 STRUCTURAL STEEL

SECTION 05 12 00 – STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section applies to the supply, fabrication and installation of structural steel items including but not limited to the following:

1. Fabrication and installation of structural steel items including miscellaneous metalwork.
2. Fabrication and installation of steel pipe for water conveyance including miter bends, reducers, manholes, ring-girders, ring-girder bases, seepage rings or puddle flanges, stiffener rings, thrust collars and grout holes.
3. Fabrication and erection of steel tunnel lining.

1.2 RELATED SECTION

A. 31 71 00 – Tunnel Construction

1.3 REFERENCE STANDARDS

A. American Institute of Steel Construction, Inc. (AISC):

1. AISC 303 – Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 325 – Steel Construction Manual.
3. AISC 326 – Detailing for Steel Construction.

B. American Welding Society (AWS):

1. AWS A2.4 – Standard Symbols for Welding, Brazing, and Non-destructive Examination.
2. AWS D1.1 – Structural Welding Code - Steel.
3. AWS B2.1 Standard for Welding Procedure and Performance Qualifications Welding Handbook.

C. ASTM International (ASTM):

1. ASTM A36 – Standard Specification for Carbon Structural Steel.

DRAFT

05 12 00 STRUCTURAL STEEL

2. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.
4. ASTM F436 – Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
5. ASTM F3125 – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1,040 MPa Minimum Tensile Strength.

D. American Society of Mechanical Engineers (ASME) - Boiler and Pressure Vessel Code (BPVC):

1. Section VIII - Rules for Construction of Pressure Vessels, Division 1.
2. Section IX - Welding, Brazing, and Fusing Qualifications.

E. American Water Works Association (AWWA):

1. AWWA C206 - Field Welding of Steel Water Pipe.
2. AWWA C207 - Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In.
3. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings.

F. Steel Structures Painting Council (SSPC):

1. SSPC-SP-6 – Surface Preparation Standards.

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Identify structural steel by specification, type and grade and heat number. Submit for review and approval mill analysis certificates for each heat number indicating the following:

1. Chemical and physical properties of steel used in this work.

C. Submit for review and approval shop drawings: in accordance with AISC 303, AISC 325, AISC 326, AWS A2.4 showing sections and profiles designation, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

DRAFT

05 12 00 STRUCTURAL STEEL

D. All welds and associated Welding Procedure Specification (WPS) and procedure qualification record, in accordance with AWS D1.1 and B2.1 or ASME Section IX if applicable.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions.

G. The steel fabricator and/or installation contractor shall have a quality control system. This system must include a written description and checklist explaining in detail the quality-controlled manufacturing process. The written description (quality control manual) must explain the company's organized and systematic way of specifying traceable procedures involving each level of design, material, fabrication, testing, and inspection.

1.5 QUALITY

A. Provide workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with AISC 303.

B. Structural weld seams shall conform to AISC 360.

C. All shop and field welding to be carried out by AWS or ASME qualified welders, as appropriate for the work. The welder shall be employed by the steel fabricator, erection firm and/or installation contractor certified as specified above.

D. Steel Fabricator's Quality Control: Arrange for the inspection and testing of welds by a qualified welding engineer, welding inspector or testing agency approved by the Engineer. The weld test records shall be kept in an orderly and traceable manner.

E. Shop and field testing: The following testing schedule will apply for general structural steel fabrication and erection:

1. All welds performed in both shop and field are to be 100% visually inspected.

F. Water conveyance fabrication and erection:

1. Manufacture steel pipe to meet the requirements of the applicable pipe specification or standard. Weld seams not specified by the pipe fabrication standard including field weld seams shall comply with the requirement of AWS or ASME.

DRAFT

05 12 00 STRUCTURAL STEEL

2. Design weld seams for 100% complete penetration except where noted otherwise.
3. 100% of fillet welds for bell and spigot joints shall be examined by a non- destructive testing method (ultrasonic or magnetic flux).
4. 50 % of all fillet welds located in areas other than bell and spigot joints shall be examined by a Non-destructive testing method (magnetic flux or dye penetration). If defects are found, 100% of that joint and the repairs to it shall be retested.
5. 100% of full penetration welds shall be ultrasonically or radiographically tested.

G. Defective work will be rejected and repaired or replaced at the direction of the Engineer. All defective work and repairs shall be documented in an orderly and traceable manner with explanations as to the cause of the defect and the methods used for repair.

H. The Engineer may to carry out random tests and inspections of the work independently and in addition to the steel fabricator's quality control procedures and may designate an independent testing authority.

1.6 SHOP INSPECTION

A. Shop inspection may be conducted to review fabrication work for general conformance with contract documents, workmanship and to establish the standard of quality for the fabrication of the steel work. Such review will not relieve the steel fabricator of his responsibility for general and detail dimensions, correct fit, good workmanship, integrity of welds and any errors or omissions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept metal fabrications on-site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather or by ground contact.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

A. Structural steel shapes: ASTM A992.

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B. Other carbon structural steel: to ASTM A36, minimum yield strength is 36 ksi, unless indicated otherwise.

C. Hollow structural section (HSS): ASTM A500 Grade B.

D. Steel pipe: ASTM A53 Grade B or ASTM A139 Grade B.

2.2 BOLTS, NUTS AND WASHERS

A. Bolts: to ASTM F3125, Grade A325 plain / hot-dip galvanized as noted on drawings.

B. Nuts: to ASTM A563 Class 8S / 10S (carbon steel), plain / hot-dip galvanized as noted on drawings.

C. Washers: to ASTM F436 Type 1 (carbon steel), plain / hot-dip galvanized as noted on drawings.

D. Anchor Bolts/Anchor Rods: to ASTM A307 Grade C (A36) or hot rolled threadbar to ASTM A615 as shown on the drawings.

2.3 WELDING MATERIALS

A. Welding materials: AWS D1.1. Minimum weld size: 3/16 inches unless noted otherwise.

2.4 GALVANIZING

A. Carbon steel items indicated on the Drawings as permanent to be hot-dipped galvanized in accordance with ASTM A123, unless noted on the Drawings.

PART 3 - EXECUTION

3.1 FABRICATION

A. In accordance with AISC 325.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds, unless indicated otherwise.

DRAFT

05 12 00 STRUCTURAL STEEL

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.

E. Water Conveyance fabrication (Pipe, Bends, Reducers):

1. Manufacture to the applicable pipe specification or ASME BPVC Section VIII.
2. Welding processes are restricted to shielded metal arc (SMAW), flux cored arc (FCAW), submerged arc (SAW), gas metal arc (GMAW) and gas tungsten arc (GTAW). Welding procedures must be qualified to the standards used for manufacturing, conforming to the Drawings and Specifications, and approved by the Engineer prior to fabrication.
3. Prepare plate edges for welding procedure chosen. Visually examine plate edges for signs of delamination, shearing cracks and other imperfections. Remove defects prior to fabricating pipe.
4. Mandatory minimum pre-heating temperature is 50 ºF.
5. Field end joints: bevelled ends for field butt welding or flanged where shown on the Drawings.
6. Lap joints shall not be used unless shown on Drawings.
7. Weld reinforcement on the surfaces of the penstock shall be ground to a smooth contour not exceeding 1/8 inch in height and shall blend smoothly into the plate surface except as shown on the Drawings.
8. Welding of joints shall be balanced about the weld axis to minimize distortion. Manual circumferential welds shall be carried out in a manner that maximizes downhand welding.

F. Galvanizing:

1. All carbon steel shall be hot dipped galvanized per ASTM A123 unless noted otherwise.
2. Clean structural steel in accordance with SSPC-SP-6 prior to galvanizing.
3. Metallic coating designations:
   a. Exterior steelwork left uncoated: 3.9 mils.
   b. Other galvanized steelwork: 3.3 mils.
4. Size bolt holes to accommodate galvanizing.

3.2 INSTALLATION

A. Erection of structural steel in accordance with AISC 325.

B. Clean and strip primed steel items to bare metal where Site welding is required.

C. Install items plumb and level, accurately fitted, and free from distortion or defects.

DRAFT

05 12 00 STRUCTURAL STEEL

D. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

E. Field-weld components indicated on Drawings.

F. Perform field welding according to AWS D1.1.

G. Obtain approval prior to Site cutting or making adjustments not scheduled.

H. Where welded connections are made between galvanized elements, grind off galvanizing 2 in each side of joint prior to welding. On same day following welding touch up galvanizing with colour matching zinc-rich paint.

3.3 TOLERANCES

A. Fabrication Tolerance:

1. Squareness: 1/8-inch maximum difference in diagonal measurements.
2. Maximum Offset between Faces: 1/16 inch.
3. Maximum Misalignment of Adjacent Members: 1/16 inch.
4. Maximum Bow: 1/8 inch in 48 inches.
5. Maximum Deviation from Plane: 1/16 inch in 48 inches.

B. Water Conveyance items (Pipe, Bends, Reducers) Fabrication Tolerances:

1. Pipe manufacturing tolerances to meet the requirements of the applicable pipe specification or standard.
2. Fabrication to meet the requirements of the applicable dimensional tolerances, including but not limited to AWWA C207 and C208.

3.4 SHOP AND FIELD QUALITY CONTROL

A. Replace damaged or improperly functioning hardware.

B. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

C. Touch up factory-applied finishes according to manufacturer-recommended procedures.

DRAFT

05 12 00 STRUCTURAL STEEL

3.5 PROTECTION AND CLEANUP

A. At completion and during progress of the Work maintain premises in a neat and orderly manner. Dispose of rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage by Work of other sections or other contractors.

C. Protect the Work of other sections from damage resulting from the work of this section.

END OF SECTION 05 12 00

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31 05 00 - MATERIALS FOR EARTHWORK

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31 05 00 - MATERIALS FOR EARTHWORK

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C	Cyrus Niamir	Benoit Otis	Craig Nistor	072920	-	-
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E	Cyrus Niamir	Benoit Otis	Craig Nistor	092520	-	-
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H	Cyrus Niamir	Cory Vos	Craig Nistor	111320	-	-

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31 05 00 - MATERIALS FOR EARTHWORK

TABLE OF CONTENTS

PAGES

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the aggregate material and geotextile requirements, including but not limited to:

1. E2 – Pipe Zone Material.
2. E3 – Structural Fill.
3. E4 – Select Fill.
4. E6/E8 – Bedding Material.
5. E7a/E7b/E7c – Erosion Protection.
6. E9/E9a/E9b – General Fill Material.
7. E10 – Random Fill.
8. E11 – Class II Aggregate Base.
9. CR1/CR2 – Concrete Rubble.

1.2 RELATED SECTIONS

A. Section 31 10 00 – Clearing, Grubbing and Stripping.

B. Section 31 23 00 – Excavation and Fill Placement.

C. Section 31 25 00 – Erosion and Sedimentation Controls.

D. Section 31 60 00 – Foundation Preparation.

E. Section 31 71 00 – Tunnel Construction.

F. Section 32 50 00 – Roads, Bridges and Culverts.

1.3 REFERENCE STANDARDS

A. Highway and Transportation Officials:

1. AASHTO M 43 - Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
2. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
3. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

B. ASTM International:

1. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D123 - Standard Terminology Relating to Textiles.
3. ASTM D276 - Test Method Identification of Fibres in Textiles.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3.
5. ASTM D2419 – Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
6. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D3744 – Standard Test Method for Aggregate Durability Index.
8. ASTM D3776 - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
9. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method.
10. ASTM D4253 - Standard test method for maximum index density and unit weight of soils using a vibratory table.
11. ASTM D4254 - Standard test method for minimum index density and unit weight of soils and calculation of relative density.
12. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D4354 - Practice for Sampling of Geosynthetics for Testing.
14. ASTM D4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
15. ASTM D4439 - Terminology for Geotextiles.
16. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
17. ASTM D4533 - Standard Test Methods for Trapezoid Tearing Strength of Geotextiles.
18. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
19. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of Geotextile.
20. ASTM D4759 - Practice for Determining the Specification Performance of Geosynthetics.
21. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
22. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
23. ASTM D6913 – Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
24. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

C. California State Parks Accessibility Guidelines, 2015 Edition.

D. California Department of Transportation (CalTrans) - Standard Specifications:

1. Section 96 – Geosynthetics.
2. Section 26 – Aggregate Bases.

E. Oregon Department of Transportation (ODOT) - Standard Specifications:

1. Section 02320 – Geosynthetics.

1.4 DEFINITIONS

A. Bedding – Material obtained from existing borrows or by blasting and/or crushing rock, cobbles, and boulders, to be used underneath erosion protection.

B. D_{50} – The diameter of the median rock size in the erosion protection gradation.

C. Filter – Natural or processed sand, gravel and cobbles, crushed rock, crushed gravel, or a mixture of these materials.

D. Optimum Moisture Content – The moisture content corresponding to the maximum dry density as determined by the standard Proctor compaction test using ASTM D1557.

E. Erosion Protection - Rock material with specified gradations used for the prevention of soil erosion caused by exposure to river flows.

F. Riprap – Previously installed rock material which may require sorting to meet Erosion Protection gradation specifications.

G. Aggregate Base – Road surface material (per Caltrans Standard Specifications, Section 26, 4-26) for all newly constructed non-asphalt surface roads.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Quality Control Plan.

C. Aggregate/Geosynthetic Supplier Accreditation.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

D. Material Certificates: submit test results from manufacturers for review and approval by the engineer.

E. Quality Control Test Results: submit test results from QC control tests from materials sourced onsite for review and approval by the Engineer.

F. Material source plan: a detailed plan for each source of material including the proposed methods of exploitation and processing (if applicable).

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with relevant state standards (i.e. State of Oregon for JC Boyle and State of California Department of Transportation Standards for all other sites).

B. Work shall be in conformance with Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General.

1. Materials should be obtained as specified in Section 31 23 00 – Excavation and Fill Placement.
2. Materials shall be composed of durable particles free of organic matter, ice, snow, and other frozen materials. Organics are allowed in Type 10 random fill.
3. All materials shall be well-graded within their gradation limits.
4. Materials shall be in conformance with gradation bands shown on the Drawings.

B. Aggregate Materials Description and Requirements.

1. See Clause 2.1, C. for gradation plots.
2. Type E2 – Pipe Zone.
   a. Material description: Gravel and Sand.
   b. Placement and Compaction: Placed and spread evenly in maximum 6-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
3. Type E3 – Structural Fill.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

a. Material description: Gravel, and Sand.
b. Placement and Compaction: Placed and spread evenly in maximum 8-12 inch lifts compacted to 95% maximum dry density as determined by ASTM D698 (Section 5.3.1 - coarse granular fill), to be observed continuously (i.e. probe testing each lift, at 20 ft intervals pending results of test fill). Method specification for achieving required compaction shall be determined by the Engineer following test fill, per ASTM D698.
c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.

4. Type E4 – Select Fill.
   a. Material description: Cobbles, Gravel, and Sand.
   b. Placement and Compaction: Placed and spread evenly in maximum 18-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
5. Type E5 – Road Embankment Fill.
   a. Material description: Cobbles, Gravel, Sand and Fines.
   b. Placement and Compaction: Placed and spread evenly in maximum 12-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557.
   c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.
6. Type E6/E8: Bedding.
   a. Material description: Cobbles and Gravel.
   b. Placement and Compaction: Placed and spread E6/E8 evenly in maximum 12-inch lifts in a non-segregating manner. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
7. Type E7 – Erosion Protection.
   a. Material description: Boulders and Cobbles.
   b. Erosion protection is categorized by type a/b/c as shown in the following table. All E7 erosion protection shall meet or exceed the gradations for each type as shown in Table 1.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

Table 1 – Type E7 – Erosion Protection Details

E7 Type	Nominal Diameter (in)	D_{15} Min (in)	D_{50} Min (in)	D_{85} Min (in)
E7a	9	5.5	8.5	11.5
E7b	21	13.0	20.0	27.5
E7c	36	22.0	34.0	47.0

c. Placement: See Section 3.4. Thicknesses asshown on Drawings.

d. Erosion protection to be hard, durable, able to withstand long exposure to weathering, and have a minimum bulk saturated surface dry (SSD) specific gravity of 2.64 for the Oregon Site and 2.74 for the California Sites.

e. Erosion Protection should have a durability index of 40 or greater and a sand equivalent of 75 or greater.

f. Size to meet or exceed the size dimensions specified on the rock intermediate dimension (secondary axis).

g. Rock particles with a minimum dimension less than 1/3.5 the maximum dimension shall not be used.

8. Type E9 – General Fill.
   a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
   b. Placement and Compaction: Type E9 material placed and spread evenly in maximum 24-inch lifts. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
9. Type E9a – General Fill.
   a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
   b. Placement and Compaction: Type E9a material is end dumped or placed with no compaction requirement.
10. Type E9b – General Fill for Final Stabilization.
    a. Material description: Boulders, Cobbles, Gravel, and Sand.
    b. Placement and Compaction: Type E9b material placed and spread evenly in maximum 24-inch lift. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
11. Type E10 – Random Fill.
    a. Material description: Overburden, rock, or organics.
    b. No gradation requirements.
    c. Placement: Material shall only be placed in designated disposal sites, as per the design drawings.
    d. Compaction: Material shall be track walked to achieve nominal compaction.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

12. Type E11 – Class II Aggregate Base.
    a. Material description: Gravel and Sand.
    b. Aggregate must be clean and consist of any combination of the following: Broken stone, Crushed gravel, Natural rough-surfaced gravel, Sand, Processed reclaimed asphalt concrete, PCC, LCB, or CTB. Use either 1-1/2- inch or 3/4-inch maximum aggregate gradation unless otherwise specified. Do not change selected aggregate gradation without authorization.
    c. Caltrans 26-1.02B Class 2 Aggregate Base Aggregate quality characteristics must comply with the requirements shown in Table 2.

Table 2 – Type E11 – Aggregate Quality Characteristics

Quality Characteristic	Requirement	
	Operating Range	Contract Compliance
Resistance (R-value, min)	--	78
Sand equivalent (min)	25	22
Durability index (min)	--	35

13. Type E12 – Engineered Streambed Material.
    a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
    b. Placement and Compaction: See Section 3.6. Thicknesses as shown on Drawings.
14. Type E13 – Drain Rock.
    a. Material description: Crushed, clean, angular gravel.
    b. Placement and Compaction: Placed and spread evenly in maximum 6-8 inch lifts, compacted using bucket tamping or hand tools.
    c. Drain Rock should have a durability index of 40 or greater and a sand equivalent of 75 or greater.
15. Type CR1/CR2 – Concrete Rubble.
    a. Material description: Broken Concrete/Reinforced Concrete, Boulders, Cobbles, Gravel, and Sand. Broken concrete destined for the disposal sites shall limit the protruding reinforcing bars to 9 inches in length. Where reinforcing bars are bent over the broken concrete pieces, the bent reinforcing bars shall be limited to 24 inches in length with a maximum of 4 inches from the surface of the broken concrete. Where reinforcing railroad rails are present in the concrete pieces, the protruding railroad rail shall not exceed 3 feet in length.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

b. Placement and Compaction of Type CR1: End – Dumped Placement. Concrete rubble shall be end-dumped. During placement of concrete rubble, care shall be taken to fill voids with soil and rock materials. Concrete rubble shall not be used for final stabilization cover material of the disposal sites. Placement of concrete rubble in the scour hole at the J.C. Boyle facility differs from the specifications outlined in this section. See Technical Specification 31 23 00 Excavation and Fill Placement for the scour hole backfilling requirements.

c. Placement and Compaction of Type CR2: Placed and spread evenly in maximum 36-inch lift to provide a reasonably level surface for safe passage of equipment and then track walked. During placement of concrete rubble Type CR2, care shall be taken to fill voids with soil and rock materials as per Section 3.5.

