EXHIBIT E: ENVIRONMENTAL ANALYSIS

1 Introduction

The Boundary Project (FERC No. 2144) (Project), owned and operated by Seattle City Light (SCL), is located on the Pend Oreille River, in Pend Oreille County, Washington (Figure E.1-1). The Project was constructed in the mid 1960s and operates under a license administered by the Federal Energy Regulatory Commission (FERC). The existing license for the Project expires on September 30, 2011, and in accordance with FERC regulations SCL must file its application for a new license no later than September 30, 2009. For the relicensing of the Project, SCL used the FERC Integrated Licensing Process (ILP) to provide the framework for its consultation with agencies, tribes, and other relicensing participants (RPs) during the period leading up to the filing of the License Application.

The filing of the License Application fulfills SCL's primary obligation under the ILP. The License Application presents SCL's proposed Project operations and non-operational protection, mitigation, and enhancement (PM&E) measures, i.e. the Proposed Action. SCL proposes to operate the Project as it does under the current FERC license, but with formalization of currently voluntary measures, including water surface elevation restrictions from Memorial Day to Labor Day for recreation enhancement, and turbine unit sequencing to reduce total dissolved gas (TDG) production associated with non-spill operations. The proposal is described in greater detail in Section 2.3.1 of this Exhibit E. SCL is also proposing a suite of non-operational PM&E measures, which are described in Section 2.3.3 and Section 4.5 of this Exhibit E. Copies of the License Application, as filed with FERC, have been distributed to all known interested state and federal agencies, tribes, local governments, non-governmental organizations, and members of the public.

1.1. Purpose of Exhibit E

The purpose of this Exhibit E is to describe the following: (1) existing Project facilities, lands, and waters; (2) existing Project operations and maintenance; (3) the continuing impacts of existing Project operations and maintenance on resources, including direct, indirect, and cumulative impacts based on information generated during the relicensing study program; 4) all proposed Project facilities, lands, and waters, the proposed operation and maintenance plan, and proposed PM&E measures for each resource area; and (5) the incremental impacts of the proposed Project and its operation and maintenance plan, including direct, indirect, and cumulative impacts, based on information generated in the relicensing study program.

The environmental analysis in this Exhibit E (Section 4) presents the assessment of effects associated with SCL's existing and proposed Project operations and facilities and the expected benefits of proposed PM&E measures. The resource analyses contained in this Exhibit E will provide the foundation for FERC's National Environmental Policy Act (NEPA) analysis.

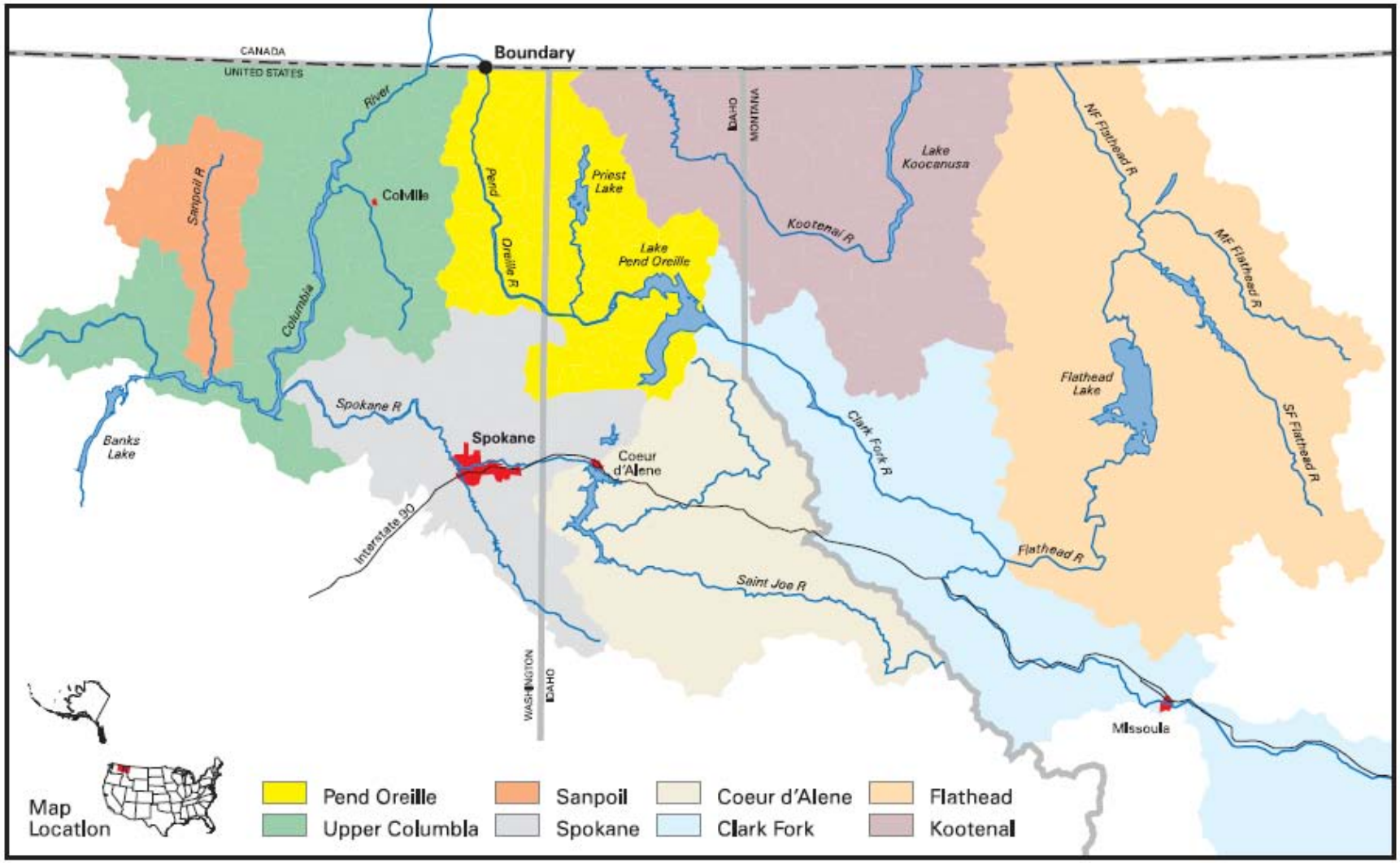


Figure E.1-1. Pend Oreille River basin within the larger Columbia River basin.

1.2. ILP Schedule

Table E.1-1 provides a summary of the major FERC filings made by SCL during the relicensing of the Project, beginning with the Pre-Application Document (PAD) and ending with the License Application. The table also includes document filings associated with related mandatory processes, including the Washington Department of Ecology (Ecology) Section 401 water quality certification process, the U.S. Fish and Wildlife Service (USFWS) Section 7 Endangered Species Act (ESA) consultation, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA). Following the filing of this License Application, FERC will establish a firm schedule for the processing of the License Application and evaluate SCL's licensing proposal through the NEPA process.

Table E.1-1. Milestones, responsible parties, dates, and applicable regulations associated with filing of the Project License Application.

Significant milestones	**Date**	**Applicable regulations[1]**
Notice of Intent (NOI) and Pre-Application Document (PAD)	May 5, 2006	ILP, 5.5, 5.6
Proposed Study Plan (PSP)	October 16, 2006	ILP, 5.11(a)
Revised Study Plan (RSP)	February 14, 2007	ILP, 5.13(a)
Initial Study Report (ISR)	March 14, 2008	ILP, 5.15(c)(1)
Updated Study Report (USR)	March 16, 2009	ILP, 5.15(f)
Preliminary Licensing Proposal (PLP)	April 30, 2009	ILP, 5.16(a)
Draft Biological Assessment (BA)	April 30, 2009 [filed with PLP]	ILP, 5.16(d)
Draft Historic Properties Management Plan (HPMP)	April 30, 2009 [filed with PLP]	ILP, 5.16(d)
Draft Recreation Needs Analysis (RNA)	April 30, 2009 [filed with PLP]	
Drafts or annotated outlines of all other management and attainment plans • Terrestrial Resources Management Plan • Total Dissolved Gas Attainment Plan • Dissolved Oxygen Attainment Plan • Aquatic Invasive Species Control and Prevention Plan •Oil Spill Prevention, Control and Countermeasure (SPCC) Plan • Fish and Aquatic Resources Management Plan •Recreation Resources Management Plan	April 30, 2009 [filed with PLP]	
Draft 401 certification application with Washington Department of Ecology	May 2009	
License Application	September 30, 2009 [no later than September 30, 2009]	ILP, 5.17, 5.18
Revised Draft BA	September 30, 2009 [filed with License Application]	ILP, 5.18(b)(3)(ii)

Table E.1-1, continued...

Significant milestones	Date	Applicable regulations[1]
Final HPMP	September 2009 [filed with License Application]	ILP, 5.18(b)(3)(v)
Final Recreation Needs Analysis	September 2009 [filed with License Application]	
Revised versions of all other management and attainment plans: •Terrestrial Resources Management Plan • Total Dissolved Gas Attainment Plan • Dissolved Oxygen Attainment Plan • Aquatic Invasive Species Control and Prevention Plan •Oil Spill Prevention, Control and Countermeasure (SPCC) Plan • Fish and Aquatics Management Plan •Recreation Resources Management Plan •Road Decommissioning Plan	September 2009 [filed with License Application]	
Issue public notice of License Application	September/October 2009 [within 14 days of filing]	ILP, 5.17(d)(2)
Request formal ESA consultation	TBD[2]	
Submit final 401 certification application to Washington Department of Ecology	January 2010 [no later than 60 days after Ready for Environmental Analysis (REA) determination by FERC]	

Notes:
1 ILP = FERC regulations pertaining to the Integrated Licensing Process, found at Title 18, Chapter 1 of the Code of Federal Regulations (CFR), Part 5.
2 Consultation to be initiated based on FERC's recommended alternative defined in FERC staff's environmental assessment.

1.3. Document Organization

In organizing this Exhibit E, SCL relied on FERC's Scoping Document 2 (SD2) for the Project (FERC 2006), FERC's content requirements for Exhibit E of the License Application (18 CFR 5.189(b)), FERC's guidance document, Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff (FERC 2008), and SCL's Revised Study Plan (RSP; SCL March 2007), Updated Study Report (USR; SCL 2009a), and Preliminary Licensing Proposal (PLP; SCL 2009b).

This Exhibit E can be divided into two general parts: (1) Introduction, Proposed Action and Alternatives, and Consultation sections (Sections 1 - 3) (A summary of consultation with RPs is contained in Attachment E-1), and (2) the Environmental Analysis (Section 4), which makes up the bulk of Exhibit E. Following a general description of the basin, Section 4 has the following section headings for each resource area:

- *Affected Environment* – Briefly describes the existing environment based on information from the PAD, Early Information Development (EID) documents, and study reports included in the Initial Study Report (ISR) and USR.
- *Environmental Analysis* – Describes the impacts of the Project under existing and proposed operations, based on the results of relicensing program studies.
- *Proposed Environmental Measures* – Describes SCL's proposed PM&E measures and their supporting rationales, based on study results and expected benefits of the PM&E measures.
- *Cumulative Impacts* – Identifies those resources for which cumulative effects have been identified and indicates whether the Proposed Action would contribute to such cumulative effects.
- *Unavoidable Adverse Impacts* – Characterizes any adverse impacts that will occur despite the implementation of proposed Project operations and the identified PM&E measures.

2 Proposed Action and Alternatives

SCL proposes to operate the Project as it does under the current FERC license, but with formalization of two currently voluntary measures, i.e., water surface elevation restrictions from Memorial Day to Labor Day for recreation enhancement and turbine unit sequencing to reduce TDG production under non-spill conditions (described in greater detail in Section 2.3.1). In addition, SCL is proposing a suite of non-operational PM&E measures to address Project impacts to particular resources (an overview is provided in Section 2.3.3 and greater detail can be found in the Proposed Environmental Measures subsections for each resource area in Section 4.5). SCL is also proposing measures to increase the efficiency of generating Units 55 and 56. These measures are described in Section 2.3.2.

SCL employed an Integrated Resource Analysis (IRA) process through March 2009 to collaborate with RPs on the development of the proposed PM&E package (consultation with RPs is described in Section 3 of this Exhibit E). SCL continued to develop and refine its PM&E package in the months leading up to the filing of the License Application.

2.1. No Action Alternative

No-action means that the Project would continue to operate as authorized by the current license, but with voluntary implementation of the summer forebay water surface elevation restriction and sequencing of the turbine units to reduce TDG (see Section 2.1.4, Existing Environmental Measures). Existing facilities would remain in place and existing protection or mitigation measures would continue, but there would be no additional protection or enhancement of natural resources. If the Project were to operate as in the past, SCL would continue to produce energy in the present manner, and the environmental consequences of its operation would remain unchanged. Any ongoing effects of the Project would continue. The No-Action Alternative represents the baseline Project energy production and environmental conditions for comparison with other alternatives.

2.1.1. Existing Project Facilities

The Project facilities included under the existing license are described below. The general layout of the Project is shown in Figures E.2-1 and E.2-2 and described in Table E.2-1. Specific facility characteristics are listed in Tables E.2-2 through E.2-6.

2.1.1.1. Dam and Spillways

2.1.1.1.1. Boundary Dam

Boundary Dam, situated in a narrow canyon and founded on interbedded limestone and dolomite of the Metaline Limestone formation, is a variable-radius concrete arch dam with a total height of 360 feet above the lowest part of the foundation and a structural height of 340 feet. The dam varies in thickness from 8 feet at its crest to 32 feet at its base, has a crest length of 508 feet, and has a total length, including the spillways, of 740 feet. The dam impounds the Pend Oreille River to a normal high water surface elevation 1,994 feet North American Vertical Datum (NAVD) 88[1], as measured in the forebay.

The average elevation of the river surface below the dam is approximately 1,731 feet NAVD 88, and the impoundment provides approximately 263 feet of gross head for energy production (normal [rated] net head of 250 feet). Instruments embedded in the dam and abutments, which are monitored according to a regular schedule, include thermometers, strainmeters, deformation meters, deflection targets, crack movement points, tiltmeters, inverted plumb lines, piezometers, and extensometers. Specific characteristics of the dam are summarized in Table E.2-2.

[1] Elevation values are in datum NAVD 88 unless otherwise noted.

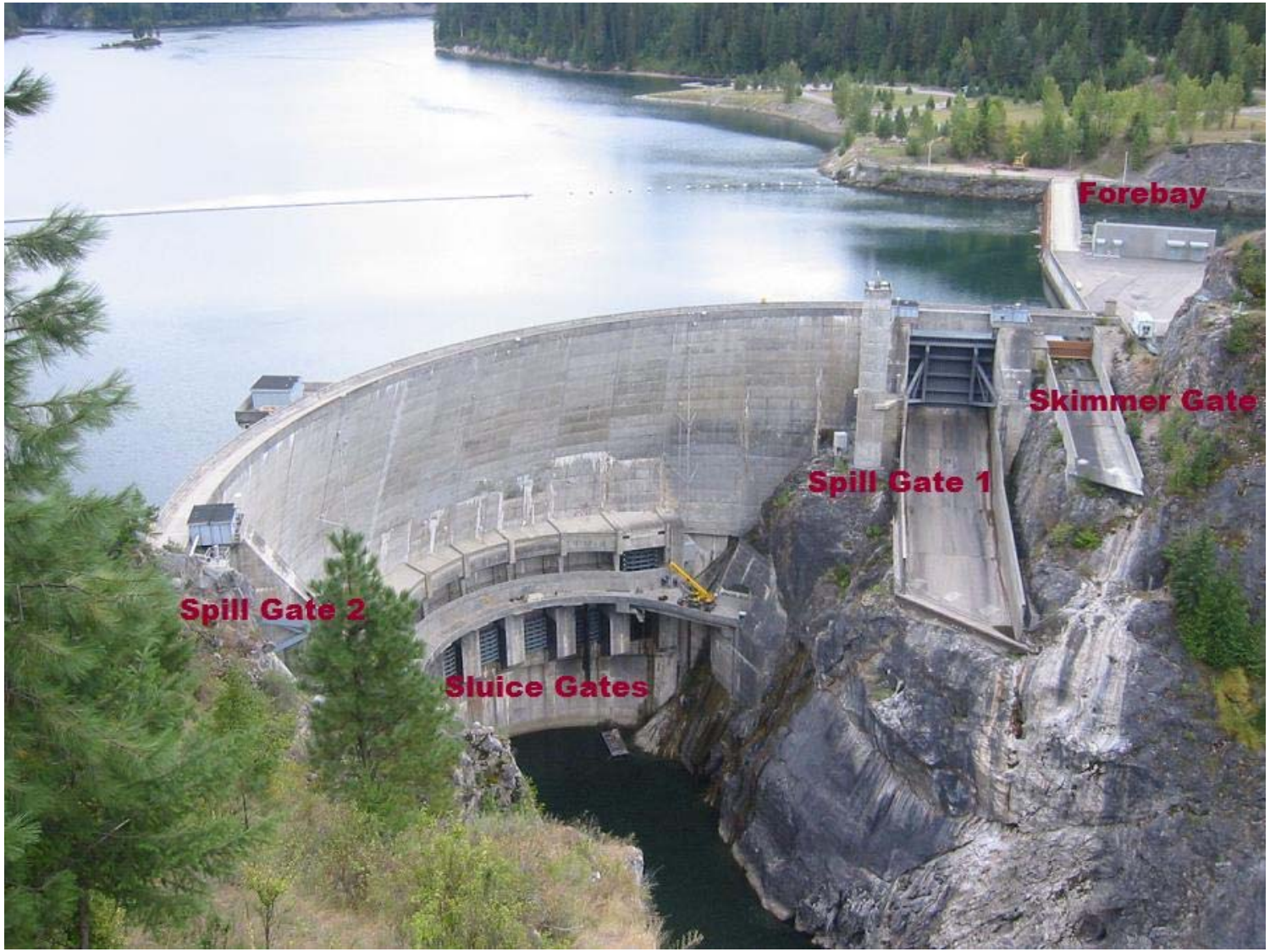


Figure E.2-1. Aerial view of Boundary Dam and associated facilities.

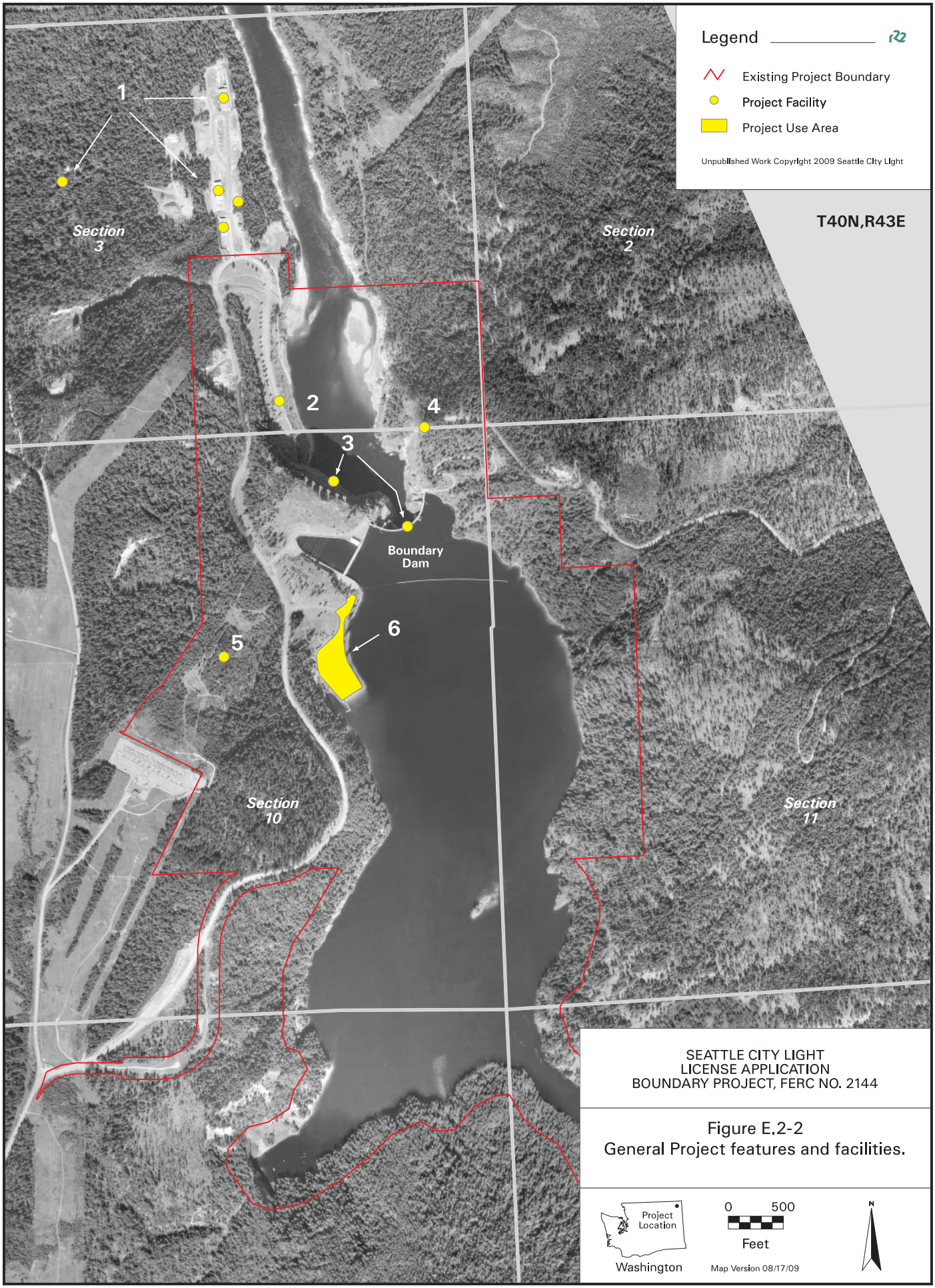


Figure E.2-2
General Project features and facilities.

Table E.2-1. Project facilities and use areas.

Site #	Project Facility/Use Area
1	Operations and maintenance support area. Includes: Shipping and Receiving building; Paint Shop/warehouse; spring water source and storage (stores water for cooling generator); maintenance shop; storage yards/staging areas (e.g., storage of aggregate); other misc. functions.
2	Tailrace Recreation Area – SCL-maintained day use and picnic area leading to the Machine Hall Visitors' Gallery.
3	Dam and power plant complex
4	Vista House – Viewpoint building, parking area, trail and viewing platform used by visitors to view the dam. Housing for SCL communications equipment inside building.
5	Transmission line right-of-away (ROW) (includes station service and associated underground utilities)
6	Forebay Recreation Area – SCL-maintained campground, boat ramp/float, picnic sites, and restrooms.

Table E.2-2. Dam characteristics, Boundary Project.

Structural height of dam	340 feet
Length of crest, arch dam only	508 feet
Total length of dam, including spillways	740 feet
Dam thickness at base	32 feet
Dam thickness at crest	8 feet
Elevation at crest of dam (roadway)	2,004 feet NAVD 88
Deepest foundation elevation	1,644 feet NAVD 88
Concrete volume: Arch dam Spillways	 120,000 cubic yard 20,000 cubic yard

2.1.1.1.2. Spillways, Sluiceways, and Skimmer

The Project dam has two spillways fitted with radial gates, one on each abutment. Each spillway is 50 feet wide and controlled by a radial gate 45 feet high. The two radial gate spillways have a combined total maximum release capacity of 108,000 cubic feet per second (cfs) at forebay elevation 1,994 feet NAVD 88. The spillways are each equipped with an air bubbler system to prevent the formation of ice at the gates. Each gate is controlled by an electrically driven wire rope hoist.

Seven low-level sluices through the dam under a head of 190 feet provide an additional 252,000 cfs of the total 360,000 cfs release capacity of the dam at forebay elevation 1,994 feet NAVD 88. The sluice gates are vertical fixed-wheel gates, 17 feet wide by 21 feet high, operated by electric wire rope hoists located on a hoist deck along the downstream face of the dam at elevation 1,864

feet NAVD 88. A sluice maintenance gate, 35 feet wide by 57 feet high, can be moved into position on the upstream face of the dam over a sluice entrance and used for dewatering the sluiceways for maintenance purposes. In addition, there is one bascule-type (hinged-leaf) skimmer gate, 26 feet wide by 9 feet high, adjacent to the left spillway that used to provide, but no longer provides, passage of surface debris from the reservoir. Table E.2-3 summarizes the specific dimensions and other characteristics of the spillways, sluiceways, and skimmer.

Table E.2-3. Spillway, sluiceway, and skimmer characteristics, Boundary Project.

Spillway gates:	
Number of gates	Two (2)
Type of gate	Radial
Dimensions of gates (each)	50 feet wide by 45 feet high
Spillway ogee crest elevation	1,950 feet NAVD 88
Maximum spillway capacity (at reservoir elevation 1,994 feet NAVD 88)	108,000 cfs
Sluice gates:	
Number of gates	Seven (7)
Type of gate	Fixed wheel
Dimensions of each gate	21 feet high by 17 feet wide
Sluice crest elevation	1,795.5 feet NAVD 88
Sluiceway total release (at reservoir elevation 1,994 feet NAVD 88)	252,000 cfs
Combined release of spillway and sluiceways (at reservoir elevation 1,994 feet NAVD 88)	360,000 cfs
Skimmer gate:	
Type of gate	Bascule (hinged-leaf, or flap)
Dimensions of gate	26 feet wide by 9 feet high
Skimmer crest elevation	1,986 feet NAVD 88

2.1.1.2. Power Intakes and Penstocks

The power intake facilities consist of a forebay (approximately 300 feet wide and 800 feet long with an invert at elevation 1,904 feet NAVD 88) excavated in the left (looking downstream) abutment area, a trashrack structure across the entrance to the forebay, and the portal face with six 30-foot-wide by 34-foot-high horseshoe-shaped tunnels extending to fixed-wheel intake gate chambers. A penstock leads from each intake gate to one of the turbine-generator units in the power plant (six penstocks total). Following a transition section of reinforced concrete in the upper part of the vertical elbow downstream of each intake gate, each penstock consists of a circular conduit of reinforced concrete down to elevation 1,822 feet NAVD 88 and a steel-lined conduit below elevation 1,822 feet NAVD 88. The concrete-lined section (which has a diameter of 24 feet by 34 feet, reducing to a diameter of 26 feet) is 165 feet long, and the steel-lined section (with a diameter varying from 26 feet to 20 feet) is 150 feet long. The forebay and

trashrack are located just upriver of the dam on the west bank as shown in Figure E.2-1. Specific dimensions and other characteristics of these facilities are summarized in Table E.2-4.

Table E.2-4. Power intake and penstock characteristics, Boundary Project.

Forebay:	
Elevation invert	Approximately 1,904 feet NAVD 88
Width of invert at trash racks	190 feet
Length	500 feet
Excavation volume	Approximately 1,000,000 cubic yards
Trashrack structure:	
Total length at roadway	290 feet
Total height	100 feet
Total weight of structural steel	700,000 pounds
Clear opening between bars	5-1/2 inch
Gross screen area at reservoir elevation 1,994 feet NAVD 88	19,000 square feet
Intake tunnels:	
Number of intakes	Six (6)
Tunnel dimensions	30 feet wide by 34 feet high (horseshoe-shaped in cross section)
Size of intake gates	24 feet wide by 34 feet high
Invert elevation	1,907 feet NAVD 88
Hoist deck elevation	2,044 feet NAVD 88
Penstocks:	
Number	Six (6)
Length of concrete-lined section (gate slot to steel liner)	165 feet
Length of steel-lined section	150 feet
Dimensions of concrete-lined section	24 feet by 34 feet, decreasing to 26-foot diameter
Diameter of steel-lined section	26 feet to 20 feet
Diameter at turbine inlet	20 feet
Penstock centerline elevation at turbine inlet	1,714 feet NAVD 88
Total weight of steel	4,000,000 pounds

2.1.1.3. Tailrace

Flows through the power plant are released into the tailrace downstream of Boundary Dam. BC Hydro's Seven Mile Project, located 11 river miles (RMs) downstream of Boundary Dam, extends its reservoir upstream to Boundary Dam, and periodically backs water up (encroaches) to

the base of Boundary Dam. The normal maximum water surface elevation of the Seven Mile Reservoir is approximately 1,734 feet NAVD 88 (528.5 meters) (BC Hydro 2003).

2.1.1.4. Power Plant

The Project power plant comprises an underground machine hall, six turbine-generator units, draft tubes, and transformer bays. The machine hall, excavated within the massive rock forming the left abutment of the dam, is 76 feet wide, 172 feet in height, and 477 feet in length. Power plant generating Units 51 and 53 each have a turbine rated at 204,506 hp (153,379.50 kilowatts [kW]) connected to a generator rated at 158,400 kW, Units 52 and 54 each have a turbine rated at 204,506 hp (153,379.50 kW) connected to a generator rated at 161,500 kW, and Units 55 and 56 each have a turbine rated at 259,823 hp (194,867.25 kW) connected to a generator rated at 200,000 kW, for a total authorized installed capacity of 1,003,253 kW based on current turbine ratings and total generating installed capacity of approximately 1,039,800 kW (1,040 MW) (FERC 2007a). Figure E.2-3 shows the machine hall from the Visitors' Center inside the power plant.

Figure E.2-3. Machine hall inside power plant, Boundary Project.

The draft tubes release water through individual short tunnels at the base of the tailrace cliff. Transformer bays branch off the dam access gallery and daylight at the face of the cliff above the tailwater. The power plant also includes a 21.3-foot-wide by 20.7-foot-high bay that houses an emergency generator. Data for the Project power plant facilities are summarized in Table E.2-5.

Table E.2-5. Power plant physical and equipment characteristics, Boundary Project.

Total power plant capability	Approximately 1,040 MW[1]
Annual capacity factor	Approximately 45 percent, on average
Normal maximum forebay water surface elevation	1,994 feet NAVD 88
Approximate normal tailwater water surface elevation	1,744 feet NAVD 88
Normal (rated) net head	250 feet
Machine hall (including service bay):	
Total length	477 feet
Total height	172 feet
Total width	76 feet
Turbines:	
Turbine type	Francis
Number of units	Six (6)
Ratings:	
Units 51 through 54 (four [4] units)	204,506 horsepower (hp) at 250 feet net head, 120 rotations per minute (RPM)[1]
Units 55 and 56 (two [2] units)	259,823 hp at 250 feet net head, 120 RPM
Generators:	
Type	Umbrella
Installed (rated) capacity:	
Units 51 and 53	158.4 MW
Units 52 and 54	161.5 MW
Units 55 and 56	200.0 MW
Power factor	0.95
Continuous overload capacity	15 percent
Draft tubes:	
Size at portal	40 feet by 48 feet
Type of draft tube gates	Bulkhead
Size of draft tube gates (each)	14.5 feet by 28.5 feet
Diameter at distributor	17 feet
Transformer bays:	
Size at portal	40 feet by 48 feet
Diameter at distributor	17 feet
Number of bays	Six (6)
Size at portal	40 feet by 48 feet
Cross section at back of hood	36.0 feet wide by 34.5 feet high (horseshoe shaped in cross section)

Note:
1 FERC (2007a)

At the average net head (241 feet), the total power plant has a hydraulic capacity of approximately 56,000 cfs. Estimated capacity, efficiency, and generator output for the six turbine units in the Project power plant are shown in Table E.2-6.

Table E.2-6. Estimated capacities, efficiency, and generator output for the six turbine units in the Boundary Project power plant.

Unit number	Generator Installed Capacity (kW) (250 ft rated head) [1]	Minimum Hydraulic Capacity (cfs)[2]	Maximum Hydraulic Capacity (cfs)	Normal Hydraulic Capacity (cfs) (250 ft rated head)			Efficiency (%) [4]			Generator Output (kW) (250 ft rated head)		
				Half gate	Best gate	Full gate	Half gate	Best gate	Full gate	Half gate	Best gate	Full gate[5]
51	158,400	4,400	9,500	5,297	7,616	9,500	86.53	92.8	87.5	94,500	146,500	172,500
52	161,500	2,700	9,500	5,297	7,616	9,500	86.53	92.8	87.5	94,500	146,500	172,500
53	158,400	2,700	9,500	5,297	7,616	9,500	86.53	92.8	87.5	94,500	146,500	172,500
54	161,500	2,700	9,500	5,297	7,616	9,500	86.53	92.8	87.5	94,500	146,500	172,500
55	200,000	6,700	11,350	6,155	9,407	11,350	81.9	89.8	87.3	104,700	178,500	206,800
56	200,000	6,700	11,350	6,155	9,407	11,350	81.9	89.8	87.3	104,700	178,500	206,800
Total	1,039,800	25,900	60,700[3]	33,498	49,278	60,700	--	--	--	587,400	943,000	1,103,600

Notes:

1 Per FERC Order Amending License and Revising Annual Charges, dated November 2, 2007. Total authorized capacity is 1,003,253 kW based on turbine installed capacities.

