EXHIBIT M—PROJECT DESCRIPTION

Lower Klamath Project
(FERC Project No. xxxxx)

PacifiCorp
Portland, Oregon

Version: September 2016

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M1.0 PURPOSE

This current version of the Exhibit M updates previous information on record and generally describes the newly designated Lower Klamath Project facilities and lands, which were formerly part of the Klamath Hydroelectric Project (FERC Project No. 2082).[1] Updates to this Exhibit M will be filed with the Commission as necessary.

[1] This Exhibit M has been prepared to correspond to the requirements of Exhibit A in FERC's current rules, 18 C.F.R. 4.51(b).

M2.0 PROJECT OVERVIEW

M2.1 PROJECT FACILITIES

The Lower Klamath Project area is located on the upper Klamath River in Klamath County (south-central Oregon) and Siskiyou County (north-central California). The nearest principal cities are Klamath Falls, Oregon, located at the northern end of the Project area; Medford, Oregon, 45 miles northwest of the downstream end of the Project; and Yreka, California, 20 miles southwest of the downstream end. Figure M2.1-1 is a map of the Project area.

The Lower Klamath Project consists of four developments which are on the Klamath River between river mile (RM) 190 and RM 228. The Lower Klamath Project begins at the J.C. Boyle Development and continues downstream to the Iron Gate Development. The four Lower Klamath Project developments are as follows:

- The J.C. Boyle Development consists of a dam, reservoir, and powerhouse (98 MW), which are located within Oregon. The top of the reservoir is at RM 228.3, the dam is at RM 224.7 and the powerhouse is several miles downstream at RM 220.4.

- The Copco No. 1 Development consists of a dam and power plant located in California at RM 198.6. The Copco No. 1 power plant (20 MW) is located at the base of the dam on the right bank.

- The Copco No. 2 Development is located at RM 198.3 and diverts water to a 5,900-foot-long water conveyance system serving a 27-MW power plant. The Copco No. 2 reservoir above the dam is small and located immediately downstream of the Copco No. 1 dam. Because it has very minimal active storage, the Copco No. 2 powerhouse operates as a “slave” to Copco No. 1.

- The Iron Gate Development consists of a dam, reservoir, and powerhouse (18 MW), and is the farthest downstream (RM 190) development in the Lower Klamath Project. The Iron Gate Development also includes the Iron Gate Fish Hatchery, which was constructed at the same time as the power generation facilities. The development is operated to provide stable river flows in the Klamath River downstream of the Project.

There are five transmission line segments associated with the Lower Klamath Project. These segments are described in subsequent sections of this Exhibit M and their locations are shown in Exhibit K maps. One-line diagrams are provided in Figures M2.1-2 and M2.1-3. The Lower Klamath Project interconnects with the PacifiCorp 230-kV system at PacifiCorp’s J.C. Boyle and Copco No. 2 230-kV substations/switchyards.

Key information about Project facilities is summarized in Table M2.1-1. Additional information about Project facilities and equipment is provided in the remainder of this exhibit.

SPENCER CREEK

4668000 N,
582000 E

4666000 N,
574000 E

J.C. BOYLE RESERVOIR

RM 229
RM 230
RM 228
RM 227
RM 226
RM 225
RM 224
RM 223
RM 222
RM 221
RM 220

J.C. Boyle Dam

J.C. Boyle Powerhouse

T39S

T40S

R6E

R7E

4660000 N,
582000 E

LEGEND

Reference points UTM 10, NAD83, meters

TYPE

- FISH HATCHERY
- LOWER KLAMATH PROJECT FERC BOUNDARY
- HIGHWAY
- MAIN ROAD
- TRANSMISSION LINE
- OR/CA State Line
- TOWNSHIP/RANGE
- SECTION
- STREAM
- LAKE OR RESERVOIR