C. Aggregate Material Gradation Limits.

1. Table 3 shows the gradation limits for the aggregate materials described in B excluding Types E7 – Erosion Protection (shown in B.) and E10 – Random Fill (no gradation requirements). The table below shall be used for plotting gradation minimum and maximum limits. Sieve sizes as required to test the materials shall be selected by the Contractor to provide the necessary information for acceptance of the material tested.

Table 3 – Aggregate Material Gradation limits

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
E2	1.5”	100	1/4”	100
	#16	5	#200	12
E3	3”	100	3/4”	100
	#4	60	#200	30
	#200	5		
E4	4”	100	3/8”	100
	#10	10	#16	60
			#200	10
E5	#4	100	3/8”	100
	#10	10	#16	60

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
			#200	30
E6	3”	100	1”	100
	1”	10	3/8”	10
E8	12”	100	3”	100
	3”	10	1”	10
E9	20”	100	3/8”	100
	3/4”	10	#16	60
			#200	30
E9a	20”	100	#16	100
	3/4”	10	#200	40
E9b	20”	100	3/8”	100
	3/4”	10	#16	60
			#200	10
E11	1”	100	¾”	100
	¾”	90	#4	60
	#4	35	#30	30
	#30	10	#200	9
	#200	2		
E12	60”	100	40”	100
	40”	85	20”	85
	12”	50	1”	50
	3/8”	0	#200	0
E13	4”	100	1.5”	100
	3”	30	1”	5
	2”	25		
	1”	5		

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
CR1	36”	100	3/8”	100
	12”	10	#16	60
			#200	30
CR2	24”	100	3/8”	100
	6”	10	#16	60
			#200	30

D. Geotextiles.

1. Geotextile installed for erosion and sediment control features shall provide bare soil retention, nurture vegetation, and provide high performance turf reinforcement. An acceptable product is Mirafi TM-Series or equivalent.
2. Geotextiles to be installed as per the Manufacturers recommendations and specifications and the following California and Oregon guidelines:
   a. California Stormwater BMP Handbook – Construction.
   b. Construction Stormwater Best Management Practiced Manual, 1200-C NPDES General Permit, State of Oregon, Department of Environmental Quality.
3. Geotextile installed for separation between subgrade and earthfill materials shall be a nonwoven, needle-punched fabric that meets the relevant state’s minimum physical property requirements, either Table 1 from Caltrans Section 96 “Geosynthetics” (shown in Table 4), or Table 2 from ODOT Section 02320 “Geosynthetics and Slope Protection” (shown in Table 5). All numeric values in Table 4 except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values. Geotextile shall not be installed until conformance test results are reviewed and the geotextile is accepted by the Engineer.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

Table 4 – Nonwoven Separation Geotextile Caltrans Requirements

Property	Value	Test Method
Grab Tensile Strength	250 lbs	ASTM D4632
Grab Tensile Elongation	< 50%	ASTM D4632
Tear Strength	90 lbs	ASTM D4533
CBR Puncture Strength	500 lbs	ASTM D6241
Permittivity	0.05 sec^{-1}	ASTM D4491
Apparent Opening Size (AOS)	0.012 in	ASTM D4751
UV Resistance (at 500 hours)	70% strength retained	ASTM D4355

Table 5 – Nonwoven Separation Geotextile ODOT Requirements

Property	Value	Test Method
Grab Tensile Strength	113 lbs	ASTM D4632
Grab Tensile Elongation	50%	ASTM D4632
Tear Strength	41 lbs	ASTM D4533
CBR Puncture Strength	223 lbs	ASTM D6241
Permittivity	0.05 sec^{-1}	ASTM D4491
Apparent Opening Size (AOS)	No. 30 US Sieve	ASTM D4751
UV Resistance (at 500 hours)	50% strength retained	ASTM D4355

DRAFT

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING OF GEOSYNTHENTICS

A. Geosynthetic labeling, shipment, and storage shall follow ASTMD4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, temperature greater than 140 degrees Fahrenheit, and mud, dirt, dust, and debris. At no time shall the geotextile be exposed to sunlight for a period exceeding 14 days.

B. Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, sunlight, and contaminants.

31 05 00 - MATERIALS FOR EARTHWORK

C. During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geosynthetic.

3.2 INSTALLATION OF GEOTEXTILES

A. The Contractor shall handle all geotextiles in such a manner as to ensure the geotextile is not damaged.

B. The surface on which the geotextile is to be placed shall be prepared to a smooth condition free of debris or obstructions which may damage the geotextile. The subgrade shall be approved by the Engineer prior to geotextile placement. Care shall be taken not to entrap stone, excessive dust, or moisture in the geotextile. The Contractor and Installer shall not operate equipment over the geotextile without meeting minimum cover requirements of capping operations. The Contractor shall follow the Manufacturer’s recommendations and these Specifications during installation of the geotextile.

C. Geotextiles shall be deployed free of wrinkles and folds. On slopes, the geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all geotextiles shall be weighted with sandbags or other material which will not damage the geotextile.

D. Adjacent geotextile panels shall have minimum two-foot overlaps. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the direction of the slope will not be accepted. The geotextile shall be examined over the entire surface after installation to ensure that no potentially harmful objects are present.

E. Damaged geotextiles and geotextiles contaminated with dirt shall be repaired immediately. Repairs shall be made with the same geotextile product style as the original material. All repairs shall meet the approval of the Engineer, prior to cover placement.

F. Geotextile panels which require repair to be replaced with new material. Replacement material shall have a minimum overlap of two feet at the entire perimeter. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the slope will not be accepted.

G. Placement of cover on the geotextile shall be accomplished in a manner as to ensure that the geotextile is not damaged. Cover material shall be placed within 15 days of deployment.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

H. Cover material shall be placed such that excess tensile stress is not mobilized in the geotextile. Cover placement operations shall comply with the requirements and limitations of the contract documents and project design documents.

3.3 INSTALLATION OF AGGREGATE MATERIALS

A. Excavation:

1. Excavate aggregate materials from Site locations as indicated in the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.
2. Materials shall be obtained from approved locations or from on-site excavation borrow sites operated by the Contractor.
3. Contractor operated borrow sites shall be developed in accordance with all applicable State Acts.

B. Stockpiling:

1. Separate different aggregate materials with dividers or stockpile apart to prevent intermixing of aggregate types or contamination.
2. Direct surface water away from stockpile site to prevent erosion or deterioration of materials as per Section 31 25 00 – Erosion and Sedimentation Controls.
3. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching until they are disposed.

C. Placement: Place aggregate materials at Site locations as indicated on the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.

D. Additional specific installation details for Type E7 – Erosion Protection included in section 3.4.

3.4 INSTALLATION OF EROSION PROTECTION - TYPE E7A/E7B/E7C

A. Erosion Protection – Type E7a/E7b/E7c shall be placed mechanically in a well interlocked fashion in locations shown in the Drawings to provide scour protection.

B. Erosion protection - Type E7a/E7b/E7c shall not be placed until foundation preparation is completed, geotextile installed (if applicable) and the subgrade surfaces have been observed by the Engineer.

C. The maximum drop high for Erosion protection - Type E7a/E7b/E7c placement is 2 feet.

D. Erosion protection - Type E7a/E7b/E7c shall be mechanically tamped after placement.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

E. Erosion protection - Type E7a/E7b/E7c layer shall be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of the underlying materials.

F. The rock shall be delivered and placed in a manner that results in a reasonably homogenous appearance, with the larger rocks uniformly distributed and firmly in contact with one another and with smaller rocks and spalls filling the voids between the larger rocks.

3.5 INSTALLATION OF CONCRETE RUBBLE

A. The installation of concrete rubble section does not apply to areas where Type E9 – General Fill is specified separately of concrete rubble. The Drawings denote separate concrete rubble placement from Type E9 – General Fill at locations such as the powerhouse backfill, and the installation of concrete rubble section only applies to the CR2 denoted locations.

B. Concrete rubble shall be covered by a minimum of 2 ft of cover material.

C. During the placement of Type CR2 - concrete rubble, care shall be taken by the contractor to infill voids between concrete pieces with soil and rock using the procedure below:

1. After a lift of concrete rubble has been placed, a layer of Type E9 general fill material shall be placed over the concrete rubble layer. The lift shall then be track walked to push the general fill into the voids and compact the concrete rubble.
2. If voids are still visible after the area has been track-walked another layer of E9 general fill shall be placed and the process repeated until the voids are no longer visible.
3. The thickness of the Type E9 fill that blankets the concrete rubble lift prior to nominal compaction will be dependant on the void ratio of the concrete and will be adjusted on an as-needed basis by the contractor. The Type E9 general fill layer shall be thin enough to avoid material bridging that would prevent the infilling of the voids.
4. The contractor shall avoid overfilling the concrete rubble and creating continuous layers of Type E9 material.

D. The placement of Type CR1 – concrete rubble shall remain end dumped and will not require the more stringent placement method outlined in Clause 3.5, C. Type CR1 is only specified on the drawings were slope stability is not a requirement, except for the scour hole which is governed by its own placement requirements as per Section 31 23 00 – Excavation and Fill Placement.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

E. Where a capping layer is specified above segregated materials, or large particle material with cavities and/or voids, filter material may be specified by the Engineer.

3.6 INSTALLATION OF ENGINEERED STREAMBED MATERIAL

A. Contractor shall begin construction of the roughened channel from the downstream end, constructing downstream apron prior to constructing the roughened channel. Order of work will begin with downstream boulder buttress construction, engineered streambed material and roughness element construction, and upstream boulder buttress.

B. Boulder buttresses will be spaced as shown on the Drawings.

C. Intermediate roughness elements (i.e. random boulders and boulder clusters, 2 ft to 3.5 ft in size, located between buttresses) shall be placed to create a complex flow field. These roughness elements will require field fitting to create a network of bifurcating and confluencing low flow paths.

D. Engineered streambed material shall be placed and spread evenly in 1 ft lifts and compacted with vibratory roller.

E. Once firmly compacted, final surface shall undergo high pressure hose treatment to direct fines into the interstitial spaces to improve compaction.

F. Final channel grade will have an average longitudinal slope between boulder buttresses as shown on the Drawings. The roughened channel surface will have localized highs and lows. Roughness elements will not be included in calculation of roughened channel slope.

G. Final testing will require percolation test every 30 ft along roughened channel. Sandbags may be used to isolate a zone for testing (2 ft area min.). If percolation rate is exceeded greater than 120 min/in (4 hr minimum measurement period), further compaction and/or filling of interstitial spaces with high pressure fines/water is required.

H. The Engineer shall direct field survey and percolation and compaction testing for the roughened channel and provide final approval.

3.7 QUALITY

A. For materials procured off-site or from commercial suppliers, the Contractor shall provide quality control certificates in accordance with the testing frequencies detailed in Table 6.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

B. The Contractor will be responsible for field quality testing (control tests) for all fill materials excavated from on-site borrow areas that are incorporated in the permanent work at the frequencies detailed in Table 66. Minimum testing requirements: frequency is "1 per" the number of cubic yards of material as required for the Work.

Table 6 – Control Testing Schedule

Material Type	Moisture Content (ASTM D2216)	Particle Size Distribution (ASTM D6913)	Laboratory Compaction (ASTM D1557 or D4523 & D4524 as applicable)	Specific Gravity and Absorption (ASTM D854 and ASTM D6473)	Atterberg Limits (ASTM D4318)	Durability Index (ASTM D3744)	Sand Equivalent (ASTM D2419)
	1 per	1 per	1 per	1 per	1 per	1 per	1 per
E2 – Pipe Zone	650	650	650	3,250	-	-	-
E3 – Structural Fill	650	650	650	3,250	3,250	-	-
E4 – Select Fill	1,300	1,300	1,300	3,250	-	-	-
E5 – Road Embankment Fill	1,300	1,300	1,300	3,250	-	-	-
E6 / E8 – Bedding	-	650	-	-	-	-	-
E7a/E7b/E7c – Erosion Protection	-	Visual	-	2000	-	2000	Source
E9/E9a/E9b – General Fill	-	20,000	-	-	-	-	-
E10 – Random Fill	-	-	-	-	-	-	-
E11 – Class II Aggregate Base	500	500	2,000	-	-	-	-
E12 – Engineered Streambed Material	-	Visual	-	2,000	-	2,000	-
E13 – Drain Rock	-	Source	-	Source	-	-	Source
CR1/CR2 – Concrete Rubble	-	Visual	-	-	-	-	-

NOTES:

1. CONTROL TESTING TO BE PERFORMED PRIOR TO USE OF MATERIALS IN THE WORKS TO CONFIRM MATERIAL COMPLIANCE. CONTROL TESTING MAY BE UNDERTAKEN ON STOCKPILED MATERIALS OR PRIOR TO DELIVERY OF COMMERCIAL PRODUCTS TO SITE. RECORD TESTING (SECTION 31 23 00 EXCAVATION AND FILL PLACEMENT) TO BE UNDERTAKEN ONCE MATERIALS ARE PLACED TO CONFIRM COMPLIANCE OF IN-SITU MATERIALS.
2. SOME E7A/E7B/E7C AND E13 CONTROL TESTS ARE USED TO CHARACTERIZE A SOURCE. ONE OF EACH TEST IS REQUIRED AT LOCATIONS OF PLANNED SOURCING, EITHER FROM A BORROW AREA OR MANUFACTURER.
3. IF TESTING VOLUME NOTED IN TABLE 6 EXCEEDS THE VOLUME OF PLACED FILL FOR A SPECIFIC AREA, THEN PERFORM A MINIMUM OF 1 TEST PER AREA.

DRAFT

31 05 00 - MATERIALS FOR EARTHWORK

C. If in the judgement of the Engineer, the volume of material represented by a failed control test is anticipated to result in work that deviates from design intent, remove, or dispose of the non-complying material. Rework shall be performed at the Contractor's expense.

D. Material quality, including such fill parameters as frozen/unfrozen state and inclusion of topsoil, shall verified by the Engineer prior to fill placement.

E. Aggregate Moisture Control:

1. Moisture Adjustment: Moisture content shall be adjusted as necessary to facilitate compaction. Moisture control shall be achieved by either windrowing, scarifying or adding water to achieve workable moisture content.
2. Water may be added to the material at the source or after the material has been brought into its final position, whichever is more practical. The Contractor shall obtain uniform moisture distribution in the lift by disking, blading, or other approved methods. The amount of water applied shall be controlled so that free water will not appear on the surface during or subsequent to compaction operations.
3. Material deposited on fill that is too wet shall be removed or spread and permitted to dry, assisted by disking or blading, if necessary, until the moisture content is reduced to the specified limits.
4. When the top surface of a layer becomes too dry or too smooth to permit suitable bonding with the subsequent layer, the Contractor shall loosen the material by scarifying or disking. The Contractor shall then moisten the loosened material to acceptable moisture content and re-compact the material to the specified density.

F. Any omissions or failure on the part of the Engineer to reject the work or materials shall not be construed as acceptance of unsuitable materials.

G. A testing laboratory will furnish test data on all materials manufactured for incorporation into permanent project structures. Certification shall meet the relevant state requirements.

END OF SECTION 31 05 00

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31 10 00 – CLEARING, GRUBBING AND STRIPPING

Prepared by:

Cyrus Niamir
Knight Piésold

Reviewed by:

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31 10 00 – CLEARING, GRUBBING AND STRIPPING

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
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A	Cyrus Niamir	Benoit Otis	Craig Nistor	020720	-	-
B	Cyrus Niamir	Benoit Otis	Craig Nistor	072920	-	-
C	Cyrus Niamir	Benoit Otis	Craig Nistor	080520	-	-
D	Cyrus Niamir	Benoit Otis	Craig Nistor	092520	-	-
E	Cyrus Niamir	Benoit Otis	Craig Nistor	100720	-	-
F	Cyrus Niamir	Benoit Otis	Craig Nistor	103020	-	-
G	Cyrus Niamir	Benoit Otis	Craig Nistor	111320	-	-

DRAFT

Approval that this document adheres to the Knight Piésold Quality System: CN

31 10 00 – CLEARING, GRUBBING AND STRIPPING

TABLE OF CONTENTS

PAGES

DRAFT

31 10 00 – CLEARING, GRUBBING AND STRIPPING

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the construction and quality management requirements for Clearing, Grubbing and Stripping activities.

B. This specification applies to the Clearing, Grubbing and Stripping as specified in this Section and set out in the Drawings.

1.2 RELATED SECTIONS

A. Section 31 05 00 – Materials for Earthwork.

B. Section 31 23 00 – Excavation and Fill Placement.

C. Section 31 25 00 – Erosion and Sedimentation Controls.

D. Section 31 30 00 – Earthwork Methods.

E. Section 31 60 00 – Foundation Preparation.

F. Section 31 80 00 – Care of Water.

1.3 REFERENCE STANDARDS

A. Conform to Siskiyou County code within the State of California for disposal of debris.

B. Conform to Klamath County code within the State of Oregon for disposal of debris.

C. California Stormwater Quality Association:

1. California Stormwater BMP Handbook – Construction.

D. State of Oregon Department of Environmental Quality:

1. Construction Stormwater Best Management Practices Manual, 1200-C NPDES General Permit.

DRAFT

31 10 00 – CLEARING, GRUBBING AND STRIPPING

1.4 DEFINITIONS

A. Clearing – The felling and removal of trees, shrubs, and vegetation to within 18 inches of the ground within areas of the Site so designated on the Drawings.

B. Grubbing – The removal of roots and stumps within areas of the Site so designated on the Drawings.

C. Stripping – The complete removal of all vegetation and organic matter to a maximum depth of 3 feet within areas of the Site so designated on the Drawings.

D. Organics and Woody Debris – All organic matter including trees, shrubs, roots, stumps, and other vegetation existing in the Site areas.

E. Merchantable Timber – Tree or portion of a tree suitable for harvesting and transport to a processing plant.

1.5 SUBMITTALS

A. Project Record Documents: Record actual locations of abandoned utilities and services, foundations, and other appurtenances.