2 These flows are provided based on turbine operating limits, not a reduced head. The rated head for the Boundary power plant is 250 feet net head. The standard minimum head is 237 feet net. These values are based on the below bullets.

- Unit 51 has a prohibited zone less than 70 MW due to penstock surging.
- Units 52 - 54 have a minimum operating point at 40 MW. All Noell runners (51- 54) should be run at loads greater than 80 MW due to rough operations, but for short periods they may be run lower to pick up morning loads.
- Units 55 and 56 are operated above 125 MW to reduce air admission that contributes to total dissolved gas (TDG) levels in the tailwater.

3 At the rated head of 250 feet, 100 percent gate, each unit can produce these flows individually, which total 60,700 cfs. However, the average net head at full plant capacity is 241 feet. At 241 feet net head, the full plant output is 990 MW at a flow rate of 56,000 cfs.

4 Turbine efficiency values (not generating unit efficiency values that include generator losses).

5 Full gate generator output is based on 100 percent full gate hydraulic capacities at rated net head of 250 feet. The total generator output of 1,103.6 kW is not possible since all units cannot operate at full gate capacities and maintain a rated net head of 250 feet (See Note 3).

2.1.2. Existing Project Operation

The Pend Oreille River system, which includes the Clark Fork River basin upstream of Lake Pend Oreille, is highly regulated, with flows controlled by dams associated with several energy production and/or storage projects (Figure E.2-4). Flows into Boundary Reservoir are influenced by the operations of upstream projects, including Box Canyon Dam (Pend Oreille County Public Utility District [PUD]), Albeni Falls Dam (U.S. Army Corps of Engineers [USACE]), and other projects farther upstream, such as Hungry Horse Dam (U.S. Bureau of Reclamation). Boundary Reservoir has a small active storage capacity relative to average daily river flow, and as a result, instream flow releases to the Pend Oreille River from the Project on annual, seasonal, or monthly time intervals are influenced by the operations of upstream projects (SCL 2008a). The Project has no control or influence over the flow releases it receives from upstream projects.

The Project is operated in a load-following mode that shapes available water to deliver power during peak-load hours with a total plant capability of approximately 1,040 MW from its six turbines. This operating regime allows SCL to meet continued service area load growth and support regional system reliability. The normal maximum forebay water surface elevation is 1,994 feet NAVD 88. The reservoir has relatively little active storage (40,843 acre-feet) within the maximum drawdown of 40 feet (active storage from elevation 1,994 NAVD 88 to elevation 1,954 NAVD 88 feet) authorized under the current license.

During the summer recreation season, SCL voluntarily restricts and maintains the summer forebay pool to a water surface elevation above 1,984 feet NAVD88 from 6:00 am through 8:00 pm from Memorial Day weekend (starting Friday evening) through Labor Day weekend (on Monday evening) to facilitate reservoir access and related recreational activities during daytime hours. At night during the summer, from 8:00 pm to 6:00 am, the forebay water surface elevation is maintained above elevation 1,982 feet NAVD 88. For the remainder of the year, the water surface may fluctuate between elevations 1,994 feet and 1,974 feet NAVD 88. Storage between elevation 1,974 feet NAVD 88 and elevation 1,954 feet NAVD 88 is reserved for extreme system load requirements. Flood storage is not provided, and other than the operating goals noted above there are no seasonal or minimum flow requirements.

The Project is staffed 24 hours a day, seven days a week and is operated both locally and remotely. Manual control is used primarily for start/stop operation in response to requests from the Seattle System Operator. Once online, the Project operates in Automatic Generation Control (AGC) as a load-following resource. At any point in time, in response to specific system and plant requirements, one or more units may be taken off of AGC and operated locally.

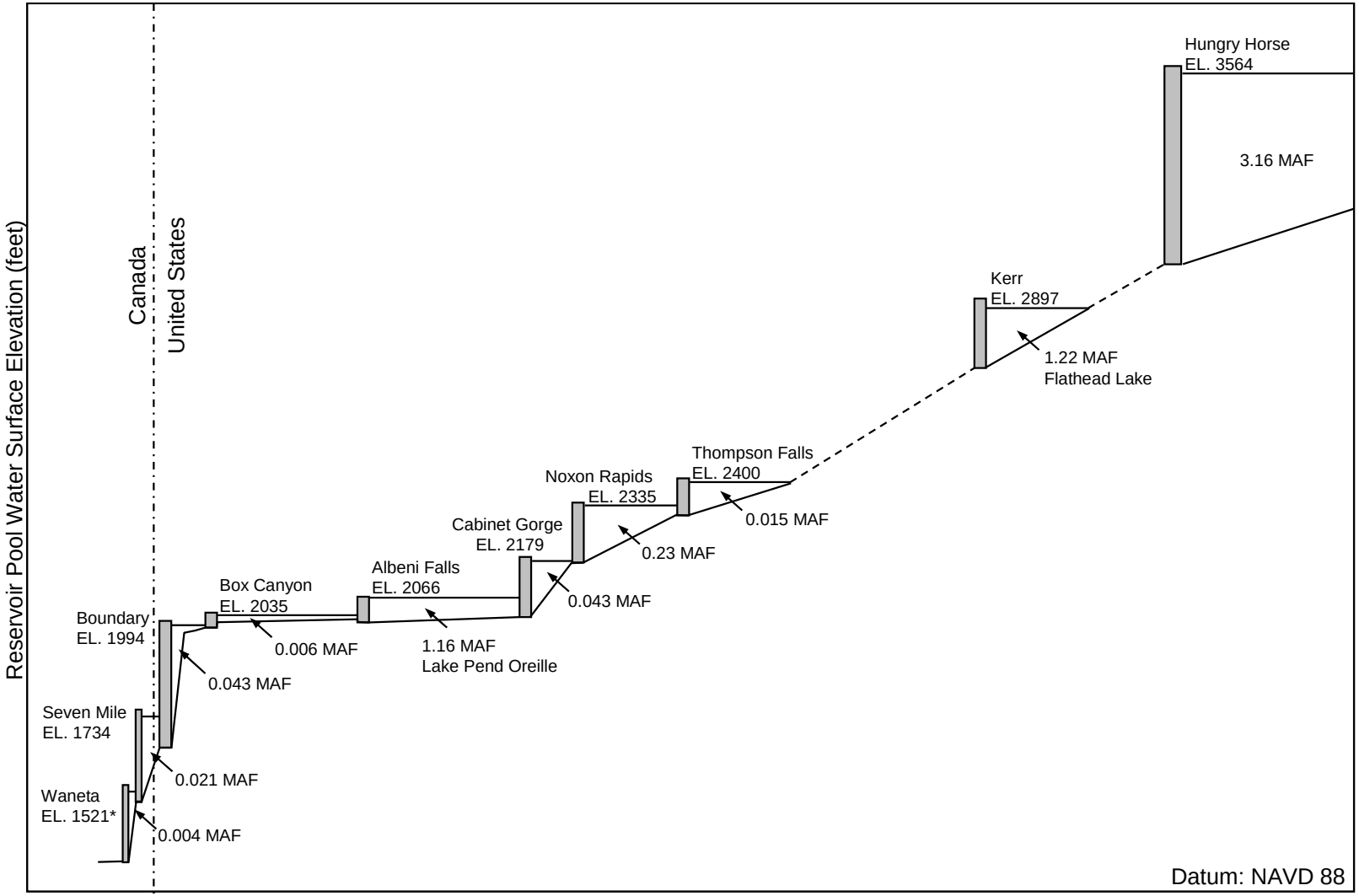


Figure E.2-4. Locations and usable storage volumes (million acre feet, MAF) of projects in the Pend Oreille River system from Hungry Horse (Montana) downriver to Waneta (Canada), near the confluence of the Columbia River. Horizontal and vertical axes are not to scale (Waneta Reservoir maximum operating level with respect to Canal Plan Agreement Operating Procedures).

2.1.2.1. Impoundment and Reservoir Storage Data

At its normal maximum forebay water surface elevation (1,994 feet NAVD 88), the 17.5-mile-long Boundary Reservoir has a surface area of approximately 1,794 acres, a shoreline length of roughly 47 miles, and a maximum depth in the forebay of approximately 270 feet.

Table E.2-7 summarizes Boundary Reservoir data. The reservoir's gross storage capacity is approximately 87,913 acre-feet (elevation 1,744 NAVD 88 to elevation 1,994 NAVD 88), and under its current license its nominal usable storage capacity is approximately 40,843 acre-feet (elevation 1,954 feet NAVD 88 to elevation 1,994 feet NAVD 88) (SCL 2008a). Because of the large volume of water flowing through the system and the limited amount of storage capacity in Boundary Reservoir, the retention time (i.e., residence time of water) of the reservoir is very short. Maximum retention time is less than four days, but more typically retention time is less than two days (Pickett 2004).

Table E.2-7. Boundary Reservoir data (SCL 2008a).

Reservoir dimensions	Length 17.5 miles Depth 270 feet (maximum)
Normal maximum water surface area	1,794 acres
Normal maximum water surface elevation	1,994 feet (NAVD 88) (at the forebay)
Gross storage capacity	87,913 acre-feet
Usable storage capacity	40,843 acre-feet

Metaline Falls is a geological feature that geographically divides the reservoir into two distinct reaches: an upstream reach that extends from Box Canyon Dam to Metaline Falls and a downstream reach that extends from Metaline Falls to Boundary Dam. The gradient and depth of the upstream reach are much less than those of the downstream reach, and depths in the upper section of the reservoir, above Metaline Falls, are much shallower, on the order of approximately 20 feet. The Pend Oreille River passes through a bedrock-controlled constriction located at Metaline Falls (elevation 1,970.6 feet NAVD 88).

Figure E.2-5 depicts a storage volume curve for the Project, developed in 2008 based on analysis of topographic and bathymetric surveys of the Pend Oreille River and adjacent floodplains between Boundary Dam and Box Canyon Dam from 2005 through 2007 (SCL 2008a). The analysis incorporated the total storage volume of the reservoir, which was divided into two portions: a lower reservoir extending from Boundary Dam to Metaline Falls, and an upper reservoir extending from Metaline Falls to Box Canyon Dam.

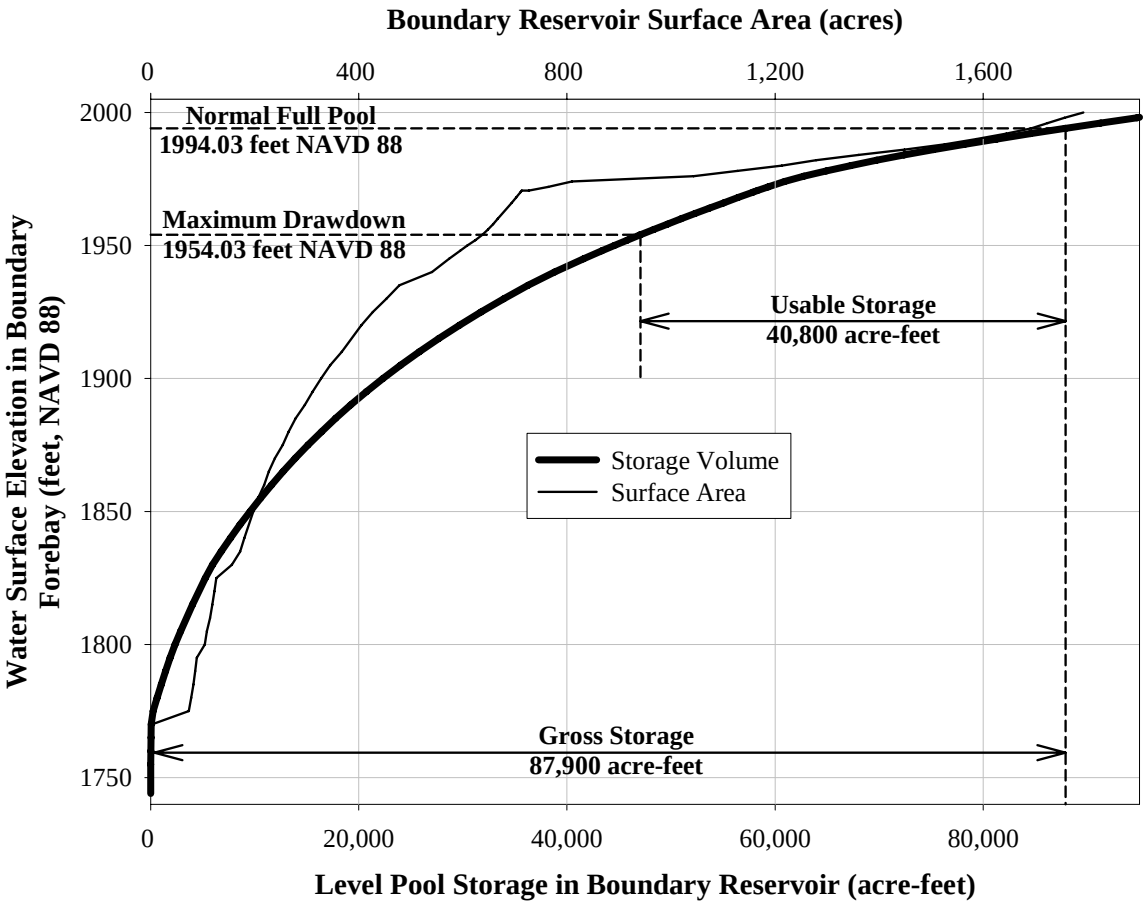


Figure E.2-5. Total storage volume in Boundary Reservoir above elevation 1,954.03 feet NAVD 88 versus water surface elevation in the Boundary forebay. Storage volumes previously used by SCL, and storage volumes derived from surveys performed from 2005 through 2007 (SCL 2008a).

2.1.2.2. Project Inflows and Releases

The total average inflow to Boundary Reservoir over the duration of 1987 to 2005 (the period of operation since the additions of Units 55 and 56) is estimated to be 24,100 cfs (SCL 2008a). Of this total, about 98.1 percent resulted from flow releases from Box Canyon Dam into Boundary Reservoir, 1.0 percent came from Sullivan Creek (the largest tributary to the Pend Oreille River between Box Canyon Dam and Boundary Dam), and 0.9 percent came from the remaining tributaries and groundwater (SCL 2008a).

The average monthly and annual total flows into Boundary Reservoir and releases from Boundary Dam for the period 1987-2005 are summarized in Tables E.2-8 and E.2-9. Further detail about the methods used to derive the inflow and release values can be found in the Compilation of Project Hydrologic Data: Preparation of Hydrologic Database and Hydrologic Statistics in Support of Relicensing Studies (SCL 2008a).

Downstream of Boundary Dam, the Pend Oreille River gains about 570 square miles of additional drainage area between Boundary Dam and Seven Mile Dam. Of this total, the Salmo River, with a drainage area of 475 square miles, accounts for 83 percent of the additional drainage area. The remainder comes from smaller tributaries. The total mean annual inflow to Seven Mile Reservoir is estimated to be 25,400 cfs. Of this total, releases from Boundary Dam to the Pend Oreille River account for 94.8 percent, the Salmo River accounts for 4.3 percent, and the additional downstream tributaries account for 0.9 percent.

Table E.2-8. Mean, minimum, and maximum monthly and annual total inflows at Boundary Dam, 1987 to 2005, calculated from the sum of all inflows (SCL 2008a).

Year	Mean Monthly and Annual Flow into Boundary Reservoir (cfs, calculated from the sum of all inflows)												
	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Annual**
1987	14,500	15,700	16,000	25,000	33,900	19,500	12,300	11,100	17,400	23,000	18,900	14,800	18,500
1988	10,100	12,300	18,900	27,600	28,900	22,400	11,800	6,400	10,300	20,700	21,400	14,000	17,100
1989	11,900	11,800	17,600	29,500	47,400	42,500	21,500	16,600	21,500	24,100	26,500	23,600	24,600
1990	22,800	22,200	19,900	39,100	46,300	71,100	31,900	14,100	16,600	26,300	28,000	20,900	29,900
1991	22,500	26,600	26,900	32,300	55,600	67,900	39,300	13,600	16,800	25,900	22,300	17,500	30,600
1992	15,300	13,400	17,200	19,800	22,500	15,900	13,700	10,300	14,900	25,800	20,000	12,600	16,800
1993	17,600	11,100	14,800	21,800	37,600	32,700	30,100	15,000	18,300	24,700	19,500	19,100	21,900
1994	18,600	15,000	16,500	21,100	25,900	26,600	11,400	7,700	10,400	19,300	20,500	13,000	17,200
1995	14,000	17,700	27,500	23,100	30,100	52,800	28,300	12,500	14,000	24,500	25,600	37,500	25,700
1996	27,800	41,600	43,400	54,600	69,200	76,400	32,300	18,600	15,400	20,500	18,700	18,600	36,300
1997	24,000	22,900	33,500	46,800	99,000	118,800	38,600	20,800	20,600	24,300	24,200	20,000	41,200
1998	17,200	14,000	18,500	25,800	39,900	53,900	32,500	15,600	15,200	17,900	19,100	16,700	23,900
1999	17,100	16,500	22,300	31,600	45,500	70,000	36,300	16,000	14,000	18,000	23,500	23,400	27,900
2000	17,800	15,100	18,900	35,800	45,300	38,600	20,700	10,000	12,300	19,000	16,600	13,400	22,000
2001	11,900	7,600	8,000	11,400	26,600	23,600	12,900	7,600	8,300	18,100	15,100	12,000	13,600
2002	16,800	16,400	18,000	29,100	46,600	82,100	37,200	14,000	12,000	16,300	15,000	16,200	26,700
2003	11,300	17,200	21,500	34,400	42,000	46,100	17,900	10,200	10,000	17,700	20,400	15,000	22,000
2004	11,800	13,700	18,100	20,600	35,500	37,100	22,900	13,800	19,400	23,700	17,300	21,000	21,300
2005	18,000	15,900	13,200	21,600	38,900	47,100	22,300	12,500	9,700	18,700	21,000	15,200	21,200
Maximum	*27,800*	*41,600*	*43,400*	*54,600*	*99,000*	*118,800*	*39,300*	*20,800*	*21,500*	*26,300*	*28,000*	*37,500*	*41,200*
Mean	*16,900*	*17,200*	*20,600*	*29,000*	*43,000*	*49,700*	*24,900*	*13,000*	*14,600*	*21,500*	*20,700*	*18,100*	*24,100*
Minimum	*10,100*	*7,600*	*8,000*	*11,400*	*22,500*	*15,900*	*11,400*	*6,400*	*8,300*	*16,300*	*15,000*	*12,000*	*13,600*

Table E.2-9. Mean, minimum, and maximum monthly and annual total flow releases from Boundary Dam to Pend Oreille River, 1987 to 2005 (SCL 2008a).

Year	Mean Monthly and Annual Total Flow Release from Boundary Dam to Pend Oreille River (cfs)												
	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Annual**
1987	14,500	15,700	15,700	25,200	34,100	19,200	12,100	10,800	17,300	23,000	18,800	14,700	18,400
1988	10,200	12,800	18,900	27,300	28,300	21,900	11,400	6,100	10,100	20,300	21,200	13,700	16,800
1989	11,800	11,800	18,200	30,000	47,400	41,500	21,300	16,400	21,200	23,500	26,200	23,100	24,400
1990	22,300	21,600	19,400	38,800	45,900	68,400	31,200	13,600	16,000	26,000	27,500	20,800	29,300
1991	21,900	26,200	26,900	32,300	55,100	67,100	39,100	13,000	16,600	25,600	21,900	17,000	30,200
1992	14,800	12,700	16,500	19,500	22,000	16,100	14,200	10,300	15,100	25,600	19,500	12,100	16,500
1993	17,100	10,500	14,300	21,100	36,400	32,100	29,200	14,000	17,600	23,900	19,300	18,900	21,300
1994	18,400	14,500	16,200	20,300	24,400	26,000	10,700	6,200	9,300	19,200	20,200	12,800	16,500
1995	13,300	17,100	27,500	22,800	29,500	50,900	28,300	11,700	13,700	24,700	28,600	37,900	25,500
1996	28,300	42,300	44,400	55,700	68,800	78,700	32,200	18,500	15,500	20,900	19,100	18,800	36,800
1997	24,600	22,600	33,200	47,400	99,200	116,200	38,600	20,000	19,700	23,400	23,300	20,000	40,700
1998	16,900	13,700	17,500	24,600	37,800	53,900	33,100	15,500	15,300	18,300	19,700	17,200	23,700
1999	17,800	17,200	23,500	32,700	45,500	67,600	36,500	16,200	14,300	18,400	24,200	24,200	28,200
2000	18,400	15,800	19,800	36,700	46,000	39,500	21,400	10,300	12,900	19,300	16,900	14,300	22,600
2001	12,600	7,900	8,600	12,000	26,200	23,500	13,100	7,700	8,200	18,500	15,600	12,500	13,900
2002	17,200	16,700	18,100	29,000	46,400	84,300	37,400	14,700	12,400	16,000	14,800	16,000	26,900
2003	10,700	17,000	21,200	34,300	40,900	44,900	17,300	9,500	9,400	17,400	20,300	14,800	21,500
2004	11,700	13,400	18,000	19,800	34,500	36,300	22,500	13,300	18,800	23,300	17,100	20,900	20,800
2005	17,800	15,700	13,200	21,500	38,100	46,000	21,800	12,000	9,200	18,300	20,400	14,700	20,700
Maximum	*28,300*	*42,300*	*44,400*	*55,700*	*99,200*	*116,200*	*39,100*	*20,000*	*21,200*	*26,000*	*28,600*	*37,900*	*40,700*
Mean	*16,900*	*17,100*	*20,600*	*29,000*	*42,400*	*49,200*	*24,800*	*12,600*	*14,300*	*21,300*	*20,800*	*18,100*	*23,900*
Minimum	*10,200*	*7,900*	*8,600*	*12,000*	*22,000*	*16,100*	*10,700*	*6,100*	*8,200*	*16,000*	*14,800*	*12,100*	*13,900*

2.1.2.3. Project Operation During Adverse, Average, and High Inflow Years

Figures E.2-6 through E.2-8 illustrate the range of historical reservoir water surface fluctuation in representative dry (adverse), average, and wet (high) inflow years (as defined by total reservoir inflows) selected from 1987 through 2005. Based on the calculated reservoir inflows and the historic generation, the driest year from 1987 to 2005 (2001) was selected as the representative dry year, and a high flow year having the greatest average annual flow from 1987 to 2005 of record (1997) was selected as the representative wet year. The average annual flow from 2001 ranks as the second driest year during the 96-year period from 1913 to 2008, and the average annual flow from 1997 ranks as the second wettest year during the long-term record. The year 2002 was selected as the representative average year because it has an annual average inflow that is close to the long-term average inflow.

Daily fluctuations in water surface elevation in the Boundary Dam forebay are minimal whenever the inflow to Boundary Reservoir exceeds plant capacity during the spring runoff, as illustrated in Figures E.2-7 and E.2-8 for the average and high inflow years, respectively. In contrast, the water surface elevation in the Boundary Dam forebay was allowed to fluctuate during the spring runoff during an adverse year (Figure E.2-6), because the inflow to Boundary Reservoir did not exceed the plant capacity.

2.1.3. Project Lands and Waters

The Project is located on the Pend Oreille River in northeastern Washington, one of eleven hydroelectric and storage projects within the Clark Fork-Pend Oreille River basin. The dam is located 1 mile south of the U.S.-Canada border, 16 miles west of the Idaho border, 107 miles north of Spokane, and 10 miles north of Metaline Falls, in Pend Oreille County. The dam is at Project river mile (PRM) 17.0 on the Pend Oreille River, in the NE ¼ of Section 10, Township 40N, Range 43E, Willamette Meridian. The upstream end of Boundary Reservoir is located immediately downstream of the Box Canyon Dam, at PRM 34.5, in the NE ¼ of Section 19 of Township 38N, Range 43E. Land ownership in the Project vicinity is shown in Figure E.2-9.

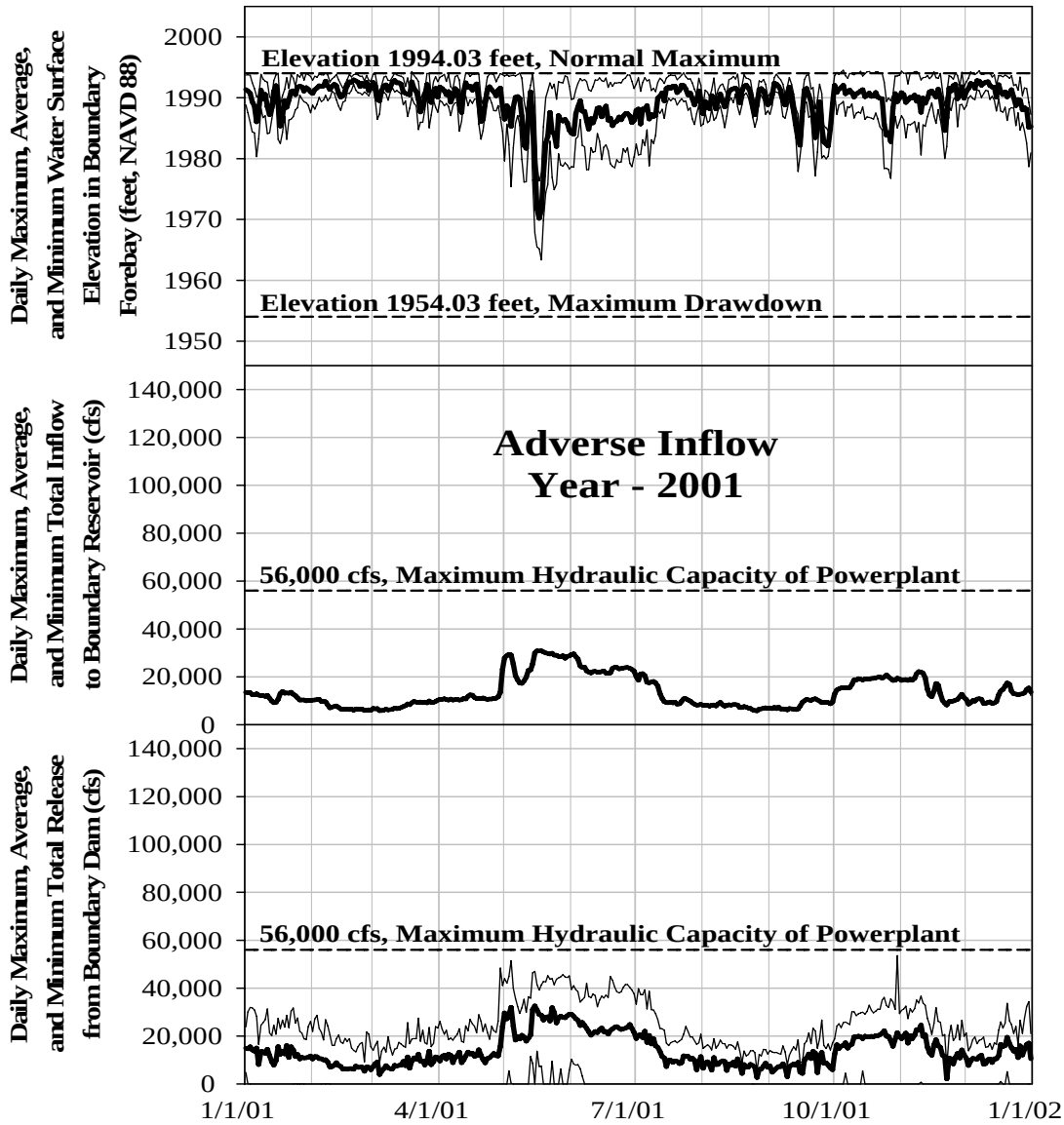


Figure E.2-6. Daily maximum, average, and minimum water surface elevation in Boundary forebay, total inflow to Boundary Reservoir, and total release from Boundary Dam during 2001 (an adverse inflow year)**.**

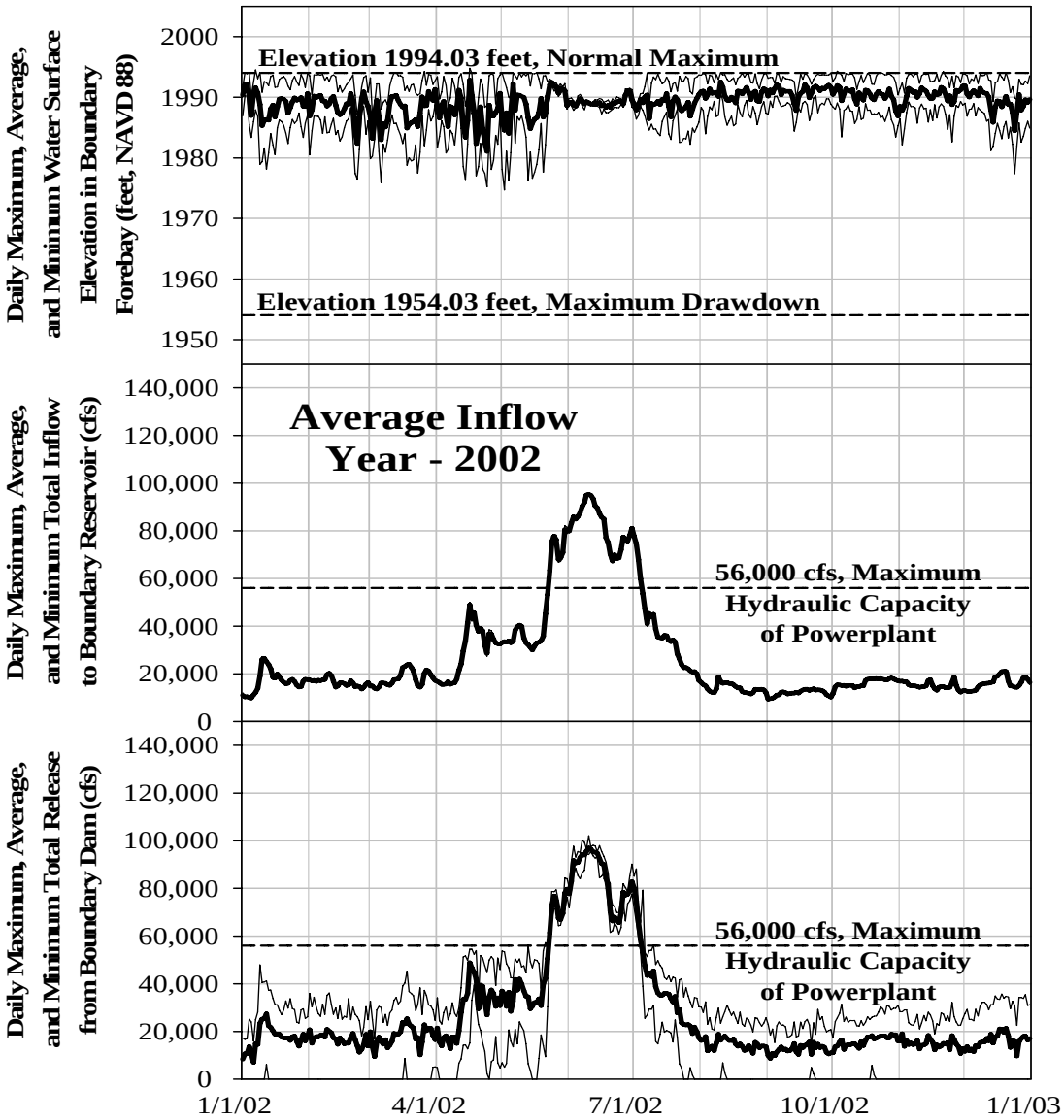


Figure E.2-7. Daily maximum, average, and minimum water surface elevation in Boundary forebay, total inflow to Boundary Reservoir, and total release from Boundary Dam during 2002 (an average inflow year).