N

0 0.25 0.5 0.75 1 Miles

Scale as shown

Tile 1 of 4

Upper Klamath Lake

1 2 3 4

OREGON

CALIFORNIA

Iron Gate Reservoir

Figure M2.1-1

Lower Klamath Project
Proposed Project Boundary

EXHIBIT M - PROJECT DESCRIPTION

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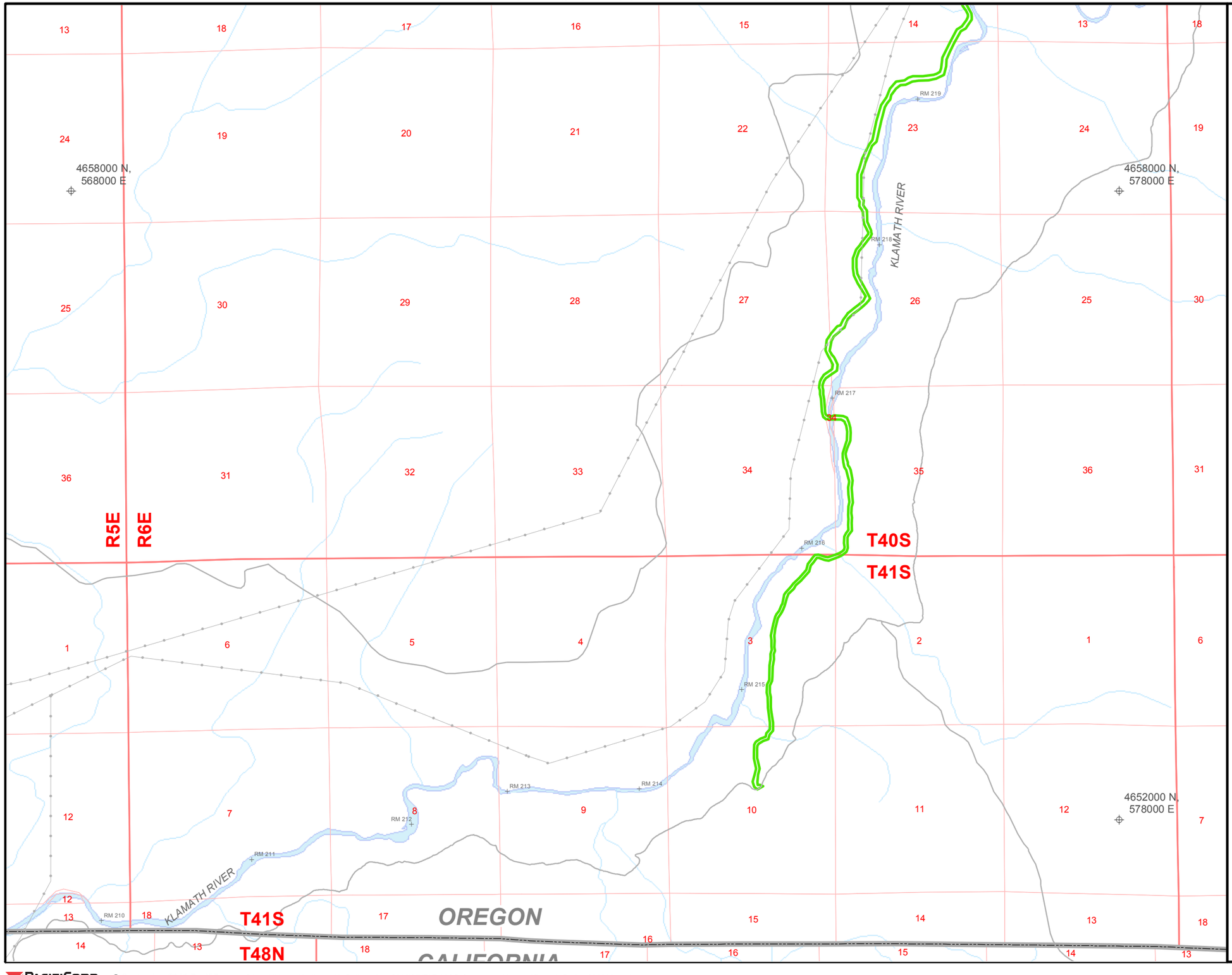

LEGEND

Reference points UTM 10, NAD83, meters

TYPE

- FISH HATCHERY
- LOWER KLAMATH PROJECT FERC BOUNDARY
- HIGHWAY
- MAIN ROAD
- TRANSMISSION LINE
- OR/CA State Line
- TOWNSHIP/RANGE
- SECTION
- STREAM
- LAKE OR RESERVOIR

N

0 0.25 0.5 0.75 1 Miles

Scale as shown

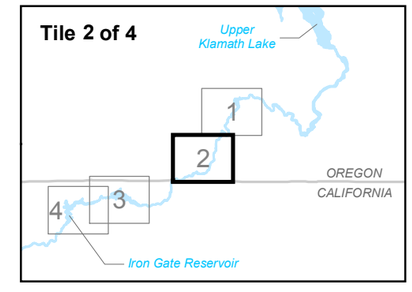

Figure M2.1-2

Lower Klamath Project
Proposed Project Boundary

EXHIBIT M - PROJECT DESCRIPTION

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Fall Creek Dam

Fall Creek Powerhouse

Fall Creek Fish Hatchery

Copco No. 2 Powerhouse

Copco No.1 Dam & Powerhouse

Copco No.2 Reservoir

Copco No. 2 Dam

COPCO RESERVOIR

COPCO RESERVOIR

T41S

T48N

T48N

T47N

R5W

R4W

R4W

R3W

4650000 N, 552000 E

4650000 N, 558000 E

4650000 N, 562000 E

4646000 N, 554000 E

4644001 N, 552000 E

4644000 N, 562000 E

RM 196

RM 197

RM 198

RM 199

RM 200

RM 201

RM 202

RM 203

RM 204

LEGEND

Reference points UTM 10, NAD83, meters

TYPE

- FISH HATCHERY
- LOWER KLAMATH PROJECT FERC BOUNDARY
- HIGHWAY
- MAIN ROAD
- TRANSMISSION LINE
- OR/CA State Line
- TOWNSHIP/RANGE
- SECTION
- STREAM
- LAKE OR RESERVOIR