1.6 QUALITY ASSURANCE

A. Work shall be in conformance with the Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment shall be the responsibility of the Contractor.

2.2 CLASSIFICATION OF MATERIALS

A. Materials removed during Clearing, Grubbing and Stripping are to be classified as either organics and woody debris or merchantable timber and stored as described on the Drawings and as specified in this Section.

DRAFT

31 10 00 – CLEARING, GRUBBING AND STRIPPING

PART 3 - EXECUTION

3.1 GENERAL

A. Site clearing operations must not commence until temporary erosion and sedimentation controls measures are in place.

B. The Contractor shall clear, grub and strip all ground surfaces prior to fill placement in any area to the limits as shown on the Drawings.

C. The Contractor shall clear, grub and strip all ground surfaces prior to excavation if the excavated materials are to be used for construction purposes and have specified material requirements.

D. In order to reduce erosion and contamination of the surface runoff to a minimum at all times, Clearing, Grubbing and Stripping shall be scheduled to be performed only as and when required to enable each portion of the Work to be carried out.

3.2 PREPARATION, PROTECTION AND EXAMINATION

A. Call Local Utility Line Information service at (800) 332-2344 (Oregon) or (811) (California) not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.
2. Obtain local as constructed record documents for local and private utilities.

B. Obtain protocols on protection of utilities and cultural resources. Locate, identify, and protect utilities indicated to remain, from damage. Protect benchmarks and other survey control points from damage or displacement.

C. The Contractor shall stake out the areas where Clearing, Grubbing and Stripping are to be carried out. Markings of the area limits should be clearly visible and remain in place following the completion of the Clearing, Grubbing and Stripping activities.

D. The Contractor must minimize the tracking of mud and soil from the project area on to the existing paved or public roads. Soil or mud tracked from the Work area and on to the roads shall be removed daily.

DRAFT

31 10 00 – CLEARING, GRUBBING AND STRIPPING

3.3 CLEARING

A. Clear the areas of the site as designated on the Drawings or in the Technical Specifications including the felling of all trees, shrubs, and vegetation to within 18 inches of the ground.

B. Collect all organics and woody debris for eventual disposal or stockpiling.

C. Any clearing, which the Contractor elects to perform for his own purposes, shall be subject to approval by the Owner. This clearing must be performed in accordance with the requirements of this Specification. Prior to the clearing of any area, which is not required for the construction of the permanent Works, the Contractor shall submit to the Owner for approval, full details of the clearing it proposes to perform.

3.4 GRUBBING

A. Grubbing shall include the complete removal of all roots and stumps in areas designated on the Drawings. Removal of root structures shall be to the bottom of the root or 18" below grade level.

B. Grubbed debris can be temporarily stockpiled or windrowed within the work area, but ultimately is to be removed to designated stockpile or disposal locations.

C. Where Grubbing will result in erosion, measures shall be taken to mitigate such as per Section 31 25 00 - Erosion and Sedimentation Controls.

D. Grubbing shall be completed as soon as Clearing operations allow.

3.5 STRIPPING

A. Stripping includes the complete removal of all vegetation and organic matter to a maximum depth of 3 feet.

B. Stripping shall be performed in a manner that maximizes the salvage of the organics for eventual site restoration.

C. Stripped debris can be temporarily stockpiled or windrowed within the work area, but ultimately is to be removed to designated stockpile or disposal locations.

D. Where Stripping will result in erosion, measures shall be taken to mitigate such as per Section 31 25 00 - Erosion and Sedimentation Controls.

DRAFT

31 10 00 – CLEARING, GRUBBING AND STRIPPING

E. Stripping shall be completed in conjunction with grubbing operations or as soon as grubbing operations allow.

3.6 REMOVAL AND STOCKPILING

A. After an area has been cleared, stripped, grubbed and the debris removed, remove surface organics and woody debris and windrow, or stockpile this material.

B. Stockpile locations shall not interfere with any other part of the Work and shall be located at a minimum 50 feet away from proposed or existing structures.

C. Stockpile the organics and woody debris in a neat workmanlike manner ensuring that it is stable and protected from erosion. Care shall be exercised during stockpiling to prevent compaction and possible mixing of the organics with subsoil.

3.7 QUALITY

A. The Contractor shall provide the Owner and Engineer access to the site at all times.

B. The Contractor is responsible for performing work in accordance with the Drawings and performing quality control.

C. The Engineer shall inspect the area to determine whether removal of material has been completed satisfactorily.

END OF SECTION 31 10 00

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

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31 23 00 – EXCAVATION AND FILL PLACEMENT

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DRAFT

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31 23 00 – EXCAVATION AND FILL PLACEMENT

TABLE OF CONTENTS

PAGES

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the construction and quality management requirements for excavation and fill placement activities, including:

1. General site grading work.
2. All excavations necessary for the construction of the Works.
3. Maintaining excavations and trenches free of water.
4. Backfilling of excavations and trenches.
5. Placing fill to final grade.
6. Construction of embankments.

1.2 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 03 60 00 – Grouting.

D. Section 31 05 00 – Materials for Earthwork.

E. Section 31 10 00 – Clearing, Grubbing and Stripping.

F. Section 31 25 00 – Erosion and Sedimentation Controls.

G. Section 31 60 00 – Foundation Preparation.

H. Section 31 71 00 – Tunnel Construction.

I. Section 31 80 00 – Care of Water.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO).

B. American Society for Testing and Materials (ASTM):

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

1. ASTM D854 - Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer.
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
4. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
5. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
6. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
7. ASTM D5030 - Standard Test Methods for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
8. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
9. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. Untied States Department of Labor Occupational Safety and Health Administration (OSHA) Regulations.

1. Part 1926.

D. California Department of Transportation (Caltrans) - Standard Specifications:

1. Section 19 - Earthwork.

E. California Stormwater BMP Handbook – Construction.

F. Construction Stormwater Best Management Practiced Manual, 1200-C NPDES General Permit, State of Oregon Department of Environmental Quality.

G. Oregon Department of Transportation (ODOT) Standard Specifications:

1. Section 00330 - Earthworks.

1.4 DEFINITIONS

A. Backfill – Materials used for fill placement.

B. Borrow – Approved area where appropriate material is sourced for use at another location.

DRAFT

C. Fill Placement – Placement of backfill to lines and dimensions shown on the Drawings.

D. Excavation – Removal of material encountered above subgrade elevations and to lines and dimensions excavated.

E. Subgrade – Uppermost surface of an excavation and the top surface of a fill or backfill immediately below subbase, structures, or geosynthetic layers.

F. Vertical Confined Openings – Vertical and confined openings where material can be dumped.

G. Horizontal Confined Openings – Horizontal and confined openings where material cannot be placed by conventional placement methods.

H. Water Management – Collection and diverting water by gravity.

I. Dewatering – Removal of water from work area by mechanical methods.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Project Record Documents: Record actual locations of abandoned utilities and services, foundations, and other appurtenances.

C. As-built surveys: Record as-constructed excavations and fills to reconcile Drawings and for review and approval by the Engineer.

D. Dewatering Work Plan: Details of proposed temporary stormwater control measures in accordance with this specification and Section 31 25 00 – Erosion and Sedimentation Controls.

E. Quality Control Plan.

F. Quality Control Test Results: submit test results from QC record tests from materials sourced onsite for review and approval by the Engineer.

G. Blasting plans in accordance with the applicable Federal, State, and local codes and regulations, indicating the following:

1. Name, qualification, and references of the proposed blaster-in-charge and personnel responsible for blast design.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

2. Method and mitigation to control noise, air blast, ground vibration, fly rock, and dust control.
3. Explosives transportation plan including handling, storage, and security.
4. Procedures for conducting blasting operations including Safety plan and fire prevention plan.

1.6 QUALITY ASSURANCE

A. Work shall be in conformance with the Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment shall be the responsibility of the Contractor.

2.2 FILL MATERIALS

A. Requirements for production and supply of fill materials detailed in Section 31 05 00 – Materials for Earthworks.

2.3 GEOTEXTILES

A. Geotextile shall be implemented as detailed in the Drawings.

B. Requirements for specifications and supply of geotextiles detailed in Section 31 05 00 – Materials for Earthworks.

PART 3 - EXECUTION

3.1 PREPARATION

A. All preparation of work areas to be performed prior to excavation or fill placement and conform to Section 31 60 00 – Foundation Preparation.

B. Site Inspection and existing conditions:

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

1. Obtain the Engineer's acceptance of prepared surfaces before backfilling or placing fill.
2. Provide access to the work areas for quality testing.
3. Provide at least 24 hours notice to the Engineer for required inspections.
4. The Contractor shall read the project geotechnical reports and all other project documents and reference information, form their own opinion regarding subsurface conditions based on the facts contained therein, and choose equipment and methods of execution to suit.

C. Use excavation methods that will not cause damage to nearby structures.

D. Protect structures near the work areas from damage.

E. The Contractor is to identify required lines, levels, contours, datum locations and lay out the excavation and fill limits.

F. Provide surface runoff and sediment control facilities as required for excavations, fills, stockpiles, borrow areas and roads as detailed in Section 31 25 00 – Erosion and Sedimentation Controls. Comply with environmental regulations.

G. The Contractor shall notify underground service alert (USA NORTH) to identify the location of existing utilities at least 72 hours prior to any excavation work, per state requirements.

3.2 EXCAVATING IN SOIL

A. Use excavation techniques and take necessary precautions to preserve in an undisturbed state all materials outside the lines and grades shown on the Drawings.

B. Underpin adjacent structures that may be damaged by excavating work.

C. Use benching excavating techniques were applicable. Benching shall be completed in accordance with the applicable Federal or State OSHA Regulations.

D. The Contractor shall immediately notify the Engineer if active utility lines which are not indicated on the Project Drawings are encountered during excavation. Abandoned sewers, piping, and other inactive utilities encountered in the progress of excavation shall be removed and plugged.

E. Provide, maintain, and operate any temporary drainage, dewatering and/or pumping facilities required to control groundwater and keep the excavations dry and stable. Discharge drainage such that erosion and sedimentation are prevented.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

F. Excavate subsoil to inverts required to accommodate the structures shown on the Drawings.

G. Install bracing and shoring as required to ensure the safety of workers and adjacent facilities.

H. Maintain excavation slopes equal to or flatter than those shown on the Drawings. The slopes of all excavations shall be neatly and evenly trimmed to the line and slope indicated on the Drawings or as directed by the Engineer.

I. Slope banks with machine to angle of repose or flatter until shored.

J. Grade top perimeter of excavation to prevent surface water from draining into excavation.

K. Hand trim excavations where required to remove loose matter. All excavation slopes should be free of loose material.

L. Notify the Engineer of unexpected subsurface conditions.

M. Protect excavation surfaces from deterioration and maintain in a stable condition.

N. Backfill over compacted foundation surfaces using specified fill materials.

O. Remove waste materials material from work area. Stockpile materials that are suitable for fill or use these materials directly in fills.

P. Excavation for Trenches:

1. Excavate trenches to indicated grades, lines, depths, and elevations as shown on the Drawings.
2. Excavate trenches to uniform widths as indicated on the Drawings.
3. Excavate below bottom of pipe and conduit elevations to allow for bedding course. Excavate deeper for bells of pipe.
4. Maximum unbraced/un-shored trench excavation height is not to exceed 5 ft per OSHA Regulation Part 1926.
5. Shielding/shoring is required for any excavations exceeding 20 ft in depth, as per OSHA Regulations.

3.3 EXCAVATING IN ROCK

A. Remove rock to the lines, grades and dimensions shown on the Drawings or required by the Engineer.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

B. Use methods, techniques, and procedures for control of all factors affecting operations in order to produce smooth and sound peripheral surfaces of all completed excavations, to minimize over-break, and to avoid damage to adjacent structures.

C. Drilling and Blasting

1. Carry out blasting operations in accordance with blasting plan, manufacturers data, and blasting schedule.
2. Drilling and blasting shall be completed as described in Section 02 41 00 – Demolition and Facility Removal.
3. Drill blasting holes as required to complete desired construction results. Review the blasting performance and adjust the blast design to achieve the requirements as per the Drawings.
4. Design the blast to comply with safe peak particle velocity (PPV) for all structures within and in the vicinity of the blast area and other locations.
5. Take necessary precautions to protect the structures, buildings and equipment not intended to be removed from blast induced damage, including protection from fly rock, protection from vibrations and air blasts.
6. Remove loose material and scale to sound unshattered base surface to the lines and grades shown on the Drawings as required to provide a stable surface.
7. Do not blast within 300 ft of fresh concrete, grout or shotcrete until the concrete has cured for a minimum of 28 days, unless achieved concrete strength is review and accepted by the Engineer.

D. Scale all excavation slopes to ensure a stable condition, and pressure wash and broom clean rock surfaces against which concrete will be cast to assist bonding.

E. Excavate trenches to the lines and grades indicated on the Drawings. Provide recesses for bell and spigot pipe to ensure bearing will occur uniformly along barrel of pipe.

F. Remove boulders and fragments which may slide or roll into excavated areas.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. Do not disturb bottom of excavations intended as bearing surfaces.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

3.5 EXCAVATION OF MATERIALS

A. The existing elevations and contours shown on the plans, cross sections, and profiles were surveyed prior to plan development. Existing elevations and grades may have changed since the original survey was completed due to stream erosion, sediment accretion, or fill. It is the Contractor's responsibility to confirm existing grades and adjust earthwork, as necessary.

B. All earthwork shall be performed in accordance with the Contract Documents and permit requirements.

C. All required erosion and sediment control measures shall be in place prior to onset of earthwork activities.

D. Erosion and sediment control devices and measures shall be utilized and maintained as per Section 31 25 00 - Erosion and Sedimentation Control.

E. Grading operations shall be conducted so that material (soil, trees, and vegetation) outside construction limits will not be disturbed.

F. Excavation and cuts shall be shaped and graded in accordance with the lines, grades, and cross sections or elevations shown on the drawings.

G. Excavate foundation soil to the lines and grades shown on the Drawings. Stockpile material for backfilling in a neat and orderly manner at a sufficient distance from the banks of the excavation to avoid overloading and to prevent slides or caving. Perform excavation and fill in a manner and sequence that will provide proper drainage at all times. The Contractor is responsible for disposal of surplus material, waste material, and material that does not meet specifications, including any soil which is disturbed by the work operations or softened due to exposure to the elements and water.

H. Material shown on the plans as suitable material but found at time of construction to be unsuitable shall be disposed of as unsuitable material.

I. Protruding or unstable rocks 5 inches or larger shall be removed from the surface of soil cut slopes.

J. The Contractor shall be responsible for stabilizing all stream banks after the completion of grading. The Contractor shall perform all care and remediation work required to maintain stable stream banks during construction as per Section 31 25 00 – Erosion and Sedimentation Controls.

K. All tree roots exposed along excavated stream banks shall be trimmed to produce a flush surface as shown on the Drawings.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

3.6 FILL PLACEMENT

A. Provide fill materials from the required excavations and from borrow areas. Make all reasonable efforts to use material from the required excavations in fills.

B. Fill removal from borrow areas:

1. Excavate fill from accepted borrow areas.
2. Selectively excavate, crush, sort, screen, wash and/or blend materials as required to provide the specified fill materials as per Section 31 05 00 – Materials for Earthwork.
3. Control drainage and dewater borrow areas as required. Provide sediment control facilities as required as per Section 31 25 00 – Erosion and Sedimentation Controls and Section 31 60 00 – Foundation Preparation.

C. Stockpiling:

1. Stockpile in sufficient quantities to meet Project schedule and requirements.
2. Separate differing materials with dividers or stockpile apart to prevent mixing.
3. Prevent intermixing of soil types or contamination.
4. Prevent excessive segregation of materials.
5. Direct surface water away from stockpile site to prevent erosion or deterioration of materials. Provide sediment control facilities where required.
6. Protect all stockpiled granular fill materials from damage by water.
7. Satisfactory soil in excess of that required for use as engineered fill shall be disposed of in designated disposal areas.

D. Prior to placement prepare subgrade and foundation as per Section 31 60 00 – Foundation Preparation.

E. Placing Fill:

1. Provide fill materials that satisfy the specifications outlined above, in Section 31 05 00 - Materials for Earthwork, and/or as shown on the Drawings. Selectively excavate, crush, sort, screen, wash and/or blend materials as required to provide the specified fill materials.
2. Employ a placement method that does not disturb or damage other work and does not result in excessive segregation.
3. The sequence of filling shall commence at the lowest section (in elevation) of the subject footprint and proceed upward in specified lifts in a manner to maintain positive drainage at all times, where possible.
4. Avoid uncompacted or segregated construction joints.
5. Maintain moisture content of fill materials to attain required compaction density and ensure uniform distribution of moisture throughout the soil.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

6. Place and compact fill material in equal continuous lifts not exceeding the lift thicknesses specified in Section 31 05 00 – Materials for Earthwork.
7. Backfill against concrete in accordance with the curing and protection requirements of Section 03 30 00 – Cast-In Place Concrete.
8. Backfill against supported foundations and walls. Do not backfill against unsupported foundation walls unless backfilling simultaneously to the same grade on each side of the wall.
9. Upon completion of pipe laying and inspection by the Engineer of the work in place, surround and cover pipe with specified surround material as shown on the Drawings. Ensure good material placement and compaction under pipe haunches.
10. The slopes of all embankments shall be neatly and evenly trimmed to the line and slope indicated on the Drawings or as directed by the Engineer to leave a compacted surface.
11. Consolidate cement treated fill by tamping into place continuously as it is placed. Do not place more than a 6 in. thickness of cement treated backfill without consolidating.
12. Make gradual grade changes. Blend slope into level areas.
13. Make good final grades, including drainage ditches, road bases and the like.
14. Re-level and re-compact fills subjected to vehicular traffic.
15. Protect fill surfaces and slopes from damage by water.
16. Place wearing course material as required on the Drawings.
17. Working surfaces left inactive for more than one week shall be sealed with a smooth drum roller and graded to promote positive drainage to reduce the potential for surface water infiltration.

F. Fill Placement During Freezing Conditions:

1. Place fill materials in freezing conditions only if the materials can be placed and compacted to the specified densities that apply to non-freezing conditions.
2. Remove all ice, snow and loose frozen fill material from compacted fill surfaces or prepared foundations prior to placing new fill materials.
3. Place fill materials on previously placed and compacted fill frozen after compaction or accepted frozen foundations provided that surfaces are cleaned as per (2) above.
4. Place only non-frozen fill. Remove frozen soils from borrow areas prior to excavation of non-frozen materials for use as fill.
5. Fill materials must meet the specified moisture content criteria before acceptance and subsequent material placement.
6. Immediately spread and compact fill materials after placement to achieve specified density before freezing.
7. Place and compact fill rapidly and in relatively small areas. Keep exposed surfaces to a minimum to minimize the potential for fill materials to freeze before compaction to the specified densities.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

8. Remove from the fill, all fill materials that freeze prior to compaction to specified densities.
9. Do not place fill when there is any accumulation of snow or ice on surfaces to be covered by the succeeding layers of fill.
10. Methods proposed by the Contractor for construction during freezing conditions shall be reviewed by the Engineer prior to commencing fill placement.