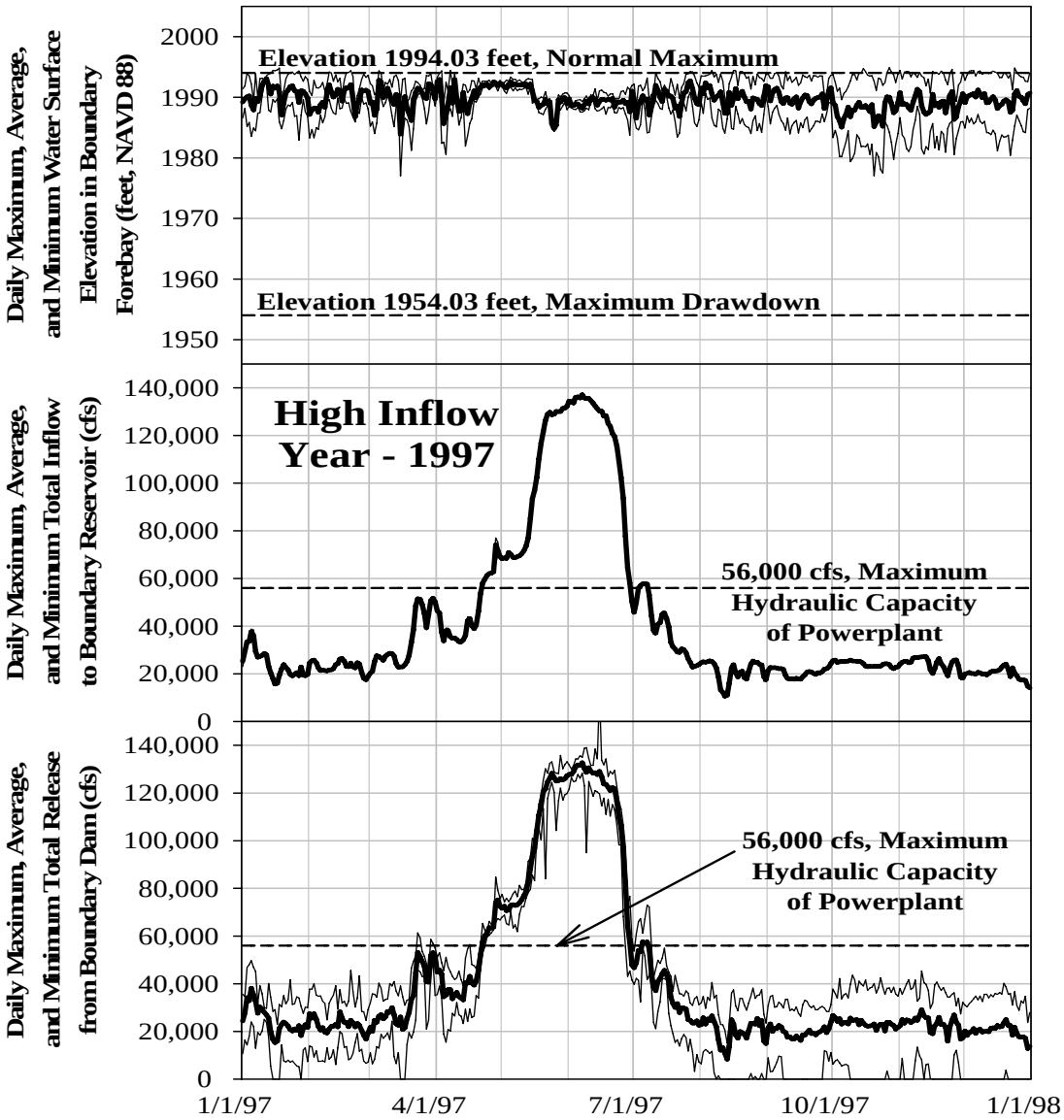
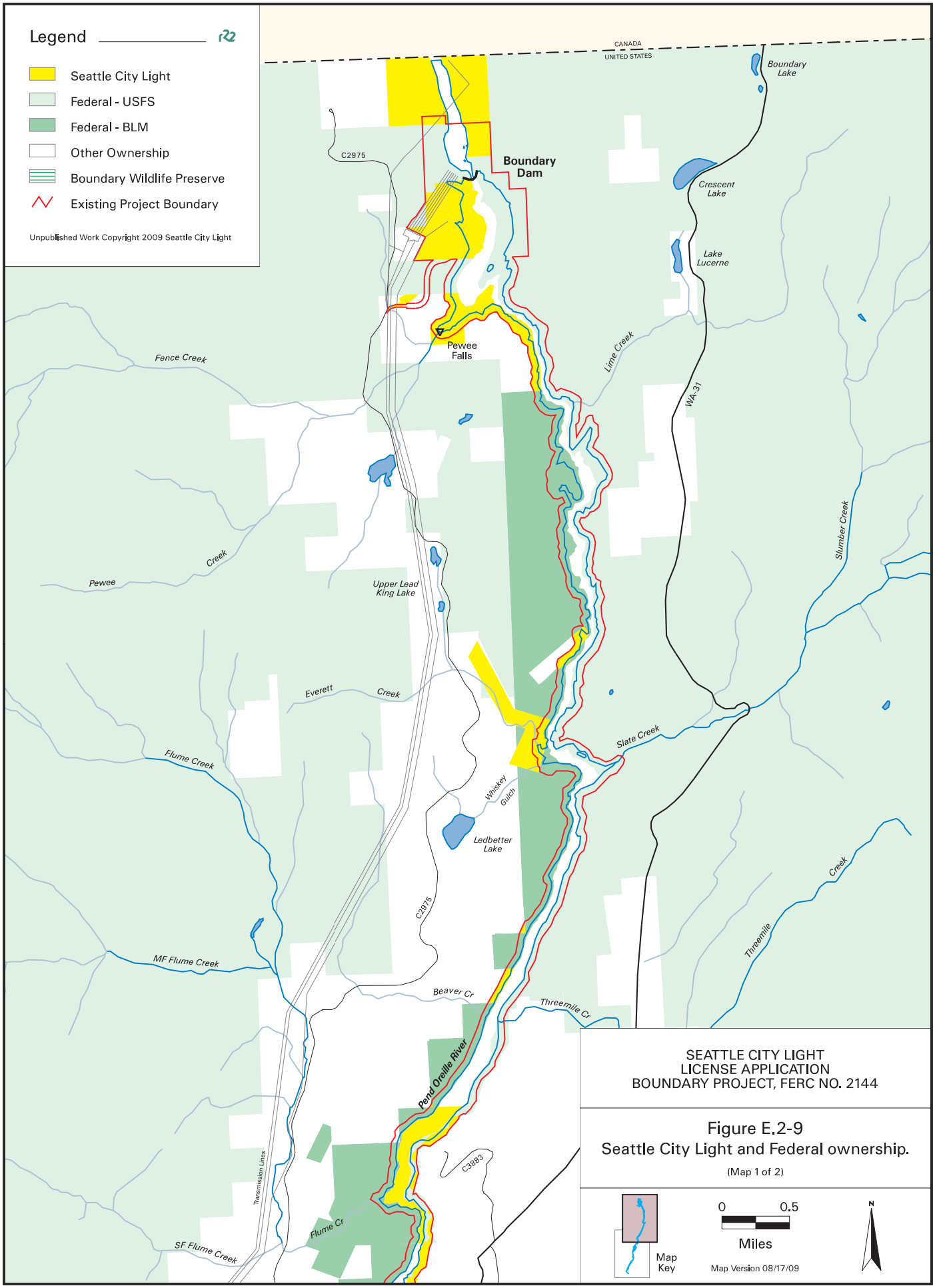


Figure E.2-8. Daily maximum, average, and minimum water surface elevation in Boundary forebay, total inflow to Boundary Reservoir, and total release from Boundary Dam during 1997 (a high inflow year).


Legend
Seattle City Light
Federal - USFS
Federal - BLM
Other Ownership
Boundary Wildlife Preserve
Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Boundary Lake
Boundary Dam
C2975
Crescent Lake
Lake Lucerne
Pewee Falls
Lime Creek
WA-31
Fence Creek
Slumber Creek
Pewee
Creek
Upper Lead King Lake
Everett
Creek
Slate Creek
Flume Creek
Whiskey Gulch
Ledbetter Lake
C2975
Threemile
Creek
MF Flume Creek
Beaver Cr
Threemile Cr
Pend Oreille River
C3883
Transmission Lines
Flume Cr
SF Flume Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.2-9
Seattle City Light and Federal ownership.
(Map 1 of 2)
Map Key
0
0.5
Miles
Map Version 08/17/09
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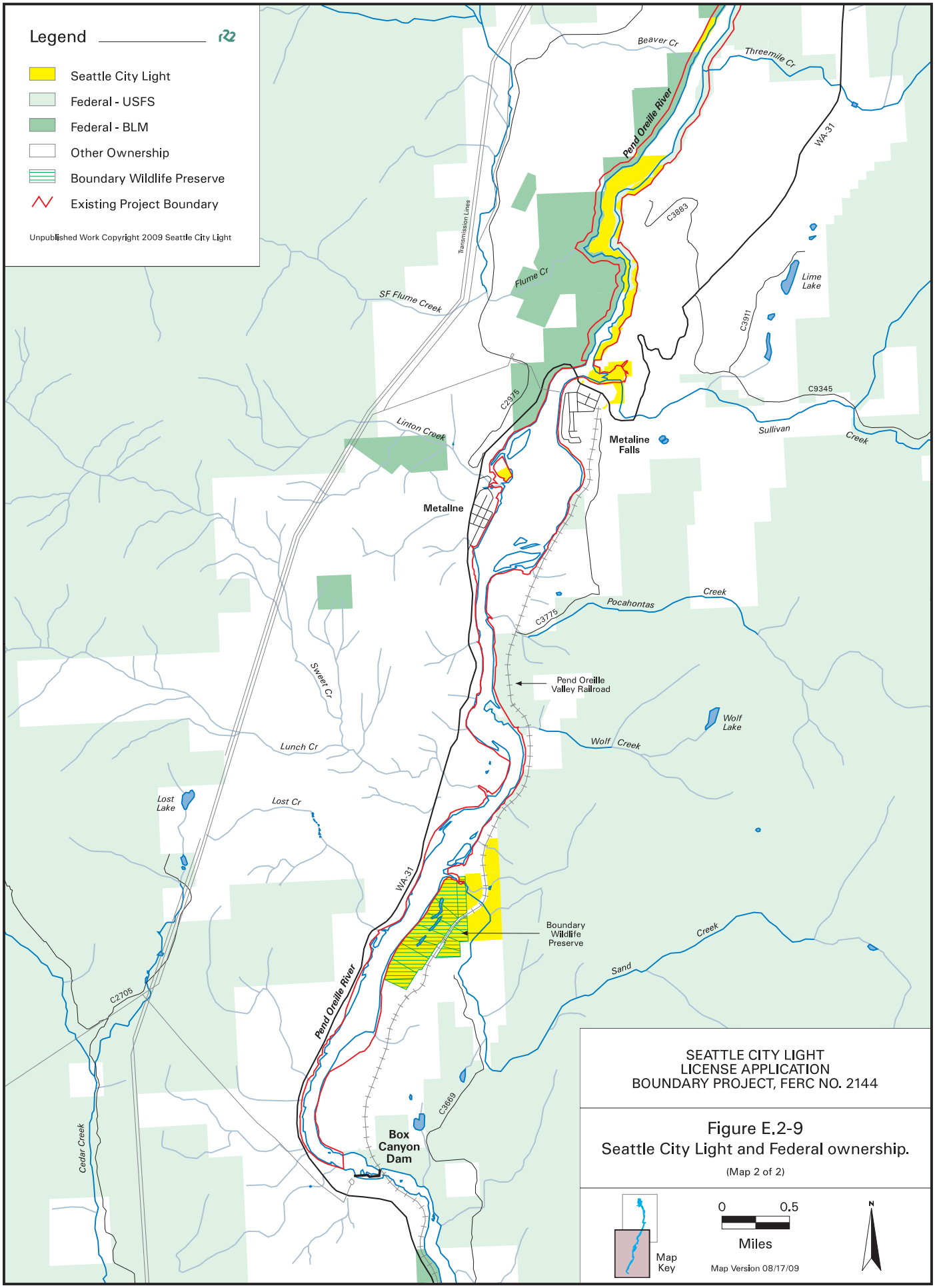
Legend
Seattle City Light
Federal - USFS
Federal - BLM
Other Ownership
Boundary Wildlife Preserve
Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
Beaver Cr
Threemile Cr
Pend Oreille River
WA-31
C3883
Transmission Lines
Flume Cr
SF Flume Creek
Lime Lake
C3911
C9345
C2975
Linton Creek
Metaline Falls
Sullivan
Creek
Metaline
Pocahontas
Creek
C3775
Sweet Cr
Pend Oreille Valley Railroad
Wolf Lake
Wolf Creek
Lunch Cr
Lost Lake
Lost Cr
WA-31
Boundary Wildlife Preserve
Sand
Creek
C2705
Pend Oreille River
C3669
Box Canyon Dam
Cedar Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.2-9
Seattle City Light and Federal ownership.
(Map 2 of 2)
Map Key
0
0.5
Miles
Map Version 08/17/09
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2.1.4. Existing Environmental Measures

2.1.4.1. Voluntary Restriction of Reservoir Drawdown in Summer

The Project is currently operated as a within-hour load following facility, with generation shaped to deliver power during peak-load hours. The current FERC license for the Project allows SCL to operate the forebay between 1,954 and 1,994 feet NAVD 88. However, the historic record shows that SCL has operated the reservoir within the top 20 feet (i.e., 1,974 - 1,994 feet NAVD 88) more than 90 percent of the time to maintain greater head and reduce unit cavitation. Typically, storage between elevations 1,974 feet and 1,954 feet NAVD 88 is reserved to respond to extreme system load requirements.

During the fall, winter, and spring when reservoir-based recreational activity is low, forebay water surface elevations fluctuate between elevation 1,994 feet and 1,974 feet NAVD 88, but from Memorial Day to Labor Day, SCL voluntarily restricts water surface fluctuations to facilitate reservoir access and related-recreational activities. The voluntary summer forebay pool restriction involves maintaining water surface elevation above 1,984 NAVD 88 from 6:00 am through 8:00 pm from Memorial Day weekend (starting Friday evening) through Labor Day weekend (on Monday evening). At night under the voluntary summer restriction, the forebay pool elevation is maintained above elevation 1,982 feet NAVD 88 from 8:00 pm through 6:00 am. Voluntary restriction of water surface elevation in summer may increase aquatic habitat stability, reduce potential fish stranding and trapping, increase primary and secondary aquatic productivity, and benefit riparian vegetation and its associated wildlife species.

2.1.4.2. Voluntary Turbine Unit Sequencing to Reduce TDG

SCL determined that operation of turbine Units 55 and 56 at specific generation levels can increase TDG in the Boundary Dam tailrace during non-spill conditions. It was determined that air admission through turbine Units 55 and 56 is the primary cause of the increased TDG levels. Air admission is required only when these units are operating at or below 125 MW. To reduce TDG under normal, non-spill operations, SCL has voluntarily implemented a provisional practice of operating these units above 125 MW and sequencing their startup and shutdown so that Units 55 and 56 are the last units to be brought on line and the first units to be shut down. A detailed account of the effects of turbine air admission at the Project and the steps taken to reduce TDG production during non-spill operations is provided in Section 5.4.7 of the Evaluation of Total Dissolved Gas and Potential Abatement Measures (TDG Evaluation) Final Report (SCL 2009a).

2.1.4.3. Boundary Wildlife Preserve

In association with the addition of Units 55 and 56, FERC License Article 51 directed SCL to "identify areas of Boundary Reservoir suitable for development as sub-impoundments to improve habitat for fish spawning and waterfowl nesting." SCL consulted with the Washington Department of Fish and Wildlife (WDFW) and the USFWS about the creation of an artificial slough, or installation of water control structures at PRM 32.8. However, this concept was dropped due to engineering constraints associated with the sandy soils at the site, limited benefits to wildlife, and the potential that such actions could adversely affect nearby riparian woodlands

(FERC 1987). As a substitute measure, SCL acquired 149[2] acres at this same location and established the Boundary Wildlife Preserve (BWP), consisting of slough, wetland, riparian, and upland forest habitats. SCL developed a Wildlife Management Plan (SCL 1988) for the BWP, which was submitted to FERC in 1988. The primary management goal of this plan is to protect the area from development and to maintain populations of native terrestrial and aquatic wildlife species and riparian and wetland communities within the BWP. At the time the BWP was established, the FERC Project boundary was not modified to incorporate the BWP. However, as part of this License Application, SCL proposes to adjust the Project boundary to include the BWP (maps showing the proposed Project boundary are provided in Exhibit G).

2.1.4.4. Recreational Facilities

SCL currently operates and maintains three public recreation sites at the Project: the Forebay Recreation Area, Tailrace Recreation Area, and Vista House. The Forebay and Tailrace recreation areas are located upstream and downstream of Boundary Dam, respectively. The Vista House is located immediately downstream of Boundary Dam on a promontory along the eastern bank of the Pend Oreille River. All three sites offer visitors unique interpretation and education (I&E) opportunities to learn about the Project and its operation and vantage points from which to observe Project features. SCL also maintains a Visitor's Gallery inside the power plant, affording visitors a view of the generator floor and interpretive exhibits that describe Project operations and the construction history of the Project.

2.1.4.5. Wastewater Treatment Facility Upgrades and Spill Prevention and Control

SCL upgraded the Project's onsite wastewater treatment facility to ensure protection of groundwater and surface waters against potential contamination. Effective March 4, 1998, SCL ceased all discharge from the Boundary Wastewater Treatment Plant to the surface waters of the Pend Oreille River, instead discharging the effluent from the treatment plant to an approved septic tank/drain-field system (Ecology 1998). In addition, SCL maintains and periodically updates a site-specific Oil Spill Prevention, Control, and Countermeasure (SPCC) Plan, which specifies measures to prevent potential spills of oil and other materials used at the Project as well as measures that would be employed to control and clean up any spills should they ever occur.

2.1.4.6. Triploid Rainbow Trout Planting Program

SCL has funded the annual planting of catchable-size triploid rainbow trout in the reservoir as a voluntary measure to increase sportfish harvest. The fish, ranging from 0.75 to 3 pounds each, are usually planted in the fall and early spring. From May 2001 through April 2008, an annual average of 7,099 triploid rainbow trout were planted in Boundary Reservoir. Anglers were requested to complete survey cards at area boat launches, and the planting program appeared to be well-received based on numerous positive comments added to the returned forms.

During a March 20, 2009 phone conversation with Al Solonsky (SCL), WDFW stated that it had evaluated SCL's triploid rainbow trout stocking program and determined that WDFW would no longer support SCL's planting of triploid rainbow trout and, therefore, no longer approve permits

[2] Due to parcel delineation updates, this summation has been changed from the previously cited value of 155 acres.

for releasing them into Boundary Reservoir. Reasons given by WDFW for discontinuing the program are as follows: (1) the program is ineffective in terms of return to the creel, i.e., the number of fish caught relative to the number planted; (2) too many triploid rainbow trout are passed downstream of Boundary Dam; (3) triploid rainbow trout might compete with native salmonids for food or habitat; and (4) anglers targeting triploid rainbow trout at the mouths of tributaries during summer might increase the inadvertent harvest of native salmonids and impact native fish recovery efforts (Robison, D. and N. Baker, WDFW, personal communication, March 20, 2009).

However, during a subsequent discussion (Robison, D., WDFW, personal communication, May 22, 2009) on May 22, 2009, SCL and WDFW agreed to stock triploid rainbow trout in Boundary Reservoir in 2009. Specifics of the agreement were as follows: (1) SCL purchased approximately 4,000 triploid rainbow trout from Troutlodge and released approximately 2,000 of them in the Boundary Dam forebay; the remaining 2,000 were released in Crescent Lake, Big Meadow Lake, and two other lakes in the vicinity; (2) SCL received a transport permit from WDFW for the distribution of the fish as described above; (3) permission for the releases described above was granted for spring 2009 only, i.e., no fall stocking was permitted; and (4) this approach was an attempt to address the local community's concerns regarding recreational fishing opportunities in 2009, while also addressing WDFW's concerns regarding potential effects of triploid rainbow trout on native salmonids in the reservoir.

2.1.4.7. Socioeconomics

SCL undertakes the following actions associated with the Project related to socioeconomics:

- *Low-cost power* – As a condition of its existing license, SCL provides up to 48 MW of electricity priced at SCL's cost of production at the Project to the Pend Oreille County PUD (PUD), which the PUD uses to serve its retail customers. Under an agreement with the PUD, SCL will continue to provide this low-cost power for the term of the new Project License (SCL 2005) (See Section 4.5.10 of this Exhibit E for power values).
- *Compensatory payments* – SCL has provided funding annually to Pend Oreille County through a local Impact Fee Agreement, in effect from 1998 - 2008. The County dispersed these funds to three local towns (Ione, Metaline, and Metaline Falls), and three County school districts (Newport, Cusik, and Selkirk). These payments varied by a negotiated amount but were approximately $1.2 million annually. In 2008 the payment was $1,315,137 (Rennie, L. SCL, personal communication, December 2008). SCL is currently engaged in negotiating a new agreement with representatives of Pend Oreille County, with the intent of continuing payments for the period 2009 - 2019.
- *Fire protection contract* – SCL has a contract for fire protection service from Pend Oreille County Fire District #2, which for the year 2008 totaled $42,035.

2.1.4.8. Noxious Weed Management

SCL manages noxious weeds at the Project to comply with applicable state and county weed control laws. These management activities are conducted in coordination with the Pend Oreille County Noxious Weed Control Board. The primary treatment methods employed at the Project are mowing and herbicide application.

2.2. Alternatives Considered But Eliminated from Detailed Study

Some alternatives to relicensing the Project were considered by FERC and eliminated from detailed study because they are not reasonable under the circumstances or they are not advocated by any of the entities involved in this proceeding (FERC 2006). These alternatives are (1) federal government takeover, (2) issuance of a non-power license, and (3) Project retirement. The following sections provide the basis for the dismissal of these alternatives.

2.2.1. Federal Government Takeover of the Project

SCL is a municipal entity, and as such, federal takeover of the Project was barred by Congress in the Act of August 15, 1953, 67 Stat.587. Moreover, no party has suggested that federal takeover would be appropriate, and no federal agency has expressed an interest in operating the Project.

2.2.2. Non-Power License

No party has sought a non-power license, and there is no basis for concluding that the Project should no longer be used to produce power. Thus, a non-power license is not a reasonable alternative to a new license with PM&E measures.

2.2.3. Project Retirement

Project retirement could be accomplished with or without dam removal. Either alternative would involve denial of a License Application and surrender or termination of the existing license with appropriate conditions. Dam removal has not been recommended by any party, and there is no basis for recommending it or studying it as an alternative. Decommissioning, involving the retention of the dam but the disabling or removing of power generation equipment, has not been suggested by any party as a reasonable alternative to Project relicensing. Nor is there any basis for recommending it. Because the power supplied by the Project is needed, a source of replacement power would have to be identified. A replacement resource would be substantially more costly, produce air emissions, and require consumptive water use, all as described in Exhibit H of this License Application. As a result, removal of the electric generating equipment is not considered to be a reasonable alternative.

2.3. Proposed Action

2.3.1. Proposed Project Operations

Under the new FERC license term SCL proposes to operate the Project as it is currently licensed, but with the formalization of two currently voluntary operational measures: forebay water

surface elevation restrictions primarily for summer recreation enhancement and turbine unit sequencing to reduce TDG production. Existing Project operations are described in Section 2.1.2 of this Exhibit E, and the voluntary measures to be formalized are described below.

From Memorial Day weekend (starting Friday evening) through Labor Day weekend (on Monday evening), forebay water surface elevations will be maintained at or above 1,984 NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use. From 8:00 pm through 6:00 am, forebay water surface elevations will be maintained at or above elevation 1,982 feet NAVD 88. Under SCL's proposed operation, the 1,984- and 1,982-foot NAVD 88 elevations would be license requirements that could not be violated except under conditions such as equipment failures, maintenance activities, electrical and mechanical device limitations, safety inspections, testing, natural disasters (e.g., lightning), compliance with Western Electricity Coordinating Council (WECC) and North American Electric Reliability Council (NERC) requirements, capacity and energy emergencies, and any event that triggers the Project Emergency Action Plan (EAP).

From Labor Day weekend to Memorial Day weekend, operating the Project as it is currently operated will result in forebay water surface elevations generally fluctuating between 1,994 feet and 1,974 feet NAVD 88, and minimum forebay elevations will often be above 1,980 feet NAVD 88 and will only occasionally be below 1,974 feet NAVD 88. The range of water surface elevations for dry (adverse) (2001), average (2002), and wet (high) (1997) inflow years is shown in Figures E.2-6 through E.2-8 and discussed in Section 2.1.2.3 of this Exhibit E.

To reduce TDG under normal, non-spill operations, SCL will operate Units 55 and 56 above 125 MW and sequence their startup and shutdown so that they are the last units to be brought on line and the first units to be shut down (see Section 5.4.7 of the TDG Evaluation Final Report, SCL 2009a).

Both of the formalized operational measures–forebay water surface elevation restrictions primarily for summer recreation enhancement and turbine unit sequencing to reduce TDG production–will be accomplished by programming and documenting (Numbered Dispatching Memoranda) these measures as administered by SCL’s System Control Center.

During the new license term, SCL plans to upgrade equipment at the Boundary Dam power plant (see Section 2.3.2). Proposed upgrades to the turbines may reduce or eliminate the conditions that in the past have led to TDG production during non-spill operations. When the proposed turbine upgrades are completed, SCL plans to reevaluate the need for the unit sequencing identified above and adjust the approach to, or eliminate, the sequencing restrictions as appropriate.

2.3.1.1. Estimates for Average Annual Energy and Dependable Capacity

The SCL integrated modeling approach was designed to use a common and historically consistent flow-based dataset to assess and compare several operation scenarios relative to potential resource benefits or to reduce resource impacts (SCL 2009a). To provide a consistent comparison among existing and alternate operations, Project operations were modeled using the Scenario Tool (ST) (further described in Exhibit B and Exhibit E, Section 4.4). For a given alternative, the ST used real Project operating parameters and historic hydrologic data (dry [adverse], average, and wet [high] inflow years) to produce the most efficient or optimized hourly total plant generation (megawatt hour [MWh]) based on perfect foresight of historic inflow conditions. Because the ST is consistent in applying optimization to hourly historic inflows, the ST does not exactly reproduce the historic day-to-day energy production due to variations in load demand, weather, operation and maintenance activities, emergency operations, and other operational decisions.

Proposed Project operations are based on the average inflow year (2002) since it has an annual average inflow that is close to the Projects' +94 year record long-term average inflow. The estimated total average annual energy produced at the Project based on the average year (2002) hourly inflows is 4,110,505 MWh based on optimizing Project operations, as shown in Table E.2-10. The actual 2002 energy produced by the Project was 3,961,282 MWh, which is less than a 4 percent difference relative to the modeled total average annual generation. This difference is primarily due to the ST's consistent, perfect foresight of actual hourly 2002 inflow conditions that optimize operations, which results in a slight increase in total annual energy production when comparing modeled to actual generation.

Table E.2-10. Boundary Project monthly and total generation (in MWh), proposed (modeled) and actual for the average flow year (2002).

Month	Average year (modeled)	Average year (actual)
January	245,915	248,177
February	220,897	218,727
March	267,160	260,726
April	410,274	401,210
May	602,493	586,461
June	768,952	701,218
July	513,778	491,306
August	209,788	212,811
September	171,178	174,292
October	243,759	230,343
November	219,708	206,131
December	236,603	229,880
Total	**4,110,505**	**3,961,282**

Because the Project has little storage (pondage) capacity, dependable capacity is based on the historic critical flows (see Exhibit B, Section 2.1.4, Critical Flow Months) for January and August 1988 with regard to energy generation when high demand coincided with low flows during winter and summer peak demand seasons, respectively. Using the average flow of 10,100 cfs for January 1988 and the 20 feet of usable pond from elevation 1,994 to 1,974 feet NAVD 88, a dependable capacity of approximately 1,040 MW for 3 hours could be attained by the Project during critical winter demand based on modeled results. Using the average flow of 6,400 cfs for August 1988 and the 20 feet of usable pond from elevation 1,994 to 1,974 feet NAVD 88, a dependable capacity of approximately 1,040 MW for 1 hour could be attained by the Project during critical summer demand based on modeled results.

2.3.2. Proposed Power Plant Equipment Upgrades, Other Improvements, and Maintenance Activities

SCL proposes to install new high efficiency turbines in Units 55 and 56. The turbine runner upgrades would increase efficiency, i.e., they would use the same flow to produce a greater amount of energy and would have a higher total generation capacity. The turbine runner efficiency upgrades would be performed concurrently with planned electrical generator rewinds and step-up transformer replacements. The generator rewinds are scheduled for Years 1 and 2 after license issuance.

Reconnaissance-level engineering and cost studies for the turbine runner upgrades were performed in 2008 and 2009. Results indicate that the installed capacity for each turbine would increase from 200 MW to 215 MW (i.e., the electrical output from the generator) for an increase of total Project capability from 1,040 MW to 1,070 MW and an estimated increase in average annual generation of 39,838 MWh. Cost estimates for this effort are detailed in Exhibit D of this License Application.

SCL anticipates rebuilding the generators and replacing runners approximately every 30 years. All Year designations are based on a license issuance date of 2011. Generator rebuilding and runner replacement for Units 55 and 56 are scheduled for approximately Years 28-32 following license issuance and Years 29-33 following license issuance, respectively.

SCL also plans to rewind the generators and replace the runners and transformers for Units 51 through 54 during the new license term; however, it is not expected at this time that these changes would result in an increase in capacity or generation. The proposed schedule for rebuilding and replacing turbine runners in units 51, 52, 53, and 54 is outlined below.

The approximate schedule for rebuilding units is as follows:

- Unit 54 - Years 4-6 and Years 34-36 following license issuance
- Unit 53 - Years 5-7 and Years 35-37 following license issuance
- Unit 51 - Years 6-8 and Years 36-38 following license issuance
- Unit 52 - Years 7-9 and Years 37-39 following license issuance

The approximate schedule for replacing the turbine runners is as follows:

- Unit 54 - Years 17-19 and 47-49 following license issuance
- Unit 52 - Years 18-20 and 48-50 following license issuance
- Unit 53 - Years 19-21 and 49-51 following license issuance
- Unit 51 - Years 20-22 and 50-52 following license issuance

SCL plans to undertake other major improvements that likely would require shoreline or other permit approvals due to project scope or project activities, such as in-water work or ground disturbance. These projects include:

- Replacing the step-up transformer – early in the new license term, and again 40 years later (approximately Years 1-5 and Years 41-45 following license issuance).
- Stabilizing rock slopes above the transformer banks by constructing a road up to the pickle folks, removing trees and shrubs, and scaling/removing surface rock – early in the new license term and then approximately every 25 years (approximately 2009-2014 [Year 3], Years 23-24, and Years 48-49 following license issuance).
- Hardening the forebay wall by dropping the water level in the forebay and applying shotcrete to the rock face to reduce spalling – approximately one year after license issuance (approximately Years 1-7 following license issuance).

Minor capital improvement projects (CIP) are difficult to predict but likely would include continued structural improvement of the facilities and grounds, continued NERC compliance, control and network improvements, continued forebay stabilization efforts (and, potentially, periodic forebay dredging), replacement of information technology (IT) and security systems, groundwater control in the power plant and dam, refurbishing buildings and improvements to service, recreation and tourism areas, dam safety instrumentation upgrades and new installations, generator operational improvements, gate upgrades (all varieties), safety projects, sump and other containment improvements, well decommissioning, service water piping replacement, lighting systems, protective relaying, shaft seal replacements, draft tube discharge improvements, high-voltage breaker and switchgear replacements, infrastructure improvements, and communication projects.

SCL also anticipates recurring operations and maintenance (O&M) activities. As with the major CIP projects, the more extensive projects would include ground disturbance, work in the regulated shoreline, or other activities that would require permit approvals. For structures that are normally submerged, the structures either would be removed to conduct the work (e.g., sluice maintenance gate refurbishment) or conducted in the dry (e.g., trash rack refurbishment). Such O&M projects potentially include:

- Sluice maintenance gate refurbishment – approximately 2010-2011 (i.e., prior to issuance of the new license) and then approximately every 10 years, as needed.