N

0 0.25 0.5 0.75 1 Miles

Scale as shown

Tile 3 of 4

Upper Klamath Lake

OREGON

CALIFORNIA

Iron Gate Reservoir

Figure M2.1-3

Lower Klamath Project
Proposed Project Boundary

EXHIBIT M - PROJECT DESCRIPTION

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Fall Creek Powerhouse

Fall Creek Fish Hatchery

Copco No. 2 Powerhouse

Iron Gate Dam & Powerhouse

Iron Gate Fish Hatchery

CAMP CREEK

JENNY CREEK

IRON GATE RESERVOIR

4648000 N, 546000 E

4646000 N, 554000 E

4644001 N, 552000 E

4642000 N, 544000 E

4642000 N, 552000 E

RM 189 RM 191 RM 192 RM 193 RM 194 RM 195 RM 196 RM 197 RM 198

T48N

T47N

R6W R5W R5W R4W

LEGEND

Reference points UTM 10, NAD83, meters

TYPE

- FISH HATCHERY
- LOWER KLAMATH PROJECT FERC BOUNDARY
- HIGHWAY
- MAIN ROAD
- TRANSMISSION LINE
- OR/CA State Line
- TOWNSHIP/RANGE
- SECTION
- STREAM
- LAKE OR RESERVOIR

0 0.25 0.5 0.75 1 Miles

Scale as shown

N

Tile 4 of 4

Upper Klamath Lake

OREGON

CALIFORNIA

Iron Gate Reservoir

Figure M2.1-4

Lower Klamath Project
Proposed Project Boundary

EXHIBIT M - PROJECT DESCRIPTION

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Figure M2.1-2. Transmission network diagram, Oregon/California area.

Transmission network diagrams are considered Critical Energy Infrastructure Information (CEII) and are not contained in this publicly available version of this filing, consistent with Federal Energy Regulatory Commission policies under Order Nos. 702, 630, 630-A, 643, 649 and 683.

Figure M2.2-3. Transmission network diagram, Oregon/California area.

Transmission network diagrams are considered Critical Energy Infrastructure Information (CEII) and are not contained in this publicly available version of this filing, consistent with Federal Energy Regulatory Commission policies under Order Nos. 702, 630, 630-A, 643, 649 and 683.

Table M2.1-1. Key data regarding the Lower Klamath Project developments.

Item	J.C. Boyle Development	Copco No. 1 Development	Copco No. 2 Development	Iron Gate Development
General Information				
Owner of the Dam	PacifiCorp	PacifiCorp	PacifiCorp	PacifiCorp
Purpose	Hydropower	Hydropower	Hydropower	Hydropower
Completion Date	1958	1918	1925	1962
Dam Location (river mile)	224.7	198.6	198.3	190.1
Powerhouse Location (river mile)	220.4	198.5	196.8	190.0
Structural Features of the Dams				
Dam Type	Earthfill	Concrete	Concrete	Earthfill
Dam Height (ft)	68	126	33	173
Dam Length (ft)	693	415	278	740
Spillway Length (ft)	115	182	130	685
Number of Spill Gates	3	13	5	0
Spill Gate Type	Tainter	Tainter	Tainter	Ungated
Spillway Crest (ft msl)	3781.5	2593.5	2454.0	2328.0
Spillway Apron (ft msl)	3763.5	2483.0	2452.0	2164.0
Gross Head (ft) at Spillway	18	111	21	164
Spillway Energy Dissipaters?	Yes	Yes	No	Yes
Upstream Fish Passage Ladders?	Yes	No	No	No[a]
Juvenile Bypass Facilities?	Yes	No	No	No
Reservoir Information				
Reservoir Common Name	J.C. Boyle Reservoir	Copco Reservoir	Copco No. 2 Reservoir	Iron Gate Reservoir
Distance to Upstream Dam (miles)	5.6	26.1	0.3	8.2
Reservoir Length (miles)	3.6	4.5	0.3	6.8
Maximum Surface Area (acres)[b]	420	1,000	40	944
Normal Maximum Depth (ft) from Normal Maximum Surface Elevation	41.7	115.5	28	162.6
Maximum Depth Elevations (ft msl) from 2001-2002 Study[c]	3,751.8	2,492.0	---	2,165.4
Normal Maximum Operating Surface Elevation (ft msl)	3,793	2,607.5	2,483.0	2,328.0
Normal Minimum Operating Surface Elevation (ft msl)	3,788	2601.0	Data not available	2,324.0
Normal Annual Operating Fluctuation (ft)	5	6.5	Data not available	4.0
Total Storage Capacity (ac-ft)[d]	3,495	46,867	73	58,794

Table M2.1-1. Key data regarding the Lower Klamath Project developments.