G. Fill Placement in Confined Openings

1. Confined openings include, but are not limited to, waterway openings in intakes, tunnel portals, powerhouse embedded penstocks, turbine pits and embedded draft tubes.
2. Confined openings are to be filled as part of the site-wide burial of partially demolished structures with concrete rubble, boulders and soils as shown on the Drawings.
3. In all confined openings, where possible, the contractor shall strive to meet the placement and compaction requirements defined for each material type in Section 31 05 00 – Materials for Earthwork.
4. Placement of fill in confined openings to be reviewed by the Engineer prior to and during construction.
5. Vertical Confined Openings:
   a. Material to be placed by dumping or pushing material into the openings.
   b. Tamping, pushing, or hammering by excavator bucket to be employed where possible. Placement of fills without nominal compaction to be approved by the Engineer.
6. Horizontal Confined Openings:
   a. Material to be placed by pushing material horizontally into the openings.
   b. Placement of material by conveyor or small equipment to be considered if pushing or placement by dozer or excavator is not possible.
   c. If track walking compaction with a dozer is not possible due to spatial constraints, nominal compaction is to be achieved by plate compactor, hand compactor or jumping jack. If the opening is deemed a confined space, tamping, pushing, or hammering by excavator bucket may employed to achieve nominal compaction.
   d. Final stabilization and cover to be placed as shown on the Drawings and in accordance with Section 31 25 00 Erosion and Sediment Control.

3.7 FILL PLACEMENT IN J.C. BOYLE SCOUR HOLE

A. For placement of the infill materials (not including cover) at the scour hole, certain variances from Section 3.7 are acceptable. These variances are as follows:

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

1. Fill placed in the bottom half of the hole to be end dumped and shall not be placed in lifts due to logistical constraints.
2. Fill placed in the upper half of the hole to be mechanically spread in lifts that do not exceed the greatest lift thickness specified for E9, E9a, CR1, or CR2.
3. All E9, E9a, CR1 and CR2 materials placed in the scour hole, regardless of placement method, are to be mixed thoroughly to the satisfaction of the Engineer, to minimize voids and avoid the creating of continuous E9 fill layers.

B. The Contractor to employ earthmoving equipment that is suitable for steep-slope operation to maximize the quantity of material that is able to be placed in lifts.

C. Exposed concrete shall not be visible on the surface of the fill.

3.8 FILL PLACEMENT FOR ROADS, BRIDGES AND CULVERTS

A. Excavation and Fill placement for road, bridge and culvert sites (5000 and 6000 series Project Drawings) shall comply with the requirements of this document in addition to Section 32 50 00 – Roads, Bridges and Culverts and the site-specific requirements noted on the Project Drawings.

3.9 CONCRETED EROSION PROTECTION

A. For concreted erosion protection placement, infill with 2,500 psi mass concrete or as specified on the Drawings. Erosion protection material shall be clean, free of mud and dust. Wet the clean stones and place the 2,500 psi concrete concurrent with placement of the large stones and vibrate the concrete into place to completely infill the voids by vibration wherever practicable or by rodding. Cure the concreted erosion protection material as per Section 03 30 00 – Cast-in-Place Concrete.

3.10 SOIL MOISTURE CONTROL

B. Moisture Adjustment: Moisture content shall be adjusted as necessary to facilitate compaction. Moisture control shall be achieved by either windrowing, scarifying or adding water to achieve workable moisture content.

C. If additional moisture content is required, water may be added to the material at the source or after the material has been brought into its final position, whichever is more practical. The Contractor shall obtain uniform moisture distribution in the lift by disking, blading, or other approved methods. The amount of water applied shall be controlled so that the moisture content remains within 2% of optimum and free water will not appear on the surface during or subsequent to compaction operations.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

D. Material deposited on fill that is too wet shall be removed or spread and permitted to dry, assisted by disking or blading, if necessary, until the moisture content is reduced to the specified limits.

E. When the top surface of a layer becomes too dry or too smooth to permit suitable bonding with the subsequent layer, the Contractor shall loosen the material by scarifying or disking. The Contractor shall then moisten the loosened material to acceptable moisture content and re-compact the material to the specified density.

3.11 VEGETATIVE COVER

F. Vegetative cover type material shall be placed as per Section 31 25 00 – Erosion and Sedimentation Controls.

3.12 DEWATERING AND WATER MANAGEMENT (OUTSIDE OF RIVER)

A. Care of Water and river diversions specific to in-River work, shall be completed in accordance with Section 31 80 00 - Care of Water.

B. Where Excavation and Fill Placement could result in erosion, measures shall be taken to mitigate such as per Section 31 25 00 – Erosion and Sedimentation Controls.

C. All excavations completed outside of the Klamath River will require the control of water via water management and/or dewatering systems to maintain dry conditions.

D. All fills placed outside of the Klamath River will require the control of water via water management and/or dewatering systems to maintain optimum moisture in the fill materials.

E. Water Management:

1. Diversion ditches/swales, check dams, berms, pumps, sumps, channels, drains, wells, and other temporary measures and equipment shall be provided to control and direct runoff and groundwater away from foundations and excavations in order to prevent ponding and infiltration.
2. Excavation and Fill Placement shall be conducted in a manner that maintains proper drainage at all times in and around the work area.
3. Protect excavations and fills from damage by water. Accumulations of water in and around foundations and excavations shall be promptly removed.
4. Sides and slopes of foundations of fills and excavations shall be protected from erosion and sloughing caused by water.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

5. Surface water management and groundwater control measures shall be compatible with the Drawings.
6. Best Management Practices and other means to control water shall be provided and maintained as shown on the Drawings and other project documents.
7. Water management should result in stable foundations of fills.

F. Dewatering:

1. Dewatering activities to occur when water builds up in construction areas such as excavations, fills and foundations.
2. Protect existing adjacent buildings, structures, and improvements from damage caused by dewatering operations.
3. Divert/collect water and seepage within construction areas into sumps and pump water away from the work site.
4. Locate system components to allow continuous dewatering operations without interfering with other activities.
5. Dewatering equipment and systems shall be installed and operated in accordance with manufacturer's instructions.
6. Conduct regular inspections of dewatering system. Make required repairs and perform scheduled maintenance.
7. When dewatering system cannot control water, notify Owner and Engineer and stop the work activity.
   a. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.
   b. Demonstrate that the dewatering system operation complies with performance requirements before resuming work activities.
8. All water to be released as per the contract documents. All applicable Federal, State, and local permits to be followed.
9. Remove dewatering equipment and systems after dewatering operations are no longer required.

3.13 QUALITY

A. The Contractor shall provide the Owner and Engineer access to the site at all times.

B. The Contractor is required to place fill materials that comply with the requirements of Section 31 05 00 – Materials for Earthworks.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

C. If in the judgement of the Engineer, the volume of material represented by a failed record test is significant or results in work that deviates from design intent, repair or replace the non-complying material. Repair may take the form of moisture conditioning, re-mixing, blending, or re-compacting the material. In the event that repairing the material is not possible or not desired, remove the non-complying material from the work and replace with material that meets the specifications. Any such re-work shall be performed at the Contractor's expense.

D. The Contractor is responsible for performing work in accordance with the Drawings and performing quality control.

E. The Contractor is responsible for field quality testing (record tests) for all engineered fill materials incorporated in the permanent work at the frequencies detailed in the following table. Minimum testing requirements: frequency is "1 per" the number of cubic yards of material as required for the work.

F. Additional excavation, fill placement, and material testing requirements for road and bridge sites are outlined in Section 32 50 00 – Roads, Bridges and Culverts, Part 2, 2.2.

DRAFT

31 23 00 – EXCAVATION AND FILL PLACEMENT

Table 1 – Record Testing Schedule

Material and Location	Moisture Content (ASTM D2216)	Particle Size Distribution (ASTM D6913)	Laboratory Compaction (ASTM D1557 or D4253 & D4254 as applicable)	Specific Gravity (ASTM D854)	In Situ Density (ASTM D1556, D6938, D5030 as applicable) Moisture Content (ASTM D2216 or D6938 as applicable)
	1 per	1 per	1 per	1 per	1 per
E2 – Pipe Zone	1,300	1,300	1,300	3,250	350
E3 – Structural Fill	1,300	1,300	1,300	3,250	350
E4 – Select Fill	1,300	1,300	1,300	-	650
E5 – Road Embankment Fill	1,300	1,300	1,300	-	650
E6 / E8 – Bedding	-	650	-	-	-
E7a/E7b/E7c – Erosion Protection	-	Visual	-	-	-
E9/E9a/E9b – General Fill	-	20,000	-	-	-
E11 – Aggregate Base	500	500	2,000	-	500
E12 – Engineered Streambed Material	-	Visual	-	-	-
E13 – Drain Rock	-	Work Area	-	-	-
CR1 – Concrete Rubble	-	Visual	-	-	-
CR2 – Concrete Rubble	-	Visual	-	-	-

NOTES:

1. DENSITY AND MOISTURE CONTENT BY NUCLEAR METHODS WILL BE RANDOMLY CONDUCTED ON EACH LIFT DURING PLACEMENT.
2. RECORD TESTING TO BE UNDERTAKEN ONCE MATERIALS ARE PLACED TO CONFIRM COMPLIANCE OF IN SITU MATERIALS. CONTROL TESTING TO BE PERFORMED PRIOR TO USE OF MATERIALS IN THE WORK AREA AND INCLUDES A GREATER TESTING FREQUENCY (SECTION 31 05 00 MATERIALS FOR EATHWORK).
3. DUE TO THE SMALL VOLUME OF DRAIN ROCK (E13) SPECIFIED, ONLY 1 RECORD GRADATION TEST PER WORK AREA IS REQUIRED.

END OF SECTION 31 23 00

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

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DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
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DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

TABLE OF CONTENTS

PAGES

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

SECTION 31 25 00 EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes temporary and permanent erosion and sediment controls including but not limited to the following:

1. Permanent erosion and sedimentation controls installed by the Contractor as specified in this Specification and as set out in the Drawings.
2. Temporary erosion and sediment controls installed by the Contractor where required.
3. The conversion of temporary measures to permanent measures.

1.2 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal.

B. Section 31 05 00 – Materials for Earthwork.

C. Section 31 10 00 – Clearing, Grubbing and Stripping.

D. Section 31 23 00 – Excavation and Fill Placement.

E. Section 31 60 00 – Foundation Preparation.

F. Section 31 80 00 – Care of Water.

1.3 REFERENCE STANDARDS

A. AASHTO

1. AASHTO M294: Standard Specification for Corrugated Polyethylene Drainage Pipe 12” - 60” (304.8mm – 1524.0mm).

B. ASTM or ASTM International (ASTM):

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
2. ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

DRAFT

3. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joint Plastic Pipe.
4. ASTM F2306: Standard Specification for 12″ – 60″ (304.8mm – 1524.0mm) Annular Corrugated Profile-Wall Polyethylene Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

C. State of California Water Resources Control Board:

1. California Stormwater Quality Association BMP Handbook – Construction.
2. Construction General Permit (CGP).

D. State of Oregon Department of Environmental Quality:

1. Construction Stormwater Best Management Practices Manual, 1200-C NPDES General Permit.
2. Section 8. Site Restoration, Erosion and Sediment Control, Clean Water Act Section 401 Certification.

E. State of California Department of Transportation (Caltrans) Standard Specifications, Section 21 – Erosion Control.

F. State of Oregon Department of Transportation (ODOT):

1. Oregon Department of Transportation (ODOT): Oregon Standard Specifications for Construction, 2018.

1.4 DEFINITIONS

A. Permanent Erosion and Sediment Control – measures required to address long term, post-deconstruction erosion and sedimentation control, that are related to stormwater pollution prevention.

B. Temporary Erosion and Sediment Control – measures installed by the Contractor to control the erosion and stormwater pollution during the mobilization and deconstruction Work.

C. BMPs – Best Management Practices, as specified in the referenced standards of the CASQA and Oregon DEQ. Non-stormwater management, material management including concrete, and dredging BMPs referenced in the standards are excluded from this specification and are addressed in the management plans.

D. SWPPP – Stormwater Pollution Prevention Plan, in California.

E. QSP – Qualified SWPPP Practitioner in California.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

F. QSD –Qualified SWPPP Developer in California.

G. CPESC – Certified Professional in Erosion and Sediment Control in California and Oregon.

H. Pre-Drawdown Year – The calendar year when the Contractor mobilizes for the deconstruction and modifies, adjusts or adapts the existing dams and appurtenant structures to facilitate safe drawdown of the reservoirs, as shown on the Drawings.

I. Drawdown Year – The calendar year, following the pre-drawdown year, when the four reservoirs will be drawdown; the dams and associated facilities will be demolished, deconstructed, buried, and/or removed; and the fish volitional channels will be restored.

J. Final Stabilization – Surface treatment or cover to provide erosion control as a permanent measure. In general terms, the measure may be vegetative or non-vegetative or a combination thereof. The QSP/CPESC will provide for determination of the final stabilization, based on visual inspection.

K. Non-vegetative Final Stabilization – Placement of a final cover material, not suitable for vegetation, at final grade as shown on the Drawings. Fines are soil materials passing a US standard sieve #200 and are limited to 10% of the surface layer, by weight. Per the Drawings and Section 31 05 00 – Materials for Earthwork, acceptable materials are Select Fill (E4) and General Fill (E9b). The QSP/CPESC will provide for determination of the final stabilization, based on visual inspections or other means.

L. Vegetative Final Stabilization – Hydroseeding the final cover material, suitable for vegetation, at final grade as shown on the Drawings. Fines are soil materials passing a US standard sieve #200 and must be greater than 10% of the surface layer, by weight. Per the Drawings and Section 31 05 00 – Materials for Earthwork, acceptable surface materials for hydroseeding would General Fill (E9). The QSP/CPESC will provide for determination of the final stabilization, based on visual inspections or other means.

M. Rain Event – A 50% chance or greater forecasted or actual heavy rain event that occurs during the deconstruction activities and may require mobilization and implementation of additional temporary erosion and control measures.

N. Rain Event Action Plan – Pre-Rain Plan for addressing a rain event with a 50% chance or greater. The requirement for these, if any, will be specified in the CA SWPPPs or OR Erosion and Sediment Control Plan.

O. Temporary construction roads – Newly constructed roads used for the duration of construction.

P. Rehabilitated construction roads – Currently existing roads that need to be widened to accommodate wider trucks with heavier loads.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

Q. Permanent construction roads – Newly constructed roads that will be fit for service by the public by the end of construction.

R. Hold Point – A period within the deconstruction activities where further progress awaits the approval or acceptance of the condition or work by the QSP, CPESC.

S. Historic Construction – Initial construction of the dams and appurtenant works.

T. Historic Staging Areas – Staging areas used in the initial construction. These are generally flat and may have some overgrowth.

U. Historic Construction Roads – Construction roads used in the initial construction. These areas have some overgrowth.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Erosion and Sediment Control Plan (ESCP) for Oregon and Stormwater Pollution Prevention Plan (SWPPP) for California including Best Management Practices (BMPs) indicating the specific erosion and sediment control measures, turbidity and silt control measures, air quality and dust control plans, QSP/CPESC hold points and plans for monitoring.

C. Seed Product Data: Data for seed mix, fertilizer, mulch, and other additives, including tackifiers (soil binder). Weed-free certifications and Phytophthora-free certifications, where available. Laboratory Test Results: indicating purity and germination rates for all seed species. It is recognized that members the Yurok Tribe have been collecting seed specimens for a number of years and that RES has recommended the Upland Diversity Mix (see Figure 1), which is subject to the CA SWPPPs and the OR Erosion and Sediment Control Plan.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

Species	Common name	Lifeform	Seed Status
Amsinckia menziesii	Menzies' fiddleneck	Annual forb	To be collected
Acmispon americanus	Spanish lotus	Annual forb	Stored (PCS)
Angelica arguta	Lyall's angelica	Perennial forb	To be collected
Artemisia tridentata	big sagebrush	Shrub	Stored (PCS)
Danthonia californica	California oatgrass	Perennial grass	To be collected
Ericameria nauseosa	Rabbitbrush	Shrub	Stored (HRF, PCS)
Festuca microstachys	small fescue	Annual grass	To be collected
Grindelia nana	Idaho gumweed	Perennial forb	To be collected
Koeleria macrantha	June grass	Perennial grass	To be collected
Lomatium macrocarpum	bigseed biscuitroot	Perennial forb	To be collected
Lomatium nudicaule	barestem biscuitroot	Perennial forb	To be collected
Lomatium triternatum	nineleaf biscuitroot	Perennial forb	To be collected
Monardella odoratissima	mountain mondardella	Perennial forb	To be collected
Penstemon deustus	rock penstemon	Perennial forb	To be collected
Perideridia bolanderi	Bolander's yampah	Perennial forb	To be collected
Phacelia heterophylla var virgata	varied leaf phacelia	Perennial forb	To be collected
Poa secunda	Sandberg's bluegrass	Perennial grass	To be collected
Stipa lemmonii	Lemmon's needlegrass	Perennial grass	Stored (HRF)
Stipa occidentalis	western needlegrass	Perennial grass	To be collected

NOTES:

1. THE UPLAND DIVERSITY MIX WILL ALSO INCLUDE SPECIES FROM THE UPLAND PIONEER SEED MIX DEPENDING ON AVAILABILITY.
2. THE APPLICATION RATE AND SEED MIX COMPOSITION WILL BE DETERMINED FOLLOWING DRAWDOWN BASED ON RESERVOIR POST-DRAWDOWN CONDITIONS

Figure 1 – Upland Diversity Mix

D. Pre-deconstruction vegetative condition: to establish a baseline for closure of the construction permits, requiring restoration of 70% of the pre-deconstruction vegetative condition or evaluation and documentation of improved conditions using established analytical methods (e.g. RUSLE).

E. Rain Event Action Plan: Planning for rain events or justification for its exclusion in the CA SWPPPs or the OR Erosion and Sediment Control Plan.

F. Manufacturer's information on all fabricated materials to be used for thepermanent and temporary erosion and sedimentation controls.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

1.6 QUALITY ASSURANCE

A. Work shall be in conformance with the Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials will include fabricated products and natural materials.

B. To the extent possible, natural erosion control materials such as gravel and rock will originate from local excavations or onsite borrow areas as described in Section 31 05 00 - Materials for Earthwork.

C. Select materials, as shown on the Drawings, may also fulfill an erosion and sediment control function. All materials shall be implemented as detailed in the Erosion and Sediment Control Plan for Oregon, SWPPP for California, as shown on the Drawings, and as per manufacturer requirements.