  - Site preparation includes removing up to 10 cubic yards of accumulated sediment from an area approximately 50 x 300 feet and replacing it with coarse gravel to accommodate the 300-ton sluice maintenance gate and the trucks and dollies necessary to move it to a dedicated location in the Forebay Recreation Area.
  - Once on land, the operating mechanism would be disassembled and repaired, and the gate completely blasted and repainted with a lead-free coating. Much of the work would occur under cover; the old paint would be contained and disposed of according to applicable regulations.
  - Work associated with the sluice maintenance gate requires drawing down the reservoir to 1,970 feet NAVD 88 twice in one year to inspect and remove the gate and once in the following year to reinstall the gate. If reinstallation of the gate in 2011 is delayed, some of the current work could occur in Year 1 following license issuance. Future repairs would follow a similar two-year schedule.

- Trash rack refurbishment – approximately Year 1 following license issuance and then approximately every 30 years (Year 31 following license issuance).
- Septic system maintenance (including excavation, grading, and potential installation of new system if necessary) – approximately Years 16-17 following license issuance.
- Draft tube gate refurbishment (12) – approximately Years 17-19 following license issuance.
- Spill gate refurbishment – approximately Years 19-21 following license issuance.
- Domestic water system replacement (including excavation, grading, and installation of replacement domestic water system) – approximately Years 19-21 following license issuance.
- Sluice gate refurbishment – approximately Years 24-25 following license issuance.
- Head gate and hoist refurbishment – approximately Year 25 following license issuance.
- Transmission conductors repairs/replacement – approximately Years 50-51 following license issuance.

Exhibit C (Table C.3-1) summarizes the general timeframes for the major planned and proposed Project development.

2.3.3. Proposed Environmental Measures

2.3.3.1. Geology and Soils

SCL's proposed PM&E measures associated with geology and soils resources are described in Section 4.5.1.3 of this Exhibit E. SCL will implement erosion control measures at the following locations to mitigate for Project-related erosion losses: Erosion Site 17W1 (Forebay Recreation

Area); Erosion Site 19W9 (BLM Boundary Recreation Area); and Erosion Site 21W19 (Dispersed Recreation Day Use/Overnight Campsite on BLM-Managed Land). SCL will also monitor ongoing erosion rates at select sites during the new license period. The erosion control measures and monitoring will be implemented, in coordination with RPs, as elements of the Terrestrial Resources Management Plan (TRMP). In addition, 89[3] acres of SCL land adjoining the BWP will be brought into the Project boundary and managed for wildlife purposes as part of a comprehensive response to loss of terrestrial habitat.

2.3.3.2. Water Resources

SCL's proposed PM&E measures associated with water resources are further described in Section 4.5.2.3 of this Exhibit E.

2.3.3.2.1. Peak Flood Flow Conditions above Metaline Falls

SCL proposes to acquire flood easements from private landowners in Metaline and Metaline Falls to compensate them for the incremental component of flooding that is Project-related and that occurs on rare occasions on their properties during high-flow events. Easement rights will be acquired to compensate landowners for the occasional flooding of these properties and will restrict building, filling, or excavating in the easement areas. Because these easements are unnecessary for normal Project operations, SCL does not propose to include any provisions relating to these easements in the new license.

2.3.3.2.2. Temperature

To help meet Ecology's temperature improvement goals for the Pend Oreille River, a variety of measures that would improve habitat conditions for aquatic species in the Pend Oreille River system, including thermal refugia, will be implemented, including tributary riparian plantings, stream channel modifications, large wood supplementation, bank improvement, and culvert replacement activities described in the Fish and Aquatics Resources section (Section 4.5.3.3) of this Exhibit E.

2.3.3.2.3. Total Dissolved Gas

As required by the Water Quality Standards for Surface Waters of the State of Washington 173-201A-510(5)(b) and Washington Administrative Code (WAC) 173-201A-510(5)(b)(iii) for projects that cause or contribute to a violation of the TDG standard, SCL is submitting a Total Dissolved Gas Attainment Plan for the Project (see Section 4.5.2.3). SCL will evaluate and implement as appropriate the following measures designed to attain TDG compliance at the Project, consistent with the approved TDG total maximum daily load (TMDL): throttle sluice gates, which involves operation of sluice gates in partially open positions; roughen sluice flow, which entails modification of the sluice gate outlets to break up and spread flow; spillway flow splitter/aerator, which entails modifying the spillways to aerate, break up, and spread flow. The three gate alternatives all involve spilling flow through existing outlets (the seven sluice gates and two spillway gates) into the tailwater plunge pool and rely on reduction in TDG production by spreading the flow and limiting plunging effects of the confined water jets.

[3] The size of the adjoining SCL-owned parcels is 89 acres, not 88 acres as previously reported.

2.3.3.2.4. Dissolved Oxygen

As required by the Water Quality Standards for Surface Waters of the State of Washington 173-201A-510(5)(b) for projects that cause or contribute to a violation of water quality standards, SCL is submitting a Dissolved Oxygen (DO) Attainment Plan for the Project (see Section 4.5.2.3). SCL proposes a monitoring program to better define the magnitude and spatial and temporal extent of DO concentrations below 8.0 mg/L in the Project area. Temperature and pH data will be collected simultaneously with DO data. SCL proposes a five-year DO monitoring plan as described in Section 4.5.2.3 of this Exhibit E, including annual reporting and consultation with Ecology, to be implemented following issuance of the 401 certificate for the Project and the new FERC license.

2.3.3.2.5. Aquatic Macrophytes and Potential Invasive Species

SCL proposes to install bottom barriers to reduce the risk of macrophyte-related fish stranding and trapping, benefit recreational use by creating boat lanes free of macrophytes, and reduce boat contact with invasive macrophytes to lower the risk of their dispersal to other locations (within and outside the Project area). In some locations in the reservoir, submerged macrophytes have been shown to reduce the ability of fish to escape from stranding and trapping areas by blocking routes of egress during periods of declining water surface elevation (see the Mainstem Aquatic Habitat Modeling Final Report, SCL 2009a). Bottom barriers will be installed at the following four locations where invasive macrophytes are abundant: Everett Island side channel, Metaline Pool, across from the Town of Metaline, Fish Stranding and Trapping Region 9 (PRM 28.8), and Fish Stranding and Trapping Region 11 (PRM 30.3).

To monitor for zebra and quagga mussel colonization, SCL will install artificial substrate samplers at two public boat launches in Boundary Reservoir: i.e., the Forebay Recreation Area boat launch and the Metaline Waterfront Park Boat Launch. SCL will conduct New Zealand mudsnail surveys in the vicinities of the same two boat launches.

SCL proposes to implement an I&E program aimed at reducing the potential for the spread of invasive macrophyte species, zebra and quagga mussels, and mudsnails. Signs will be installed at boat launches as part of a larger public education program.

2.3.3.3. Fish and Aquatics Resources

2.3.3.3.1. Gravel Augmentation below Box Canyon Dam

SCL proposes to increase mountain whitefish spawning opportunities by augmenting gravel levels by a total area of 4,500 square yards split among three sites in the Upper Reservoir between PRM 29.1 and Box Canyon Dam. Average depth of augmented gravel would be 1 foot, resulting in a total augmented volume of 1,500 cubic yards. SCL proposes to replenish up to 25 percent of the initial volume, as needed, at each site every five years.

2.3.3.3.2. Channel Modifications for Mainstem Trapping Pools at Project RM 30.3

SCL proposes to modify four pools, totaling about 67,320 square feet, within the Cobble Sisters area of the reservoir near PRM 30.3 (i.e., Stranding and Trapping Region 10). The modifications would include excavation of a 1,800-foot channel to connect three fish trapping pools and using

spoils from excavation to fill one trapping pool. The objective of this measure would be to maintain a wetted connection between the pools and the mainstem reservoir under proposed operations. The measure would reduce the current risk to fish of being trapped in pools during periods of declining reservoir water surface elevation.

2.3.3.3.3. Upstream Fish Passage

SCL proposes to develop a trap-and-haul facility to provide upstream passage for native salmonids 3.9 inches (100 millimeters [mm]) and larger. Because of the low abundance of native salmonids in the tailrace and the uncertainty regarding the feasibility of implementing a permanent upstream passage solution, SCL is proposing a phased approach to addressing the need for upstream passage. Phase I will result in the design and construction of a temporary floating trap-and-haul facility and generate biological information that will be used to determine alternative locations and periods for deploying the temporary facility. Phase II will consist of deploying the temporary facility at the locations and during the periods identified as part of Phase I and identifying the best location(s) for deploying a potential permanent trap-and-haul facility. Phase III will involve operation of a permanent trap-and-haul facility at a fixed location or a long-term temporary trap-and-haul facility that could be deployed on a seasonal basis and operated at various locations.

2.3.3.3.4. Mainstem Engineered Large Woody Debris at Tributary Deltas

SCL proposes to enhance tributary delta habitat by providing additional cover for salmonids through placement of engineered large woody debris (LWD) jams in the upper delta regions of Sullivan, Sweet, Slate, and Linton creeks. Sullivan Creek would receive two LWD jams and Slate, Sweet, and Linton creeks would each receive one LWD jam. LWD jams would be sized based on tributary delta size: each LWD jam in Slate Creek, Sweet Creek, and Linton Creek would have a target volume of 529 cubic feet, and LWD jams in Sullivan Creek would have a target size of 1,700 cubic feet. LWD jam designs would be based on engineering guidance provided by WDFW.

2.3.3.3.5. Boundary Reservoir Fish Community Monitoring

SCL proposes to conduct fish community surveys in Boundary Reservoir, Boundary Dam tailrace, and select tributaries at five-year intervals to obtain information on trends in the size and composition of the fish community. Information for Boundary Reservoir will be collected for each of the three major reaches: Forebay, Canyon, and Upper Reservoir. Tributaries to be surveyed include Slate, Flume, Sullivan, Sweet, Linton, and Sand creeks. SCL anticipates that the level of effort and techniques used will be similar to previous efforts so that trend data will be comparable across years. At a minimum, the techniques to be used will include electrofishing, gill netting, and snorkeling.

2.3.3.3.6. Habitat Protection, Riparian Improvement, and Stream Channel Enhancement in Sullivan Creek from RM 0.00 to 0.54

This measure involves three components–habitat protection, riparian improvement, and stream channel enhancement–that will be implemented between the mouth of Sullivan Creek and at RM 0.54 (just downstream of the Highway 31 Bridge and the Sullivan Creek Hydroelectric Project [FERC Project No. 2225] boundary). Habitat protection would protect up to 54.7 acres within

the stream corridor and a buffer adjacent to Sullivan Creek from RM 0.00 to 0.54 through a combination of conservation easements and land acquisition. Riparian improvement would occur along the left and right banks for up to 3,000 feet of stream, with the objective of improving riparian functions (i.e., shade, potential instream LWD, and erosion control), improving riparian habitat for wildlife, and decreasing the presence of invasive plant species. Stream channel enhancement would improve instream fish spawning and rearing habitat and channel conditions along 1,450 feet of stream by adding a combination of structural elements, primarily in the form of groins, barbs, porous boulder weirs, boulder clusters, and LWD. Addition of structural elements would contribute to pool formation and retention of LWD and coarse sediment suitable for salmonid spawning. Structural elements along the left bank would help stabilize the stream bank, decreasing bank erosion and protecting downstream property owners. Up to 100 boulders averaging 3 feet in diameter would be placed in the stream.

2.3.3.3.7. Riparian, Streambank, and Channel Improvements in Sullivan Creek from RM 2.30 to 3.93

This measure will enhance Sullivan Creek from approximately 265 feet downstream of the confluence of Sullivan Creek and North Fork Sullivan Creek to the Sullivan Creek Hydroelectric Project boundary downstream of Mill Pond Dam. The measure will focus primarily on streambank and channel enhancement but will also include a limited amount of riparian planting in conjunction with streambank enhancement. The objective would be to deflect water from the right bank to the left bank in areas hydrologically connected to Sullivan Lake Road, decrease bank erosion on the right bank, provide instream structure to promote pool creation and deposition and retention of spawning gravel, decrease the channel width-to-depth ratio, and promote the riparian buffer along right bank. This measure would implement the design and construction of up to seven engineered LWD jams. Each LWD jam would have a target volume of 1,100 cubic feet. Up to 100 boulders averaging 3 feet in diameter would be placed in the stream, primarily in boulder clusters, and be used to anchor LWD pieces.

2.3.3.3.8. Culvert Replacements in Slate Creek Tributaries Slumber Creek at RM 0.2 and Styx Creek at RM 0.1

Culverts at Slumber and Styx creeks (RM 0.2 and 0.1, respectively) will be replaced with new culverts that meet Washington State criteria. The objective is to provide passage for juvenile, sub-adult, and adult salmonids at all flow levels and provide access to more than 0.3 miles of resident trout habitat available in Slumber Creek and more than 1.9 miles available in Styx Creek. A secondary objective is to improve downstream transport of LWD. As part of culvert replacement, riparian planting will occur as needed in disturbed areas to control erosion and provide shade.

2.3.3.3.9. Riparian Planting in Linton Creek RM 0.0 to 0.2

This measure would involve implementation of riparian improvements along the left and right banks of Linton Creek for up to 655 feet of stream upstream of the mouth, with the objective of improving riparian functions (i.e., shade, potential instream LWD, leaf and needle litter, erosion control, etc.), improving riparian habitat for wildlife, and decreasing the presence of invasive plant species. Any non-native vegetation found in the reach within a 100-foot buffer on both sides of the stream (total area approximately 3.0 acres) will be removed and replaced with native

vegetation. Plants will be a mix of native coniferous and deciduous trees, shrubs, and herbaceous plants or ground cover.

2.3.3.3.10. Channel Improvements in Sweet Creek from RM 0.4 to 0.5

This measure will be undertaken to increase channel complexity and gravel retention through LWD placement over a 558-foot reach downstream of the Highway 31 culvert. The bankfull width of Sweet Creek is approximately 33 feet in this reach, making it suitable for placement of channel-spanning LWD. Up to 10 channel-spanning structures will be installed to reduce erosion. As part of post-license planning, other types of structural elements, such as partial spanning structures, porous boulder weirs, or boulder clusters, could be substituted for proposed elements.

2.3.3.3.11. Riparian Buffer Protection and Improvement in Sweet Creek from RM 0.0 to 0.5

SCL will pursue the acquisition of or protective land easements for 11.8 acres within a 100-foot buffer (excluding existing roads) on either side of Sweet Creek from the mouth to RM 0.5, which is the location of the Highway 31 culvert. SCL proposes to remove non-native vegetation and plant native brush and trees over 3.3 acres within that buffer. The majority of plantings would occur over a 3-acre area near the mouth of Sweet Creek where trees are mostly lacking, but would also include a 0.3-acre area north of the access road.

2.3.3.3.12. Tributary Non-native Trout Suppression

SCL will conduct non-native trout suppression activities over an average of 5.8 miles of stream annually using a single-pass of backpack electrofishing equipment. The basis for this amount of stream is the assumption that suppression would occur over 2.4 miles of Sweet Creek, between the barrier falls at RM 0.92 and the fish bearing headwaters, except for Lunch Creek, on a three-years-on/two-years-off cycle. Suppression will also occur over 7.3 miles of Slate Creek, between the barrier chutes and falls at RM 0.75 and the fish bearing headwaters, also with a single-pass of a backpack electrofishing unit on a three-years-on/two-years-off cycle. SCL selected these two creeks because they have barrier falls that will prevent immigration of non-native fish residing downstream and non-native fish populations appear to be moderate in size.

2.3.3.3.13. Native Trout Supplementation Facility

SCL proposes to fund the construction and operation of a hatchery for the production of native salmonids to supplement tributaries draining into Boundary Reservoir. The initial target species would be Westslope cutthroat trout, but the facility would be designed to simultaneously propagate two species of fish, which could include bull trout, Westslope cutthroat trout, redband trout, or mountain whitefish. The target capacity for the hatchery would be up to 45,000 eyed eggs, fry, or fingerlings (3 to 4 inch) per year (approximately 1,000 pounds per year if all were reared to fingerling-size). In addition, the hatchery would have the capacity to sustain the necessary numbers of broodstock to produce this number of eggs, fry, or fingerlings. Because mature Westslope cutthroat trout tend to be small in Boundary Reservoir tributaries, SCL estimates broodstock requirements could be 200 to 300 fish, assuming 500 eggs per female. Assuming an average size of 2.2 pounds per fish, broodstock rearing capacity would need to be approximately 440 to 660 pounds.

2.3.3.4. Terrestrial Resources

SCL's proposed PM&E measures associated with botanical and wildlife resources are described in sections 4.5.4.3 and 4.5.5.3, respectively, of this Exhibit E. Environmental measures related to botanical and wildlife resources will be implemented, in coordination with the resource agencies, under the TRMP. Elements of the plan related to botanical resources include an Integrated Weed Management Plan (IWMP), a Rare, Threatened, and Endangered (RTE) plant monitoring program, and management of habitat on SCL-owned lands located within the Project boundary. The TRMP also includes the following proposed mitigation measures for wildlife resources: monitoring of RTE and other wildlife, including bald eagles, peregrine falcon, osprey, and bank swallows; habitat enhancements on select SCL-owned parcels; and development of an adaptive management strategy that will respond to Project-related human disturbances and other Project-related effects. The TRMP also provides for erosion control at three locations along the reservoir as well as long-term erosion monitoring. In addition, SCL will incorporate an additional 89 acres of adjacent land into the Project boundary and manage these lands for biodiversity goals. SCL will implement Best Management Practices (BMPs) for operation and maintenance of Project facilities, which will ensure that activities are conducted in a way that protects, maintains, and enhances botanical and wildlife resources on Project lands.

2.3.3.5. Cultural Resources

SCL's proposed PM&E measures associated with cultural resources are described in Section 4.5.8.3 of this Exhibit E and the Historic Properties Management Plan (HPMP). SCL proposes to provide historic property treatment for three properties within the Project Area of Potential Effects (APE) that are eligible for the National Register of Historic Places (NRHP): the Josephine Mine Historic Mining District, the Pend Oreille Mine and Metals Company powerhouse, and the Carl Harvey Homestead archaeological site. SCL will develop interpretive materials for these facilities to be installed onsite where feasible and at the Project Visitor Center (Vista House), the Cutter Theatre in Metaline Falls, or another appropriate venue(s). SCL's proposed HPMP also provides for monitoring protocol that includes the three sites determined to be NRHP-eligible, as well as two prehistoric archaeological sites.

2.3.3.6. Recreation and Land Use

SCL's proposed PM&E measures associated with recreation resources are described in Section 4.5.9.3 of this Exhibit E. SCL has developed a Recreation Resources Management Plan (RRMP) to guide recreation use and management at the Project during the new license term. The RRMP includes the following programs:

- Recreation Capital Facility Improvements – this program focuses on recreation facility development and includes proposed locations, conceptual layouts, and descriptions for recreation facility development measures that will help meet current and anticipated future recreation needs at the Project.
- Operations and Maintenance – this program describes SCL’s responsibilities related to providing routine operations and maintenance (O&M) at Project-related developed recreation sites and use areas.

- Shoreline Dispersed Recreation Management – this program provides a framework for development and management of dispersed recreation sites along the Project reservoir shoreline.
- Recreation Monitoring – this program defines SCL's responsibilities to measure recreation use levels (including impacts, changes in visitor perceptions, needs, etc.) over time, thereby providing a basis for maintaining and enhancing the desired recreation experience and resources over the term of the license.
- Multi-Resource I&E – this program describes SCL's approach to providing I&E opportunities at the Project.

SCL's proposed PM&E measures associated with land use and roads are described in Section 4.5.9.3 of this Exhibit E. SCL proposes to adjust the current FERC Project boundary to include the West Side Access Road, the Operations and Maintenance Support Area, the BWP and the adjoining 89 acres, the proposed Metaline Falls Portage Trail, and portions of certain roads used exclusively or primarily for Project purposes.

A Shoreline Management Program consistent with FERC guidelines is included in the TRMP. The Shoreline Management Program identifies appropriate shoreline land uses to minimize potential environmental effects on sensitive plant and wildlife species and habitat and to protect and enhance the Project shoreline. It also recommends managing and coordinating private and public (non-federal) shoreline development permitting within the Project boundary. Finally, the Shoreline Management Program recommends managing debris accumulation and removal along the reservoir shoreline, particularly following spring runoff.

SCL has coordinated with the U.S. Forest Service (USFS) on a plan for the decommissioning of various forest roads that were used in the past by SCL to access groundwater monitoring wells installed by SCL but which are no longer needed. SCL proposes to close a spur off of Forest Road (FR) 3165-200 to public use and to decommission a spur off of FR 3165-340; both of these roads have been used in the past to access survey monuments. Greater detail regarding road closure and decommissioning can be found in Section 4.5.9.3 of this Exhibit E and the Road Decommissioning Plan (see Section 4.5.9.3). Additionally, SCL's plan for ongoing maintenance of roads used exclusively or primarily for Project purposes is presented in Section 4.5.9.3.2 of this Exhibit E.

2.3.3.6.1. Capital Facility Development Measures

Specific measures included in the Capital Facility Development Program are listed below. Any proposed new facilities or modifications to existing facilities will be subject to FERC review and approval. The Capital Facility Development Measures will also include Americans with Disabilities Act (ADA) regulations and guidance, general aesthetic/visual design guidelines, and an appropriate development scale level (which establishes the extent of development) to guide the design, construction, and management of Project recreation sites and facilities. Related to ADA regulations and guidance, FERC encourages "Universal Design" and "Universal Access" at FERC-licensed hydroelectric projects. Universal design typically refers to sites, facilities, and other features that are usable for all people, not just those with disabilities. SCL will consider universal design during the design phase of recreation capital improvements, but will generally

rely on ADA accessibility guidelines to help foster consistency between Project recreation sites located on federal and SCL-managed Project lands.

SCL proposes the following capital facility measures included in the RRMP:

- Forebay Recreation Area
  - Enhance campground facilities at this site: increase the number of designated RV and tent campsites (phased - up to approximately 22 to 25 total), better delineate campsites, provide appropriate signage, use vegetation and/or other site features (e.g., rocks) to create separation between campsites and day use picnic sites, and limit vehicle access to roads and parking areas.
  - Enhance day use picnic sites with signage, improved access, and separation from campsites.
  - Provide additional I&E signage and/or other visitor I&E opportunities (see I&E Program).
  - Extend an existing boat ramp lane so that boats can be launched/retrieved during the primary recreation season (Memorial Day weekend to Labor Day weekend) without problems due to fluctuating reservoir water surface elevations. Provide adequate parking, signage, and circulation at the boat launch.
  - Provide for a sluice maintenance gate area to be used approximately every 10 years, as needed.
  - Incorporate ADA enhancements into the design.
- Vista House Recreation Area
  - Add I&E signage and/or other opportunities at the overlook platform.
  - Incorporate ADA enhancements into the design.
- Tailrace Recreation Area/Machine Hall Visitors' Gallery
  - Update I&E signage, displays, and visitor opportunities at the Machine Hall Visitors' Gallery (see I&E Program) (the extent of upgrades at this site needs to be consistent with the level of anticipated use; security restrictions contribute to low use levels).
  - Incorporate ADA enhancements into the design.
- Peewee Falls Viewpoint and Trail
  - Develop a new trail in the vicinity of the Vista House access road to a viewpoint of Peewee Falls. The trail alignment would take advantage of the existing National Forest System (NFS) road network in this area.
  - Develop appropriate support facilities, including parking, vault toilet, and signage.
  - Incorporate ADA enhancements into the design.

- Metaline Falls Portage Trail
  - Develop a new portage trail in the vicinity of the falls to provide non-motorized boaters an alternative to avoiding or running the rapids at the falls under certain natural flow and Project operational conditions.
  - Provide I&E signage.
- Metaline Waterfront Park Boat Launch
  - Replace the existing boat launch and extend a boat ramp lane so that boats may be launched/ retrieved during the primary recreation season (Memorial Day weekend to Labor Day weekend) without problems due to fluctuating reservoir water surface elevations.
  - Provide adequate roadway access to the boat ramp, improved circulation and parking for single vehicles and vehicles with trailers, and other boat launch support facilities (e.g., signage, dock, and boarding float).
  - Provide an accessible restroom in the vicinity of the boat launch parking area (may be dual vault toilets or may potentially combine this new facility with an upgraded park restroom facility, location undefined).
  - Incorporate ADA enhancements into the design.
- Future repair and/or replacement of existing recreation sites
  - Replace and/or repair recreation site facilities, infrastructure, and amenities, as needed, based on monitoring facility conditions and normal facility life cycles, during the new license term.
  - If needed, consider additional recreation capital facility development based on periodic monitoring during the new license term (see RRMP Monitoring Program).

2.3.3.6.2. Programmatic and O&M Measures

SCL proposes the following programmatic and O&M measures in the RRMP:

- Operations and Maintenance (O&M) Program.
  - Develop an O&M Program for SCL-managed recreation sites and use areas.
  - Provide annual maintenance at the boat launch at the Town of Metaline Waterfront Park.
  - Provide appropriate O&M of Project-related recreation sites and use areas.
  - Periodically re-assess public access/security policies at the Tailrace Recreation Area and Machine Hall Visitors' Gallery.

- Shoreline Dispersed Recreation Management Program
  - Develop a Shoreline Dispersed Recreation Management Program to guide development and management of shoreline dispersed recreation sites and use areas.
  - Incorporate 16 existing shoreline sites into the management program by establishing appropriate development levels (as described under the Capital Facility Development Program) and management direction for dispersed shoreline recreation sites.
- Recreation Monitoring Program
  - Develop and implement a Recreation Monitoring Program with facility and visitor management actions and triggers identified.
- Multi-Resource Interpretation and Education (I&E) Program
  - Develop a comprehensive Multi-Resource I&E Program that establishes themes, messages, and media that would be considered at recreation sites throughout the Project. Address all Project resources in one integrated multi-resource I&E Program: recreation, aesthetics, geology, engineering, scenic byway, fisheries/aquatics, cultural/historic, and terrestrial resources.
  - Communicate to the public the seasonal changes in flows, spring runoff conditions, and Project operations that may affect conditions at the falls north of the Highway 31 bridge, as well as issues related to fluctuating water surface elevations.

2.3.3.7. Aesthetic, Socioeconomic, and Tribal Resources

There are no specific PM&E measures proposed for aesthetic, socioeconomic, or tribal resources. Rather, there are benefits to these three resource areas as the result of the implementation of PM&E measures developed primarily to address other resource needs. PM&E measures designed to address recreation resource needs, e.g., the Peewee Falls Viewpoint and Trail, have clear links to aesthetic resources in the Project area. A number of proposed measures have potential benefits for the local economy, and these are discussed 4.5.10.2 of this Exhibit E. Benefits incurred by PM&E measures aimed at improving natural resource values in and adjacent to the Project area will contribute to meeting the regional objectives of Indian tribes in the Pend Oreille River basin. In addition, general aesthetic/visual resource management guidelines will be adhered to for future Project recreation facilities. Such guidelines will ensure that new facilities blend in with the surrounding natural environment.

2.3.4. Proposed Changes to the Project Boundary

As noted above, SCL is proposing to expand the existing Project boundary to include features currently not included in the boundary. Exhibit G of this License Application explains in greater

detail the specifics of the proposed Project boundary expansion and the rationale for the proposal.[4]

SCL proposes to expand the Project boundary to include the following features:

- Operations and Maintenance Support Area
- BWP and adjacent 89-acre parcel (the BWP Addition)
- Metaline Falls Portage Trail
- Roads (all existing roads used exclusively or primarily for Project purposes)
    - West Side Access Road (portion not already in the boundary)
    - Operations and Maintenance Support Area road network
    - Bonneville Power Administration (BPA) substation road
    - Spur off of BPA substation road (portion not already in the boundary)
    - South end of FR 6200-348
    - FR 3165-350 (small portion not already in the boundary)

SCL is not proposing at this time to include the new Peewee Falls Viewpoint Trail in the boundary, or to expand the boundary to include more of the Metaline Waterfront Park Boat Launch area or incorporate the Wolf Creek dispersed recreation site because plans are not developed enough to define the location/boundary (see Exhibit G of this License Application for approximate locations of recreation sites). For the same reason, SCL is not proposing to expand the Project boundary at this time to include off-site measures being proposed to benefit fish and aquatic resources in tributaries to the reservoir. At such time as these measures are approved and their specific locations determined, they will be proposed for inclusion in the Project boundary.

SCL is also proposing to expand the Project boundary in the lower reservoir to re-establish the 200-foot no-mining buffer in those locations where the current line of ordinary high water is less than 200 feet from the current Project boundary.

Finally, SCL is proposing to revise the Project boundary in the vicinity of the Pend Oreille County PUD Campbell Park boat ramp and downstream end of Box Canyon Project boundary, where the recently revised FERC boundary for the Box Canyon Project overlaps with the current FERC boundary for the Project. SCL proposes to revise the Project boundary in this area to align with the Box Canyon Project boundary, thereby eliminating the overlap. Following issuance of the new Project license, SCL will consult with FERC to finalize necessary revisions to the Project boundary.

[4] Study plans and their respective reports, as reflected in this Exhibit E, are based on the existing Project boundary in Exhibit K of the existing license. In contrast, the acreages presented in Exhibit A of the License Application are based on the updated depiction of the Project boundary in Exhibit G of this License Application. As such, Exhibit E and its attachments may present acreage values that differ slightly from those values presented in Exhibits A and G. In addition, the Project boundary shown on maps of Exhibit E and its attachments is the existing Project boundary of Exhibit K. For the location of the proposed boundary, see Exhibit G of this License Application.

2.3.5. Continuing Environmental Measures

The following existing environmental measures, described in Section 2.1.4 of this Exhibit E, will be continued under the new Project license. Other measures included in Section 2.1.4 have been modified and are addressed in the preceding section.

- Wastewater Treatment Facility Upgrades and Spill Prevention and Control
- Socioeconomics
  - Sale of low-cost power to the Pend Oreille County PUD, which the PUD uses to serve its retail customers.
  - SCL is currently engaged in negotiating a new agreement with representatives of Pend Oreille County to provide funding annually to Pend Oreille County through a local Impact Fee Agreement. The County will then disperse these funds, as appropriate, to three local towns (Ione, Metaline, and Metaline Falls), and three County school districts (Newport, Cusik, and Selkirk).
  - Fire protection contract with Pend Oreille County Fire District #2.

2.3.6. Proposed Project Facilities

The following facilities installations or modifications are proposed for implementation under the new Project license (see Section 2.3.3 and respective Resource sections [Sections 4.5.1.3 - 4.5.9.3 of this Exhibit E] for greater detail). Any proposed new facilities or modifications to existing facilities will be subject to FERC review and approval. For greater detail regarding the facilities listed below, including maps showing locations of proposed Project facilities and conceptual designs, see the relevant resource sections of the Environmental Analysis (Section 4.5) and respective attached management plans.

- Upstream fish passage trap-and-haul facility
- Structural TDG abatement measures
- Recreation Facilities
  - Boundary Dam Forebay Recreation Area
    - Enhancements of campground and day-use facilities
    - Extension to existing boat launch
    - I&E signs
  - Vista House Recreation Area
    - I&E signs
  - Tailrace Recreation Area/Machine Hall Visitors' Gallery
    - Update I&E signs
  - East Peewee Falls Viewpoint and Trail
  - Metaline Falls Portage Trail
  - Metaline Waterfront Park Boat Launch
    - Replace existing boat launch and extend a boat ramp lane
    - Provide adequate road access to boat ramp
    - Improve circulation and parking

2.4. Requested PM&E Measures

As noted previously, SCL filed its PLP with FERC on April 30, 2009. RP comments on the PLP were due on July 30, 2009. A summary of RP's PLP comments, and SCL's responses to those comments, is provided in Attachment E-2. As part of their comments on the PLP, some RPs recommended PM&E measures beyond those proposed by SCL in the PLP. Table E.2-11 lists the requested PM&E measures, identifies the entity that requested each PM&E measure, and provides a reference to SCL's PLP comment-response table (Attachment E-2), which provides SCL's rationale, based on Project-specific reasons, for rejecting some of the requested PM&E measures.

Table E.2-11. PM&E measures requested by RPs as part of PLP comments and SCL's response to those requests.