Item	J.C. Boyle Development	Copco No. 1 Development	Copco No. 2 Development	Iron Gate Development
Current (2001-2002) Estimate of Gross Storage Capacity[d]	NA	33,724	NA	50,941
Active Storage Capacity (ac-ft)	1,724	6,235	Negligible	3,790
Retention Time (days)				
Average Flow (cfs)[e]	1,511	1,885	1,885	1,852
At Average Flow	1.2	12	0.020	16
At 710 cfs	2.5	32	0.052	42
At 1,500 cfs	1.2	15	0.025	20
At 3,000 cfs	0.6	8	0.012	10
At 10,000 cfs (extreme event)	0.2	2	0.004	3
Power Generation Features				
Fish Screens	Yes; four Rex traveling band screens	None	None	None
Trash Racks	At intake to power canal 4 vertical traveling screens (0.25-mesh). Before tunnel and penstocks, 60 x 17.9 ft with 2-inch bar spacing.	Two 44 x 12.5 ft with 3-inch bar spacing	36.5 x 48 ft with 2-inch bar spacing	At penstock entrance, 17.5 x 45 ft with 4-inch bar spacing
Diversion to Powerhouse	Gated intake to 638-ft steel flow line; 2-mile concrete canal; small forebay; 2 steel penstocks	Three penstocks at the dam	Wood-stave flow line and rock tunnel to two steel penstocks	Gated intake tower to penstock at dam
Number of Turbines	2	2	2	1
Turbine Type	Vertical Francis	Horizontal Francis	Vertical Francis	Vertical Francis
Turbine Generator Nameplate Capacity (MW)	Unit 1: 50 Unit 2: 48	Unit 1: 10 Unit 2: 10	Unit 1: 13.5 Unit 2: 13.5	18
Total Nameplate Generating Capacity (MW)	98	20	27	18
Gross Head (ft) at Powerhouse	463	123	152	158
Total Turbine Hydraulic Capacity (cfs)	Rated: 2,850 Max: 3,000 Min: Unit 1: 344 Unit 2: 407	Rated: 3,200 Max: 3,560 Min: Unit 1: 241 Unit 2: 467	Rated: 3,200 Max: 3,250 Min: 258	Rated: 1,550 Max: 1,735 Min: 296

Table M2.1-1. Key data regarding the Lower Klamath Project developments.

Item	J.C. Boyle Development	Copco No. 1 Development	Copco No. 2 Development	Iron Gate Development
Powerhouse Construction	Reinforced concrete structure	Reinforced concrete substructure with a concrete and steel superstructure	Reinforced concrete structure	Reinforced concrete structure
Transmission Lines				
Line Designation	98	15, 26-1, 26-2	19	62
Length (mi)	0.24	1.29, 0.07, 0.07	0.14	6.55
Voltage (kV)	230, 69	69, 69, 69	115	69
Interconnections	This 69 kV line tap is not currently energized. Generation output from JC Boyle plant is delivered to JC Boyle 230 kV substation.	Line 15 from Copco No. 1 switchyard to Copco No. 2 plant, line 26-1 from Copco No. 1 plant to switchyard, line 26-2 from Copco No. 1 plant to switchyard	Copco No. 2 plant to Copco No.2 switch yard	Plant to Copco No. 2

[a] Two fish ladders serve the Iron Gate fish hatchery**,** but do not allow passage past the dam.

[b] Pool elevations for these values are unknown.

[c] Data from the Final Bathymetry and Sediment Classification of the Klamath Hydropower Project Impoundments, J.M. Eilers and C.P. Gubala of JC Headwaters, Inc. prepared for PacifiCorp, April 2003.

[d] Total storage capacity is at normal full pool.

[e] Data are average daily turbine flows plus spill flows for 1994 through 1997 provided by PacifiCorp.

M2.2 FERC PROJECT BOUNDARY

The FERC Project boundary is depicted in Figure M2.1-1 of this Exhibit M. The FERC Project boundary encloses those lands necessary for operation and maintenance of Project facilities.

PacifiCorp, the current licensee of the Lower Klamath Project, owns and manages approximately 86.5 percent of the FERC Project boundary area, including the land containing most of the Project powerhouses, portions of the transmission lines, conduits, canals, and dam facilities, and land underlying the Project reservoirs, Klamath River, and tributary streams. Approximately 9.7 percent of the Project boundary area is federally owned, 3.1 percent is owned by the State of Oregon (original bed of the Klamath River in J.C. Boyle reservoir) and there is a small amount of private ownership. Portions of the J.C. Boyle canal and the entire powerhouse are located on BLM land.

Contemporary land use in the Project area and adjacent properties includes hydroelectric generation, livestock grazing, recreation, and timberlands.

M2.3 LANDS OF THE UNITED STATES

The lands of the United States enclosed by the Project boundary are listed in Table M2.3-1 with township/range/section descriptions and total areas in acres. Acreages were calculated using geographical information system (GIS) ArcInfo® software. It should be noted that the parcel and FERC boundary GIS data used to calculate ownership acreages are not survey accurate and some discrepancies may exist.

Table M2.3-1. Lands of the United States.