D. Check dams shall generally be comprised of gravel bags that allow ready conformity to the local site topography. For gravel bags to be used for final stabilization, bag material will be made of a biodegradable material like burlap, or similar.

E. Pipes, and manholes and headwalls for managing storm water collection and conveyance to the outfalls will comply with the Drawings and manufacturer's instructions.

1. The pipe material is high density polyethylene (HDPE). Selected pipe is the Type S HDPE pipe with corrugated exterior and smooth interior. Joints will be gasketed bell and spigot. Nonrated and non-pressure tested watertight joints are suitable for gravity flow drainage applications. The pipe shall conform to the AASHTO and ASTM standards listed in the Reference Standards.
2. The pipe manufacturer shall provide material technical performance information and detailed instructions for installation. The installation instructions shall include minimum cover requirements corresponding to the expected traffic loadings of the Contractor's earthmoving equipment during the deconstruction period.

F. Grass Seed, Fertilizer and Mulch for Hydroseeding:

1. All seed for designated seeded areas will be genetically appropriate and sourced from the Upper Klamath and Lost River Watersheds as per the Contract Documents and the Restoration Specifications. See Figure 1.
2. The seed mix shall conform to the final seed mix selected in the Erosion and Sediment Control Plan in Oregon and the SWPPP in California.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

3. Fertilizer may be added to the hydroseeding slurry to add the nutrients necessary to provide an acceptable soil for growth. Refer to the applicable guidelines provided in the ODOT Standard Specifications.
4. A straw or wood chip mulch may be added to the hydroseeding slurry to provide stability to the seed bed. Straw waddles/Fiber rolls, where necessary, to be installed in conjunction with hydroseeding to reduce sheet flow erosion and sediment transport so the seed can germinate and achieve revegetated stabilization. In some instances, erosion control mats may be necessary to foster vegetative growth.

G. Fiber Roll or Straw Wattles:

1. Straw wattles or fiber rolls shall consist of rolls or bales of tight fibrous material. The wrapping material shall also be primarily biodegradable.
2. See Table 1 for required fiber roll/straw waddle spacing criteria.

Table 1 – Fiber Roll/Straw Waddle Spacing Criteria

State	BMP Name	Slope	Spacing
California	Fiber Roll (SE-5)	< 4H:1V	20’
		4H:1V < Slope < 2H:1V	15’
		Slope > 2H:1V	10’
Oregon	Straw Waddle (2.16)	-	10’ to 25’

H. Tackifier or Soil Binder:

1. A tackifier or soil binder shall be used in locations where appreciable fines are high (>10%), as judged by the QSP/CPESC based on visual inspection.
2. A tackifier or soil binder shall be selected so as to minimize adverse impacts on native fisheries, if required.

I. Construction Entrances/Exits:

1. Construction entrances may comprise natural or man-made materials or a combination thereof.
2. Natural construction materials would include an aggregate-type material similar to E4 or E9b material described in Section 31 05 00 - Materials for Earthworks.
3. Fabricated material would include the many commercially available entrance/exit pads. Such pads are durable, U/V stable, and easily transferred to/from work fronts. Refer to FODS® LLC trackout control system, or similar.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

PART 3 - EXECUTION

3.1 GENERAL

A. Historic staging areas and historic construction roads will be utilized to the extent practical.

B. Existing vegetation will be preserved to the extent practical.

C. For the staging areas, an initial setting out of the area will be undertaken prior to full mobilization of equipment, office trailers, and construction plant and services. The setting out will include site planning, establishment of limits, and staking the area. Drainage paths will be confirmed, stormwater diversion berms shall be constructed, and gravel bag check dams shall be established, as shown on the Drawings. The gravel bag check dams are intended to retain sediment upstream from the check dam. Prior to full mobilization, these perimeter BMPs shall be in place.

D. During deconstruction works, certain areas, such as powerhouse tailraces, will require dewatering by pumping. In accordance with the CA SWPPP and the OR Erosion and Sediment Control Plan, sediment controls will be used to extract excessive sediment from the pumping discharges.

E. Many project areas comprise steep, rocky terrain. Existing and cut stable rock slopes may not require any additional erosion and sediment control measures, as rock is an acceptable erosion and sediment control BMP.

F. After safe construction access is established to the disposal areas, the following BMPs will be established:

1. For disposal areas that border along the river valley wall, a buttress toe will be established at the base of the disposal area, above the 100-year flood level, as shown on the Drawings. The toe will be established with E4 or E9b material, which is available from: (a) a local quarry or (b) required excavation from deconstruction of the dams or road improvements.
2. Graded drainage paths along with gravel bag check dams, as shown on the Drawings.

G. Within the accelerated deconstruction period, the Contractor shall maintain placement of disposal material within the disposal site boundaries in order to maintain an active work site. Accelerated placement of disposal material will ultimately lead to faster final stabilization, subject to the review of a QSP/CPESC.

H. When any disposal area, or portion thereof, is deemed ready for final stabilization by the Contractor, a hold period will be scheduled to facilitate QSP/CSESC review and approval.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

I. The Contractor shall verify that finished grades of each disposal site are in accordance with the Drawings, including final stabilization, which may include the application of hydroseeding or other measures.

J. Installation of erosion protection and bedding materials as engineered materials are described in Section 31 05 00 - Materials for Earthwork and Section 31 23 00 – Excavation and Fill Placement.

3.2 CONSRUCTION ROADS

A. Table 2 summarizes the various construction road types across the project areas.

Table 2 – List of KRRP Construction Roads

Project Site	Temporary Construction Road	Rehabilitated Construction Road	Permanent Construction Road
J.C. Boyle	Left Bank Access Road	Scour Hole Access Road (Optional)	Powerhouse Access Road Realignment
	Left Disposal Haul Road	Penstock Access Road (Optional)	-
	Right Disposal Haul Road	-	-
Copco No.1	Workpad Road (Stage 1)	Powerhouse Access Road Widening	Powerhouse Access Road Realignment
	Workpad Road (Stage 2)	-	-
Copco No.2	-	Diversion Dam Access Road	Spillway Apron Access Road
	-	Left Bank Access Road (Optional)	-
Iron Gate	Downstream Diversion Tunnel Access Road	-	-
	Powerhouse Haul Road	-	-
	Spillway Haul Road	-	-
	Disposal Site #1 and #2 Haul Roads	-	-

B. For all construction roads, measures shall be installed to reduce sediment laden runoff to surrounding construction areas and the Klamath River. Diversion berms or, in some cases safety berms, are to be constructed on the downstream side of road to trap sediment during rain events. All drainage paths, whether existing or constructed, shall be clear of debris throughout the deconstruction. Gravel bag check dams are to be installed along drainage paths near and downstream of borrow areas to trap sediment

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

during rainfall events. All culverts, existing or constructed, shall have their inlets protected by gravel bags or similar.

3.3 CONSTRUCTION SCHEDULING

A. Under the accelerated deconstruction schedule, it may be necessary to select final erosion control measures in the field, with oversight of the QSP/CPESC. The QSP/CPESC generally maintains a toolbox of possible solutions that may be implemented under special circumstances. Such toolbox is described in the reference standards.

B. Construction of erosion and sedimentation control measures are to be completed in accordance with the Erosion and Sediment Control Plan in Oregon, SWPPP in California, the Drawings, and these Specifications.

C. Accelerated Scheduling:

1. Scheduling of the construction of temporary and permanent erosion and sedimentation control measures is to be completed by the Contractor.
2. Required erosion and sediment control measures, where applicable, are to be constructed prior to clearing, construction and/or demolition activities.
3. Accelerated scheduling shall be addressed in the CA SWPPPs and the OR Erosion and Sediment Control Plan.

D. Rain Event Action Plan (REAP)

1. In general, deconstruction will be accelerated so that permanent stabilization occurs relatively quickly and during the dry summer months, such that some temporary BMP's may be unnecessary. This is unique to the nature and mission of this project.
2. The requirement for REAP BMPs, if any, will be specified in the CA SWPPPs and OR Erosion and Sediment Control Plan.
3. If high fines materials are placed in a disposal area prior to a rain event (before permanent stabilization can be reached), they shall be stabilized with temporary BMPs including geotextile and mats or tackifier.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

4. If permanent stabilization of the disposal areas can not be reached prior to a forecasted qualifying rain event, temporary BMP's will be deployed such that stormwater pollution will be prevented at a maximum extent practicable. Such temporary BMP's that will be considered include, but not limited to: Geotextile and mats and/or tackifier for slope protection, slope drains to divert concentrated flows, gravel bag check dams and other BMP's designated by the QSP or CPESC at the time the REAP inspection is conducted, if any.

3.4 CONVERSION OF TEMPORARY MEASURES TO PERMANENT MEASURES

A. Temporary measures may be converted to permanent measures, where accepted by the QSP/CPESC. As and where practical, temporary diversion berms, drainage paths/ditches, biodegradable gravel bag check dams, and sediment traps shall be converted to permanent measures, and will form part of the documentation for closure of the construction permits. Such conversion shall require the following:

1. Inspection by the Engineer and QSP/CPESC.
2. Removal and replacement of damaged measures.
3. Cleaning of sediment traps where the accumulated sediment is more than one- third the depth up to the overflow elevation. Sediment collected will be disposed of in designated areas.
4. Other measures in accordance with specific field conditions.

3.5 TEMPORARY MEASURES

A. Maintain all temporary erosion and sediment control structures during the Work or until the permanent erosion and sediment control structures are installed.

B. Temporary measures are to remain in place until completion of construction activities and appropriate permanent measures are in place. The Contractor is responsible for the removal of all temporary measures, unless converted to permanent measures as outlined above.

C. Construction access roads, where practical, will utilize the remnants of construction roads that were developed during the original construction.

3.6 PERMANENT MEASURES

A. Fill locations must be stabilized by either of two methods: vegetative or non-vegetative as described in the California Stormwater BMP Handbook and the Oregon Construction Stormwater Best Management Practices Manual.

DRAFT

31 25 00 EROSION AND SEDIMENTATION CONTROLS

1. Vegetative grade stabilization involves hydroseeding, as shown on the Drawings. Seeding of designated areas shall be carried out upon completion of construction or disposal work and after any required reclamation work has been completed.
2. Non-vegetative stabilization involves providing rock slope protection or a gravel mulch protection, as shown on the Drawings.

3.7 SITE DEWATERING AND WATER CONTROL

A. Refer to Section 31 23 00 – Excavation and Fill Placement.

B. The Contractor shall be responsible for dewatering excavations and the Worksite by the control of groundwater and/or river or stream diversion where required to complete the Work.

C. Where possible install collection swales downstream of the Worksite to collect sediment laden runoff.

D. Where possible install diversion swales upstream of the Worksite to divert runoff before contact.

E. Where appropriate, control the discharge of collected/diverted water and provide energy dissipation.

F. Care of water must meet permit requirements, Section 31 80 00 – Care of Water requirements and comply with the Contract Documents.

3.8 INSPECTION AND MAINTENANCE

A. The Contractor shall regularly inspect and maintain the construction site for the control measures identified in the Erosion and Sediment Control Plan for Oregon or the SWPPP for California. As a minimum, the Contractor shall inspect temporary infrastructure on a daily basis during periods of prolonged rainfall. The Contractor shall identify corrective actions and time frames to address any damaged measures or reinitiate any measures that have been discontinued. The CA SWPPPs and OR Erosion and Sediment Control Plan is to provide further details on BMP inspection requirements.

B. If the Engineer or QSP/CPESC identifies a deficiency in the deployment or functioning of an identified control measure, the deficiency shall be corrected in a timely manner. If the permitting agency identifies a deficiency in the deployment or functioning of an identified control measure, the Contractor will be notified, and the deficiencies shall be corrected by the Contractor in a timely manner.

END OF SECTION 31 25 00

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31 60 00 – FOUNDATION PREPARATION

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31 60 00 – FOUNDATION PREPARATION

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D	Cyrus Niamir	Benoit Otis	Craig Nistor	092520	-	-
E	Cyrus Niamir	Benoit Otis	Craig Nistor	100720	-	-
F	Cyrus Niamir	Benoit Otis	Craig Nistor	103020	-	-
G	Cyrus Niamir	Benoit Otis	Craig Nistor	111320	-	-

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31 60 00 – FOUNDATION PREPARATION

TABLE OF CONTENTS

PAGES

DRAFT

31 60 00 – FOUNDATION PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the construction and quality management requirements for preparation and dewatering activities for foundations where engineered structures or fills are being constructed.

B. This specification applies to the Foundation Preparation as specified in this Section and set out in the Drawings.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 03 60 00 – Grouting.

C. Section 31 05 00 – Materials for Earthwork.

D. Section 31 10 00 – Clearing, Grubbing and Stripping.

E. Section 31 23 00 – Excavation and Fill Placement.

F. Section 31 25 00 – Erosion and Sedimentation Controls.

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):

1. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.

B. California Stormwater Quality Association:

1. California Stormwater BMP Handbook – Construction.

C. State of California Department of Transportation (Caltrans) Standard Specifications, Section 21- Erosion control.

D. State of Oregon Department of Environmental Quality:

DRAFT

31 60 00 – FOUNDATION PREPARATION

1. Construction Stormwater Best Management Practices Manual, 1200-C NPDES General Permit.

E. State of Oregon Department of Transportation (ODOT):

1. Oregon Department of Transportation (ODOT): Oregon Standard Specifications for Construction, 2018.

1.4 DEFINITIONS

A. Foundation – Native surface on which earthwork, road, concrete, or metal structures are placed.

B. Unsuitable Material – Material encountered during Foundation Preparation work that is not acceptable as foundation or subgrade material for fill placement.

C. Proof-roll – The act of compacting overburden foundation material to densify the strata and to identify unsuitable material requirement removal.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Project Record Documents: Record actual locations of abandoned utilities and services, foundations, and other appurtenances.

C. Inspection and Testing Plan: Detail inspection and testing plans including foundation inspection hold points, testing requirements and inspection sheets for review and approval by the Engineer.

1.6 QUALITY ASSURANCE

A. Work shall be performed in conformance with the Drawings, submittals, and other project documents.

31 60 00 – FOUNDATION PREPARATION

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment shall be the responsibility of the Contractor.

2.2 MATERIALS

A. Concrete used in Foundation Preparation Work shall be as specified in Section 03 30 00 – Cast-in-Place Concrete.

B. Water used in Foundation Preparation Work shall be as specified in Section 03 30 00 – Cast-in-Place Concrete.

C. Grout used in Foundation Preparation Work shall be as specified in Section 03 60 00 – Grouting.

D. Earthwork fill materials used in Foundation Preparation Work shall be as specified in Section 31 05 00 – Materials for Earthwork.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall prepare all foundations prior to installation of structures or fill placement to the limits as shown on the Drawings.

B. Foundation Preparation shall be scheduled to be performed immediately prior to when approval is required to enable each portion of the Work to be carried out.

C. Foundation Preparation varies by structure and location and includes but is not limited to:

1. Cleaning and compaction of overburden materials.
2. Cleaning and preparation of rock foundations.
3. Dewatering.

DRAFT

31 60 00 – FOUNDATION PREPARATION

3.2 OVERBURDEN FOUNDATIONS

A. All overburden foundations shall be cleaned by the Contractor to remove mud, debris, topsoil, ice, snow and other unsuitable materials to the lines and grades shown on the Drawings.

B. All overburden foundations shall be proof-rolled with 6 passes of a minimum 20,000 lb vibratory drum roller in the static mode or other approved equipment. The resulting surface shall be free from potholes and uniform. Soft foundations identified by proof- rolling shall be removed as per the direction of the Engineer. Replacement of removed materials with compacted fill may be necessary.

C. Sloping surfaces shall be trimmed as shown on the Drawings.

D. Before earthwork fill placement, scarify the overburden foundation surface to a depth of 6 inches to ensure a bond between the layers.

E. The prepared overburden foundation should not be frozen or contain frost.

3.3 ROCK FOUNDATIONS

A. All rock foundations shall be cleaned by the Contractor including potholes, cavities, and fault zones. Loose materials such as roots debris and other unsuitable materials shall be removed to the lines and grades shown on the Drawings.

B. Concrete and grout may be used to prepare overhangs or fill cavities and faults per the drawings.

C. Overhangs may be eliminated by excavation to produce a final surface not steeper than 70 degrees.

3.4 ROAD FOUNDATIONS

A. All road foundations or native structural subgrades shall be firm, unyielding native material free of unsuitable material.

B. Rocks greater than 4 inches in diameter are to be removed.

C. Road foundations are to be scarified to 8” depth and recompacted to a minimum of 95% relative density and within 2% of optimum moisture or until firm and unyielding under vibratory proof-roll. Compaction is to be tested as per ASTM D698.

DRAFT

31 60 00 – FOUNDATION PREPARATION

3.5 DEWATERING

A. All Foundation Preparation Dewatering shall be completed in accordance with Section 31 23 00 – Excavation and Fill Placement.

B. All Foundation Preparation Work shall be completed in near dry conditions.

1. Protect all prepared foundations from damage by water. Accumulations of water in and around foundations shall be promptly removed.
2. Sides and slopes of foundations should be protected from erosion and sloughing caused by water.
3. If a was previously approved foundation is exposed to runoff or precipitation or other source of water, the foundation will require a subsequent inspection and re- approval.

3.6 QUALITY

A. The Contractor shall provide the Owner and Engineer access to the site at all times.

B. The Contractor is responsible for performing work in accordance with the Drawings and performing quality control. An inspection and test plan for Foundation Preparation including hold points, testing requirements and inspection sheets is the responsibility of the Contractor and requires approval prior to implementation from the Engineer.

C. The Engineer shall inspect all Foundation Preparation Work to determine whether preparation and cleaning has been completed satisfactorily.

D. A foundation approval will become invalid if the foundation is left exposed for longer than 24 hours. The Contractor is responsible for maintaining the foundation if fill or structure placement is delayed.

E. Survey will be taken of the area for as-built information in order to verify quantities and/or verify layer thicknesses.

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END OF SECTION 31 60 00

31 71 00 TUNNEL CONSTRUCTION

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31 71 00 TUNNEL CONSTRUCTION

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31 71 00 TUNNEL CONSTRUCTION

TABLE OF CONTENTS

PAGES

DRAFT

31 71 00 TUNNEL CONSTRUCTION

SECTION 31 71 00 – TUNNEL CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Work specified in this Section describes underground tunnel construction and improvements as indicated on the Drawings.

B. The work includes:

1. The excavation required to advance and modify tunnels and adits.
2. Contractor designed and construction of support systems.
3. Construction of tunnel linings.

1.2 DEFINITIONS

A. Blasting Specialist – Approved blasting designer with experience in the design and/or construction of underground excavations as required for the Work.