Proposed PM&E measure	Entity proposing PM&E	Measure adopted by SCL	Reference (i.e., row number[s]) to PLP comment-response table (Attachment E-2)
Closure/decommissioning of Project-related roads	USFS	Yes	27
Mitigation for original impacts to federal lands caused by reservoir shoreline erosion	USFS	No	34
Measures to mitigate presumed water temperature impacts	USFS, Selkirk Conservation Alliance (SCA)	No	41, 45, 46
Downstream fish passage/measures to reduce fish entrainment	USFS, SCA	No	86
I&E program directed towards the recreational fishing public	USFS, SCA	Yes	87
Increase the number of off-site mitigation locations (i.e., more tributary streams)	USFS, SCA	No	88
Discontinue stocking of triploid rainbow trout in Boundary Reservoir	USFS, SCA	Yes	103
Increase the number of tributary deltas receiving engineered LWD jams	USFS	No	105
Minimum instream flows downstream of Boundary Dam	SCA	No	108
Northern pike suppression program ("pike derby")	SCA	No	110
Stocking trout in other lakes in the region of the Project	USFS, SCA	No	110, 117

Table E.2-11, continued…

Proposed PM&E measure	Entity proposing PM&E	Measure adopted by SCL	Reference (i.e., row number[s]) to PLP comment-response table (Attachment E-2)
Manage water surface elevations to expose northern pike eggs to drying conditions	SCA	No	114
Acquire additional lands for wildlife habitat beyond those identified in the PLP	USFS	No	131
Develop more opportunities to view natural features within the Project area	USFS	No	165

3 Consultation

3.1. Consultation

RPs were consulted throughout the Project relicensing process, both during engagements required by FERC's ILP and during additional consultation opportunities provided by SCL. The consultation record for the relicensing is provided in Attachment E-1, summarized in a comment-response table, with the official consultation record provided electronically on an accompanying compact disk.

For the development of the License Application, SCL, in its RSP (February 2007), proposed that "study results be synthesized in an integrated resource analysis to characterize Project-related resource impacts and evaluate potential PM&E measures." The IRA process was initiated with RPs on December 3, 2008 and ended on July 15, 2009 (Table E.3-1). The outcome of IRA meetings held before March 1 is addressed in SCL's PLP (SCL 2009b).

Table E.3-1. Relicensing participant involvement in Boundary Project relicensing meetings and teleconferences between March 1, 2009 and the filing of the License Application in September 2009; IRA meetings held before March 1, 2009 are discussed in the PLP (SCL 2009b).

Date (2009)	Activity
IRA meetings and other public meetings and site visits after March 1, 2009	
March 24	Combined USR and IRA meeting
March 25	IRA meeting
March 26	IRA meeting
April 7	RRMP teleconference
April 8	IRA meeting
April 9	IRA meeting
May 5	Recreation resource site visit (Day 1)
May 6	Recreation resource site visit (Day 2)
May 27	HPMP teleconference
July 1	TRMP meeting
July 15	RRMP teleconference

3.2. Scoping

The NEPA requires FERC to independently evaluate the environmental impacts of the relicensing of the Project as proposed, and also consider reasonable alternatives to SCL's Proposed Action. FERC has indicated its intent to prepare an Environmental Assessment (EA) that describes and evaluates the probable impacts, both site-specific and cumulative, of SCL's Proposed Action and any other action alternatives (FERC 2006). The EA preparation is supported by the scoping process, which was undertaken to ensure that all pertinent issues were identified and analyzed.

Scoping is the process whereby issues, concerns, and opportunities associated with a proposed action are identified. The purposes of the scoping process are to invite participation of federal and state resource agencies, Indian tribes, non-governmental organizations (NGOs), and the public to identify significant environmental and socioeconomic issues potentially related to the proposed action; determine the significance and depth of analysis needed to address issues in the EA; identify how the Project would or would not contribute to cumulative effects; identify reasonable alternatives to the proposed action to be evaluated in the EA; solicit from participants available information on the resources at issue; and determine the resource areas and potential issues that do not require detailed analysis.

FERC issued Scoping Document 1 (SD1) for the Project on June 19, 2006. FERC conducted scoping meetings in Spokane and Metaline Falls, Washington on July 18 and 19, 2006, respectively. Announcements of the scoping meetings were published in local newspapers and in the Federal Register. A court reporter recorded the content of the meetings. During the meetings and subsequent comment period, FERC received comments on the Project's PAD and on the SD1, and RPs filed study requests. In SD1, FERC discussed its preliminary view of the

scope of environmental issues. Subsequent to scoping meetings, FERC issued its SD2, which was intended to serve as a guide to the issues and alternatives to be addressed in FERC's EA. For an account of key changes made by FERC between SD1 and SD2, see FERC (2006).

3.3. Integrated Resource Analysis

The IRA was planned by SCL and RPs with the objective of synthesizing information to assess the impacts of the Project as it is currently operated. Between December 3, 2008 and April 9, 2009, SCL met with RPs to discuss issues, solicit input on study results and conclusions, and identify areas of agreement and disagreement regarding existing Project impacts and potential non-operational PM&E measures. Key conclusions reached during the IRA process through February 2009 were discussed in SCL's PLP (2009b). Discussions at meetings held between March 1 and July 15, 2009 can be found in the consultation record attached to this Exhibit E.

3.4. Response to PLP Comments

As noted previously, SCL filed its PLP with FERC on April 30, 2009. RP comments on the PLP were due on July 30, 2009. A summary of RP's PLP comments, and SCL's responses to those comments, is provided in Attachment E-2.

3.5. REA Notice

Once FERC has determined that SCL's License Application meets all filing requirements, any deficiencies with the application have been resolved, and no additional information is required, FERC will issue the notice of acceptance and Ready for Environmental Analysis (REA).

The acceptance/REA notice solicits comments, protests, and interventions—along with recommendations, preliminary terms and conditions, and preliminary fishway prescriptions—including all supporting documentation. Comments, protests, and interventions, must be filed within 60 days of the notice. SCL then has 45 days to respond to submitted comments (105 days from the REA notice). SCL will direct responses to the entity providing the original comment and file a copy of the responses with FERC.

When the application is accepted, FERC provides public notice in the Federal Register, local newspapers, and directly to resource agencies and Indian tribes. In its notice, FERC invites protests and interventions and requests the final fish and wildlife recommendations, prescriptions, mandatory conditions, and comments from the resource agencies and Indian tribes.

4 Environmental Analysis

4.1. General Description of the River Basin

4.1.1. Mainstem and Tributaries

With a total drainage area of 26,260 square miles (25,090 square miles in the United States and 1,170 square miles in Canada), the Pend Oreille River is one of the two main tributaries to the Columbia River (Figure E.1-1), contributing approximately 10 percent of the Columbia River's

flow on an annual basis (Muckleston 2003). The eastern boundary of the Pend Oreille River basin lies along the continental divide and extends from Canada to approximately Butte, Montana. The major tributaries to the Pend Oreille River include the Flathead and Clark Fork rivers. The Flathead River flows into the Clark Fork River, which flows from Montana across northern Idaho into Lake Pend Oreille. The Pend Oreille River begins at the outlet of Lake Pend Oreille and flows into Washington, where it heads north into Canada for its last 16 miles, joining the Columbia River at RM 747.5 (at Waneta, in British Columbia). The Pend Oreille River proper is approximately 120 miles long from its head at the outlet of Lake Pend Oreille to its confluence with the Columbia River.

Between the outlet of Lake Pend Oreille and its confluence with the Columbia River, the Pend Oreille River is fed by numerous tributaries (Figure E.4-1). On average, the Pend Oreille River gains about 1,300 cfs between Albeni Falls Dam and Boundary Dam; about 18 percent of that is inflow coming from Sullivan Creek. Additional significant contributions to flow within this section of the river come from Calispell, LeClerc, and Tacoma creeks (about 5 percent each). However, most of the river's tributaries are small creeks and streams that flow directly into the mainstem (ENTRIX 2001). The largest tributary to the Pend Oreille River downstream of Lake Pend Oreille is the Salmo River, located in British Columbia, which has an annual flow that varies between approximately 50 cfs and 10,000 cfs (Pine et al. 1964).

4.1.2. Hydrology

The portion of the Pend Oreille River basin upstream of Boundary Dam has a drainage area of more than 25,200 square miles. Average annual flows from the 94-year period of record (1913-2006) were analyzed to determine historical trends in basin hydrology. The long-term mean flow during this period was 26,370 cfs. Annual runoff is produced primarily by melting snow upstream of the Project, with peak flows typically occurring from April through June.

Average monthly and annual inflows to Boundary Reservoir, 1987 to 2005, are presented in Table E.2-8. A detailed report containing hydrologic statistics that describe the 19-year period (calendar years 1987 through 2005) used to characterize existing operations can be found in SCL (2008). The report also provides a comparison of this dataset to the historic record (1913 to 2005).

Because of the large volume of water flowing through the system and the limited amount of storage capacity in Boundary Reservoir, the hydraulic retention time (residence time of water) of Boundary Reservoir is very short. Maximum retention time is less than four days, but more typically retention time is less than two days (Pickett 2004).

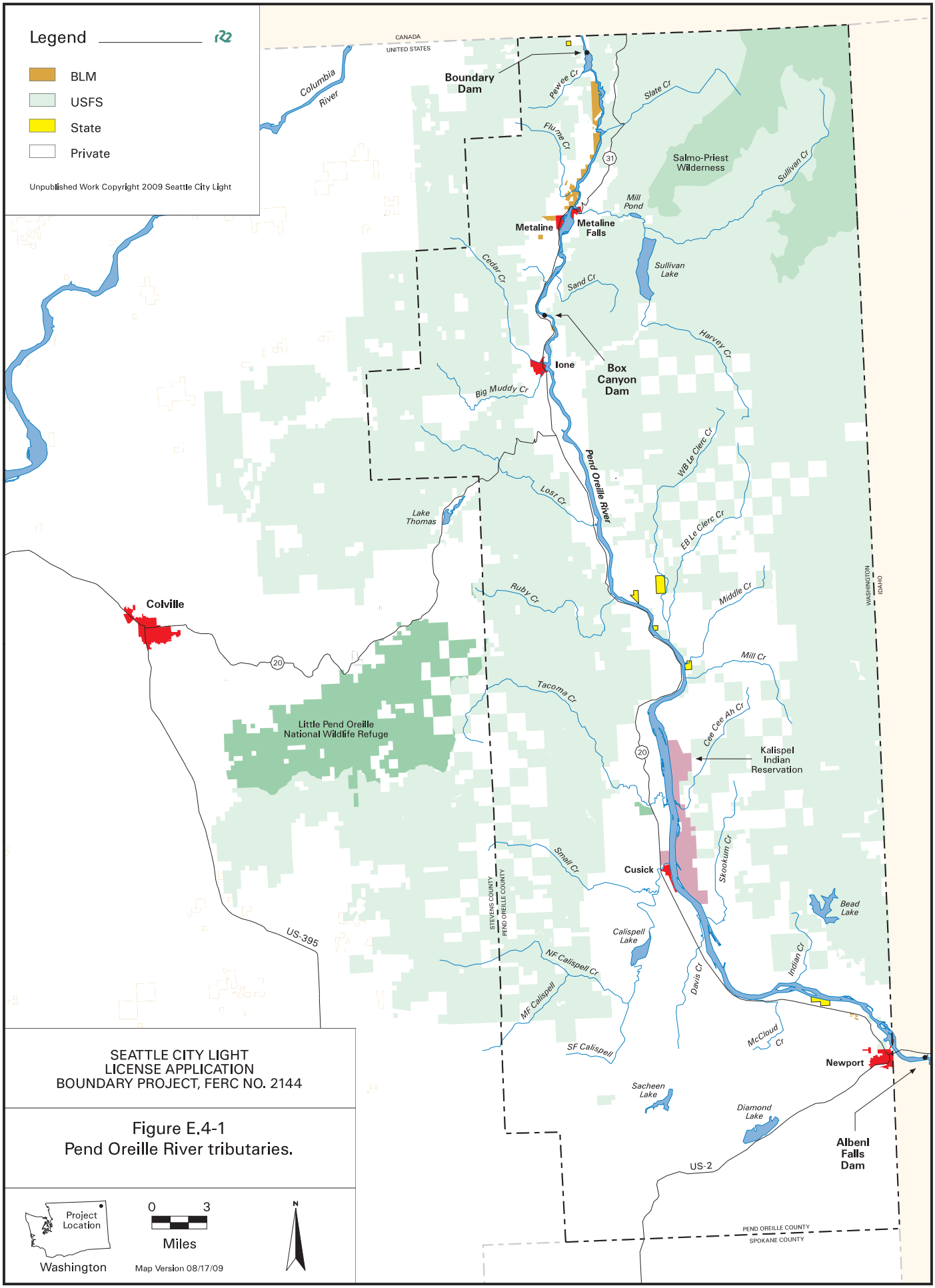

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Figure E.4-1
Pend Oreille River tributaries.

4.1.3. Topography

The Project is set within the heavily forested Selkirk Mountains, and the surrounding topography is relatively rugged. The mountains in the Project vicinity reach 6,834 feet NAVD 88 in elevation with intervening valleys ranging in elevation from 2,004 to 2,404 feet NAVD 88. The major topographic features at the site have been imposed by glacial erosion and deposition above elevation 2,004 feet NAVD 88 and by stream erosion below that level. Boundary Dam is located in a relatively narrow section of the river canyon. The isolated pyramidal rock mass that houses the Project's underground powerplant rises abruptly from a wide section of the stream about 500 feet downstream from the dam (Schilling 1966).

In the Project vicinity, the Pend Oreille River flows through a valley of varying width and steepness. The gradient of the river channel (stream bed) is relatively flat from Albeni Falls (RM 90.1, where tailwater elevation at mean low flow is 2,043 feet NAVD 88) to Metaline Falls (PRM 26.8, where elevation of the channel is approximately 1,983 feet NAVD 88), and this portion of the river flows through a relatively wide, deep valley. From Metaline Falls downstream, the river flows through a deep, narrow gorge with steep canyon walls for most of its length to its confluence with the Columbia River (RM 0, at about elevation 1,294 feet NAVD 88).

4.1.4. Climate

The climate of the Project vicinity has both maritime and continental influences. The influence of the continental air masses generally results in summers that are warmer and winters that are colder than in coastal areas. The majority of precipitation in the area falls in winter and spring, with the highest totals occurring from November through January. During winter, the maritime, prevailing winds create humid air masses that rise over the mountains and conflict with the cold air masses in the jet stream. The mixing of cold and warm air masses releases precipitation, particularly at higher elevations. At lower elevations snow generally arrives in November and remains on the ground through February or early March. Prevailing winds continue through June, bringing moisture that gradually weakens to warmer eastern continental conditions. This causes an increase in temperature and a decrease in rainfall, cloud cover, and humidity. Summers are generally warm and sunny with periodic light rainfall, although localized thunderstorms occasionally cause heavier amounts of precipitation (Pend Oreille Conservation District 2004).

Within the Pend Oreille River valley, mean annual precipitation is approximately 27 inches. December and January account for about 25 to 35 percent of the annual precipitation, whereas July and August account for only 6 percent. On average, approximately 30 days each year have rainfall of at least 0.1 inches and approximately 73 days each year receive at least 1.0 inch of snow. Winters are typically cold, and the snowpack normally covers all but the lowest elevations continuously from November through May (ENTRIX 2001).

4.1.5. Land and Water Uses

Major land uses within the Project area and immediately surrounding lands include undeveloped uses (forested land, wetlands, and waterbodies) as well as developed uses (timber production and

residential, commercial, and industrial uses). Based on information on file with Ecology's Water Resources Section, uses of surface and groundwater within approximately 1 mile of the Project include industrial cooling, commercial and industrial manufacturing, general domestic use, fire protection, irrigation, mining, domestic municipal, power generation, and stock watering (Ecology 2005a).

4.1.6. Dams and Diversion Structures

Boundary Dam is one of eleven dams on the mainstem and major tributaries in the Pend Oreille River basin. The nine dams upstream of the Project significantly influence inflows to the Project reservoir. The dams and corresponding locations (RM upstream of the Columbia River, except for Priest Lake, where RM refers to distance upstream of the Pend Oreille River) are as follows:

- Hungry Horse (South Fork Flathead River) - RM 390.3
- Kerr Project (Flathead River) - RM 318.0
- Thompson Falls (Clark Fork River) - RM 208.0
- Noxon Rapids (Clark Fork River) - RM 169.7
- Cabinet Gorge (Clark Fork River) - RM 149.9
- Priest Lake (Priest River) - RM 42.0
- Albeni Falls (Pend Oreille River) - RM 90.1
- Box Canyon (Pend Oreille River) - RM 34.5
- Boundary (Pend Oreille River) - RM 17.0
- Seven Mile (Pend Oreille River) - RM 6.0
- Waneta (Pend Oreille River) - RM 0.5

Significant storage reservoirs in the basin include Hungry Horse Reservoir and Flathead Lake in Montana, and Lake Pend Oreille and Priest Lake in Idaho. Other projects along the mainstem upstream of the Project include the Box Canyon Project, the Albeni Falls Project, the Cabinet Gorge Development and Noxon Rapids Development of the Clark Fork Project in Idaho and Montana, and the Thompson Falls Project in Montana. Downstream of Boundary Dam, the Pend Oreille River flows past Seven Mile and Waneta dams, both in Canada, before entering the Columbia River. Because of the basin size and corresponding annual flow, typically no single project has an overriding influence on flows in the river. Potential influence on flows by individual projects is greater during low-flow periods and for those reservoirs having significant storage capacity (Enserch 1994). In addition to the dams listed above, the Sullivan Creek Hydroelectric Project Dam and Mill Pond Dam are located in the Sullivan Creek drainage, the main tributary to Boundary Reservoir.

As noted above, upstream projects have a significant effect on inflows to the Project reservoir. In the absence of upstream impoundments, flows would typically exceed regulated flows from May through July, during the periods when water is stored in upstream projects (SCL 2008a). Regulated flows are typically greater than unimpaired flows from August through April, as stored water is released from upstream projects.

The unimpaired hydrograph has two peaks: a primary peak in May resulting from spring snowmelt and a secondary peak in October as precipitation starts to increase prior to winter freezing (SCL 2008a). The unimpaired hydrograph also has two lows: a primary low in September following three consecutive months of low precipitation and a secondary low in January during the coldest month of the year.

The regulated hydrograph also has two peaks and two lows. However, the magnitude of the primary peak is smaller under regulated conditions than it would be under unimpaired conditions, as would be expected with storage in upstream projects (SCL 2008a). Similarly, the magnitude of the primary low is greater under regulated conditions than it would be under unimpaired conditions. The timing of the regulated hydrograph also differs from the unimpaired hydrograph, with the primary peak shifted from May to June under regulated conditions, and the primary low shifted from September to August under regulated conditions.

4.1.7. Tributaries to Boundary Reservoir

Twenty-seven tributaries enter Boundary Reservoir, 14 of which are named (Table E.4-1). Sullivan Creek, with a drainage area of 142.46 square miles (about 57 percent of the total drainage area between Box Canyon and Boundary dams), is the largest tributary. None of the 27 tributaries, except Sullivan Creek, has a flow gage. Consequently, flow estimates for most tributaries are based on visual observations, infrequent measurements, and modeling. Flow in Sullivan Creek is modified by the presence of Sullivan Lake Dam.

Table E.4-1. Descriptive statistics for tributaries to Boundary Reservoir.

Stream name	Project river mile	Drainage area (mi^2)	Measured flow (cfs), 2007	Date flow measured	Measured flow (cfs), 2008	Date flow measured
Unnamed No. 1	17.2	0.61	0.1	9/6/07	0.1	9/22/08
Peewee Creek	17.9	10.37	2[2]	9/6/07	2[5]	9/22/08
Unnamed No. 2	17.9	0.02	0.004	9/6/07	Dry	9/22/08
Lime Creek	19.45[1]	2.93	2.7	9/6/07	0.5	9/22/08
Everett Creek	21.9	2.18	0.3	9/6/07	2	9/22/08
Whiskey Gulch	21.9	0.70	Dry	9/6/07	Dry	9/22/08
Slate Creek	22.2	32.33	6.8	9/6/07	8.3	9/5/08
Beaver Creek	24.3	1.77	0.9	9/7/07	3	9/22/08
Threemile Creek	24.3	4.91	0.5	9/7/07	2	9/22/08
Unnamed No. 3	25.4	0.15	0.04	9/7/07	Dry	9/22/08
Flume Creek	25.8	19.33	5.0	9/7/07	6.6	9/5/08
Sullivan Creek	26.9	142.46	40.5	9/10/07[4]	59.47	9/5/08[4]
Unnamed No. 4	27.1	0.08	—[3]	—[3]	—[3]	—[3]
Linton Creek	28.1	2.11	1.9	9/8/07	1.8	9/6/08
Unnamed No. 5	28.9	0.62	0.1	9/8/07	No data	n/a
Unnamed No. 6	29.2	0.01	Dry	9/11/07	No data	n/a
Pocahontas Creek	29.4	3.92	Dry	9/9/07	Dry	9/22/08
Unnamed No. 7	29.6	0.30	Dry	9/11/07	No data	n/a
Unnamed No. 8	30.1	0.07	Dry	9/11/07	No data	n/a
Wolf Creek	30.3	1.57	Dry	9/11/07	No data	n/a
Sweet Creek / Lunch Creek	30.9	11.12	2.5	9/11/07	2.81	9/5/08
Unnamed No. 9	31.1	0.04	Dry	9/11/07	Dry	9/22/08
Sand Creek	31.7	8.22	Dry	9/11/07	Dry	9/22/08
Lost Creek	32.2	1.20	0.03	9/12/07	1.4	9/23/08
Unnamed No. 10	33.5	0.93	0.001	9/12/07	0.3	9/23/08
Unnamed No. 11	33.6	0.23	0.002	9/12/07	Dry	9/23/08
Unnamed No. 12	34.0	0.93	0.06	9/12/07	0.5	9/23/08
Unnamed No. 13	34.3	1.72	0.4	9/12/07	1.5	9/23/08

Notes:

1 The current mouth of Lime Creek is at Project river mile (PRM) 19.45. Approved geographic information system (GIS) streams coverage shows the mouth at PRM 19.0. Due to a saddle in the stream, flow can diverge and enter the reservoir at either location.

2 Flow rate at the base of Pewee Falls was visually estimated.

3 No tributary channel could be found in September 2007 and 2008.

4 Sullivan Lake is maintained at an elevation of 2,588.7 feet from May through September and drawn down in October; monthly mean flows range from 63 cfs in February to 519 cfs in May.

5 North Fork Peewee Creek only.

4.1.8. Project Area Reach Descriptions

To conduct studies for the Project's relicensing, the Project area was divided into four reaches, three in the reservoir and one downstream of the dam.

- Boundary Reservoir
  - Forebay Reach – Boundary Dam to downstream end of Z Canyon (PRM 17.0 – 18.0)
  - Canyon Reach – Downstream end of Z Canyon to Metaline Falls (PRM 18.0 – 26.8)
  - Upper Reservoir Reach – Metaline Falls to Box Canyon Dam (PRM 26.8 – 34.5)
- Boundary Tailrace
  - Tailrace Reach – Boundary Dam downstream to Red Bird Creek confluence with the Pend Oreille River, British Columbia (PRM 13.9 – 17.0)

These four reaches are illustrated in Figure E.4-2. Reaches were delineated based on the similarity of aquatic habitats and aquatic resources. Physical habitat conditions in the reservoir changes in response to variations in water surface elevation in the Boundary Dam forebay and inflows from Box Canyon Reservoir. Fluctuations in water surface elevations resulting from Project operations are attenuated with increasing distance upstream of Boundary Dam. Variations in channel characteristics of the Pend Oreille River upstream of the Project affect the magnitude of this dampening effect. The presence of Metaline Falls, a bedrock controlled constriction in the river, is the most significant of these channel characteristics. Therefore, Metaline Falls (Figure E.4-3) was identified as an important breakpoint and divides the Canyon and Upper Reservoir reaches.

Conditions in the tailrace vary in response to releases from the Project and the operation of BC Hydro's Seven Mile Project, which is located at PRM 6.0. Although the downstream extent of the Project's Tailrace Reach is the confluence with Red Bird Creek, hydraulic conditions throughout most of this reach are influenced largely by the operation of the Seven Mile Project, which is located approximately 7.9 miles downstream of the Red Bird Creek confluence.

The following sections summarize conditions within each of the four reaches. Photographs are presented to provide a visual reference for typical conditions within each reach.

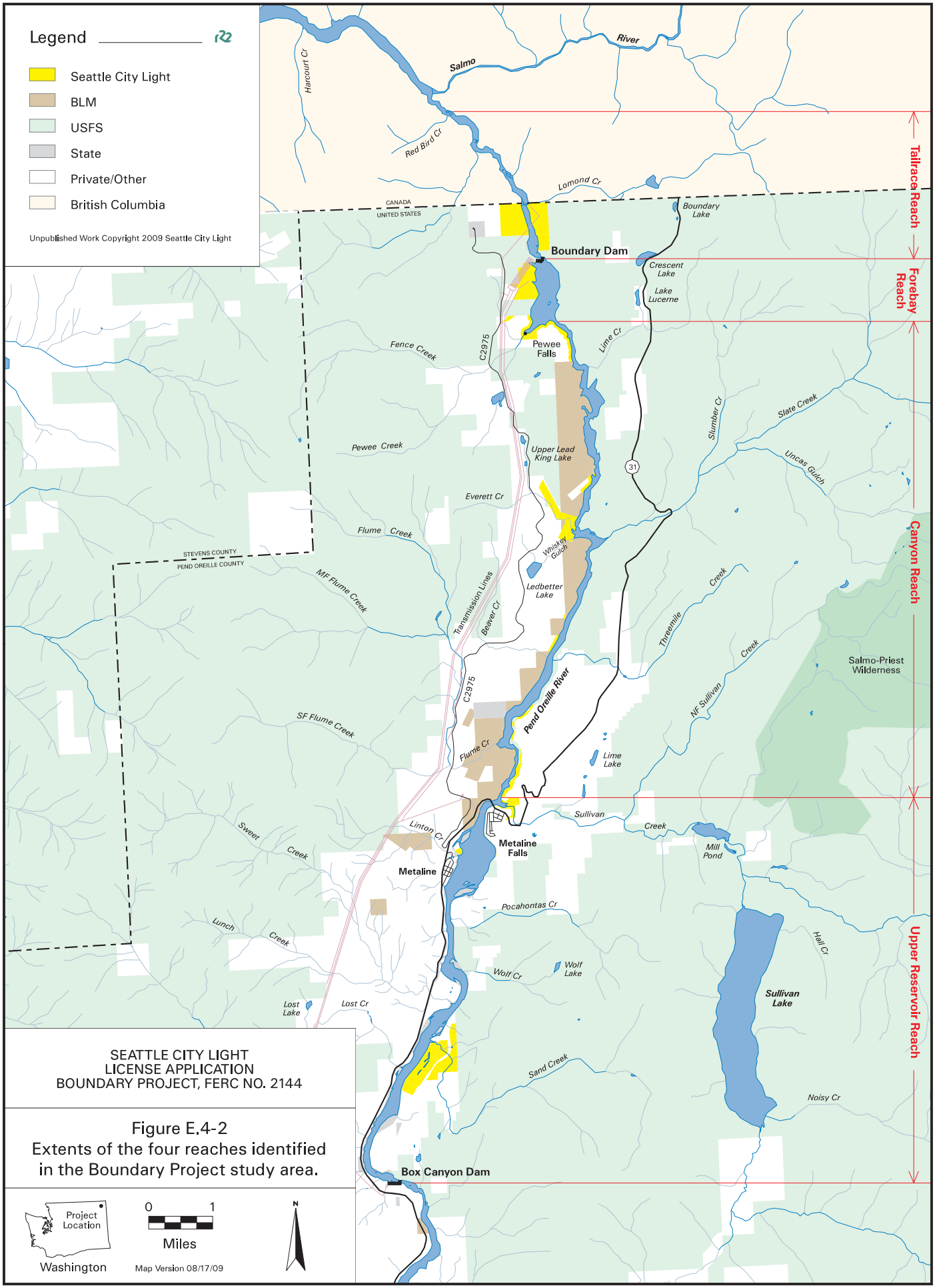

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Figure E.4-2
Extents of the four reaches identified in the Boundary Project study area.

Figure E.4-3. Downstream view of the constriction (within circle) at Metaline Falls (taken near PRM 27).

4.1.8.1. Forebay Reach: PRM 17.0 – 18.0

The first mile of Boundary Reservoir upstream of Boundary Dam was identified as the Forebay Reach. The average wetted width of this reach is nearly 2,000 feet, which is considerably greater than the width of the other three reaches. A view of the Forebay Reach looking north toward Boundary Dam is shown in Figure E.4-4. Maximum depths in the Forebay Reach range from approximately 230 to 270 feet. The width and depth of this reach generally limit mean channel velocities to no more than a few tenths of a foot per second (fps), except during high flow events. As a result of these low velocities and substantial depths, aquatic habitat is generally lacustrine in nature. The Forebay Reach contains less shallow water habitat (defined as habitat present in depths up to 20 feet) than any of the other Project reaches. The shallow water habitats are potentially more productive than deeper water habitats, and they are important to a variety of fish species during certain times of the year.

Figure E.4-4. Downstream view of the Forebay Reach (taken near PRM 18).

4.1.8.2. Canyon Reach: PRM 18.0 – 26.8

An abrupt change in reservoir width marks the boundary between the Forebay Reach and the Canyon Reach. In contrast to the nearly 2,000-foot average wetted width of the Forebay Reach, the average wetted width of the Canyon Reach is just over 500 feet. Figure E.4-5 illustrates one of the narrowest sections (approximately 100 feet wide) of the Canyon Reach. The Canyon Reach is characterized by steep canyon walls (Figure E.4-6), and these vertical profiles continue below the water's surface to depths between 50 feet at the upstream end of the reach and 250 feet at the transition to the Forebay Reach. Prior to the inundation of the reservoir in the summer of 1967, the average gradient of the Canyon Reach was the most varied of any of the four reaches. Under typical flow conditions, velocities in the reach are generally less than 1 fps. Like the Forebay Reach, limited shallow water habitat is present in the Canyon Reach, and the existing habitat is generally lacustrine in nature.

Figure E.4-5. Downstream view of the Canyon Reach (taken near PRM 22).

Figure E.4-6. Upstream view of the Canyon Reach (taken near PRM 19).

4.1.8.3. Upper Reservoir Reach: PRM 26.8 – 34.5

Metaline Falls is the dividing point between the Canyon Reach and the Upper Reservoir Reach. Though referred to as a “falls," the feature is actually a steep, boulder strewn section of river that forms a substantial rapid at lower forebay elevations (Figure E.4-7). Under full pool conditions (1,994 feet NAVD 88 at the forebay) the falls are completely submerged (Figure E.4-8); as the water surface elevation drops, the falls become partially exposed. Although the Canyon Reach experiences nearly the full range of fluctuations in daily water surface elevation associated with Project operations, Metaline Falls acts as a hydraulic control that allows only a portion of these fluctuations to propagate upstream through the Upper Reservoir Reach. For a given release, the lower the forebay elevation the less influence forebay water surface elevation fluctuations due to Project operations have on water surface elevations in the Upper Reservoir Reach.

Figure E.4-7. Downstream view of Metaline Falls at a low forebay water surface elevation (PRM 26.8).

The average channel width of the Upper Reservoir Reach is about 1,000 feet. The range of depths in this reach is approximately 25 to 60 feet under typical flow conditions. The relatively wide and shallow geometry of the Upper Reservoir Reach, coupled with the hydraulic control imposed by Metaline Falls, results in more riverine conditions than in the other reaches of the reservoir. Figure E.4-9 presents an upstream view as seen from the Highway 31 bridge near PRM 27. For the majority of the reach, velocities under normal inflow conditions vary between about 1 and 3 fps, depending on the location and forebay elevation.

Figure E.4-8. Downstream view of Metaline Falls when completely submerged (PRM 26.8).

Figure E.4-9. Upstream view of the Upper Reservoir Reach taken from the Highway 31 bridge near PRM 27.