Meridian	Township/Range/ Section	Owner	Area (acres)	Project
Willamette	40S /6E/1	BLM	27.52	J.C. Boyle
Willamette	40S/6E/12	BLM	78.08	J.C. Boyle
Willamette	40S/6E/13	BLM	51.42	J.C. Boyle
Willamette	40S/6E/14	BLM	21.93	J.C. Boyle
Willamette	40S/6E/23	BLM	21.19	J.C. Boyle
Willamette	40S/6E/26	BLM	15.21	J.C. Boyle
Willamette	40S/6E/27	BLM	3.27	J.C. Boyle
Willamette	40S/6E/34	BLM	2.56	J.C. Boyle
Willamette	40S/6E/35	BLM	12.18	J.C. Boyle
Willamette	40S/7E/6	BLM	14.58	J.C. Boyle
Willamette	41S/6E/2	BLM	0.31	J.C. Boyle
Willamette	41S/6E/3	BLM	8.25	J.C. Boyle
Willamette	41S/6E/10	BLM	5.65	J.C. Boyle
Total			**262.14**	**J.C. Boyle**
Mt. Diablo	47N/5W/4	BLM	47.42	Iron Gate
Mt. Diablo	47N/5W/8	BLM	8.07	Iron Gate
Mt. Diablo	48N/5W/34	BLM	77.46	Iron Gate
Total			**132.95**	**Iron Gate**
Totals			**395.09**	**All**

M3.0 J.C. BOYLE DEVELOPMENT

M3.1 OVERVIEW

The J.C. Boyle Development consists of a reservoir, a combination embankment and concrete dam, a water conveyance system, and a powerhouse on the Klamath River between about RM 228 and RM 220. The J.C. Boyle Development is downstream of the Keno dam and upstream of the Copco No. 1 dam. The purpose of the J.C. Boyle facility is to generate hydroelectric power.

M3.2 DAM

The embankment dam is a 68-foot-tall (at its maximum height above the original streambed) earthfill structure with a 15-foot side crest and a length of 413.5 feet at El. 3,800.0 feet msl. The concrete portion of the dam is 279 feet long and is composed of a spillway section, an intake structure, and a 115-foot-long gravity section of 23 feet maximum height between the intake block and the left abutment.

The spillway is a concrete gravity ogee overflow section with three 36-foot-wide by 12-foot-high radial gates. The spillway crest is at El. 3,781.5 feet msl and normal pool is 0.5 feet below the top of the gates (El. 3,793.5). The spillway bay discharges onto a 13-foot-long concrete apron stepped at three elevations generally following the profile of the bedrock surface. Below the apron is a vertical drop of 15 feet maximum height to the discharge channel, which was excavated in rock. The discharge channel is generally unlined. The estimated spillway capacity at water surface El. 3,793 feet msl with all three gates open is 14,850 cfs.

The intake structure is located to the immediate left of the spillway and consists of a 40-foot-high reinforced concrete tower. It has four 11-foot, 2-inch-wide openings to the reservoir, each of which has a steel trash rack followed by a vertical traveling screen (0.25-inch mesh) with high-pressure spray cleaners. Spray along with any screened fish are collected and diverted downstream of the dam. A fabricated metal building was added to the intake structure in 1989.

Behind the intake traveling screens is an entrance to the 14-foot-diameter steel flowline, the downstream end of which is equipped with a 14-foot by 14-foot automated fixed wheel gate. A bulkhead gate is also provided at the upstream end of the 14-foot flowline.

A 24-inch fish screen bypass pipe provides approximately 20 cfs of instream flow below the dam. An 24-inch instream flow augmentation pipe provides water from the steel flowline to supplement instream flow releases that are primarily comprised of flows from the fish ladder, fish screen bypass, and spill gate leakage at the dam.

A pool and weir fishway approximately 569 feet long with 63 pools is located at the dam for upstream fish passage. The fishway operates over a gross head range of approximately 55 to 60 feet.

The water conveyance infrastructure between the dam and the powerhouse has a total length of 2.56 miles. From the intake structure, the water flows through a 638-foot long, 14-foot-diameter, steel flowline. The flowline is supported on steel frames where it spans the Klamath River and discharges into an open power canal. The power canal is 2 miles long along a bench cut in the

face of the river canyon. Depending on the terrain, the canal is either a double- or single-walled concrete flume. The power canal is provided with overflow structures at the upstream and downstream ends and terminates in a forebay. The forebay overflow section is equipped with float-operated gates, which release water during the hydraulic surge from the canal following any load rejection at the powerhouse. The released water discharges through a short, concrete-lined chute and returns to the bypass reach.

Water for power generation is drawn from the forebay through a 60-foot-wide and 17.9-foot-high trash rack with 2-inch bar spacing before entering a 15.5-foot-diameter, concrete-lined, horseshoe-section tunnel, which is 1,660 feet long. The last 57-foot length of the tunnel before the downstream portal is steel lined with the liner bifurcating into two 10.5-foot-diameter steel penstocks. The bifurcation is encased in a concrete anchor block, and a steel surge tank is mounted on the thrust block. Descending to the powerhouse, the penstocks reduce in two steps to 9 feet in diameter. Each penstock is 956 feet in length and is supported by ring girders seated on concrete footings.

Key information about J.C. Boyle dam is summarized in Table M2.1-1.