1.3 RELATED SECTIONS

A. 02 41 00 – Demolition and Facility Removal.

B. 03 10 00 – Concrete Forms and Accessories.

C. 03 20 00 – Concrete Reinforcing.

D. 03 30 00 – Cast-In-Place Concrete.

E. 03 60 00 – Grouting.

F. 31 23 00 – Excavation and Fill Placement.

G. 31 25 00 – Erosion and Sedimentation Controls.

DRAFT

31 71 00 TUNNEL CONSTRUCTION

1.4 REFERENCES STANDARDS

A. California Code of Regulations, Title 8, Chapter 4, Division of Industrial Safety – Subchapter 20, Tunnel Safety Orders.

B. California Department of Industrial Relations: Division of Occupational Safety and Health (DOSH) – Cal/OSHA:

1. Title 8, Division 1. Department of Industrial Relations, Chapter 4. Division of Industrial Safety Subchapter 20. Tunnel Safety Orders.

C. International Society of Explosives Engineer (ISEE):

1. ISEE - Blaster's Handbook.

D. National Fire Protection Association (NFPA):

1. NFPA 495 - Explosive Materials Code.

E. Occupational Safety and Health Standards for Construction Industry (OSHA) 29 Code of Federal Regulations (CFR) Part 1926 Subpart S – Underground Construction.

F. Vibration Subcommittee of the International Society of Explosive Engineers (ISEE), blast monitoring equipment operation standards (1999).

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works.

B. Work Plan: method statement, equipment, indicate proposed method including descriptions and sequence of construction in accordance with the California Code of Regulations Subchapter 20 and OSHA 29 CFR, tunnel surveying plan including method for alignment and grade control.

C. Survey Report including Photos/Documentation on conditions of structures, buildings, equipment near locations of the Work.

D. Probe Hole Survey: include procedures for alignment and grade control and frequency of verification.

E. Daily logs and shift report of Work during tunnel construction.

F. Blasting Specialist:

DRAFT

31 71 00 TUNNEL CONSTRUCTION

1. If using drilling and blasting methods, the Contractor shall retain a Professional Engineer who will be responsible for developing the complete designs, drawings, directing the Work, monitoring the performance of the Work, and making adjustments to the blast design as required during construction. Submit forreview the name, qualifications, and reference of the Blasting Specialist.
2. The Blasting Specialist shall be experience in the design of (if required):
    a. Blasting services near operational water retaining structures including dams and hydrotechnical equipment.
    b. “Lake Tap” blasting method.

G. Drilling and Blasting, submit the following:

1. Blasting plans in accordance with the applicable federal, State, and local codes and regulations, indicating the following:
    a. Name, qualification, and references of the proposed Blasting Specialist, blaster-in-charge, and personnel responsible for blast design.
    b. Method and mitigation to control noise, air blast, ground vibration, fly rock, and dust control.
    c. Explosives transportation plan including handling, storage, and security.
    d. Procedures for conducting blasting operations including Safety plan and fire prevention plan.
2. Controls for blasting near structures including design peak vibration limits and frequency and the proposed blast monitoring program.
3. Submit for review any proposed modifications to the drilling and blasting plan.
4. Blasting Report - Submit a blasting report detailing the blast outcome within 48 hours of each blast. Include in the report the following:
    a. Drill logs and notes regarding conditions encountered in the drill holes, including:
        1) Description of encountered subsurface conditions such as open joints, soft or fractured rock zones, groundwater conditions, hole alignment, probing ahead of excavation face and drilling problems.
    b. Any variations from the submitted Blasting Plan, including any changes to explosives type or amount, loading dimensions, hole spacing, and initiation sequence and delay times.
    c. Blast monitoring documentation in accordance with ISEE.
    d. A comment section that includes the Contractor's evaluation of the blast performance, any unusual conditions or situations during the blast, and any misfires.
    e. Details of any other information.

DRAFT

31 71 00 TUNNEL CONSTRUCTION

1.6 QUALITY

A. Work shall be in conformance with the Drawings, submittals, and other project documents.

B. Temporary Bracing:

1. Design tunnel support, initial support, and temporary bracing system.
2. Provide temporary ground support structures and rock surface protection as required.

1.7 SITE CONDITIONS

A. Provide lighting of the worksite.

B. Employ measures to mitigate dust, noise/ vibration, water, and other pollution created by the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and perform tunnel excavation according to the Drawings to achieve the excavation shapes, roughness and dimensions as indicated on the drawings.

B. If drilling and blasting method is selected, design blasting to achieve the project requirements, obtain necessary permits.

2.2 EQUIPMENT

A. Use equipment that comply with the California Code of Regulations Orders and OSHA CFR.

B. Seismographs: shall comply with the ISEE Blaster’s Handbook.

DRAFT

31 71 00 TUNNEL CONSTRUCTION

PART 3 - EXECUTION

3.1 GENERAL

A. Take precautions to not damage structure or equipment near the excavation. This includes direct damage (fly rock) or indirect (vibrations).

B. Follow the safe work procedures detailed within the Work Plan.

C. Provide, operate, and maintain ventilation system as required.

D. Provide dust suppression methods and system to control dust and operate such methods and system from tunnel excavation work.

3.2 EXCAVATION METHODS

A. Tunnel excavation method, techniques and procedure is at the discretion of the Contractor. The selected method shall be submitted for review, no work shall be performed until the Engineer has reviewed and approved the proposed method, materials, and equipment.

B. The excavation method, techniques and procedure shall be capable of removing all material to the minimum line of excavation and surface roughness.

C. Probe drilling for determining rock and upstream hydrostatic conditions shall be accomplished with equipment capable of pre-grouting above the maximum upstream hydrostatic pressure condition.

D. Probe drilling for determining the rock mass conditions shall be accomplished with rotary core drilling rigs, as indicated by the Engineer.

3.3 DRILLING AND BLASTING

A. Follow a blast design, prepared by the Blasting Specialist and the monitoring plan.

B. Drill blasting holes as required to complete desired construction results. Review the blasting performance and adjust the blast design to achieve the requirements as per the Drawings.

C. Blasting to be performed using the perimeter-controlled blasting techniques including presplitting and trim (cushion) blasting adjacent to the minimum line of excavation.

DRAFT

D. Take necessary precautions to protect the structures, buildings and equipment not intended to be removed with the drilling and blasting from blast induced damage, including protection from fly rock, protection from vibrations due to blasting or air blasts.

E. The Contractor is responsible to coordinate blasting and notify the Owner, and Other Contractor's and personnel working on site or near site.

F. Design the blast to comply with safe peak particle velocity (PPV) for all structures within and the vicinity of the blast area and other locations.

G. Remove loose material and scale to sound unshattered base surface and to the lines and grades as per the Drawings or beyond as required to provide a stable surface.

H. Limit damage to adjacent structures by preventing flyrock and limiting blast vibration, vibration frequency and overpressure as required.

3.4 MECHANICAL EXCAVATION

A. Underground excavation by mechanical methods may include hydraulic impact hammer, drilling and expansion methods and saw cutting.

B. The mechanical excavation methods shall be compatible with the requirement and scheduling of the Work and nature of the material to be removed.

3.5 ROCK SUPPORT

A. Provide any rock support, including rock bolts, rock dowels immediately after material has been removed from the excavation.

B. In accordance with Section 03 20 00 – Concrete Reinforcing and Section 03 60 00 – Grouting.

3.6 TUNNEL LINING

A. Cast-In-Place Concrete Lining:

1. In accordance with Section 03 30 00 – Cast-In-Place Concrete.
2. Provide provision to purge air from the formwork and falsework from the tunnel crown or interior of the formwork.

DRAFT

31 71 00 TUNNEL CONSTRUCTION

B. Steel Liner:

1. Fabricate and install steel structures within tunnel in accordance with Section 05 12 00 – Structural Steel.

3.7 DISPOSAL OF EXCAVATION MATERIAL

A. Waste material created by tunnel construction Work shall be disposed at the disposal sites in accordance with Section 02 41 00 – Demolition and Facility removal.

3.8 TOLERANCES

A. Variation on drilling from the design grade and alignment:

1. Tunnel Excavation: grade ± 3 inch.
2. Tunnel Excavation: alignment ± 8 inch.

B. Tunnel linings: in accordance with Section 03 30 00 – Cast-in-Place Concrete or Section 05 12 00 – Structural Steel as applicable.

3.9 PROTECTION AND CLEANUP

A. At completion and during progress of the Work maintain premises in a neat and orderly manner. Dispose of rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage by Work of other sections or other contractors.

C. Protect the Work of other sections from damage resulting from the work of this section.

END OF SECTION 31 71 00

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31 80 00 – CARE OF WATER

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31 80 00 – CARE OF WATER

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D	Cyrus Niamir	Benoit Otis	Craig Nistor	111320	-	-

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DRAFT

31 80 00 – CARE OF WATER

TABLE OF CONTENTS

PAGES

DRAFT

31 80 00 – CARE OF WATER

PART 1 - GENERAL

1.1 SUMMARY

A. This specification applies to the works related to Care of Water including but not limited to control of water for temporary work below the normal river water level with the purpose of creating a dry work area for construction activities. This includes construction and operation of:

1. River diversions, work platforms and cofferdams.

B. Site dewatering and water control include water collection, diversion, containment and pumping activities are described in Section 31 23 00 – Excavation and Fill Placement and 31 25 00 – Erosion and Sedimentation Controls.

1.2 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal.

B. Section 31 05 00 – Materials for Earthwork.

C. Section 31 23 00 – Excavation and Fill Placement.

D. Section 31 25 00 – Erosion and Sedimentation Controls.

E. Section 31 60 00 – Foundation Preparation.

F. Section 31 71 00 – Tunnel Construction.

G. Section 32 50 00 – Roads and Bridges.

1.3 REFERENCE STANDARDS – NOT USED

1.4 DEFINITIONS

A. Cofferdam –Earthfill structure used to provide a dewatered area for construction activities. The Cofferdam may be a historic pre-existing structure.

B. Work Platform – Platform built in Klamath River or portion of embankment left-in-place during removal which is used to provide dry access to or a dewatered construction area.

DRAFT

31 80 00 – CARE OF WATER

C. Historic Diversion Dam – Historic earthfill structure located immediately upstream of the Copco No. 2 intake. There are no technical requirements for this structure.

D. Diversion Period – Period during which the Klamath River is diverted by work platforms and cofferdams.

E. Drawdown – Period during which the facility reservoirs are drawdown to provide access to appurtenant hydraulic structures.

F. Final River Channel – Final excavation lines and grades of Klamath River in areas of embankment, dam, and cofferdam removal.

1.5 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

B. Work Plan and Schedule: Details of in water works methodology and timeline for review and approval by the Engineer prior to commencement of phased embankment, dam, cofferdam, or work platform removal and/or construction.

C. Flow Monitoring Plan: Methods for providing real-time reservoir inflow data for review and approval by the Engineer.

D. Reservoir Manipulation Plan: Agreement/planning document describing the use of the upstream project (Keno) and manipulation of reservoir inflows for review and approval by the Engineer.

E. Maintenance and Surveillance Plan: Develop a maintenance and surveillance plan for all work platforms and cofferdams for review and approval by the Engineer.

1.6 QUALITY ASSURANCE

A. Work shall be performed in conformance with the Drawings, submittals, and other project documents.

DRAFT

31 80 00 – CARE OF WATER

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment shall be the responsibility of the Contractor.

2.2 MATERIALS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall not commence removal or breach of the work platforms or cofferdams until the final river channel construction, including placement of Erosion Protection (E7) material is complete.

B. Work initiating a breach shall only be commenced with prior written confirmation from the Engineer.

C. All work located within the Klamath River and below the applicable flood water level shall meet the applicable Federal, State and local codes and regulations.

3.2 COFFERDAM REQUIREMENTS

A. Cofferdams include the J.C. Boyle historic cofferdam, Copco 1 historic cofferdam, Iron Gate historic cofferdam and extended cofferdam, and the Iron Gate Downstream Toe Berm.

B. Cofferdam locations and integrity may vary from those assumed on the Drawings and design documents. All cofferdams utilized for river diversion during construction shall be inspected and approved by the Engineer following drawdown and prior to use.

C. The Contractor shall determine specific cofferdam requirements for each of the above listed locations and if additional construction is necessary for the cofferdams to meet these requirements.

D. If bypass pumping is necessary, all pumps shall have sufficient capacity to control the upstream water level at peak design flow of the cofferdam.

DRAFT

31 80 00 – CARE OF WATER

1. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

3.3 WORK PLATFORM REQUIREMENTS

A. Work Platforms include all structures labelled as work platforms and the Iron Gate Spillway Access Tracks.

B. Work platform locations and alignments may be varied by the Contractor to suit the Contractor's construction planning, means and methods, provided the following requirements are strictly satisfied:

1. Work platform top elevations remain unchanged.
2. Work platform slopes and minimum crest widths remain unchanged.
3. All changes are approved by the Engineer prior to construction.

C. Work platforms shall provide access for the design construction vehicle load and resist piping and internal erosion. Work platforms exposed to high velocity flowing water or susceptible to erosion shall be stabilized to reduce the potential for erosion.

3.4 RIVER DIVERSION

A. The Contractor shall develop a debris management plan to ensure the river diversions function as designed.

B. River diversions to be monitored during drawdown, operations and following storm events.

C. Debris management to be implemented as required.

3.5 SEEPAGE AND CARE OF WATER

A. Seepage shall be controlled or diverted for the full diversion period as required so that erosion of cofferdams or work platforms does not take place.

B. The Contractor is responsible for the extent of dewatering required to perform the construction work in the dry.

DRAFT

C. Sumps and dewatering pumps may be provided to keep excavations and fill placement occurring as per Section 31 23 00 – Excavation and Fill Placement and foundations per Section 31 60 00 – Foundation Preparation.

D. All excavations and placement of fills occurring in-River requires the development of an in-River Placement Plan. Methods are the responsibility of the Contractor, to be approved by the Engineer.

3.6 HYDRAULIC CONDITIONS AND PLANNING

A. The design water levels and associated flows are presented on the Hydrotechnical Drawings.

B. The Cofferdam and Work Platform crest elevations, including freeboard, are minimum requirements.

C. The Project Area is located downstream of the Keno Dam/Link River Dam and planning document shall be developed to manipulate inflows to the project Area during the drawdown year.

D. All drawdown and construction scheduling requirements are to adhere to the drawdown staging and embankment removal staging as shown on the Drawings and in the Design Report.

3.7 MAINTENANCE AND SURVEILLANCE

A. The Contractor shall prepare and implement a Maintenance and Surveillance Plan for each cofferdam or work platform for the detection, prevention, and correction of issues in order to ensure the safety of all personnel and the construction area.

B. Notification and communication to the Engineer is required in all emergency situations related to Care of Water.

3.8 COFFERDAM CONTROLLED BREACH

A. The partial removal of material from the cofferdams or work platforms will limit the cofferdam ability to resist high water levels and other design loads.

B. All controlled cofferdam breach shall be monitored, surveyed, and maintained in accordance with the Drawings.

DRAFT

31 80 00 – CARE OF WATER

3.9 REMOVAL OF COFFERDAMS AND WORK PLATFORMS

A. Removal of a Cofferdam or Work Platform shall be to the lines and grades as shown on the Drawings.

B. Removal of a Cofferdam or Work Platform can only commence following inspection and approval of the structures and construction located within the associated work areas by the Engineer.

C. The excavations required for removal shall comply with Section 31 23 00 – Excavation and Fill placement.

END OF SECTION 31 80 00

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32 50 00 ROAD, BRIDGES AND CULVERTS

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32 50 00 ROAD, BRIDGES AND CULVERTS

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32 50 00 ROAD, BRIDGES AND CULVERTS

TABLE OF CONTENTS

PAGES

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers the general requirements applicable to the roads, bridges, and culverts construction of the Klamath River Renewal Project and as shown on the Project Drawings.

B. Nothing in the specifications voids the Contractor's public safety responsibilities.

C. Reference information for the Work identified in the Contract is made available for the Contractor to use for its own purpose. The Contractor shall be solely responsible for any interpretation placed thereon and for all impacts resulting from such interpretation.

1.2 DEFINITION

A. Road Improvements – Repairs or modifications to the existing public Project road network which are required to facilitate Project activities prior to and during the Project duration. This also includes repairs or modifications following Project completion to address any degradation or damage to Project Roads due to Project Activities. All repairs and modifications made to the public roads shall be reviewed and approved in agreement with the Memorandum of Understanding (MOU), with Siskiyou Co. in California and Klamath County in Oregon, and will be in kind with current conditions.

B. Temporary Roads and Bridges – All new roads and bridges required for Project activities which will be removed, following completion of the Project. The temporary Road and Bridge sites include:

1. Temporary Construction Access Bridge at Daggett Road Bridge
2. Dry Creek Bridge at Copco Road Temporary Support
3. Fall Creek Bridge at Copco Road Temporary Support
4. Temporary intersection improvements
5. Temporary shoofly detour roads required for construction of new structures

C. Permanent Roads and Culverts – All new roads and culverts required as permanent infrastructure which will remain in place following completion of the Project. The permanent crossings include:

1. Scotch Creek Culvert
2. Camp Creek Culvert

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

3. Fall Creek Culvert at Daggett Road

1.3 RELATED SECTIONS

A. Section 02 41 00 – Demolition and Facility Removal

B. Section 03 30 00 – Cast-in-Place Concrete

C. Section 03 10 00 – Concrete Forming and Accessories

D. Section 03 20 00 – Concrete Reinforcement

E. Section 03 60 00 – Grouting

F. Section 05 12 00 – Structural Steel

G. Section 31 05 00 – Materials for Earthwork

H. Section 31 10 00 – Clearing, Grubbing and Stripping

I. Section 31 25 00 – Erosion and Sedimentation Controls

J. Section 31 60 00 – Foundation Preparation

1.4 REFERENCE STANDARDS

A. The work outlined in the following sections shall be completed in accordance with the relevant construction practices and specifications.

B. California Department of Transportation (CalTrans):

1. Standard Specifications, 2018.
2. Manual of Traffic Controls (2014, Revision 4, effective March 20, 2019).
3. Maintenance Manual (2014, Revision 16, effective August 23, 2017).

C. American Association of State Highway and Transportation Officials (AASHTO):

1. LRFD Bridge Design Specifications (8th Edition, 2017).
2. LRFD Bridge Construction Specifications (4th Edition, 2017).

D. Oregon Department of Transport:

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

1. Standard Specifications (2018).

E. Federal Highway Administration (FHWA):

1. Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-14.
2. Gravel Roads Construction and Maintenance Guide.

1.5 GENERAL REQUIREMENTS

A. The Contractor shall give all requisite notices in connection with the Work to the proper authorities and shall procure at the Contractor's expense all permits, licences, etc., of every description necessary for the construction and completion of the Work. The Contractor shall deliver or make available all original certificates to the Project Company for all or any part of the Work for which such certificates/permits/authorizations may be required in connection with performing the Work. Jurisdictional agencies include:

1. Siskiyou County.
2. Klamath County.
3. Oregon Department of Transport.
4. Regional Water Quality Control Board (RWQCB).
5. California Department Fish and Wildlife.
6. U.S. Army Corps of Engineers.
7. Oregon Department of Fish and Wildlife.