The Upper Reservoir Reach contains nearly 90 percent of the shallow water habitat in Boundary Reservoir. This shallow water habitat is largely the result of numerous low-gradient bars in the channel and along its margins. With more riverine conditions and the vast majority of the shallow water habitat in the reservoir, the Upper Reservoir Reach possesses a more diverse fish species and life history assemblage than the other Project reaches. Within this 7.7-mile reach, a variety of habitat conditions is provided by several islands, back channels, and nearshore aquatic vegetation (Figure E.4-10). Many of the off-channel areas contain widespread and seasonally dense concentrations of submerged aquatic macrophytes (Figure E.4-11), bordered by less dense emergent vegetation and flooded grasses in nearshore areas and flooded swales. These areas serve as both spawning and rearing areas for fish. Nearshore areas in the more confined, steeper portions of the reach provide gravel and cobble habitats, often in conjunction with greater water velocities, which provide seasonal habitat for salmonids. The Upper Reservoir Reach also contains a number of tributary deltas, which represent areas of potential high aquatic resource value due to cool inflow from the tributaries. Because of the nature of the processes that form tributary deltas, much of a delta's surface may lie within the range of elevations that are subject to water surface elevation fluctuations resulting from Project operations. Figure E.4-12 illustrates the Sullivan Creek delta, the largest of the deltas in the Project area.

Figure E.4-10. Upstream view of the Upper Reservoir Reach taken from Highway 31 near PRM 32.

Figure E.4-11. Northward view of off-channel swale in the Upper Reservoir Reach (PRM 33).

Figure E.4-12. Eastward view of the Sullivan Creek delta (PRM 26.9) as seen from the Highway 31 bridge.

4.1.8.4. Tailrace Reach: PRM 17.0 – 13.9

The 3.1-mile-long Tailrace Reach is located downstream of Boundary Dam (Figure E.4-13). The first mile of the reach is located in the United States, and the remainder is in Canada. Conditions in this reach are influenced by Project releases and fluctuations in water surface elevation resulting from the operation of the Seven Mile Project. At a median pool elevation in the Seven Mile forebay (1,727 feet NAVD 88) and a median hourly flow released from the Project (22,600 cfs), the average channel width in the Tailrace Reach is about 500 feet. Depths range from approximately 25 to over 100 feet. Although the Tailrace Reach contains shallow water habitat, the combined influence of the Seven Mile and Boundary projects at times results in substantial fluctuations in the daily cycle of inundation and dewatering. Consequently, the Tailrace Reach can exhibit both reservoir-like and riverine-like conditions, depending on releases from the Project and the forebay elevation of Seven Mile Dam.

Figure E.4-13. Downstream view of the Tailrace Reach as seen from the Boundary Dam Vista House (PRM 17).

4.2. Cumulative Effects

According to the Council on Environmental Quality's regulations for implementing NEPA (50 C.F.R. 1508.7), a cumulative effect is the effect on the environment that results from the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such

other actions (FERC 2006). Based on preliminary staff analysis, FERC identified in its SD2 the following resources that may be cumulatively affected by the proposed operation of the Project: aquatic (including water quality and fishery resources), terrestrial, and recreation.

In its SD2, FERC identified the following aquatic resources that could be cumulatively affected by the Project: summer water temperatures, sediment and LWD transport, non-native macrophyte abundance and distribution, pH and DO levels, accumulation of toxic compounds, TDG levels; shoreline erosion, abundance and diversity of macroinvertebrates, fish spawning habitat, and fish community structure (FERC 2006).

In its SD2, FERC identified the following terrestrial resources that could be cumulatively affected by the Project: shoreline erosion; wildlife habitat; invasive species distribution; Threatened, Endangered, and sensitive plant and animal species; big game movement corridors; and riparian and wetland habitats (FERC 2006).

In its SD2, FERC identified the following recreation resources that could be cumulatively affected by the Project: the public's use and enjoyment of recreation resources in the Project area and, at times, public access to the reservoir (FERC 2006).

4.2.1. Geographic Scope

FERC's geographic scopes for the cumulative effects analyses associated with the Project are defined by the physical limits or boundaries of the Proposed Action's effect on given resources, and contributing effects from other hydropower and non-hydropower activities in the Pend Oreille River basin. Because the Proposed Action will affect each resource differently, the geographic scope varies among resource areas.

FERC has tentatively identified the portion of the Columbia River Basin upstream of Grand Coulee Dam as the geographic scope of analysis for aquatic resources; however, the primary focus of the cumulative effects analysis for aquatic resources is the Pend Oreille River basin, including the Clark Fork River and Flathead River sub-basins. The Pend Oreille River basin is the geographic scope of analysis for terrestrial resources. For recreation resources, a northeast Washington regional scope applies, including the greater Spokane and Coeur d'Alene areas and the small communities, both in Canada and the United States, along the western portion of the International Selkirk Loop Byway.

4.2.2. Temporal Scope

The temporal scope of SCL's cumulative effects analysis includes a brief discussion of past, present, and reasonably foreseeable future actions, to the extent feasible. Based on the potential term of a new license, the temporal scope would extend 30 to 50 years into the future, with a focus on the effects of reasonably foreseeable future actions. The effects of historical activities are generally evaluated in the discussion of the affected environment and are, by necessity, limited to the amount of information available for each resource.

4.3. Applicable Laws

4.3.1. Section 401 of the Clean Water Act

As part of the ILP, SCL consulted with the Ecology regarding the development of an application for water quality certification under Section 401 of the Clean Water Act. On May 11, 2009, SCL filed its draft 401 application with Ecology. SCL will file its final 401 application no later than 60 days after FERC files its REA for the Project License Application.

4.3.2. Endangered Species Act

As a component of its relicensing process, SCL consulted with the USFWS to assess potential Project effects on federally listed Threatened and Endangered species in the Project vicinity, including Canada lynx, grizzly bear, woodland caribou, and bull trout. Because SCL is FERC's non-Federal designee for informal consultation under the ESA, SCL's revised draft Biological Assessment (BA) is included as an attachment to this License Application (see Section 4.5.6). A draft BA was filed with SCL's PLP on April 30, 2009. Anticipated Project effects on the aforementioned species are described in Section 4.5.6 and in the attached revised draft BA.

4.3.3. National Historic Preservation Act

Section 106 of National Historic Preservation Act (NHPA) requires FERC to take into account the effect of licensing a hydropower project on any historic properties, and allow the Advisory Council on Historic Preservation (Advisory Council) a reasonable opportunity to comment on the Proposed Action. ‘‘Historic Properties’’ are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the NRHP. The effect of the Project on historic properties, as well as PM&E measures associated with historic properties, are described in Section 4.5.8 of this License Application and the HPMP being filed in conjunction with this application. The HPMP includes documentation of consultation with the Advisory Council, the State Historic Preservation Officer, Tribal Historic Preservation Officer, National Park Service, members of the public, and affected Indian tribes.

4.3.4. Northwest Power Planning and Conservation Act

In 1990, Congress enacted the Pacific Northwest Electric Power Planning and Conservation Act. As authorized under the Act, the states of Idaho, Washington, Oregon and Montana created the Northwest Power and Conservation Council. In accordance with the Act, the Council prepared the Fish and Wildlife Program aimed at protecting, mitigating, and enhancing fish and wildlife of the Columbia River Basin that have been affected by the construction and operation of hydroelectric dams while also assuring the Pacific Northwest an adequate, efficient, economical, and reliable power supply. The program was first adopted in November 1982 and was most recently revised in 2009.

The overarching biological objectives of the 2009 Program include (1) a Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife, (2) mitigation across the basin for the adverse effects on fish and wildlife caused by the development and operation of the hydro system, (3) sufficient populations of fish and wildlife for abundant

opportunities for tribal trust and treaty right harvest and for non-tribal harvest, and (4) recovery of the fish and wildlife affected by the development and operation of the hydro system that are listed under the Endangered Species Act.

The 2009 Program is to be implemented principally at the subbasin level. For each of the 50 subbasins of the Columbia River Basin, a locally developed "plan" will be adopted into the 2009 Program. Each plan is to have its own vision and biological objectives and will identify specific actions needed for fish and wildlife in that subbasin. The plans must be consistent with the visions, biological objectives, and strategies adopted at the basin and province levels, but otherwise are free to make unique choices and reflect local policies and priorities.

4.3.5. Other

4.3.5.1. Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, commonly referred to as the Magnuson-Stevens Act, is the primary law governing marine fisheries management in the United States. The Act was originally passed in 1976, amended by Congress in 1996, and reauthorized in 2006. Because there are no anadromous fish in the Pend Oreille River basin, the Magnuson-Stevens Act does not apply.

4.3.5.2. The National Wild and Scenic Rivers Act

The National Wild and Scenic Rivers Act was passed to protect select rivers of the United States from development that would substantially alter their wild or scenic nature. Selected rivers are preserved because they possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other values. Designation as a wild and scenic river does not confer the same level of protection as a Wilderness Area designation; rather than mandatory conservation measures, the goal is often to preserve the character of a river. National Wild and Scenic rivers are each managed by one or more agencies of the federal or state government. No portion of the Pend Oreille River in the Project area has been designated a wild and scenic river.

4.3.5.3. Coastal Zone Management Act

Congress passed the Coastal Zone Management Act (CZMA) in 1972. The Act, administered by NOAA's Office of Ocean and Coastal Resource Management (OCRM), provides for management of the nation's coastal resources and calls for balancing economic development with environmental conservation. The CZMA outlines two national programs, the National Coastal Zone Management Program and the National Estuarine Research Reserve System. The overall program objectives of CZMA remain balanced to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." The Act is not applicable to the Pend Oreille River basin.

4.4. Approach for Assessing Alternatives

Aquatic biota and habitats immediately upstream and downstream of the Project are influenced by Project operations, hydrologic conditions, and releases from upstream hydroelectric and water

storage projects. The effects of Project operations on aquatic habitats were assessed using a Physical Habitat Model to generate indices reflecting habitat conditions in Boundary Reservoir and the Boundary Dam tailrace. A habitat-based modeling approach was chosen to allow assessment of alternative operation scenarios.

SCL developed a suite of models and post-processing analyses to support the evaluation of existing conditions and alternative operations. These models included the Scenario Tool (ST) (CddHoward 2008), Hydraulic Routing Model (HRM), Peak Flow Model, mainstem habitat model, trapping and stranding models, mainstem sediment transport model, and tributary delta habitat models.

The ST is an Excel® spreadsheet-based hydroelectric operations tool tailored to the requirements of relicensing the Project (CddHoward 2008). Using an hourly time-step, the ST optimizes Project energy production using as input existing turbine efficiency curves, current storage capacity, and historic hydrologic data under specific operational constraints for three hydrologic periods corresponding to the adverse (dry), average, and high (wet) inflow years as presented in Section 2.1.2.3 of this Exhibit. For each alternative operation (scenario), output from the ST consists of hourly time series of Project energy production (MWh), releases (cfs), and forebay water surface elevations (feet) to serve as input to the HRM to assess changes in habitat and recreation parameters.

The HRM was used to translate hourly changes in forebay water surface elevations to locations upstream and downstream of the Project. The HRM computes water surface elevations, average velocities, and timing of water surface fluctuations at locations throughout Boundary Reservoir and the tailrace. Although the effects of Project operations on fish and aquatic resources were evaluated by analyzing HRM output using the mainstem habitat model (see below), some resource areas used HRM output directly to assess impacts of Project operations, e.g., effects of fluctuating water surface elevations on waterfowl nesting.

As noted above, the mainstem habitat model used water surface elevations and average velocities from the HRM, along with specific velocity measurements within habitat cells at various habitat transects, to determine depths and velocities for each habitat cell for each hour of simulated operation. In addition to depth and velocity, substrate and cover were incorporated into the habitat model and compared to Habitat Suitability Indices/Criteria (HSI/HSC) for lifestages and fish species of interest (native salmonids, smallmouth bass, forage species) and other aquatic organisms (macrophytes, periphyton and benthic macroinvertebrates). The integration of hydraulic, channel morphology and biological response data was used to calculate the relative amount of potential habitat, termed weighted usable area (WUA), at each transect for lifestages and species of interest for each hour of simulated Project operation. The mainstem habitat model was also used to track the effect of fluctuating water surface elevations on potential mountain whitefish and smallmouth bass spawning areas to evaluate which cells of potential spawning habitat remain inundated through the subsequent incubation period (Effective Spawning Index [ESI]).

In coordination with RPs, several of the habitat indices were selected as prime indicators of Project effects to evaluate alternative operations:

- Potential habitat (weighted usable area) for adult cutthroat trout and bull trout calculated as average daily minimum channel width (square feet/foot) and average daily fluctuation in (square feet/foot).
- Area of potential thermal refugia (10,000 square feet) for Flume, Sullivan, Linton and Sweet creeks.
- Percent of time that the delta foreset of Sullivan, Sweet, and Sand creeks were exposed potentially affecting upstream fish movement.
- Juvenile mountain whitefish and smallmouth bass stranding calculated as mean daily channel width (feet) and average daily fluctuation (feet).
- Juvenile mountain whitefish and smallmouth bass trapping as total channel area (10,000 square feet).
- Effective spawning/incubation and nest viability for mountain whitefish and smallmouth bass as transect-weighted, reach averaged channel width (feet), and the ratio of Effective Spawning Habitat/Potential Spawning Habitat to assess the channel area supporting spawning habitat but impacted by operations.
- Periphyton and benthic macroinvertebrate distribution and abundance calculated as average daily minimum channel width (square feet/foot) and average daily fluctuation (square feet/foot).

The habitat index values were summarized on a monthly and annual basis under representative high (1997), adverse (2001), and average (2002) inflow years. In coordination with RPs, habitat values were evaluated under alternative operations ranging from existing conditions to run-of-river operations. In order to provide a consistent comparison among alternate operations, existing conditions were modeled using the ST, HRM, and habitat models rather than actual historic operations. On a voluntary basis under the existing license, SCL maintains forebay water surface elevations above 1,984 feet NAVD 88 during summer daylight hours and above 1,982 feet NAVD 88 during summer nighttime hours. During the 10-year period 1996 through 2005 there were an average of 34.4 hourly excursions from the voluntary guidelines, ranging from none in 2005 to 242 hours in 2001. To model existing conditions, the summer recreational pool constraints were modified by allowing the ST to exceed the forebay pool level constraints according to the magnitude and frequency of excursions observed historically during the high, adverse, and average years. Under the Proposed Action, modeling assumptions included SCL implementing the summer recreational pool level constraints as a firm obligation (hard constraint of the new Project license).

4.5. Proposed Action and Action Alternatives

This section describes the anticipated impacts of the Proposed Action on environmental resources, including discussion of resources that would not be affected by the action. The following topics are addressed for each resource: Affected Environment; Environmental Analysis; Proposed Environmental Measures and their effects on resources; Cumulative Effects; and Unavoidable Adverse Impacts.

Because the Proposed Action does not include any operational changes other than formalization of current voluntary summer pool-level restrictions and turbine sequencing, the environmental effects of Project operations under the Proposed Action are nearly the same as those under the No Action alternative. In those few instances where the formalization of current voluntary measures results in different effects on a resource, the differences are described in the following sections.

The primary difference between the Proposed Action and the No Action alternatives is the suite of proposed non-operational PM&E measures, the benefits of which are only associated with the Proposed Action. For each resource, the analysis of unavoidable adverse impacts assumes that the proposed PM&E measures are implemented, and so reflects the effects of the Proposed Action.

4.5.1. Geology and Soils

4.5.1.1. Affected Environment

The Affected Environment for geology and soils includes the Project facilities and the area within the FERC Project boundary (i.e., Project structures, Project-related roads, reservoir, and transmission line ROW from the Project power plant to the BPA substation) as well as the surrounding area (i.e., Pend Oreille River and land within 0.25 mile on either side of the river from Boundary Dam to the U.S.-Canada border; from Boundary Dam to Metaline Falls, the area between Highway 31 [on the east side of the reservoir] and County Road 2975 [on the west side of the reservoir]; from Metaline Falls to the Box Canyon Project tailrace, the area between Highway 31 [on the west side of the reservoir] and 0.25 mile east of the reservoir shoreline; and the SCL-owned BWP and adjoining property [i.e., Project vicinity]). Detailed descriptions of existing data, reports, and literature, and the results of more recent SCL reconnaissance-level surveys along the Boundary Reservoir shoreline and at locations along Project-related roads are found in the PAD (SCL 2006), the RSP (SCL 2007), and the USR (SCL 2009a).

4.5.1.1.1. Geology/Lithology

The Project is located within the Okanogan Highlands physiographic province. The unique geology results from volcanism, intrusion of granitic rock, and deformation and metamorphism of accreted marine sediments (Williams et al. 1995, Alt and Hyndman 1984). Continental glaciation approximately 20,000 to 10,000 years ago (Stoffel et al. 1991) deeply eroded the bedrock and left areas of thick glacial and postglacial sediments. The Pend Oreille River in the Project vicinity bisects the Selkirk Mountains and cuts through Metaline Limestone and Ledbetter Slate. These two formations predominate along Boundary Reservoir downstream of Metaline Falls, with pockets of glacial sediments between rock outcrops. The Metaline Limestone is exposed near Boundary Dam. The Z Canyon Fault crosses the Pend Oreille River at the downstream toe of the spillway and offsets the Metaline Limestone and the overlying Ledbetter Slate (SCL 2006). The upstream portion of the reservoir, above Metaline Falls, consists predominantly of unconsolidated glacial sediments and side stream and mainstem river alluvial deposits, with a few outcrops of Ledbetter Slate (SCL 2007).

Project geology was mapped (Figure E.4-14) along the entire Project shoreline and is described in the Erosion Study Final Report (SCL 2009a). These descriptions are excerpted below:

- *Metaline Limestone* – The Metaline Limestone is approximately 1,500 feet thick and forms vertical cliffs more than 500 feet high along sections of the canyon, which is evidence of its resistance to erosion. The Metaline Limestone varies in color, texture, composition, amount of weathering, and strength.
- *Ledbetter Slate* – The Ledbetter Slate overlies the Metaline Limestone and is offset by the Z Canyon Fault. The Ledbetter Slate varies in composition and erosional characteristics from a well-consolidated slate with quartzite zones to a highly sheared and fractured slate.
- *Talus* – Talus cones have formed in several locations along the base of cliffs in both the Metaline Limestone and the Ledbetter Slate. The material in the cones is unconsolidated cobble, gravel, sand, and fines and generally grades from finer material at the top of the cone to coarser material at the base.
- *Quaternary glacial deposits (Till)* – Glaciers left behind unconsolidated deposits, including till and ice-contact deposits and glaciolacustrine and glaciofluvial deposits. These deposits often grade into each other. Pockets of non-glacial alluvial deposits also are present, the result of river and stream alluvium stranded on the valley walls as the river cut downward. Downstream of Metaline Falls, these units occur together (either stacked or interfingering), are not always easily differentiated, and are mapped as a single unit.
- *Quaternary lacustrine/alluvium* – Lacustrine and alluvium deposits are widespread in the valley upstream of Metaline Falls. The deposits consist of still water deposits that originated near the end of the last glacial period and fine-grained alluvial deposits from side streams and the river itself. The deposits are laminated, slightly compacted sand, silt, and clay.
- *Fill* – Fill includes road fill along roads adjacent to the reservoir and fill associated with Project features and other development.
- *Riprap* – Riprap has been placed at various locations in the study area to protect shoreline areas, roads, facilities, and home sites from erosion. Riprap consists of large, angular boulders.
- *Mine-related Sediment* – Mine-related sediments were mapped in locations where disturbed rock and sediments appeared to be related to past or current mining operations. These sediments include unconsolidated piles of unsorted coarse and fine-grained rock, as well as fine-grained sediments.

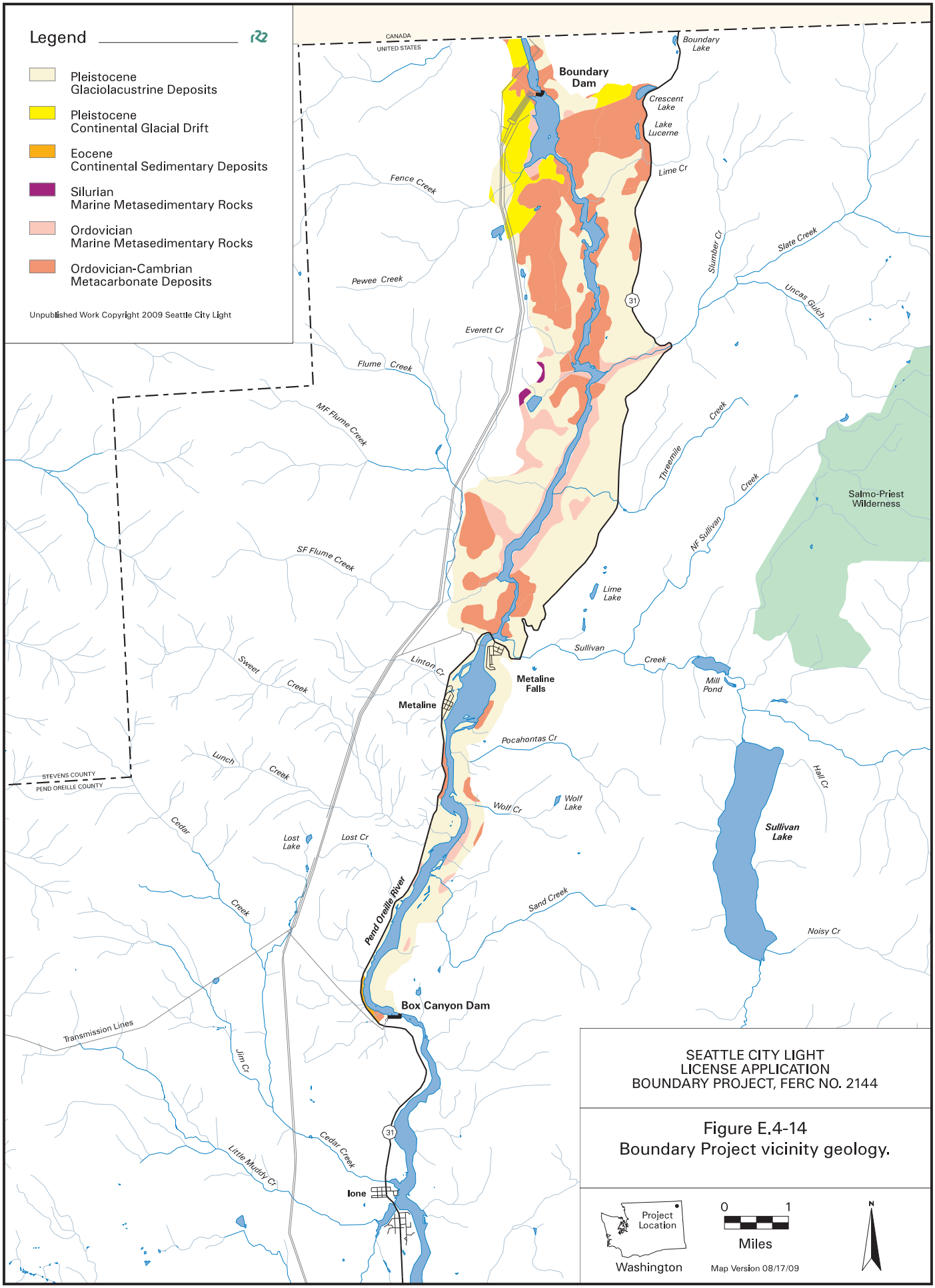

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Figure E.4-14
Boundary Project vicinity geology.

Soil Types and Characteristics

Soils in the Project vicinity are relatively undeveloped due to geologically recent volcanic and glacial activity (SCL 2006). Soils derive from material deposited during the advance and retreat of large ice sheets, the last of which was present approximately 10,000 years ago. Most of the sediments are silty sands and gravels in terrace deposits on both sides of the valley formed by glaciofluvial processes (associated with meltwater from retreating ice). Soils found in the broad valley bottoms are glaciolacustrine deposits (derived from lakes associated with glacial movement). Concentrations of sands and clays are scattered throughout the vicinity (SCL 2006). Post-glacial sediments of any appreciable thickness primarily consist of boulders, sand, and gravel and occur in and near the Pend Oreille River, particularly downstream of Boundary Dam (NRCS 1992). Table 4.3-1 of the PAD (SCL 2006) identifies the specific soil types that occur in the Project vicinity. Detailed descriptions of the soil types can be found in the Pend Oreille County Soil Survey (NRCS 1992).

Soil-type characteristics, including susceptibility to erosion, vary among the three main reaches of the reservoir as outlined below (SCL 2006):

- *Forebay Reach* – All three soil types that occur along this segment of the reservoir have a high erosion potential.
- *Canyon Reach* – The nine soil types that occur in this reach are more variable than those found in the Forebay Reach and are generally less prone to erosion. Many of these are deep, well-drained soils, some with a substantial rock component.
- *Upper Reservoir Reach* – Ten soil types occur adjacent to the reservoir upstream of the Metaline Falls Bridge. These soils vary in permeability but most are well-drained and characterized by low to moderate erosion potential. Seasonal wetness and cut bank instability are common.

Mining History

The 75-square mile Metaline Mining District dates from 1855 and is one of the older mining districts in Washington (McClelland and Whitebread 1965). Large-scale commercial mining in the area began in 1904 with the Lehigh Cement Company's plant and quarries, followed by several zinc-lead mines (SCL 2006). In 1906, the river channel at Box Canyon was blasted to improve access to the area and to accommodate river navigation downstream to Metaline Falls. Commercial drilling and mining in the area expanded rapidly through the 1930s, and the largest limestone mine in the state was established to supply a growing cement industry (EPA 2002). In addition to the mines identified by the U.S. Environmental Protection Agency (EPA) during an investigation in 2002, a SCL survey of Z Canyon identified several small adits that have since been covered by the reservoir (SCL 1966).

The only recently active mine in the Project vicinity is the Pend Oreille Mine, a lead and zinc mine with surface facilities located on the east side of the river approximately 2 miles north of Metaline Falls. This mine began operation in 1952, operated intermittently until it was shut down in 1977, and was then reopened from January 2004 to January 2009. The mine was one of the earliest, largest, and most productive mines in the Metaline Mining District.

Erosion and Stability

Characteristics of the geology and soil relevant to erosion are described in the Erosion Study Final Report (SCL 2009a). The geology was mapped at each erosion site and along the entire Project shoreline. Samples of several of the erodible units were collected. The susceptibility to erosion of each geologic unit is described below (SCL 2009a):

- *Metaline Limestone* – Metaline Limestone is resistant to erosion because of its high strength, lack of closely spaced fractures, and relative lack of weathering at the majority of locations along Project shorelines.
- *Ledbetter Slate* – The consolidated portions of the Ledbetter Slate resist erosion and form cliffs (such as the cliffs around Beaver Creek). Talus from the resistant areas is primarily gravel with minor amounts of sand and fines. The sheared portions of the slate are susceptible to wave erosion and undercutting (for example, the bluffs on either side of the Pewee Falls area). The sheared portion of the slate is a mix of gravel and sand with some fines.
- *Talus* – The talus cones are moderately erodible, primarily influenced by wave action and surficial grain size. A sample of talus at the base of a Metaline Limestone cliff was primarily gravel with sand and minor amounts of fines.
- *Quaternary glacial deposits (Till)* – These glacial deposits are unconsolidated and susceptible to erosion by all erosional processes. Samples of the glacial deposits ranged from bouldery gravel with sand to gravely sand with minor fines to silty sand.
- *Quaternary lacustrine/alluvium* – The Quaternary alluvium/lacustrine deposits are slightly compacted but still moderately susceptible to erosion by wave action, reservoir fluctuations, and river currents. They are composed of silty sand with 10 to 20 percent clay.
- *Fill* – The composition and erodibility of fill varies depending on the mix of materials that was used as fill. In most road locations adjacent to the reservoir, the fill was placed on the side of an already steep slope and left at the angle of repose of the fill material. This material can be susceptible to erosion from road runoff or wave action if not protected by riprap.
- *Riprap* – Riprap is not very erodible because the angular boulders have been sized to resist erosion.
- *Mine-related sediment* – Piles of coarse-grained mine-related sediments are somewhat erodible, but the large, angular rock fragments (cobble to gravel size) in many of these piles provide some resistance to surface erosion. Fine-grained mine-related sediments are more erosive.

The Erosion Study Final Report (SCL 2009a) summarizes the geology along Boundary Reservoir and composite grain size distribution as shown in Table E.4-2:

Table E.4-2. Surface geology along the Boundary Reservoir shoreline and composite grain size distribution.

Geology	Shoreline length (feet)	Percent of total shoreline length[1]	Percent boulder/ cobble	Percent gravel	Percent sand	Percent silt	Percent clay
Metaline Limestone (ML)	89,531	35%	No sample collected				
Ledbetter Slate (LSL)	46,040	18%	0%	46%	43%	5%	6%
Talus	644	<1%	2%	73%	21%	3%	1%
Quaternary Glacial Deposits (Till)	19,148	8%	12%	36%	45%	5%	2%
Quaternary Lacustrine/ Alluvium High Terrace (Qgl_1)	25,248	10%	0%	0%	47%	38%	15%
Quaternary Lacustrine/ Alluvium Low Terrace (Qgl_2)	60,532	24%					
Fill	6,683	3%	No sample collected				
Riprap	5,379	2%					
Mine-Related Sediment (MRS)	1,563	1%					

Note:
1 Total slightly exceeds 100 percent due to rounding error.

The Erosion Study (SCL 2009a) estimated the past erosion rates over the life of the Project since the initiation of commercial operations, 1967 to 2007. Methods used to estimate erosion and slope failures varied by site, depending on the type and extent of erosion, slope conditions, and vegetation. Techniques included both qualitative and quantitative methods.

Shoreline Erosion

The Erosion Study Final Report (SCL 2009a) also summarizes the results of the 2007 reservoir erosion inventory that identified 54 erosion sites between Boundary Dam and Metaline Falls, 30 sites between Metaline Falls and the Box Canyon Project boundary, and 3 sites along the Pend Oreille River between Boundary Dam and the U.S.-Canada border. Figure 5.2-4 of the Erosion Study Final Report (SCL 2009a) shows sites representing both linear erosion along the shoreline and mass wasting sites that extend above the shoreline.

As described in the Erosion Study Final Report (SCL 2009a), the seven erosion processes observed during the reservoir erosion inventory are described below:

- *Undercut bank* – Undercut banks occur where the soil or rock is consolidated enough to form steep, sometimes near-vertical banks. Erosion at the base of a bank removes material until the weight of the overlying material causes the bank to topple or slide and the process repeats. Roots and vegetation can provide additional strength to material at the top of the bank.
- *Shallow translational slides* – Shallow translational slides occur on steep banks. The surficial soil layer (generally 3 to 5 feet thick) slides down the slope. Shallow

translational slides can be initiated by removal of toe support or by saturated soils within or at the base of the slope.

- *Slumping* – Slumping is a deep-seated, rotational mass movement of material that often occurs in more homogeneous, fine-grained sediments. Slumping can be initiated by removal of toe support or saturated soils within or at the base of the slope.
- *Raveling* – Raveling is a loose, grain-by-grain movement of material down slope. It often occurs in unconsolidated material on steep slopes when vegetative cover is removed or not yet established.
- *Rills/gullies* – Rills and gullies form when surface runoff is concentrated and has enough energy to erode and transport soil particles.
- *Trampling* – Trampling occurs in locations where people or animals congregate, trample vegetation, and scuff underlying soils.
- *Non-Project roads adjacent to reservoir* – Road erosion occurs on some unpaved road surfaces and on steep road fillslopes adjacent to the reservoir. The roads included in this category are non-Project roads. Project-related roads are addressed below.

Table E.4-3 categorizes shoreline erosion by geology and by the extent (length) of erosion by bank height.

Table E.4-3. Length of erosion sites by bank height and major geologic unit.

	Bank height					
Geology	**0-5 feet**	**5-10 feet**	**10-20 feet**	**20-40 feet**	**>40 feet**	**Total Length Eroding (feet)**
Metaline Limestone	2,747	318	0	762	460	4,287
Ledbetter Slate	2,368	1,169	3,898	4,615	1,316	13,366
Talus	0	327	181	1,724	0	2,232
Glacial and non-glacial deposits (Till)	145	275	9,497	2,096	3,458	15,471
Quaternary Lacustrine/Alluvium	3,707	9,086	20,396	1,217	1,724	36,130
Fill	0	109	943	5,408	1,983	8,443
Mine-related Sediment	0	0	1,677	0	0	1,677
Total	8,967	11,284	36,592	15,822	8,941	81,606
Percent of total erosion area length	11%	14%	45%	19%	11%	

Road Erosion

Approximately 11 miles of Project-related roads were inventoried as part of the Erosion Study (SCL 2009a). The inventory focused on the roads that are known to be needed for Project purposes, as outlined in the Land and Roads Study Revised Final Report (SCL 2009a). In addition, approximately one mile of road within the BWP and the adjacent 89-acre parcel was inventoried, bringing the total to 11 miles of roads. Complete information collected on road

characteristics, drainage structures, and mass wasting sites is included in the Erosion Study Final Report (SCL 2009a).