M3.3 RESERVOIR

The J.C. Boyle dam impounds a narrow reservoir of 420 surface acres (J.C. Boyle reservoir). The normal maximum and minimum operating levels are between El. 3,793 feet and El. 3,788 feet msl, a range of 5 feet. The reservoir contains approximately 3,495 acre-feet of total storage capacity and 1,724 acre-feet of active storage capacity.

Key information regarding J.C. Boyle reservoir is summarized in Table M2.1-1.

M3.4 POWERHOUSE

The conventional outdoor-type reinforced concrete powerhouse is located approximately 4.3 river miles downstream of the dam on the right bank of the river.

There are two vertical-Francis turbines. Both have a rated discharge of 1,425 cfs. Unit 1 turbine is rated 75,700 hp at 440 feet of net head. Unit 2 turbine is rated 63,873 hp at 435 feet of net head. Unit 1 generator is rated at 53,000 kVA at 0.95 power factor (50.35 MW). Unit 2 generator is rated at 51,000 kVA at 0.95 power factor (48.45 MW). Key information about J.C. Boyle powerhouse is summarized in Table M2.1-1.

Two three-phase transformers (Unit 1 46,000 -kVA, 11,000/236,000-V and Unit 2 42,300-kVA, 11,000/236,000-V) step up the generator voltage for transmission interconnection.

M3.5 TRANSMISSION LINES

The power from the powerhouse is transmitted a very short distance to the J.C. Boyle substation. From there the plant is connected to the Klamath Falls substation via the 230 kV JC Boyle to Klamath Falls line. There is also a second line that pre-dates the substation. This 0.24-mile 69-kV transmission line (PacifiCorp line 98) connects the plant to a tap point on PacifiCorp's Line 18. This line is not currently energized.

M4.0 COPCO NO. 1 DEVELOPMENT

M4.1 OVERVIEW

The Copco No. 1 Development consists of a reservoir, dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between approximately RM 204 and RM 198 near the Oregon-California border. Copco No. 1 is downstream of the J.C. Boyle dam and upstream of Copco No. 2 dam. The purpose of the facility is to generate hydroelectric power.

M4.2 DAM

The Copco No. 1 dam is a concrete gravity arch structure with a 462-foot radius at the crest. As originally designed, the spillway crest was approximately 115 feet above the original river bed. After construction began, the river gravel was found to be over 100 feet deep at the dam site; this material was excavated and then backfilled with concrete, making the total height of the dam 230 feet, measured from the lowest depth of excavation to the spillway crest, and 250 feet to the top of the spillway deck.

The crest length between the rock abutments is approximately 410 feet. The upstream face of the dam is vertical at the top, then battered at 1 horizontal to 15 vertical. The downstream face is stepped, with risers generally about 6.0 feet in height.

The ogee-type spillway is located on the crest of the dam. It is divided into 13 bays controlled by 14-foot by 14-foot Tainter gates. The spillway crest is located at El. 2,593.5 feet msl. The normal operating reservoir water level is 1.5 feet below the top of the gates at El. 2,606.0 feet msl. The estimated spillway capacity at water surface El. 2,607.5 feet msl with all 13 gates open is 36,764 cfs.

Two intake structures are located at approximately invert El. 2,575.0 feet msl in the dam near the right abutment. The left intake houses four vertical lift gates. Two 10-foot-diameter (reducing to 8-foot-diameter) steel penstocks feed Unit No. 1 in the powerhouse. The right intake houses four vertical-lift gates. A single, 14-foot-diameter (reducing to two 8-foot-diameter) steel penstock feeds Unit No. 2. Facilities exist at the intake for future expansion of the powerhouse, but there are no plans to expand the Project capacity. There are two side-by-side trash racks, which measure 44 feet wide, 12.5 feet high, and have bar spacings of 3 inches, in front of each intake.

The low-level sluice outlet has been abandoned.

Key information about Copco No. 1 dam is summarized in Table M2.1-1.

M4.3 RESERVOIR

The Copco No. 1 reservoir is approximately 1,000 acres in extent and contains approximately 15,200 acre-feet of total storage capacity at elevation 2,607.5 and approximately 6,235 acre-feet of active storage capacity. The normal maximum and minimum operating levels are between El. 2,607.5 and El. 2,601.0 feet, respectively, a range of 6.5 feet. Key information about Copco No. 1 reservoir is summarized in Table M2.1-1.

M4.4 POWERHOUSE

The Copco No. 1 powerhouse is a reinforced-concrete substructure with a concrete and steel superstructure enclosed by metal siding located at the base of Copco No. 1 dam on the right bank. The two turbines are double-runner, horizontal-Francis units, each with a rated discharge of 1,180 cfs. Unit 1 turbine is rated at 21,759 hp at a net head of 125 feet. Unit 2 turbine is rated at 18,600 hp at a net head of 125 feet. The generators are rated at 12,500 kVA at 0.8 power factor (10 MW). There are no turbine bypass valves.