B. Construction in and around existing waterways shall comply with the relevant rules and regulations. The Contractor shall provide a work plan for any in-water work, to be reviewed and approved by the Engineer and governing agencies.

C. Implement Erosion Control Plan and storm water management program as specified in the approved Storm Water Pollution Prevention Plan (SWPPP) as per Section 31 25 00 - Erosion and Sedimentation Control,).

D. Protect items to remain in place from damage (e.g. existing bridge structures, culverts, private driveways, fencing etc.). In the event of damage to items indicated to remain in place, immediately notify the Owner.

E. Obtain encroachment permit and approval from Siskiyou County for the Traffic management plan prior to any construction within the Siskiyou County road right-of-way.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

F. The Contractor shall stay within the work limits shown on the Project Drawings unless approved by the Owner.

G. Following Project completion, all temporary structures shall be removed unless otherwise noted or approved by Siskiyou County.

H. Following Project completion, all Project sites shall be restored to original site conditions.

1.6 CO-ORDINATION WITH RESTORATION CONTRACTOR

A. The Contractor shall construct the roughened channels at the Camp Creek Culvert at Copco Road, Scotch Creek Culvert at Copco Road, and the Fall Creek Culvert at Daggett Road as shown on the Project Drawings. The downstream and upstream tie-in point marks the limit of work between construction zone for the road/bridge/culvert site (which includes the roughened channel) and the limits of the Project Restoration efforts. The Contractor shall co-ordinate the tie-in points, as shown on the Project Drawings.

B. Special consideration shall be made to avoid potential downstream ponding or drainage issues resulting from new culvert invert elevations. This will involve removal of the existing delta deposits downstream of new roughened channels. Removal of the deposits is required prior to structure installation to avoid any adverse impact from backwater and ponding.

C. Seed mix design for riparian zones shown on the Final Erosion and Sediment Control Drawings shall be as per the Restoration Contractor's proposed mix design.

1.7 SUBMITTALS

Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.

A. Photograph and Video documentation of pre-construction and post-construction conditions of all access routes and road and culvert improvements as per contract requirements.

B. Contractor to complete a pre-construction condition assessment at each site which shall include:

32 50 00 ROAD, BRIDGES AND CULVERTS

1. Photo/video documentation of general conditions of any existing structures, on public or private roads, that may be impacted during construction as a baseline for post-Project review with Siskiyou County MOU and private entities (i.e. guardrails, connections, approaches, barriers, abutments, erosion protection/riprap, road surfaces, deck surface, utilities, vegetation, signage).
2. Documentation of any damage/deficiencies observed at existing structures.

C. Clear water diversion system details necessary for new culvert construction at Camp Creek, Scotch Creek and Fall Creek at Daggett Road.

D. Shop Drawings for all prefabricated structures for review and approval.

E. Quality Control (QC) Plans for review and approval as specified in the relevant Sections (Cast-In Place Concrete, Foundation Preparation, Steel Reinforcement, Excavation/Fill Placement).

F. Quality Control Plans for Roads, Bridges and Culverts components shall meet the requirements of;

1. California Building Code 2019, Chapter 17 Special Inspections and Tests.
2. Federal Highways Agency, F14, Section 105 – Control of Materials, Section 106 – Acceptance of Work.
3. International Building Code (for sites in Oregon), as required.

G. Erection and dismantling procedures and plans for falsework, assembly sequencing, crane operations and formwork details in accordance with Section 02 41 00 – Demolition and Facility Removal.

H. QC survey results for site layout (i.e. grade staking (per Section 152 of FHWA, Standard Specifications FP-14), key structural elevations, profiles and geometry prior to construction).

I. Post construction QC survey results for final grades and as-built dimensions for new structures).

J. Lane Closure and Full Road Closure Plans and Schedules, in accordance with the Siskiyou County MOU and in compliance with the Oregon Department of Transportation.

K. Any changes to the Traffic Management Plans shown on the Project Drawings.

L. Construction material data sheets (material properties) as per QC plan.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

M. Materials Certificates of Compliance shall be submitted for:

1. Asphalt materials.
2. Class II Aggregate Base (E11).
3. Traffic Stripe, Pavement Marking, and Retroreflective Markers.
4. Storm Drain Boxes and Pipes.

N. Engineering data and calculations as may be necessary and other engineering services required to facilitate construction.

O. Contractor to provide as-built drawings for all permanent construction for submittal to the Owner, including.

1. Camp Creek Culvert
2. Scotch Creek Culvert
3. Fall Creek at Daggett Road Arch Culvert

1.8 QUALITY

A. Quality control for construction of the Temporary Roads and Bridges to comply with the Project Drawings and the related sections of this Specification.

B. Quality control for construction of the Permanent Roads and Culverts to comply with the Project Drawings and the related sections of this Specification and applicable Federal or State Department of Transportation Standard Specifications or as specified.

C. The Engineer is responsible for quality assurance, which refers to review and approval of third-party quality control inspection and test plans and the review/approval of quality control data, as required, for each site. Quality assurance may also involve direct visual inspection and/or observation of key construction activities.

D. The Contractor shall immediately notify the Engineer and any jurisdictional agencies or owners which may be permanently/temporarily impacted by a non-conformance during quality control testing for review prior to continuing work.

E. Quality assurance related to the manufacture and installation of prefabricated structures shall be provided by the suppliers and the Contractor.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

PART 2 - PRODUCTS

1.9 GENERAL

A. The Contractor shall provide all materials and products required for the completion of the work as shown on the Project Drawings and in compliance with the applicable related sections noted in Section 1.3 and as noted on the Project Drawings. Any alternative equivalent materials/products proposed by the Contractor require review and approval from the Engineer before use. Review and approval of alternatives by the Engineer at Contractor's expense.

1.10 FOUNDATION PREPARATION FOR ROADS, BRIDGES AND CULVERTS

A. Foundation preparation shall comply with Section 31 60 00 – Foundation Preparation

B. After completing the stabilizing and compacting operations, ensure that the subgrade is firm and substantially unyielding to the extent that it will support construction equipment and will have the bearing value required by the Plans. Remove all soft and yielding material, and any other portions of the subgrade which will not compact readily, and replace it with suitable material so that the whole subgrade is brought to line and grade, with proper allowance for subsequent compaction.

C. At Daggett Road Temporary Construction Access Bridge, the rock fill foundation must be clean of loose rock and debris and contoured to provide shear keys at the toe and mid points along the foundation section. The toe of the rockfill embankment shall be keyed into the channel bedrock, as shown on the Project Drawings. The Engineer shall inspect and confirm adequate foundation conditions have been met prior to progressing with rockfill material placement.

1.11 FILL MATERIALS AND MATERIALS FOR EARTHWORKS

D. The materials listed on the Project Drawings comply with specifications listed in Section 31 05 00 - Fill Materials and Materials for Earthworks. Material that does not meet the specifications needs to be approved and exempted by the Engineer.

E. All Fill Materials and Materials for Earthworks for both temporary and permanent applications shall be placed and compacted as per the Project Drawings.

F. The following fill materials for Road, Bridge and Culvert components shall undergo a test lift to establish compaction and placement requirements for QA/QC during construction, per ASTM D698;

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

1. E3
2. E5,
3. E7a

G. All temporary construction access roads open to public or non Project Company traffic shall be surfaced with E11 material.

H. Construction of the rock fill embankment at the Temporary Construction Access Bridge at Daggett Road shall comply with the following:

1. Rock fill embankment subgrade shall be free of loose boulders and debris. Contractor shall remove silt/sediment and loose material as much as practical prior to constructing rock fill embankment to ensure a clean interface between subgrade and rock fill.
2. Excavate rock fill embankment toe shear key as per the Project Drawings.
3. Select rocks so that angular interlocking shapes provide a stable structure for the required section.
4. Rocks shall be angular.
5. Erosion Protection material, and large roughness elements (individual boulders) shall be dense, sound, and free from cracks, seams, and other defects.
6. Erosion Protection material will be sourced from a SAMRA approved rock quarry or when sourced on-site will need to be tested to confirm compliance with Erosion Protection material specifications.
7. Do not place Erosion Protection material by dumping. Erosion Protection material to be placed using an excavator bucket or equivalent. Erosion Protection material to be placed to be well interlocked, rolled into place, and tamped down.
8. Placement of Erosion Protection Material (E7a, E7b, E7c) at the Temporary Construction Access Bridge at Daggett Road shall comply with Specification 31 05 00 – Materials for Earthwork.

I. Placement of foundation material at Dry Creek and Fall Creek temporary strengthening structures comprises of E3 or E7a and shall conform to the following requirements:

1. Material shall be placed and compacted as noted in the Project Drawings.
2. Material shall be removed from the river channel following removal of the temporary bridge structures. This includes removal of any material placed within the steel confinement structure for the foundation at Fall Creek and any material encased within the geotextile for the foundation at Dry Creek.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

J. Backfill material for permanent road embankments shall be as per the Project drawings in addition to meeting the following placement requirements.

1. Comply with Specification 31 05 00 – Materials for Earthworks and 31 23 00 – Excavation Fill Placement.

2. Minimum compaction of materials shall not be lower than 95% of the bulk relative density, to be achieved by the specified compaction methods or, if the specified compaction is not applicable, with the following observed method specification.

3. Minimum of 4 passes with a 20,000 lb vibratory drum roller and proof rolled with a loaded dump truck having a single axel loaded with at least 10 ton with a tire ground pressure of 90 psi for visible deflection, as measured every other lift.

4. Material placed in permanent road embankments shall be free of any rocks larger than 4 inch and organic debris and shall have a plasticity index of less than 12. Material shall be moisture conditioned, as approved by the Engineer during placement.

5. Fill material placed in permanent road embankments shall have a fines content of less than 35% passing the No.200 sieve.

6. Material shall be placed in maximum 1 foot lifts and moisture conditioned to optimum levels, as approved by the Engineer during placement.

K. Backfill material for temporary road embankments shall be as per the Project drawings in addition to meeting the following placement requirements.

1. Comply with Specification 31 05 00 – Materials for Earthworks and 31 23 00 – Excavation Fill Placement.

2. Minimum compaction of materials in temporary road embankments for the Road, Bridge and Culvert sites shall not be lower than 90% bulk relative density, to be achieved by the specified compaction methods or, if the specified compaction is not applicable, through the following observed method specification.

   a. Minimum of 4 passes with a 20,000 lb vibratory roller or proof rolled with a loaded truck having a single axel loaded with at least 10 ton, producing a tire bearing pressure of 90 psi, observed for visible deflection, as measured every other lift.

L. Backfill material within 3 ft. of new culvert structures shall be placed and compacted per supplier specifications.

M. Roughened Channel Installation.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

1. The Engineer or designated representative shall observe construction of the roughened channel.
2. Contractor shall begin construction of the roughened channel from the downstream end, constructing the downstream apron prior to constructing the roughened channel. The sequence of work shall include;
   i. downstream boulder buttress construction.
   ii. engineered streambed material and roughness element construction.
   iii. upstream boulder buttress construction.
3. Boulder buttresses will be spaced as per project drawings.
4. Intermediate roughness elements (i.e. random boulders and boulder clusters, 2 ft -3.5 ft in size, located between buttresses) shall be placed to create a complex flow field, which will require field fitting roughness elements to create a network of bifurcating and confluencing low flow paths.
5. Roughness elements (i.e. boulders and boulder clusters 2 ft - 3.5 ft in size) shall be placed, as directed by the Project Engineer (or designated representative) to project upwards (1 ft - 1.5 ft min) into the field of flow and remain in position following compaction of the surrounding material, per Project Drawings.
6. Place engineered streambed material between roughness elements, vibratory compaction (vibratory plate) is required following every 1 ft lift of E12 material between protruding roughness elements.
7. Once firmly compacted, final surface shall undergo high pressure hose treatment to direct fines into the interstitial spaces to improve compaction and achieve increased impermeability.
8. Final channel grade will have an average longitudinal slope between boulder buttresses as shown on the plans. Roughened channel surface will have localized high points and low points due to roughness elements. Roughness elements will not be included in the calculation of the roughened channel slope.
9. The Engineer or designated representative shall direct field survey of the roughened channel slope and confirm slopes match Project Drawings.
10. The Engineer or designated representative shall direct and approve compaction testing for the roughened channel.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

11. Compaction testing will require a percolation test every 30 ft along the roughened channel. Sandbags may be used to isolate a zone for testing (2 ft^2 area minimum, embedded 6" minimum testing zone). If percolation rate exceeds greater than 120 min/in (over a 4-hour minimum measurement period), further compaction and/or filling of interstitial spaces with high pressure fines/water is required. In the event of a failed percolation test, the testing zone may be reduced to 15 ft length and re-tested prior to vibratory/high pressure treatment.

1.12 CAST-IN-PLACE CONCRETE

A. Temporary cast-in-place concrete to comply with Section 03 30 00 – Cast-in-Place Concrete, and as noted on the plans.

B. Permanent cast-in-place concrete to comply with Section 8 of the AASHTO LRFD Bridge Construction Specifications (4th Edition).

C. The Engineer or designated representative shall confirm that cast-in-place concrete components are placed as per the Project Drawings to within ¾ in., per the Quality Control Plan.

1.13 CONCRETE REINFORCEMENT

A. Temporary concrete reinforcement shall comply with Section 03 20 00 - Concrete Reinforcing.

B. Permanent concrete reinforcement shall comply with Section 9 of the AASHTO LRFD Bridge Construction Specifications (4th Edition).

C. The Engineer or designated representative shall confirm bar placement prior to concrete placement at Daggett Temporary Construction Access Bridge abutments prior to and following launch for each phase of concrete work.

D. The Engineer or designated representative shall confirm bar placement prior to concrete placement at Fall Creek at Daggett Road Arch Culvert strip footings (if footings are cast- in-place).

1.14 PRECAST CONCRETE COMPONENTS

A. For all Permanent Roads and Culverts, precast concrete components shall comply with AASHTO and as per supplier specifications or as approved by the Engineer.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

B. Interlocking concrete blocks shall be 4,000 psi concrete, LockBlock, UltraBlock, or equal.

C. The Engineer or designated representative shall confirm that pre-cast components are placed as per the Project Drawings to within ¾ in., per the Quality Control Plan.

1.15 ASPHALT

A. Permanent asphalt construction to comply with Section 400 of the Standard Specifications for Construction of Roads and Bridges on Federal Highways Projects (FP-14).

B. Shall be performed by a licensed paving contractor. Asphalt concrete shall be Type A, ½ inch maximum size aggregate, medium grading. Asphalt binder shall be PG 64-16. Asphalt shall conform to Federal Highways Specifications.

C. Asphalt pavement shall be placed and compacted as per the Federal Highways Agency, Standard Construction Specifications, Section 403 for asphalt concrete.

D. At connections to existing pavements and previously placed asphalt lifts, the contractor shall ensure the transverse joints are vertical. Transverse joints shall be formed by cutting back the previous lift to expose the full-depth of pavement. Roughen the joint surface and apply an asphalt tack coat to the joint edge.

1.16 EROSION PROTECTION FOR BRIDGE AND CULVERT STRUCTURES

A. Placement of Erosion Protection material shall comply with Section 31 05 00 - Materials for Earthworks in addition to the following requirements.

B. Erosion Protection Material (E7a, E7b, E7c) shall be installed as per the Project Drawings.

C. Do not place Erosion Protection material by dumping. Erosion Protection material to be placed using an excavator bucket or equivalent. Erosion Protection material to be placed to be well interlocked, rolled into place, and tamped down.

D. Erosion Protection Material will be sourced from either approved on-site sources or from a SMARA approved quarry.

E. In addition to the material gradations specified in Section 31 05 00 – Materials for Earthworks, Erosion Protection material shall meet the following requirements:

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

Table 1 – Erosion Protection Material (E7a, E7b, E7c) Material Property Requirements

Property	California Test Method[1]	Required Value
Apparent Specific Gravity	206	2.35 min.
Absorption	206	4.2% max.
Durability Index	206	52 min

NOTES:

1. CALIFORNA TEST METHOD 206, (METHOD OF TEST FOR SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE, 2011).

1.17 PREFABRICATED CROSSING STRUCTURES

A. Temporary Prefabricated Bridge Structures, by bridge supplier shall be designed for single lane HL-93 Design Vehicle only. Design shall include shop drawings and calculation package, both stamped by a California registered civil or structural engineer. Bridge suppliers shall be responsible for providing final bridge bearing reactions for applicable design load combinations applicable during construction and service. This information shall be reviewed for acceptance by the Engineer to finalize foundation design.

B. Permanent Prefabricated Culvert Structure, by culvert supplier shall be designed for HL-93 Design Vehicle and P-13 Permit loads (as per AASHTO) by appropriate suppliers. Design shall include shop drawings and calculation package, both stamped by a California registered civil or structural professional engineer. Culvert supplier shall be responsible for providing final foundation bearing pressures for anticipated design loads. This information shall be reviewed for acceptance by the Engineer to finalize foundation design.

C. Construct crossing structures, guard rails, signage, and road markings according to the Project Drawings and as indicated on supplier shop drawings, which may contain additional technical specifications.

D. The Contractor shall refer to the prefabricated bridge and culvert supplier specifications for installation of the prefabricated crossing structures.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

PART 3 - EXECUTION

1.18 GENERAL

A. The Contractor shall complete the work at each site as shown on the Project Drawings.

B. The Contractor shall correct promptly any unacceptable work to the satisfaction of the Engineer.

1.19 EQUIPMENT

A. The Contractor shall ensure that all construction access vehicles and haul vehicles adjust loads according to the posted load limits of the Project bridges. Construction of the Temporary Construction Access Bridge at Daggett Road shall require reduced loads when crossing the existing Daggett Road Bridge.

B. The Contractor shall ensure that the maximum allowable haul loads do not exceed standard AASHTO highway vehicle loading (i.e. HL-93 Design Truck).

1.20 WATER POLLUTION CONTROL AND DRAINAGE FACILITIES

A. For both Temporary and Permanent Roads, Bridges, and Culverts, management of storm water and surface water to comply with the Project BMPs, as per Section 31 35 00 - Erosion and Sedimentation Control. Contractor shall install culverts and/or drainage components as shown on the Project Drawings. If site conditions vary from the Project Drawings, the Contractor shall contact the Engineer to approve a modified drainage plan, as needed.

B. Walls shall be drained as shown on the Project Drawings. The drainage collection pipe, drain pipe, shall be a 6 in. perforated or slotted PVC/HDPE (Schedule 40) pipe or as approved by the Engineer. The drain pipe should be located at the back of the drain rock behind the wall, and as close to the bottom of the wall as allowed while still maintaining a positive gradient for drainage to daylight.