Overall, Project-related roads are in good condition, with paved surfaces on roads with higher traffic volumes and gravel on low-use roads (Table E.4-4). Most drainage structures are maintained and are in good condition. Three culverts out of the 47 inventoried were rated as having a high priority for cleaning or maintenance, primarily because the intakes or catch basins were more than 75 percent blocked by sediment. Roads that are only occasionally used (such as USFS spur roads) are maintained at a lower level, consistent with USFS road management objectives and the low traffic use. Since the road analysis was conducted, SCL has determined that it no longer needs to use a spur off of FR 3165-200 and off of FR 3165-340 for Project purposes (Table E.4-4, #10 and #11); FR 3165-340 will be decommissioned under the new license (see Road Decommissioning Plan, Attachment E-13).

Approximately 30 percent of the 11 road miles surveyed were hydrologically connected to streams or water bodies. Of the hydrologically connected road length, 17 percent was native surfaced road, 23 percent was gravel road, and 60 percent was paved road. Seven mass wasting sites were inventoried along roads (SCL 2009a) (Table E.4-4).

Table E.4-4. Summary of road inventory results.

Map road ID[1]	Road number/name	Length inventoried (miles)	Surface	Number of drainage structures	Hydrologic connectivity		Stability issues?
					Length (feet)	Percent of total length	
1	West-Side Access Road	2.14	Paved	15	5,745	51%	Continuing raveling and shallow debris slides on steep cutslopes at through cut (HC1). Barriers and re-vegetation help to control and contain sediment (site already treated).
2	Maintenance facility road network	1.59	Paved / gravel	1	437	5%	No
3	Road to Forebay Recreation Area	0.36	Paved / gravel	0	1,890	100%	No
4	BPA substation road	0.21	Gravel	0	0	0%	No
5	Spur off the BPA substation road	0.38	Gravel / native	1	704	35%	No
6	South end of FR 6200-348	0.50	Native	2	793	30%	No
7	POC 3990/FR 3165-000 Boundary Dam/Crescent Lake	2.10	Paved	19	2,181	20%	No
8	FR 3165-350	0.48	Gravel	4	2,110	83%	No
9	Tailrace boat launch road (west side)	0.23	Gravel	1	1,200	100%	No
10	FR 3165-200	0.28	Native	1	0	0%	One small, inactive shallow debris slide in over-steepened road fill (200-1)
10	Unnamed spur off of FR 3165-200	0.95	Native	2	0	0%	No
11	FR 3165-340	0.71	Native	1	1,363	36%	2 active/potential mass movement sites, road blocked by past sliding (340-1 and 340-2). Seeping, drainage issues, over steepened fill. Delivers to stream.
BWP	Boundary Wildlife Preserve Road	0.47	Native	0	831	33%	2 inactive shallow debris slides. Areas still raveling, but no recent sliding. Does not deliver sediment to waterways.
SCR	Sand Creek Road	0.62	Gravel/ native	0	0	0%	No

Note:
1 For road locations, see Figure 5.2-4 (pages 24-32; SCL 2009a).

4.5.1.2. Environmental Analysis

4.5.1.2.1. Erosion

The greatest potential for Project-related erosion exists along reservoir shorelines (Table E.4-3) and Project-related roads (Table E.4-4). The Erosion Study Final Report (SCL 2009a) describes road-related erosion sites as either stabilized or not Project-related. Minor surface erosion will continue in areas where Project roads and facilities are not vegetated; however, a conclusion from the Erosion Study was that such erosion is not substantially affecting high-value resources. Therefore, this analysis, based on the results of the Erosion Study (SCL 2009a), focuses on shoreline erosion.

The reservoir shoreline erosion inventory (SCL 2009a) identified 87 erosion sites between Box Canyon Dam and the U.S.-Canada border. Erosion occurs along 15.5 miles (32 percent) of the total shoreline; several erosion sites are at least partially stabilized. Shoreline erosion at 12 of the sites (35 percent of the 15.5 miles) was not continuous along the entire mapped length but occurred intermittently at dispersed locations (the distinct erosion areas in some locations were too small and numerous to map separately). Factors affecting erosion include reservoir fluctuations, wave action, flood flows, upslope road use, industrial activities, frost heave, and private development. Project-related erosion factors include Project-related wave action (wind and boat generated), Project-related reservoir fluctuation, Project-related stream flow variations downstream of Boundary Dam, and Project-related recreation. Project-related factors were determined to be solely responsible for 37 percent of the eroding shoreline and partially responsible (along with non-Project factors) for 49 percent of the eroding shoreline.

Substrate was mapped to estimate potential erosion in the drawdown zone. Approximately 21 percent of the substrate is not very susceptible to erosion (e.g., concrete, bedrock, riprap, boulder); 42 percent is moderately susceptible (e.g., cobble, gravel); and 37 percent is highly susceptible (e.g., sand, silt). Finer-grained substrate and material in tributary deltas will continue to be reworked over the term of the new license, resulting in slightly coarser substrate and inhibiting revegetation in some locations.

Project and non-Project erosion has resulted in the loss of approximately 14 to 15 acres of land (240,000 cubic yards of material) adjacent to the shoreline since Project operations began 40 years ago. Future shoreline loss rates are unknown but are expected to be less than past rates because erosion tends to be more active following initial inundation.

High flows in the Pend Oreille River occur primarily during the spring runoff season, typically between May and early July. During flood flows, bank erosion can occur above Metaline Falls, as was observed following the spring 2008 high flows. Bank erosion during high-flow events would occur in this reach without the Project in place; however, Project operations could potentially increase bank erosion during peak flows via three mechanisms: (1) inundating additional areas, (2) increasing the hydraulic forces on the banks, or (3) lowering water surface levels more rapidly than would occur without the Project (i.e., downramping). Modeling results from the Analysis of Peak Flood Flow Conditions above Metaline Falls Study (SCL 2009a) showed that little Project-related erosion would result from mechanisms 1 or 2 during peak flows.

Of the three mechanisms identified above, only Project downramping could potentially result in a small increase in erosion of the Quaternary lacustrine/alluvium deposits during the descending limb of the peak flow hydrograph. Downramping rates during the descending limbs of peak flow events are considerably muted (2 to 4 inches/hour) in the upper reservoir due to the effects of the hydraulic constriction at Metaline Falls and the effects of the high inflows, and the resulting increased erosion is small. One report of bank erosion in the town of Metaline during the 1996 peak flow event was not related to Project operations and most likely was related to downramping rates in the Box Canyon tailrace of up to 17 inches per hour (SCL 2009a).

The potential extent and severity of erosion on specific resources (by category) are presented in Table 5.4-1 of the Erosion Study Final Report (SCL 2009a). The Erosion Study Final Report (SCL 2009a) also identifies sites where erosion potentially affects high-value resources. Section 5.4.2 of the Erosion Study Final Report (SCL 2009a) describes high-value resources as those that are geographically limited (e.g., limited habitat for an important species' life stage) or are considered high value by a regulating agency (e.g., rare, RTE species, or cultural resources). High-value sites were identified through discussions with researchers conducting relicensing studies for the following subjects:

- Aesthetic/visual resources (Aesthetic/Visual Resource Study)
- Aquatic habitat, (Mainstem Aquatic Habitat Modeling Study)
- Cultural resources (Cultural Resources Study)
- Recreation (recreation effects on erosion and erosion effects on recreation), (Recreation Resource Study)
- Structures/infrastructure (buildings, roads, bridges, etc.), (Land and Roads Study)
- Terrestrial habitat/vegetation (sensitive habitats/plants, noxious weeds), (Rare, Threatened and Endangered [RTE] Plant Species Inventory)
- Toxics, (Toxics Assessment: Evaluation of Contaminant Pathways)
- Water quality (turbidity), (Water Quality Constituent and Productivity Monitoring)
- Wetlands and riparian habitats, (Inventory of Riparian Trees and Shrubs)
- Wildlife (roost trees, bank swallow nesting, other habitat), (Waterbird/Waterfowl Study, Rare, Threatened and Endangered [RTE] Wildlife Species Study, Big Game Study, and Bat Surveys and Habitat Inventory)

Table 5.4-2 of the Erosion Study Final Report (SCL 2009a) identifies high-value resource sites and the effect of erosion on the resource(s). In July 2008, resource leads and RPs visited these sites to determine if Project-related erosion is affecting high-value resources and to assess the feasibility of erosion control measures at select sites. At four of the sites, erosion is creating nesting habitat for bank swallows, kingfishers, and beavers. Ongoing Project-related erosion at nine sites is slow, resulting in minor effects on wildlife or riparian/terrestrial resources. Ongoing erosion at 19 sites affects individual RTE plants but does not affect these species at the population level. At four reservoir erosion sites, the risk to high value resources from Project-related erosion was great enough to warrant conducting feasibility analyses for erosion control at

those sites. These sites include three recreation areas: Forebay Recreation Area (Erosion Site 17W1), Bureau of Land Management (BLM) Boundary Recreation Area (Erosion Site 19W9), and a dispersed boat-in day use/overnight campsite on BLM-managed land (Erosion Site 21W19) as well as a riparian area in the Sullivan Creek delta (Erosion Site 26E112). Section 5.5 of the Erosion Study Final Report (SCL 2009a) assesses erosion at these four sites and the feasibility of erosion control measures.

Erosion Site 17W1 (Forebay Recreation Area) – The site is owned by SCL and is located just upstream from Boundary Dam at the Forebay Recreation Area (Figure E.4-15). The bank is 10 to 15 feet high. Erosion extends approximately 850 feet and is progressing toward the existing fence and picnic area. Reservoir fluctuations and surficial erosion due to runoff from the recreation area are causing the bank to slough and erode.

Figure E.4-15. Photo of Erosion Site 17W1 (Forebay Recreation Area).

Erosion Site 19W9 (BLM Boundary Recreation Area) – BLM manages this recreation area (Figure E.4-16; see the Erosion Study Final Report, SCL 2009a, for additional figures). The eroded area is approximately 280 feet long; approximately 30 linear feet of the bank is 2 to 3 feet high, and the rest of the bank is approximately 7 to 8 feet high. The bank is well vegetated, but reservoir fluctuations are undermining the toe and causing bank erosion. This site is believed to be an old log landing, with logs placed along the toe to control undermining. However, the structure was not properly installed; the logs were not anchored and backfill material was inadequate. Trampling of the site by recreational users and informal access trails to the reservoir also contribute to bank erosion. These trails decrease slope stability and bank uniformity and damage rare plant habitat.

Figure E.4-16. Overview photo of Erosion Site 19W9 (BLM Boundary Recreation Area).

Erosion Site 21W19 (Dispersed Recreation Day Use/Overnight Campsite on BLM-Managed Land) – This boat-in day use and overnight campsite is located on BLM-managed land. The low bank (3 to 4 feet high) is eroded for approximately 120 feet along the shoreline. The soil in the bank is soft and friable and, as with site 19W9, the bank is undercut and slumping due to reservoir fluctuations (Figure E.4-17; see the Erosion Study Final Report, SCL 2009a for additional figures). Trampling of the bank by recreational users also contributes to bank erosion.

Figure E.4-17. Overview photo of Erosion Site 21W19 (dispersed recreation day use/overnight campsite on BLM-Managed land).

Erosion Site 26E112 (Sullivan Creek Delta) – This site is located at the confluence of the Sullivan Creek delta and Boundary Reservoir. Ownership is split between SCL and a private party. An outside channel of Sullivan Creek has eroded approximately 185 feet along the stream bank (Figure E.4-18; see the Erosion Study Final Report, SCL 2009a, for additional figures). The eroded bank is 15 to 20 feet high, with riparian vegetation and RTE plants growing on top of the bank. An existing pipeline is exposed and buttressed with concrete blocks. Pend Oreille County PUD personnel indicated that this water supply pipe was abandoned when it failed in 2000 (Scott, B., Pend Oreille County PUD, personal communication, September 8, 2008).

Figure E.4-18. Overview photo of Erosion Site 26E112 (Sullivan Creek delta).

Following the site visit, resource leads examined historic aerial photographs from before Project construction (1943, 1955, 1962) and following Project construction (1972, 2005). Potential Project effects on delta formation were discussed with relicensing team members conducting the Sediment Transport and Boundary Reservoir Tributary Delta Habitats Study (Sediment Transport and Tributary Delta Study) (SCL 2009a). The historic aerial photographs show that the Sullivan Creek delta was active and that the main channel migrated across the delta and eroded the stream bank prior to Project construction.

The aerial photographs also show that the spit of land protruding into the Sullivan Creek delta was extended approximately 40 to 50 feet between 1972 and 2005, likely during installation of the pipeline. Existing riprap, concrete blocks, and other bank protection measures presumably were installed then. The 2005 aerial photograph shows the main channel of Sullivan Creek flowing along erosion site 26E112, resulting in most of the erosion observed during the 2007 inventory and 2008 site visit. Although the main channel shifted to the center of the delta in 2008 and is not currently adjacent to the eroding bank, the channel likely will continue to meander across the delta.

The relicensing team also investigated whether higher water surface elevations in the reservoir could alter the location of deposition in the delta, potentially causing the creek channel to migrate more frequently toward the erosion site, and whether reservoir fluctuations could undercut the base of the bank by either wave action or wet/dry cycles.

The lead investigator concluded that (1) during peak flows when most of the bedload transport in Sullivan Creek occurs, reservoir water levels are approximately 10 feet deep near the erosion site, (2) Project operations may increase reservoir elevations up to 1.6 feet during peak flows compared to conditions without the Project (see Section 4.5.2.2 of this Exhibit E for discussion of peak flood flow conditions upstream of Metaline Falls), and (3) the location of the deposition zone and active channel migration in the Sullivan Creek delta is not substantially different in aerial photographs taken before and after the presence of the Project.

The toe of the bank at site 26E112 is within the zone of Project-related reservoir fluctuations, and the bank is composed of fine-grained materials (i.e., fine sand, silt, clay). Therefore, reservoir fluctuations may result in some continued undercutting of the toe of the bank if the material is saturated and reservoir levels drop quickly. Because this location is fairly well protected from wave action, erosion from waves is not likely.

Erosion Effects Summary – Erosion occurs along approximately 32 percent of the total reservoir shoreline length; several erosion sites are at least partially stabilized. Project and non-Project erosion has resulted in the loss of approximately 14 to 15 acres of land (240,000 cubic yards of material) adjacent to the shoreline since Project operations began 40 years ago. Future shoreline loss rates are unknown but are expected to be lower than past rates because erosion tends to be more active following initial inundation. Under the proposal to continue operating the Project with voluntary summer pool restrictions, finer-grained substrate and material in tributary deltas would continue to be reworked over the term of the new license, resulting in coarser substrate and limited establishment of vegetation in some areas. Overall, erosion (including reworking of finer-grained substrate) at high-value resource sites is expected to be limited. For example, while erosion is having some effect on individual RTE plants, it does not appear to be affecting RTE plants at the population level. Erosion may benefit certain species, for example, providing opportunities for nesting in the shoreline banks.

The Erosion Study Final Report (SCL 2009a) identified three shoreline recreation sites affected by Project-related erosion. At the Sullivan Creek delta erosion site, erosion is primarily caused by channel meandering, a process that was already occurring before Project construction. Although proposed Project operations may contribute to erosion near the Sullivan Creek delta, they are not considered to be the primary cause of erosion at this location.

4.5.1.3. Proposed Environmental Measures

The environmental measures proposed below are designed to reduce ongoing erosion where important resources are at risk and to mitigate for Project-related erosion losses. These measures will be integrated, along with measures to address other resource values, into the TRMP (Attachment E-3).

Erosion Site 17W1 (Forebay Recreation Area) – Bank erosion at this site will be controlled by installing seeded erosion control blankets or turf reinforcement mats. Minor slope grading prior to installation is recommended. Toe protection is not required; however, the erosion control fabric should be anchored at the toe of the slope and at the top of the bank. Future erosion from above also will be prevented by controlling surface runoff from the recreation area. Runoff from the picnic area currently flows in a drainage swale that discharges at the bank and contributes to erosion. Armoring the outlet of the swale where it discharges to the bank, or rerouting the swale to discharge closer to the boat ramp, would reduce bank erosion.

Erosion Site 19W9 (BLM Boundary Recreation Area) – Bank erosion at this site will be controlled by a combination of biotechnical stabilization techniques. Various measures such as tree revetments, live cribwalls, live siltation, coconut logs, and native rock could be installed to protect the toe of the bank. The bank itself will be revegetated using brushlayering, branch packing, and/or live cribwalls. Any stabilization technique should be carefully planned to minimize further destruction of established vegetation on the bank. The site could be further improved by constructing more formal public access to the reservoir using terraced log cribwalls and eliminating the existing casual trails by revegetating the trails and blocking access with downed trees or other natural materials.

Erosion Site 21W19 (Dispersed Recreation Day Use/Overnight Campsite on BLM-Managed Land) – Bank erosion at this site will be controlled by a combination of biotechnical stabilization techniques such as brushlayering, branch packing, and/or live cribwalls. Native rock should be used to help protect the toe of the bank. Other soft toe protection techniques also might be used; however, the soft, friable nature of the bank toe should be considered when designing the toe protection. Constructing more formal public access using terraced log cribwalls and minimizing the number of access points to the reservoir would reduce the amount of human-caused bank erosion.

Monitor erosion rate – As part of the TRMP, a plan will be developed to monitor ongoing erosion rates at select sites during the new license period. The specific monitoring schedule and other details are described in the TRMP as part of a comprehensive Project monitoring program.

Provide off-site mitigation for continuing erosion effects – Eighty-nine acres adjacent to the BWP (i.e., the "BWP Addition") will be brought into the Project boundary as part of a comprehensive response to loss of terrestrial habitat. This addition is intended to compensate for ongoing Project-related erosion and the loss conservatively estimated at 15 acres of habitat during the new license period. The TRMP will include a comprehensive management plan for this site.

4.5.1.4. Cumulative Effects Analysis

Past erosion over the term of the existing license (i.e., the last 40 years) from all causes is estimated to have resulted in the loss of approximately 15 acres of upland habitat, with the erosion thought to be most active following Project construction and initial reservoir inundation. Present erosion rates, therefore, are likely less than rates earlier in the license term. Therefore, the estimated erosion to date (approximately 240,000 cubic yards of material) provides a conservative (i.e., high estimate) projection of erosion resulting from the proposed operation and

maintenance of the Project over the new license term. Other sources, such as the operation of other hydropower projects, mining, and forestry activities, also contribute cumulatively to erosion in the basin.

In its SD2, FERC indicated that shoreline erosion could be cumulatively affected by the Project (FERC 2006). Although ongoing erosion due to the presence and operation of the Project would cumulatively contribute to erosion in the Pend Oreille River basin, the anticipated cumulative contribution of up to 15 acres of erosion in the Project area would be insignificant.

4.5.1.5. Unavoidable Adverse Impacts

Project- and non-Project-related erosion would result in the loss of up to 15 acres of land (240,000 cubic yards of material) adjacent to the shoreline. Although the future erosion rate is unknown, it is expected to be less than past rates (i.e., during the last 40 years) because erosion tends to be more active following initial reservoir inundation. The Project's potential contribution to future shoreline erosion and the associated loss of upland habitat would be a minor, unavoidable effect over the term of the new license.

4.5.1.6. Consistency with Comprehensive Plans

The geology and soils related management goals and policies associated with relevant comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

U.S. Department of Agriculture (USDA) Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The Colville National Forest land and resource management plan (USFS 1988) contains a number of forest-wide standards and guidelines related to soils and erosion. These were reviewed, and the Proposed Action was determined to be consistent with the Land and Resource Management Plan (USFS 1988) guidelines applicable to Project activities and erosion, including:

- National Forest system lands will be managed under the principle of multiple use and sustained yield without permanent impairment of land productivity.
- Identify areas of high soil erosion or mass failure potential and evaluate probable impacts of resource development.
- Comply with State requirements in accordance with the Clean Water Act through the selection and implementation of BMPs. These BMPs include practices to prevent or minimize erosion and runoff from roads, protection of riparian areas, and prompt revegetation of disturbed areas (USFS 1988).
- Revegetate cut and fill slopes and other large areas of disturbed soil as quickly as possible with vegetation suitable for the management goals of the area.

- Suspended and bedload sediment and/or changes in bank stability caused by management activity will be considered excessive and mitigation will be implemented.
- Emphasize the protection and improvement of soil, water, vegetation, fish, and wildlife resources while managing riparian areas.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

- The stated goal of the plan is to provide a variety of uses within the sustained yield capability of the resource, which applies generally to all resources.
- The plan does not contain goals or objectives that relate specifically to geology and soils resources.

4.5.2. Water Resources

4.5.2.1. Affected Environment

The Affected Environment for water resources extends from the U.S.-Canada border upstream to Box Canyon Dam (see Section 4.1.2 for a discussion of basin hydrology).

4.5.2.1.1. Water Quantity

Existing and Proposed Water Uses

The primary nonconsumptive use of water in the Project area is for hydroelectric power. SCL holds several active water rights on file with Ecology's Water Resources Section. SCL's water rights authorize use of Pend Oreille River water for the purpose of hydropower generation in the quantities indicated below. SCL has also applied for a water right for an additional 4,400 cfs (for greater detail regarding Project water rights, see Exhibit A, Section 5.3).

- 53,700 cfs (instantaneous quantity)
- 94,500 acre-feet (annual quantity)

Other water rights are held by SCL, as described in Exhibit A, Section 5.3, Table A.5-2, authorizing the following uses: seasonal irrigation, fire protection, domestic supply, and power plant cooling.

Peak Flood Flow Conditions above Metaline Falls

Potential Project-induced flooding in the reservoir upstream of Metaline Falls was identified as an issue during the July 19, 2006 FERC scoping meeting for the Project relicensing (FERC 2006). During the meeting, Mr. Karl McKenzie, owner of Riverview Trailer Court & RV Park in Metaline, indicated that Project operations might exacerbate flooding in the Upper Reservoir Reach of Boundary Reservoir (above Metaline Falls), thereby potentially contributing to the flooding of his property. Mr. McKenzie specifically identified periods of high flow in 1972, 1974, and 1997 as the times when flooding occurred.

However, existing information (SCL 2006) suggests that the natural constriction formed by the Canyon Reach and Metaline Falls may prevent Project operations from significantly affecting flood water surface elevations in the Upper Reservoir Reach. SCL used recent topography and bathymetry to develop a hydraulic routing model (the Peak Flow Model) to characterize reservoir conditions upstream of Metaline Falls relative to Project operations during periods of high flows in 1972, 1974, and 1997. Results of this analysis are provided in Section 4.5.2.2.

4.5.2.1.2. Water Quality

The application for certification under Section 401 of the Clean Water Act (CWA)(401 certification) requires characterization of existing water quality conditions in the Project area and an assessment of whether water quality meets Ecology's regulatory standards. Water quality in the Project area is largely influenced by the Project's location within the highly regulated Pend Oreille-Clark Fork system. The Pend Oreille River is considered to have good water quality overall (Tri-State Water Quality Council 2007). However, Ecology has identified exceedances of temperature, TDG, and pH in the mainstem Pend Oreille River and polychlorinated biphenyls (PCBs) in fish tissue samples (Ecology 2008a). Toxics and macrophyte growth have also been identified by Ecology as parameters of interest in the Pend Oreille-Clark Fork system. In addition, based on its investigation of potential contaminant sources from 21 mines and mills along the lower reach of the Pend Oreille River, EPA (2002) identified potential toxics contamination from historical mining activities as an issue in the Project vicinity.

SCL collected water quality data in the Project area during recent years, including data collection in 2007 and 2008 as part of FERC relicensing. Data collection in the Project area during 2007 and 2008 addressed temperature, TDG, pH, toxics, dissolved oxygen (DO), turbidity, conductivity, nutrients, hardness levels, and the effects of macrophytes on pH and DO. Detailed summaries of existing data and reports related to water quality are available in the PAD (SCL 2006) and in the USR (SCL 2009a).

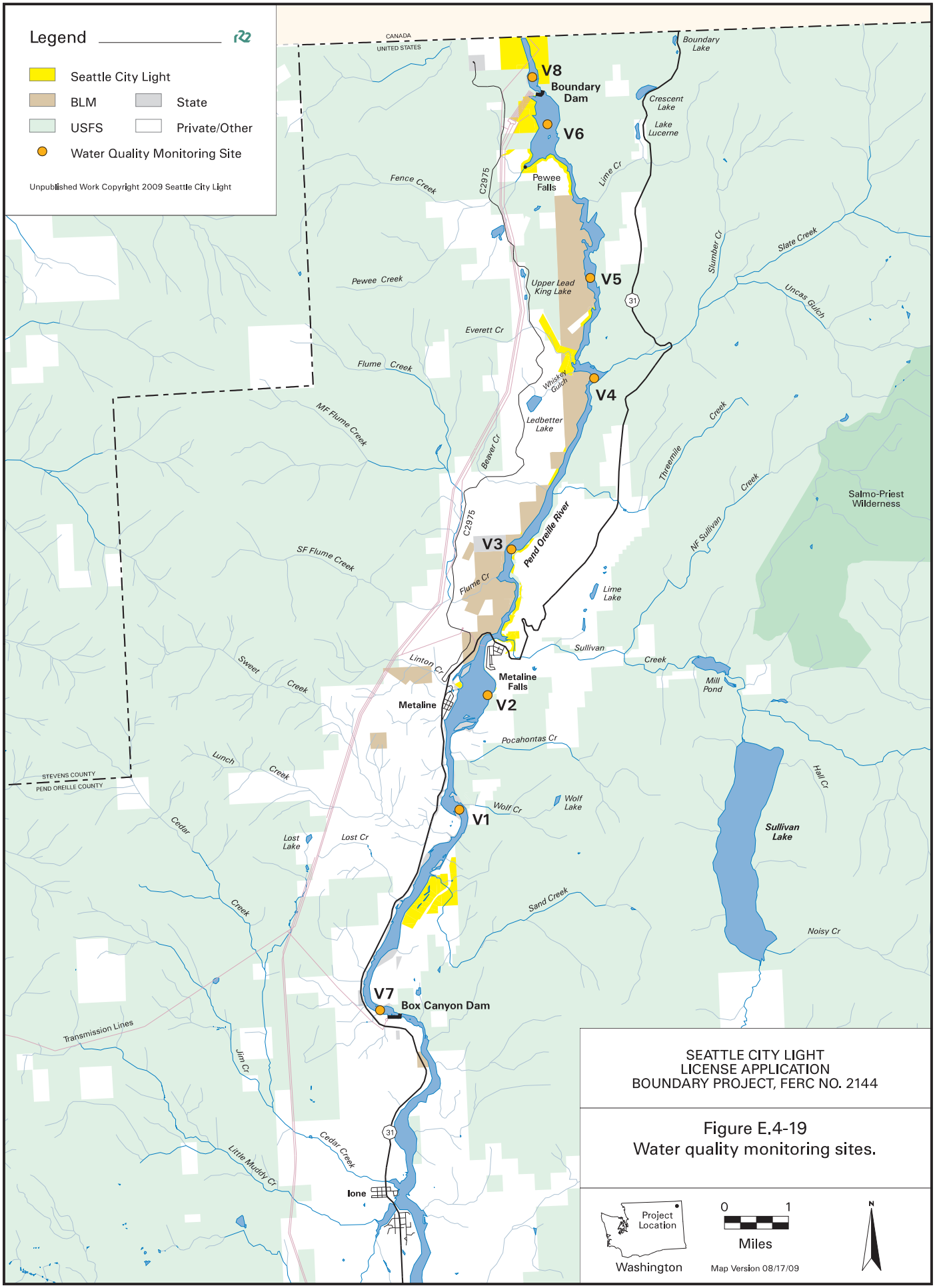
SCL conducted water quality monitoring at eight sampling locations in the Project area (Table E.4-5); a site map is provided in Figure E.4-19. Water quality parameters were monitored at six of these sites from 2004 - 2006, and results are reported in Taylor Associates (2007). In 2007 - 2008, two additional sites were added to represent water quality just downstream of Box Canyon Dam and just downstream of Boundary Dam (Water Quality Constituent and Productivity Monitoring [Water Quality Study] Final Report, SCL 2009a). In addition, Ecology has a long-term water quality monitoring site in Boundary Reservoir near Metaline Falls.

Table E.4-5. Water quality monitoring sampling locations used in 2007 -2008 relicensing studies.

Sample site	Location description
Box Canyon Tailrace (V7)	In Boundary Reservoir just downstream of Box Canyon Dam
Wolf Creek (V1)	Adjacent to Wolf Creek inlet (above Metaline Falls)
Metaline Old (V2)	Old channel of Pend Oreille River across from Metaline (above Metaline Falls)
Pend Oreille Mine (V3)	Downstream of Pend Oreille Mine (below Metaline Falls)
Slate Creek (V4)	Downstream of Slate Creek across from campsite on left bank (below Metaline Falls)
Everett Creek Island (V5)	Upstream of Everett Creek Island (below Metaline Falls)
Boundary Forebay (V6)	Boundary forebay
Boundary Tailrace (V8)	Downstream of Boundary Dam

Data were collected to evaluate compliance with Washington water quality standards. Ecology adopted use-based standards in 2003 that were approved by EPA in 2006. These uses are defined in WAC 173-201A-200. Designated uses in the mainstem Pend Oreille River from the U.S.-Canada border (RM 16.0) to the Idaho border (RM 87.7) are:

- Aquatic Life Use: Salmonid Spawning, Rearing, and Migration
- Recreation Use: Primary Contact Recreation
- Water Supply Uses: Domestic, Industrial, Agricultural, and Stock Water Supply
- Miscellaneous Uses: Wildlife Habitat, Fish Harvesting, Commerce and Navigation, Boating, and Aesthetic Values


Legend
Seattle City Light
BLM
State
USFS
Private/Other
Water Quality Monitoring Site
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
V8
Boundary Dam
V6
Pewee Falls
V5
Upper Lead King Lake
V4
Ledbetter Lake
V3
Pend Oreille River
V2
Metaline Falls
Metaline
V1
V7
Box Canyon Dam
Ione
Boundary Lake
Crescent Lake
Lake Lucerne
Fence Creek
C2975
Lime Cr
Pewee Creek
Everett Cr
Flume Creek
Whiskey Gulch
MF Flume Creek
Beaver Cr
SF Flume Creek
Flume Cr
Linton Cr
Sweet Creek
Lunch Creek
Cedar Creek
Lost Lake
Lost Cr
Wolf Cr
Wolf Lake
Pocahontas Cr
Sand Creek
Sullivan Creek
Lime Lake
Mill Pond
Sullivan Lake
Hall Cr
Noisy Cr
Slumber Cr
Slate Creek
Uncas Gulch
Threemile Creek
NF Sullivan Creek
Salmo-Priest Wilderness
STEVENS COUNTY
PEND OREILLE COUNTY
Transmission Lines
Jim Cr
Little Muddy Cr
31
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-19
Water quality monitoring sites.
Project Location
Washington
0
1
Miles
Map Version 08/17/09
N

Applicable standards for the Pend Oreille River and its tributaries are summarized in Table E.4-6. Water bodies in the Project area that deviate from these water quality standards are identified in Table E.4-7.

Table E.4-6. Applicable Washington surface water quality standards for designated uses in the Pend Oreille River and tributaries between the Idaho and Canada borders (Ecology 2006a).

Parameter	Water Quality Standard
Fecal Coliform	*Pend Oreille River*: Not to exceed a mean value of 100 colonies/100 ml with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 ml
	Sullivan Creek (above Harvey Creek and its tributaries) and Slate Creek and its tributaries: Not to exceed a mean value of 50 colonies/100 ml with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 ml
Dissolved Oxygen	*Pend Oreille River*: Levels shall exceed 8.0 mg/l
	Sullivan Creek (above Harvey Creek and its tributaries) and Slate Creek and its tributaries: Levels shall exceed 9.5 mg/l
Temperature	*Pend Oreille River:* Not to exceed 1-DMax of 20.0˚C due to human activities. When natural conditions exceed 1-DMax of 20.0˚C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3˚C; nor shall such temperature increases, at any time, exceed t=34/(T+9)
	Sullivan Creek (above Harvey Creek & its tributaries) and Slate Creek and its tributaries (Char spawning/rearing): 12˚C Highest 7-DADMax
Total Dissolved Gas	Not to exceed 110 percent of saturation at any point of sample collection; this criterion shall not apply when flow exceeds the seven-day, ten-year frequency flood (108,342 cfs).
pH	Within 6.5-8.5 with human caused variation within the above range of less than 0.5 units
Turbidity	Should not exceed either a 5 NTU increase over background when the background is 50 NTU or less; or a 10 percent increase in turbidity when the background is more than 50 NTU

Table E.4-7. Water bodies in the Project area (and Box Canyon Dam forebay) identified as not meeting applicable Washington water quality standards.