Unit 1 has three single-phase, 5,000-kVA, 2,300/72,000-V transformers to step-up the generator voltage for transmission interconnection. Unit 2 has three single-phase, 4,165-kVA, 2,300/72,000-V transformers to step up the generator voltage for transmission interconnection.

Key information about the Copco No. 1 powerhouse is summarized in Table M2.1-1.

M4.5 TRANSMISSION LINES

Copco No. 1 plant has four associated 69-kV transmission lines. PacifiCorp Line 15 connects the Copco No. 1 switchyard to Copco No. 2, approximately 1.29 miles to the west. PacifiCorp line 3 approximately 1.66 miles in length connect Copco No 1 switchyard to a tap on the 69 kV line from Fall Creek plant. PacifiCorp lines 26-1 and 26-2, each approximately 0.07 mile in length, connect Copco No. 1 powerhouse to the Copco No. 1 switchyard.

M5.0 COPCO NO. 2 DEVELOPMENT

M5.1 OVERVIEW

The Copco No. 2 Development consists of a diversion dam, small impoundment, a water conveyance system, and a powerhouse. The dam is located approximately ¼ mile downstream of Copco No. 1 dam at RM 198.3. The purpose of the Copco No. 2 facilities is to generate hydroelectric power.

M5.2 DAM

The Copco No. 2 dam is a concrete gravity structure with an intake to the flowline on the left abutment and a 145-foot-long spillway section with five Tainter gates. The dam is 33 feet high, has an overall crest length of 335 feet and a crest width of 9 feet. The crest elevation is El. 2,493 feet msl. The dam has a 132-foot-long earthen embankment with a gunite cutoff wall. The dam has a manual gate controlling a sluiceway adjacent to the intake. A corrugated metal flume provides approximately 5 cfs of instream flow in the bypass reach. The concrete gravity spillway section crest elevation is 2,473 feet msl. The estimated spillway capacity at water surface El. 2,483 feet msl is 13,060 cfs with the five gates open.

The intake structure incorporates trash racks and a roller-mounted (caterpillar) bulkhead gate. The trash rack is 36.5 feet by 48 feet and has 2-inch bar spacing.

The flow line to the powerhouse consists of portions of 2,440 feet of concrete-lined tunnel, 1,313 feet of wood-stave pipeline, an additional 1,110 feet of concrete-lined tunnel, a surge tank, and two steel penstocks. The diameter of the tunnel and wood stave pipeline sections is a constant 16 feet. The two penstocks, one 405.5 feet long and one 410.6 feet long, range from 16 feet in diameter at the inlet to 8 feet in diameter at the turbine spiral cases.

Key information about Copco No. 2 dam is summarized in Table M2.1-1.

M5.3 RESERVOIR

The reservoir created by the Copco No. 2 dam is approximately 1/4-mile long and has a storage capacity of 73 acre-feet. At the normal water surface elevation of El. 2483 feet msl, there is very minimal active storage. El. 2,483 feet msl is both the maximum and minimum normal water surface. As a result, Copco No. 2 generation tracks Copco No. 1 generation.

Key information about Copco No. 2 reservoir is summarized in Table M2.1-1.

M5.4 POWERHOUSE

The powerhouse is a reinforced concrete structure that houses two vertical-Francis turbines. Each turbine has a rated discharge of 1,338 cfs. Unit 1 turbine is rated at 26,285 hp at 145 feet of net head and Unit 2 is rated at 20,000 hp at 140 feet of net head. The synchronous generators are rated 15,000 kVA at 0.9 power factor (13.5 MW).

There is one three-phase, 35-megavolt ampere (MVA), 6,600/115,000-V transformer for each generator to step up the voltage for transmission interconnection.

Key information about Copco No. 2 powerhouse is summarized in Table M2.1-1.

M5.5 TRANSMISSION LINES

A 115-kV transmission line (PacifiCorp Line 19) connects Copco No. 2 plant to Copco No. 2 switchyard approximately 0.14 miles to the northwest. The 69-kV bus at the Copco No. 2 powerhouse switchyard includes two 69-kV transmission lines to the PacifiCorp transmission system, a 69-kV transmission line (PacifiCorp Line 15) to the Copco No. 1 switchyard approximately 1.29 miles to the east, and a 69-kV transmission line (PacifiCorp Line 62) to the Iron Gate plant approximately 6.55 miles to the southwest.

M6.0 IRON GATE DEVELOPMENT

M6.1 OVERVIEW

The Iron Gate Development consists of a reservoir, an earth embankment dam, an ungated side-channel spillway, intakes for the diversion tunnel and penstock, a steel penstock from the dam to the powerhouse, and the powerhouse. It is located on the Klamath River between approximately RM 196.8 and RM 190, approximately 20 miles northeast of Yreka, California. It is the farthest downstream hydroelectric facility of the Lower Klamath Project. The purpose of the Iron Gate facilities is to generate hydroelectric power.

M6.2 DAM

Iron Gate dam is a zoned earthfill embankment. The dam has a height of 189 feet from the rock foundation to the dam crest at El. 2.343.0 feet msl. The crest is 20 feet wide and approximately 740 feet long. It has a central, vertical-asymmetrical clay core. The dam is founded on a sound basalt rock foundation. There is a grout curtain in the bedrock beneath the impervious core.