C. As an alternative to drain rock, walls may be vertically drained by a suitable prefabricated retaining wall drainage product for approval by the Engineer. The drainage collection pipe shall be installed per supplier recommendations.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

1.21 SHOP DRAWINGS

A. The Contractor shall verify shop drawings for any Project materials/products which are shipped to site and used during construction.

1.22 TRAFFIC MANAGEMENT

A. The Contractor shall cause as little inconvenience as possible to the travelling public during the Contractor's operations and shall erect and maintain proper and adequate barricades, traffic signs, lights and other traffic control devices as may be considered necessary, in the opinion of the Engineer, for the safety of both workers and public traffic. All road barriers, traffic signs, lights and other control devices shall be provided at the Contractor's expense, and shall be erected in accordance with, and otherwise conform to the standards as set out in the County MOU's.

B. The Contractor shall be responsible for obtaining the relevant haul permits and overload permits for any overweight or oversize vehicles for public roads. The Contractor shall provide adequate traffic control during transport of overweight or oversize vehicles along Project Roads to ensure the safety of public traffic. Overweight or Oversize vehicles shall not be permitted to cross any bridge structures identified with insufficient load carrying capacity without prior review and approval, as per the County MOU's and any required permits.

C. The Contractor shall provide and install temporary support structures at Dry Creek at Copco Road and Fall Creek at Copco Road, which shall service public traffic, as shown on the Project Drawings.

D. The Contractor shall submit a traffic control management plan (by a licenced engineer) for each temporary and permanent crossing site on public roads for review and approval by the jurisdictional agency, as per the County MOU's, prior to construction.

E. The Contractor shall ensure no vehicles other than Project Company vehicles (with maximum axle loads of HL-93 Design Vehicle) shall be permitted to use the following temporary construction access bridges.

1. Temporary Construction Access Bridge at Daggett Road Bridge.

1.23 ROAD AND CULVERT REMOVAL

A. Comply with the requirements of Section 02 41 00 – Demolition and Facility Removal.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

B. Demolished materials to be wasted or disposed of off-site and on-site shall be in accordance with state and federal regulations.

1.24 ROAD AND CULVERT IMPROVEMENTS/REPAIRS

A. Remove all waste materials and spoil as per Section 31 10 00 - Clearing, Grubbing and Stripping.

B. Install all traffic controls per the traffic plans submitted by the Contractor and as per the County MOU's. (This section will be co-ordinated with the Project Traffic Control Plan).

C. Road Repairs shall be reviewed and approved by the Engineer and the County in accordance with the MOU between the Contractor and the County.

D. Culvert repairs and replacements will be determined using guidance from the Caltrans Maintenance Manual (Chapter C5, 2014) as well as the pre-construction baseline studies. Existing culverts requiring replacement due to construction related damage will be replaced with equal or greater capacity culverts. Plans will be communicated to Siskiyou and Klamath County. Sequencing of construction shall minimize disruption to local traffic and any effected intersections.

1.25 TEMPORARY ROADS AND BRIDGES

A. Temporary Roads and Bridges to be constructed as shown on the Project Drawings and in compliance with the related clauses of this specification. For any work not described by the referenced clauses of this specification, the Contractor shall comply with CalTrans, Standard Specifications and AASHTO LRFD Bridge Construction Specifications (4th Edition). The Contractor may propose alternative means, methods, and/or products which will require review and approval from the Engineer. Review and approval from the Engineer at Contractor's expense for alternative methods proposed.

B. Following Project completion, roads which featured temporary Project components during Project activities will be restored to their original alignment and condition. Repair any damages from construction usage of roadways. Siskiyou and Klamath County shall review and approve repairs with the Project Company. Temporary bridges and abutments shall be fully removed, and stream channel widths shall be restored to their pre-construction condition.

C. The Contractor shall locate and protect any existing sub-surface, surface, and overhead utilities at each of the Road and Bridge sites to avoid accidental damage during Project activities.

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

D. The Contractor shall protect existing structures as required to avoid accidental impact or damage to the existing structures (e.g. bridge abutments, bridge deck, culverts, services, walls, fences, and private property boundaries).

E. Existing in-water structures shall be protected from potential damage due to construction activities.

F. Existing masonry bridge piers at Daggett Road Bridge shall be inspected prior to construction activities and protected against increased flow velocities to mitigate scour/erosion damage during temporary bridge service, to be determined by the Engineer. Protective measures shall be installed as per the Project Drawings and Project Design Report.

G. Temporary bridge foundations shall be installed as per the Project Drawings.

H. Temporary Bridge approaches shall be constructed as per the Project Drawings.

I. The Contractor shall protect and avoid damaging any existing structures/property/utilities due to Project activities. In the event of accidental damage, the Contractor shall provide a full incident report including photographs and a detailed description to the Engineer for corrective action.

J. The Contractor shall conduct in-situ load tests on the temporary strengthening structures at Dry Creek and Fall Creek following installation. Any post-installation settlement resulting from the load test shall be addressed through installation of shims to increase temporary support height and shall be approved by the Engineer. The temporary strengthening systems shall be visually inspected and checked for relative settlement. periodically during the Project, quarterly and following any substantial events which include:

1. Heavy haul periods.
2. Major rain events (i.e. 50% Probable Annual Flood or greater).
3. Seismic events.
4. Collision or impact or impact events.

1.26 PERMANENT ROADS AND CULVERTS

A. Permanent road and culvert construction to comply with the latest version of AASHTO LRFD Bridge Construction Specifications (4th Edition).

DRAFT

32 50 00 ROAD, BRIDGES AND CULVERTS

B. Permanent culverts shall be constructed as per the Project Drawings and in compliance with the AASHTO LRFD Bridge Construction Specifications (4th Edition). Any variances proposed by the Contractor to the construction standards must be reviewed and approved by the Engineer prior to construction.

C. Following completion of the permanent culverts at Scotch Creek at Copco Road, Camp Creek at Copco Road, and Fall Creek at Daggett Road, the Contractor shall re-route traffic permanently along the new road alignment. The temporary bypass roads shall be decommissioned after the permanent roads are completed as shown on the Project Drawings.

D. The Contractor shall co-ordinate scheduling and timing of construction activities as needed with the Project Restoration team to ensure new crossing installations can function as free-flowing crossings. This will require prior removal of downstream sediment deposits as required to avoid any adverse effects due to ponding or backwater at new crossing locations.

E. Decommissioning of the temporary bypass roads includes:

1. The Contractor shall remove all fill from the stream crossings and slope embankments back to stable angles of 3H:1V or less, and they shall prevent reasonable access by public vehicles and pedestrians to the temporary road sections through installation of permanent berm/embankments/fences/gates or a proposed alternative method of access prevention, to be reviewed and approved by Siskiyou and Klamath County.
2. The Contractor shall implement Project BMPs.

1.27 CLEAN-UP

A. At completion and during progress of the Work maintain premises in a neat and orderly manner. Dispose of rubbish, construction debris and surplus materials at least on a weekly basis.

B. Cover and protect the work from damage by Work of other sections or other contractors.

C. Protect the Work of other sections from damage resulting from the work of this section.

END OF SECTION 32 50 00

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

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DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

REVISION INDEX

Revision No.	Signatures			Date (MMDDYY)	Pages Revised	Remarks
	Prepared by	Reviewed by	Approved by			
A	Larry Buetikofer	Benoit Otis	Craig Nistor	090320	-	-
B	Larry Buetikofer	Benoit Otis	Craig Nistor	100720	-	-
C	Larry Buetikofer	Benoit Otis	Craig Nistor	103020	-	-
D	Larry Buetikofer	Benoit Otis	Craig Nistor	111320	-	-

Approval that this document adheres to the Knight Piésold Quality System: CN

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

TABLE OF CONTENTS

PAGES

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the requirements for dredging, transporting and disposal of dredged materials.as specified in this Section and set out in the Drawings.

1.2 REFERENCE DOCUMENTATION AND STANDARDS

A. U.S. Army Corps of Engineers (USACE):

1. Engineering Manual, EM 1110-2-5025, Dredging and Dredged Material Management.
2. Engineering Manual, EM 1110-2-1003, Hydrographic Surveys.

B. California Stormwater Quality Association:

1. California Stormwater BMP Handbook – Construction.

C. U.S. Bureau of Reclamation (USBR):

1. Pacific Northwest Underwater Inspection Team, Dive Report dated April 2010.
2. Best Practices in Hydrographic Surveying, Living Quick Users Guide for Hydrographic Survey Equipment, Version 1.0, September 2019.

1.3 DEFINITIONS

A. Open-Water Disposal – Disposal of material from a barge within a reservoir area that is defined by a coordinate system and shown on the Drawings. Also defined as an unconfined disposal area in open water within the reservoir.

1.4 SUBMITTALS

A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works.

B. Undertake a pre-dredging hydrographic survey of existing conditions including the existing underwater contours and features in the area upstream from the dam, as shown on the Drawings.

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

1. The survey must be referenced to the horizontal and vertical datum references as shown on the Drawings, and hydrographic positioning requirements shall be in accordance with the USACE EM-1110-2-1003, Hydrographic Surveys.
2. Water depths and contour lines shall be determined. The water depth measurements must be as accurate as possible considering the equipment employed and the site availability of a real-time network connection to GPS. Refer to the USBR Manual and Standards Report: "Best Practices in Hydrographic Surveying, Living Quick Users Guide for Hydrographic Survey Equipment, Version 1.0," dated September 2019.
3. Reservoir level at the time of the survey shall be determined from onsite water level gages, supported with at least six photographs of water level relative to the spillway crest or gate piers, taken from the reservoir.
4. The hydrographic survey report and supporting data files shall include a description of the equipment and procedures employed during the survey, contour and water depth maps, identification of locations for debris removal including depths, and initial estimation of quantities of material to be dredged.

C. Dredging Detailed Schedule, including mobilization, execution, and demobilization. The Main Contractor shall arrange access to Mallard Cove/Keaton Cove boat ramps and parking areas with the following restrictions:

1. Dredging Contractor shall be allowed to utilize one-third (1/3) of the parking area for staging of equipment and materials for the duration of the dredging activities.
2. Dredging Contractor shall be allowed to close the boat ramp(s) for up to 3 days consecutively for mobilization and demobilization.

D. Dredging Contractor's Traffic Plan for transporting dredging and material disposal equipment to the boat ramps.

E. Dredging Contractor's Health and Safety Plan: The plan shall include the placement of lighted buoys to indicate the location of the Open-Water Disposal area, including entrance/exit lanes. Warnings to recreational boaters shall also be placed at the boat ramps and the barge transport lanes.

F. Dredging Execution Plan, incorporating the following:

1. Organization and contact information of the dredging, including licenses and certifications.
2. Work plan for mobilizing and erecting the floating plant and equipment, specifically including the loading, and unloading of the crane to/from the barge.
3. Open-water dredging method and equipment.
4. Names and identification numbers of vessels and principal equipment, along with their annual certification of the crane and wire capacities.
5. Bin and barge capacities.

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

6. Control method for determining the vertical and horizontal location of the dredge and barges during dredging and disposal operations.
7. Dredging dates and locations.
8. Dredged material transport and disposal method statement.
9. Barge displacement tables for each specific barge, to be utilized to verify tons of material removed.
10. Engineering drawings and calculations showing the stability of the proposed barge and crane configurations. The full range of lifting loads and crane reach shall be considered. The drawings shall be stamped by a licensed State of California Professional Engineer.
11. Stormwater Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP): including water placement procedure to reduce turbidity and spill prevention, control, and containment response plan for all dredging and dredge material placement work and Drawings showing the proposed layout of the containment boom at both the dredging site and disposal site.

G. Post-Dredging Hydrographic Survey, including the following:

1. The survey must be referenced to the horizontal and vertical datum references as shown on the Drawings, and hydrographic positioning requirements shall be in accordance with the USACE EM-1110-2-1003, Hydrographic Surveys.
2. The water depth measurements must be accurate to +/-1.0 feet. Water depths and contour lines shall be determined. Reservoir level at the time of the survey shall be determined from onsite water level gages, supported with photographs of water level relative to the spillway crest and gate piers, taken from the reservoir.
3. The hydrographic surveys shall utilize the lengths of the approach channels established in the pre-dredge survey, based on the elevations and geometry shown on the Drawings, as updated after the pre-dredge hydrographic survey. Any identified high spots shall be removed.
4. The hydrographic survey report and supporting data files shall include a description of the equipment and procedures employed during the survey, the contour and water depth maps, etc. for the post-dredging condition.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Dredging equipment shall be the responsibility of the Dredging Contractor. It is anticipated that a barge-mounted mechanical dredge will be employed.

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

B. Equipment used in transporting debris to the disposal site is the responsibility of the Dredging Contractor. For the purposes of this specification, it is anticipated that dredged debris will be transported to the disposal area in flat-top barges.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with Federal, State, and local safety requirements, with particular attention to Section 29 CFR Part 1926 (Part 1926-Safety and Health Regulations for Construction).

B. Dredging is planned between June 1 and October 15 of any year, yet to be defined. The dates of the hydrographic surveys will be prior to and after the dredging operations, and, thusly, are yet to be defined.

C. The Hydrographic Survey Contractor and Dredging Contractor will perform work during the pre-drawdown phase when the reservoir level will be considered high the reservoir is expected to fluctuate. The elevation of the spillway crest and historic average monthly water levels are shown on the Drawings. Certain flow and reservoir elevation data are available form the USGS and other sources. It is the responsibility of the Hydrographic Survey Contractor and Dredging Contractor to monitor the flows and levels so as to provide safe operations.

D. Dredging and Disposal of Dredged Debris will comprise dredging of materials as indicated on the Drawings, placing the dredged materials on a transport flat-top barge and disposing the materials in the open-water disposal area as indicated on the Drawings.

E. Dredging activities shall avoid striking the existing structures. Confined dredging procedures shall be employed when dredging is required directly adjacent to existing structures.

F. Dredging and disposal activities shall avoid interference with recreational boater activities on the water and at the boat ramps.

G. The debris transport barge shall employ a non-watertight barrier system around the flat- top barge perimeter using K-rail or a similar containment system to contain the dredged material on the top of the barge.

DRAFT

35 24 00 – DREDGING AND DISPOSAL OF DEBRIS

3.2 SEDIMENT CONTROL

A. The dredging contractor will propose and be responsible for best management practices (BMP) for sediment control during dredging, transport of the dredged material and disposal of the dredged material.

B. A floating absorptive containment boom, consisting of a silt curtain deployed at the dredging site. The silt curtain shall fully surround the storage barges, active work zones, bucket's path of travel from the dredging zone to the sediment storage barge, and the dredge barge.

C. A floating containment boom shall be deployed around the transport barge when it is offloading the dredged material.

END OF SECTION 35 24 00

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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
PacifiCorp	**2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT R-4
Iron Gate Facility – Diversion Tunnel (Public)

Iron Gate Facility – Diversion Tunnel

Tunnel Survey and Design Model Comparison

February 8, 2021

Knight Piésold CONSULTING

Going further together

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

PAGES 2-11

(Tunnel Survey Overview; Survey-Model Comparison)

Q & A

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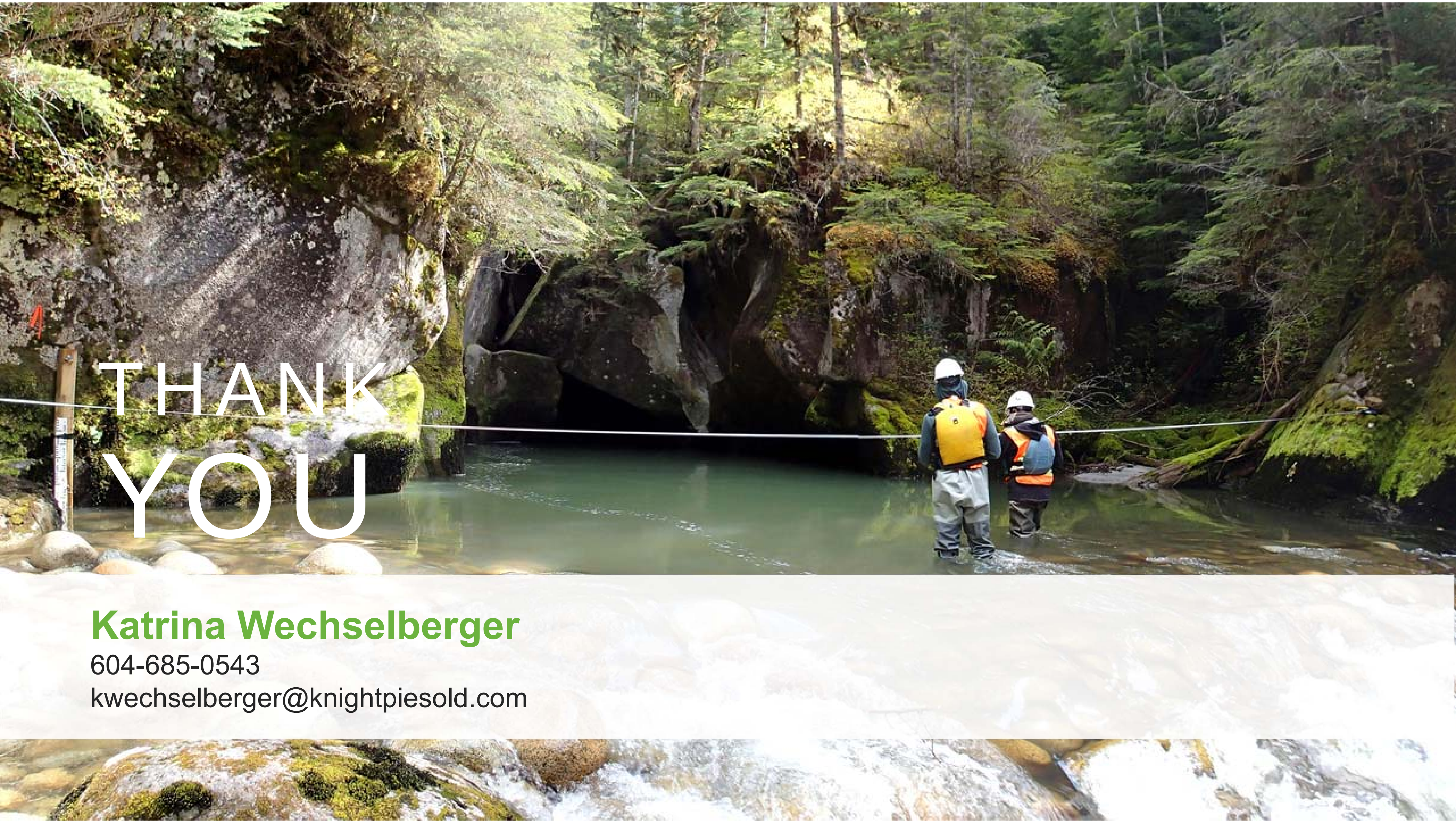

THANK YOU

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