There are fish trapping and holding facilities located on the random fill area at the dam toe. The top of the random fill area is at El. 2,189.0 feet msl. High- (El. 2,310.0 feet msl) and low-level (El. 2,250 feet msl) intakes for the fish facility water are incorporated into the dam.

In 2003, modifications were made to Iron Gate Dam to raise the dam crest elevation from El. 2343 feet msl to El. 2348 feet msl. The modifications included construction of a concrete wall extension along the dam crest, anchored into the existing dam structure. Additional riprap materials were placed on the upstream face of the dam to protect those areas inundated by the higher reservoir elevations. This work included shotcrete protection at the top of the spillway and spillway chute.

The spillway is excavated in rock at the right dam abutment. It is an ungated chute spillway with a side channel entrance. The spillway crest is at El. 2,328.0 feet msl, 15 feet below the dam crest. The spillway crest is 727 feet long and consists of a concrete ogee and slab placed over the excavated rock ridge. The upper part of the channel is partly lined with concrete. At the end of the chute, a flip-bucket terminal structure is located approximately 2,150 feet downstream of the toe of the dam. Key information about Iron Gate dam is summarized in Table M2.1-1.

The diversion tunnel used during construction was driven through bedrock in the right abutment and is still in place. The tunnel terminates in a reinforced concrete outlet structure at the downstream toe of the dam. Control of the flow in the tunnel is provided by a slide gate approximately 112 feet upstream of the dam axis. The gate is housed in a reinforced concrete tower accessible by bridge from the dam crest. The intake is a reinforced concrete structure equipped with trash racks and is submerged on the floor of the reservoir approximately 380 feet upstream from the dam axis. Operation of the gate controlling flow through the tunnel is limited to emergency use during high flow events. If needed for such purposes, the tunnel can pass up to approximately 5,000 cfs.

The intake structure for the powerhouse is a 45-foot-high, free-standing, reinforced-concrete tower, located in the reservoir immediately upstream of the left dam abutment. It is accessed by a

foot bridge from the abutment. It houses a 14-foot by 17-foot slide gate, which controls the flow into a 12-foot-diameter, welded-steel penstock. The penstock is concrete-encased where it penetrates the dam approximately 35 feet below the normal maximum reservoir level. The penstock is supported on concrete supports down the dam abutment. There is a trash rack at the penstock entrance, which is 17.5 feet by 45 feet with 4-inch bar spacing.

M6.3 RESERVOIR

The reservoir formed upstream of the Iron Gate dam is approximately 944 surface acres and contains approximately 58,794 acre-feet of total storage capacity (at El. 2,328.0 feet msl) and 3,790 acre-feet of active storage capacity. The normal maximum and minimum operating levels are between El. 2,328.0 feet msl and El. 2,324.0 feet msl, respectively, a range of 4 feet.

Key information about Iron Gate reservoir is summarized in Table M2.1-1.

M6.4 POWERHOUSE

The powerhouse is located at the base of the dam on the left bank.

The Iron Gate powerhouse consists of a single vertical Francis turbine. The turbine has a rated discharge capacity 1,735 cfs, with a rated output of 25,000 at a rated net head of 154 feet. The synchronous generator is rated 18.947 kVA at 0.95 power factor (18 MW). In the event of a turbine shutdown, a synchronized Howell-Bunger bypass valve located immediately upstream of the turbine diverts water around the turbine to maintain flows downstream of the dam.

There is a single three-phase, 18,947-kVA, 6,600/69,000-V step-up transformer at the powerhouse to interconnect the PacifiCorp transmission system.

Key information about Iron Gate powerhouse is summarized in Table M2.1-1.

M6.5 TRANSMISSION LINES

Iron Gate plant has one associated 69-kV transmission line. Line 62 runs along the north side of Iron Gate reservoir for approximately 6.55 miles, to the Copco No. 2 switchyard.

M6.6 IRON GATE FISH HATCHERY

The Iron Gate fish hatchery was constructed in 1966 and is located downstream of Iron Gate dam, adjacent to the Bogus Creek tributary. The hatchery complex includes an office, incubator building, rearing ponds, fish ladder with trap, visitor information center, and employee residences. Up to 50 cfs is diverted from the Iron Gate reservoir to supply the 32 raceways and fish ladder.

The hatchery produces Chinook salmon, steelhead trout, and coho salmon. Annual production goals are 6 million Chinook, 200,000 steelhead, and 75,000 coho. The hatchery is operated by the California Department of Fish and Wildlife. Per the license, eighty percent of operations and maintenance costs are required to be funded by PacifiCorp, but PacifiCorp currently funds 100 percent of those costs pursuant to the Klamath Hydroelectric Settlement Agreement.

M7.0 INFORMATION SOURCES

Eilers, J.M. and C.P. Gubala. 2003. Final Bathymetry and Sediment Classification of the Klamath Hydropower Project Impoundments. Prepared for PacifiCorp by JC Headwaters. April 2003.