Water Body Name	Listing ID	Location Description (Township; Range; Section)	2008 Washington State Impaired Waters Classification[1]
Water Quality Parameter: Temperature			
Pend Oreille River	43539	Boundary Dam tailrace (40N;43E;03)	5
Pend Oreille River	42515	Boundary Dam forebay (40N;43E;10)	5
Pend Oreille River	11452	Above Boundary Dam near Metaline Falls (39N;43E;21)	5
Pend Oreille River	42512	Box Canyon dam tailrace (38N;43E;19)	5
Pend Oreille River	42513	Box Canyon dam forebay (38N;43E;19)	5
Water Quality Parameter: Total Dissolved Gas			
Pend Oreille River	42516	Boundary Dam tailrace (40N;43E;03)	4A
Pend Oreille River	6287	Box Canyon Dam tailrace (38N; 43E; 19)	4A
Water Quality Parameter: pH			
Pend Oreille River	11451	Above Boundary Dam near Metaline Falls (39N; 43E; 21)	5
Water Quality Parameter: PCBs (fish tissue)			
Pend Oreille River	52935	Above Boundary Dam near Metaline Falls (39N; 43E; 21)	5

Note:

1 The state of Washington uses five water quality assessment categories. Category 1: Meets tested standards for clean water; Category 2: Waters of concern – for waters where there is some evidence of a water quality problem, but not enough for a TMDL to be required; Category 3: No data; Category 4: Polluted waters that have water quality improvement plans in place (Category 4a is for water bodies that have an approved TMDL); Category 5: Polluted waters that require a TMDL (commonly referred to as the "303(d) list"). There are numerous sites in the Project area reported in Category 1; only those waters currently (2008) listed for Category 4A or 5 are included in this table.

As noted above, Ecology identified exceedances of temperature, TDG, and pH in the mainstem Pend Oreille River (Ecology 2008a). In addition, toxics (including PCBs), DO, and macrophyte growth have been identified as parameters of interest in the relicensing process. These six water quality parameters are addressed below under separate headings. Other water quality parameters not specifically identified, but measured during relicensing studies, are addressed under "Other Water Quality Parameters."

Temperature

Temperatures in the Pend Oreille River upstream of the Project area (i.e., water entering the Project from Box Canyon Reservoir) at times exceed the applicable numeric water quality standard of 20 ˚C daily maximum temperature. Field measurements show that water temperatures are consistent along the length of Boundary Reservoir. Little vertical variation in temperatures exists, with temperatures at the deepest point in the reservoir being similar to those measured at the surface (see Figure 3-1 in Temperature Modeling Analyses for Boundary Hydroelectric Project – Clean Water Act 401 Certification Support Technical Memorandum,

Khangaonkar et al. 2009). Temperatures throughout the Pend Oreille River can reach 25 ºC in the summer months, in excess of the numeric standard of 20 ºC. During this period, the natural conditions provision is the applicable water quality standard (i.e., numeric criteria is Natural Condition + 0.3ºC). Therefore, modeled temperatures were used to evaluate temperature conditions in the Pend Oreille River. A CE-QUAL-W2 model (Breithaupt and Khangaonkar 2007) was used to estimate natural temperature conditions by removing all known human heat influences in the model. The CE-QUAL-W2 model shows that existing temperatures in Boundary Reservoir are frequently within the range of natural temperature conditions, or cooler. Analysis of the Existing Condition relative to the Natural Condition temperatures was applied in developing a draft temperature Total Maximum Daily Load (TMDL) for the Pend Oreille River from Lake Pend Oreille in Idaho to the Canadian border (Ecology et al. 2007) to determine compliance with Washington water quality standards. Data from representative years[5] (2004-2005) were modeled and compared to temperatures under the modeled Natural Condition and under the modeled Existing Condition without the Project. Comparisons of temperatures under the Existing Condition, the Natural Condition, and the Existing Condition without the Project are discussed in Section 4.5.2.2.

Ecology has identified several tributaries to Boundary Reservoir as impaired by water temperatures. Sullivan Creek and Lime Creek have approved temperature TMDLs (Ecology 2005b), and a water quality implementation plan is in place (Ecology 2006b). Draft temperature TMDLs for the unlisted tributaries Slate Creek and Flume Creek were incorporated into the draft Pend Oreille River temperature TMDL (Ecology et al. 2007).

Total Dissolved Gas

TDG levels in the Clark Fork/Pend Oreille system at times exceed the applicable water quality standard of 110 percent saturation. TDG data have been gathered at the Project since 1998; TDG levels are measured at U.S. Geological Survey (USGS) stations in the forebay (USGS Gage No. 1238550) and in the tailrace (USGS Gage No. 12398600). Exceedances of Ecology's TDG standard typically occur during high spring flows, if flows exceed the power plant capacity of approximately 56,000 cfs and significant spill occurs. Average incoming TDG levels in the Boundary Dam forebay range from 103 to 128 percent. Average tailrace TDG levels range from 106 to 131 percent, with the average TDG contributed by the Project ranging from 0 to 4 percent between the forebay and the tailrace (Evaluation of Total Dissolved Gas and Potential Abatement Measures [TDG Evaluation] Final Report, Appendix 2, SCL 2009a).

EPA approved the TDG TMDL for the Pend Oreille River in Washington (Ecology 2007) in March 2008. The TMDL outlines TDG reduction goals for each hydroelectric project on the Pend Oreille River in Washington, recognizing that incoming TDG levels often exceed the 110 percent standard. There is a TMDL goal for each project to manage its spill (and reduce its contribution to TDG levels) to create TDG conditions in the downstream effectiveness monitoring location that are no worse than forebay conditions.

[5] During the development of the Pend Oreille River temperature model, EPA, Ecology, the Kalispel Tribe, and the Idaho Department of Environmental Quality (IDEQ) reviewed data from the historical record and determined that 2004 and 2005 were representative of critical conditions for temperature (Ecology et al. 2007).

pH

During 2007 and 2008 sampling, pH in the Project area ranged from 7.6 to 9.1 across all monitoring stations (Water Quality Study Final Report, SCL 2009a). No consistent longitudinal pattern was observed for pH in the reservoir, although from June through October 2007, the pH of water entering the reservoir from Box Canyon Dam was higher than the pH measured in the Boundary Dam forebay, as shown in Table 5.1-3 of the Water Quality Study Final Report (SCL 2009a). Readings exceeded Ecology's water quality criterion of 8.5 at several sampling stations from June through October 2007. However, as noted above, during these times the pH of water entering the Project area from Box Canyon Reservoir also exceeded the 8.5 standard and was higher than the pH of the water being released from Boundary Reservoir. Monthly pH data from Ecology's monitoring stations at Metaline Falls and Newport, Washington (the latter upstream of the Project Area and Box Canyon Dam) reflect a similar pH range to that observed in the Project area during 2007 and 2008 (i.e., 7.0 – 9.0), with one to three exceedances of the water quality standard recorded annually since 2001 at the Metaline Falls station (Ecology 2008b).

Dissolved Oxygen

Most DO measurements in the reservoir during the 2007 - 2008 sampling period were at or above the 8.0 mg/L water quality standard, as shown in Table 5.1-2 of the Water Quality Study Final Report (SCL 2009a). On occasion in July and August, DO measurements at a few sites were between 7.0 - 8.0 mg/L (most of them between 7.6 - 7.9 mg/L), mostly occurring in the lower depths of the reservoir. Monthly DO levels measured at Ecology's Metaline Falls long-term monitoring station were typically at or above 8.0 mg/L, with two recorded measurements below the water quality standard since 1996 (7.9 and 7.8 mg/L) (Ecology 2008b).

Aquatic Macrophytes, pH, and Dissolved Oxygen

Aquatic invasive macrophytes (primarily Eurasian watermilfoil and curly pondweed) have been identified by Ecology as an impairment in Box Canyon Reservoir upstream of the Project area, and dense populations of macrophytes have been found to influence pH in Box Canyon Reservoir (FERC 2004). In Box Canyon Reservoir, 31 percent of all measurements collected between July and November 1998 exceeded Washington water quality standards for pH (Pelletier and Coots 1990). Both pH and DO can be affected by macrophyte photosynthesis and respiration. Because reservoirs may promote macrophyte growth, Ecology identified the effects of macrophyte growth on pH and DO in Boundary Reservoir as an area of interest. During the Evaluation of the Relationship of pH and Dissolved Oxygen to Macrophytes in Boundary Reservoir Study (Relationship of pH and DO Macrophytes Study), data were collected to determine the potential influence of macrophyte growth on reservoir-wide pH and DO levels (SCL 2009a). Results of this data collection are discussed in Section 4.5.2.2.

Toxics

Due to historic mining practices in the local area, as well as throughout the Pend Oreille-Clark Fork system, toxics were identified by Ecology as a potential water quality issue in the Project area. The only recently active mine in the Project vicinity is the Pend Oreille Mine, a lead and zinc mine with surface facilities located on the east side of the river approximately 2 miles north of Metaline Falls. This mine began operation in 1952, operated intermittently until it was shut down in 1977, and was then reopened from January 2004 to January 2009. Treated water

discharged from the Pend Oreille Mine into the Pend Oreille River at RM 25 is monitored by Ecology under the mine's National Pollutant Discharge Elimination System (NPDES) discharge permit.

In 2001, EPA investigated 21 historical mines in the Project vicinity (EPA 2002) and found five to represent potential sources of contamination to the lower Pend Oreille River and its tributaries: Blue Bucket Mine, Oriole Mine, Grandview Mine/Mill, Pend Oreille Mine, and Josephine Mine. A detailed summary of historic information on toxics in and adjacent to the Project area is included in SCL's PAD (SCL 2006).

Based on a screening of existing information, SCL, in consultation with RPs, identified six toxics of concern for the Project area: arsenic, cadmium, lead, mercury, PCBs, and zinc. In July 2007, SCL completed a detailed evaluation of potential contaminant pathways for these toxics of concern, and based on this, developed a toxics Sampling and Analysis Plan (SAP) for the relicensing (SCL 2007).

Data collection based on the SAP was conducted during fall 2007 and spring 2008, and additional verification sampling was performed in October 2008. Water column, pore-water, and sediment samples were collected and analyzed, and results were documented in the final Toxics Assessment: Evaluation of Contamination Pathways (Toxics Assessment) Final Report (SCL 2009a). A summary of toxics sampling results and an assessment of their significance in relation to Project operations is provided in Section 4.5.2.2.

Other Water Quality Parameters

Nutrient data indicate that the Pend Oreille River in the Project area is oligotrophic, i.e., a low productivity system (Water Quality Study Final Report, SCL 2009a). Phosphorous and nitrogen concentrations are low throughout the year, with soluble reactive phosphorus (SRP) and total Kjeldahl nitrogen (TKN) concentrations often below detection limits. Nitrogen-phosphorus ratios indicate that the reservoir is phosphorus limited. Turbidity measurements in the Project area were all well below Ecology's turbidity standard, indicating that water in the reservoir is clear. Secchi disk measurements taken concurrently with turbidity measurements also indicate high water clarity.

Chlorophyll *a* concentrations, representing phytoplankton growth, ranged from 0.9 μg/L to just over 5 μg/L during 2007 - 2008 sampling (SCL 2009a). No longitudinal or lateral trends were observed in the reservoir, likely as the result of the reservoir's short hydraulic retention time and low nutrient levels, both of which limit phytoplankton growth. In contrast, seasonal differences in chlorophyll *a* were observed, with the highest concentrations in May and June 2007 and March 2008, likely due to a slight increase in nutrients associated with higher inflow during spring runoff.

Zooplankton densities in the Project area are low, again indicating that the system is oligotrophic. Data collected in the reservoir during 2007 - 2008 reveal seasonal patterns in zooplankton community structure (SCL 2009a). Rotifers predominated during spring in pelagic and littoral areas. During July and August, copepods and cladocerans were the dominant taxonomic groups. Abundance and biomass of zooplankton were lowest at all sampling stations

during November. Zooplankton abundance and species composition throughout the reservoir reflect the abundance and species composition in the inflow from Box Canyon Reservoir. Seasonal zooplankton drift samples collected in the tailraces of Boundary and Box Canyon dams in June and August 2007 and March 2008 showed similar patterns of abundance and species composition.

4.5.2.2. Environmental Analysis

4.5.2.2.1. Peak Flood Flow Conditions above Metaline Falls

SCL used recent topography and bathymetry to develop a hydraulic routing model (the Peak Flow Model) that was applied to characterize reservoir conditions upstream of Metaline Falls relative to Project operations during periods of high flows in 1972, 1974, and 1997 (Analysis of Peak Flood Flow Conditions above Metaline Falls [Peak Flood Flow Analysis], SCL 2009a). The study evaluated whether Project operations appear to influence flood conditions on the McKenzie property (see Section 4.5.2.1) in the town of Metaline or on other improved properties above Metaline Falls within the reservoir floodplain. For the purpose of the study, flood conditions were defined as the point at which normal functioning of the community is impacted as a result of elevated water levels. In the case of the town of Metaline, this point occurs when flood waters begin to flow overbank in areas adjacent to the riverfront along the high bank at an elevation of approximately 2,013 feet NAVD 88. This occurs when inflows from Box Canyon to Boundary Reservoir are at or above approximately 120,000 cfs. Historically, Project forebay elevations during such peak flows have generally been approximately equal to 1,989 feet NAVD 88.

Analyses comparing the simulated maximum extent of inundation with and without the influence of Project operation were used to estimate the effects of the Project on private property flooding. Table E.4-8 summarizes the difference in model-simulated water surface elevation within the town of Metaline during the 1972, 1974, and 1997 periods of high water, and indicates the estimated Project effect (SCL 2009a). An example of the estimated Project effect in the town of Metaline is shown in Figure E.4-20.

Legend
Inundation Extent Without the Hydraulic Influence of Project Operations
Increased Inundation Due to Project Effects
Unpublished Work Copyright 2009 Seattle City Light
Linton
Creek
Metaline
WA-31
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-20
Estimated Project effect within the Town of Metaline during the 1997 period of high water.
Map Key
0
250
Feet
Map Version 08/17/09
N

Table E.4-8. Summary information of model-simulated maximum water surface elevation within the Town of Metaline during the historical high-flow events with and without the influence of Project operations (SCL 2009a).

High Water Year	Peak Flow at USGS Gage 12396500 (cfs) (Box Canyon tailrace)	Boundary Dam Forebay Elevation at Peak Water Surface Elevation (feet NAVD 88)	Boundary Dam Forebay Elevation Fluctuation during Peak[1] (feet NAVD 88)	Difference in Boundary Dam Forebay Elevation (feet)	Modeled Peak Water Surface Elevation at town of Metaline (PRM 28.9, HEC-RAS Station 71550)[2]		
					With Influence of Project Operations (feet NAVD 88)	Without Influence of Project Operations (feet NAVD 88)	Estimated Influence of Project Operations (Difference in feet)
1997	134,000	1,987.76	1,987.56 – 1,989.65	1.89	2,016.19	2,014.63	+1.56
1974	133,000	1,987.17	1,987.07 – 1,987.22	0.15	2,015.54	2,014.20	+1.34
1972	136,000	1,987.70	1,987.65 – 1,987.74	0.09	2,016.12	2,014.69	+1.43

Notes:

1 Forebay elevation range +/- 1 day of peak water surface elevation at McKenzie's house (PRM 28.9, HEC-RAS Station 71550).

2 Refer to figures in Appendix 1of the Peak Flood Flow Analysis Final Report (SCL 2009a), for HEC-RAS cross section locations.

The model simulation results displayed in Table E.4-8 indicate that Project operations appeared to slightly influence the peak water surface elevation within the town of Metaline during the historical peak flow periods, when releases from Box Canyon Dam result in flooding. It is estimated that an additional 1.3 to 1.6 feet of inundation was experienced during the 1972, 1974, and 1997 events as the result of Project operations. During the historical events, the Project forebay was operated between 1,987.07 to 1,989.65 feet NAVD 88 at the time of the model-simulated peak stage at the location of McKenzie's house, which is below the normal maximum pool elevation authorized by the current FERC license of 1,994.03 feet NAVD 88. Because proposed Project operations during future high flows would be the same during the term of the new Project license as they are under existing operations, it is anticipated that the Project's effect on reservoir water surface elevation would be similar to that simulated in the Peak Flood Flow Analysis, under similar flow conditions.

Review of inundation maps overlaid on recent aerial photography (Terrapoint 2005) suggest that there are currently no habitable structures influenced by the flooding associated with peak flows or with the increased inundation caused by the influence of Project operations that is estimated to occur during the highest historical peak flow events, i.e., those approaching 140,000 cfs. Currently, the improved properties affected by increased inundation during these peak flow events consist primarily of lawns, naturally vegetated areas, and recreational areas such as Metaline Park. Given that the nature and extent of private property flooding is generally understood by landowners surrounding the reservoir, there is no anticipated increase in the number of improved properties that would be affected by flooding during the new license term.

In general, the duration of inundation above specific elevations during historic peak flow events also appears to be increased by the influence of Project operations. In the case of the 1997 event, the estimated maximum increase in duration of inundation is +24.2 days, occurring between the range of 2,014.5 to 2,015 feet NAVD 88. The estimated increase in duration of inundation during the 1972 event and 1974 event was +6.1 and +6.7 days, respectively. Model-simulated durations of inundation occurring above particular elevations due to the influence of Project operations for each of the three historical events are presented in Table 5.2-2 in the Peak Flood Flow Analysis Final Report (SCL 2009a). Because proposed Project operations during future high flows would be the same as those associated with existing operations, it is anticipated that the Project would have a similar effect on flood duration to that simulated in the Peak Flood Flow Analysis, under similar flow conditions.

4.5.2.2.2. Temperature

Temperatures in the Pend Oreille River are influenced by many environmental factors but are most sensitive to meteorological conditions and hydraulic characteristics. For the Pend Oreille River in Washington, the Washington water quality standards include a site-specific numeric temperature criterion of 20˚C daily maximum temperature, unless the temperature would be above 20˚C under Natural Conditions, in which case the criterion is Natural Conditions + 0.3˚C[6]. A Natural Condition model simulation prepared by Ecology and reported here indicates that, in the Boundary Reach, temperatures under the Natural Condition would exceed 20 ˚C the majority of the time during the summer months[7].

The presence of reservoirs for hydroelectric power generation alters the distribution of heat load from solar radiation and also affects the hydrologic and hydraulic behavior of the Pend Oreille River, resulting in modification of the temperature conditions. This section presents the results of a CE-QUAL-W2 modeling-based assessment of the effect of Boundary Project on temperature in the Pend Oreille River (Khangaonkar et al. 2009). As part of this evaluation, several items are examined including: (1) the methods (cumulative frequency analysis, number of days above numeric criteria, and peak annual temperature) for assessing temperature effect where reservoirs impact the travel time (lag time) and thermal inertia in the river, (2) the total temperature difference at the Metaline Pool, Boundary Dam Forebay, and Boundary Dam Tailrace stations due to the presence of dams on the Pend Oreille River, through comparisons of Existing and Natural Conditions, and (3) the contribution of Boundary Dam to the total temperature difference between Existing and Natural Conditions. The analyses presented include the assessment of the flow-weighted daily maximum temperatures as well as surface daily maximum temperatures. Table E.4-9 summarizes model simulations prepared by Ecology for the draft Pend Oreille River temperature TMDL and analyzed by SCL to determine the temperature effects of the Project.

[6] WAC 173-201A-602 (WRIA 62, note 1)
[7] The focus of the evaluation is the summer period (7/9/2004 through 9/4/2004 and 7/8/2005 through 9/8/2005) when modeled Existing Condition temperatures were greater than 20ºC.

Table E.4-9. Model conditions for temperature analyses defined in Ecology's draft Pend Oreille River Temperature TMDL (Ecology et al. 2007).

Ecology Model Simulation	Existing Condition	Existing Condition Without Project	Natural Condition
Upstream Dams Present (Albeni Falls and Box Canyon)	Yes	Yes	No
Boundary Dam Present	Yes	No	No
Downstream Dam Present (Seven-Mile)	Yes	Yes	No
Vegetation Condition	Current	Current	Potential Natural Vegetation
Point Sources Present	Current	Current	No

Temperature Analysis Methods

Summer temperatures in the Pend Oreille River, including the Project area, exceed the 20 ˚C temperature criterion in the modeled Natural Condition as well as in the Existing Condition. Therefore, temperature compliance assessment is based on increases in temperature relative to the Natural Condition +0.3 ˚C and the modeling of the Natural Condition is important baseline information for compliance assessment.

To assess current temperature conditions in Boundary Reservoir, including the effects of the Project and other dams, the Existing Condition was compared to the Natural Condition. To assess the Project's contribution to current temperature conditions, the Existing Condition was compared to the Existing Condition without the Boundary Project. This alternative analysis simulates changes in temperature response at three locations in the Project area without the Boundary Project in place, but with the upstream dams (Albeni Falls and Box Canyon) present. This case corresponds to the temperature change that would occur if Boundary Dam alone were to be removed from the existing system.

Each of the analyses below reports predicted temperatures at the Metaline Pool (V2), Boundary Dam Forebay (V6), and Boundary Dam Tailrace (V8) stations. Locations of monitoring stations are shown in Figure E.4-19. The Existing Condition at all sampling sites is discussed further in SCL's model calibration report (Breithaupt and Khangaonkar 2007).

Results are presented for both flow-weighted and surface daily maximum temperatures. SCL believes that the flow-weighted analysis provides the most representative assessment of the Project's influence on overall temperature conditions because: (1) it takes the entire water column into account rather than the small portion of the water column at the reservoir's surface and (2) within the water column, maximum temperatures typically occur in the surface layers of reservoirs, but these are not representative of conditions throughout the water column[8]. In the

[8] WAC 173-201A-200(1)(c)(vi) requires that temperature measurements used to assess compliance "represent the dominant aquatic habitat." Accordingly, the regulation promotes use of samples from "well mixed portions" of rivers, and discourages use of samples from the surface. This regulatory requirement is based on Washington's Data Credibility Act, which requires that, for purposes of establishing compliance with water quality standards, the data that are collected and analyzed must be representative of water quality conditions. RCW 90.48.585(1)(b).

case of the Boundary Dam forebay, the surface layer in the model is 2-meters (6.6 feet) deep, and its cross-sectional area is about 5.5 percent of the total water column cross-sectional area. The flow of the surface layer contributes 4.5 percent of the total flow in the water column. Analysis of flow-weighted temperatures is also appropriate for Boundary Reservoir because it is well-mixed with relatively small vertical variation in temperature, unlike other reservoirs formed by high-head dams or lakes with long retention times that can show significant temperature stratification. The observations at Boundary forebay show only a small difference in both modeled and measured temperatures from the surface waters to the bottom waters. Even during the times of maximum temperature gradient, the difference in temperature from top to bottom was about 2.0 ˚C (Figure 3-1 in Khangaonkar et al. 2009).

A frequency analysis approach was used to assess the effect of the Project on temperature, because it is a better indicator of actual changes in stream temperature than that provided by comparison of instantaneous temperature results (i.e., comparing temperatures at the same day/time that is typical for point sources of heated effluent). A comparison of instantaneous temperature results between two model simulations of the Project area leads to an erroneous conclusion about the stream temperatures. Instantaneous comparisons of simulations with different river hydraulics may show apparent heating that does not actually exist if differences in travel time for the two simulations are not accounted for in the analysis. In contrast, the frequency analysis approach characterizes peak temperatures during a critical period[9] and evaluates whether the cumulative distribution of high temperatures under one set of conditions has increased or decreased in magnitude and frequency relative to another set of conditions. A detailed description and justification for use of the frequency analysis method is provided in the Temperature Modeling and Alternative Operation Analyses for Boundary Hydroelectric Project - CWA 401 Certification Support (Khangaonkar et al. 2009).

The results of the analyses show that the hydraulic characteristics in Boundary Reservoir, as the result of dam operations, induce a short lag in the timing of the peak temperatures relative to Natural Conditions. The analyses presented in the following sections provide comparisons of temperature distributions under different conditions, and identify the maximum temperature differences between the cumulative frequency curves. This approach eliminates the apparent temperature differences resulting from the effects of travel time and thermal inertia differences when comparing any two sets of conditions (e.g., when comparing the Existing Condition to the Natural Condition).

Temperature conditions and Project effects were also evaluated through analysis of the number of days during which daily maximum temperatures exceeded the numeric water quality standard of 20 ˚C and the peak annual temperatures experienced under the Existing Condition, Natural Condition, and Existing without Boundary Project Condition.

Finally, at Ecology's request, SCL investigated whether there were operational changes that could lower surface daily maximum temperatures. The analysis involved modeling of conditions assuming run-of-river operations at a forebay elevation of 1,974 feet NAVD 88 during summer

[9] The critical time period analyzed by SCL included the summer period when existing temperatures exceeded the 20˚C temperature criterion for the Pend Oreille River (7/9/2004 through 9/4/2004 and 7/8/2005 through 9/8/2005).

months, which is the most extreme operational change possible, consistent with operational constraints. This analysis provides an outer bound on operational changes relative to current operations.

Project Effects – Modeling Results

Cumulative Temperature Effects under Existing Conditions

Figure E.4-21 presents a time-series comparison of simulated flow-weighted daily maximum temperatures for Existing and Natural Conditions. These results show that temperatures in the Natural Condition are higher than in the Existing Condition during some periods and vice versa. Close examination also shows that during the summer months the Natural Condition is warmer than the Existing Condition mostly at the start of the warming period in July and early August, and that the Existing Condition is warmer than the Natural Condition mostly at the start of the cooling period in late August. During July and early August, the temperatures in the Natural Condition warm more quickly than in the Existing Condition, whereas in late August the temperatures in the Natural Condition cool more quickly than the temperatures in the Existing Condition. In both circumstances, the resulting temperature difference is relatively small and of short duration (Khangaonkar et al. 2009). This is primarily due to the differences in travel time and thermal inertia between the two conditions. The Natural Condition responds faster to changes in atmospheric heating or cooling than does the Existing Condition.

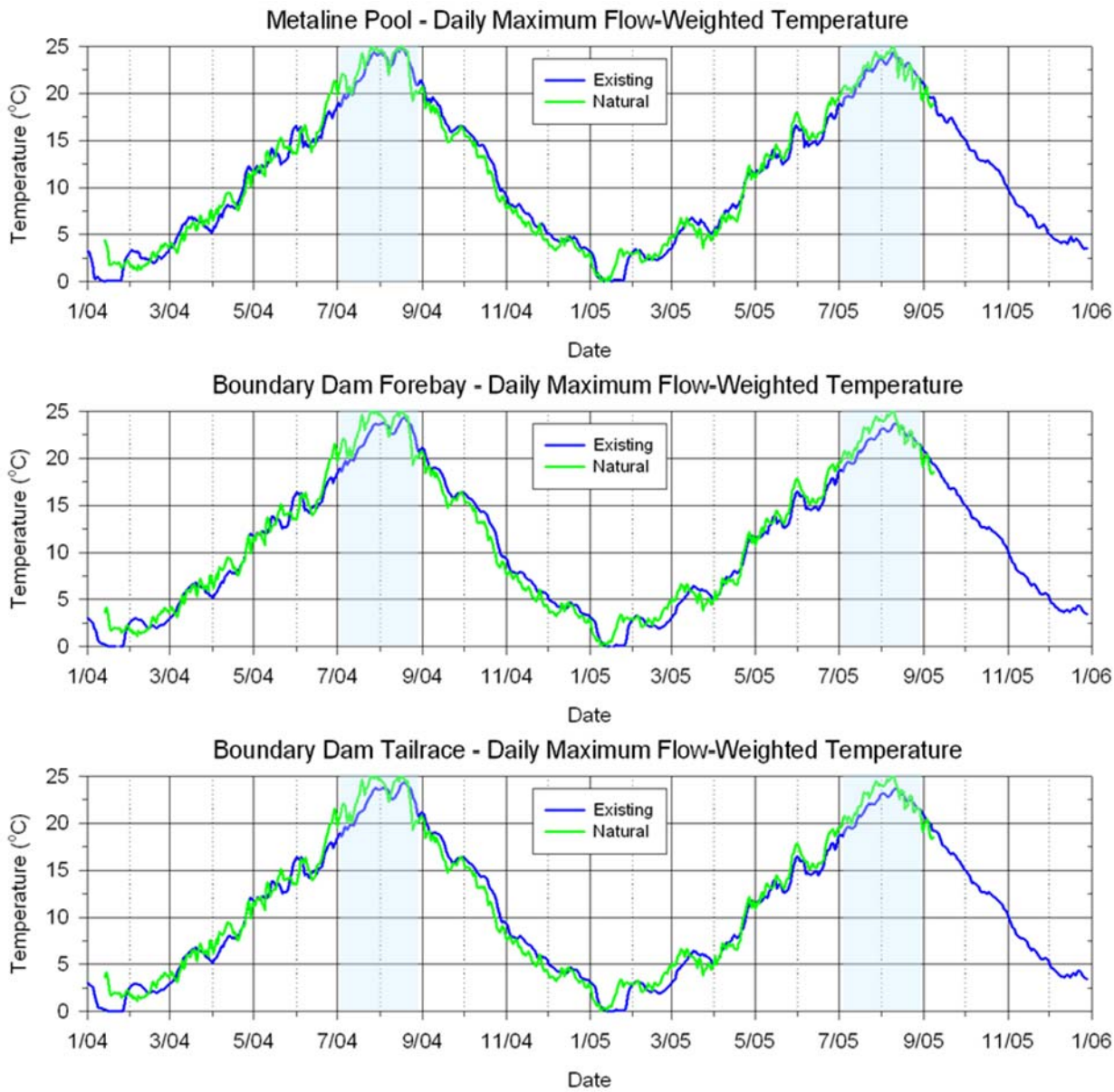


Figure E.4-21. Flow-weighted daily maximum temperatures in the modeled Existing and Natural Conditions. The shading indicates the time periods during which the Existing Condition is greater than 20 ˚C.

Figure E.4-21 shows a comparison of instantaneous temperatures at three sites; comparing these instantaneous temperatures would lead to an erroneous conclusion about actual stream temperature changes due to the travel time and the thermal inertia-induced lag between Natural and Existing Conditions. Figure E.4-22 presents the plot of the frequency distribution of the flow-weighted daily maximum temperatures for the Existing and Natural Conditions. The frequency analysis approach looks at maximum daily temperatures during the critical period and evaluates

whether the cumulative distribution of high temperatures as a group has increased or decreased in magnitude and frequency. The frequency analysis method compares percentile temperature values under each condition, rather than instantaneous temperatures on a particular day or time. The frequency analysis method indicates that, for the majority of the critical summer period, flow-weighted daily maximum temperatures at all locations would be higher under the Natural Condition than they are under the Existing Condition; the maximum temperature difference is seen at the Boundary Dam Forebay and Tailrace stations, when the Natural Condition is more than 1.0 ˚C higher than the Existing Condition once temperatures reach the 70th percentile. It is notable that for all temperatures above 21 ˚C in the Boundary Forebay and Tailrace and 22.4 ˚C at Metaline Pool, the Natural Condition is predicted to be above the Existing Condition. The frequency analysis method also predicts some conditions in which the Existing Condition would be higher than the Natural Condition, with maximum differences in temperature of 0.50 ˚C, 0.20 ˚C, and 0.19 ˚C at the Metaline Pool, Boundary Dam Forebay, and Boundary Tailrace stations, respectively. These temperature increases occur less frequently than the temperature decreases discussed above, and are experienced only at lower temperatures (below 21 ˚C). Further, these increases include the influence of the upstream projects, Box Canyon Dam and Albeni Falls Dam, and further analysis is required to identify the influence of the Project alone (described below in Temperature Effects of the Boundary Project).

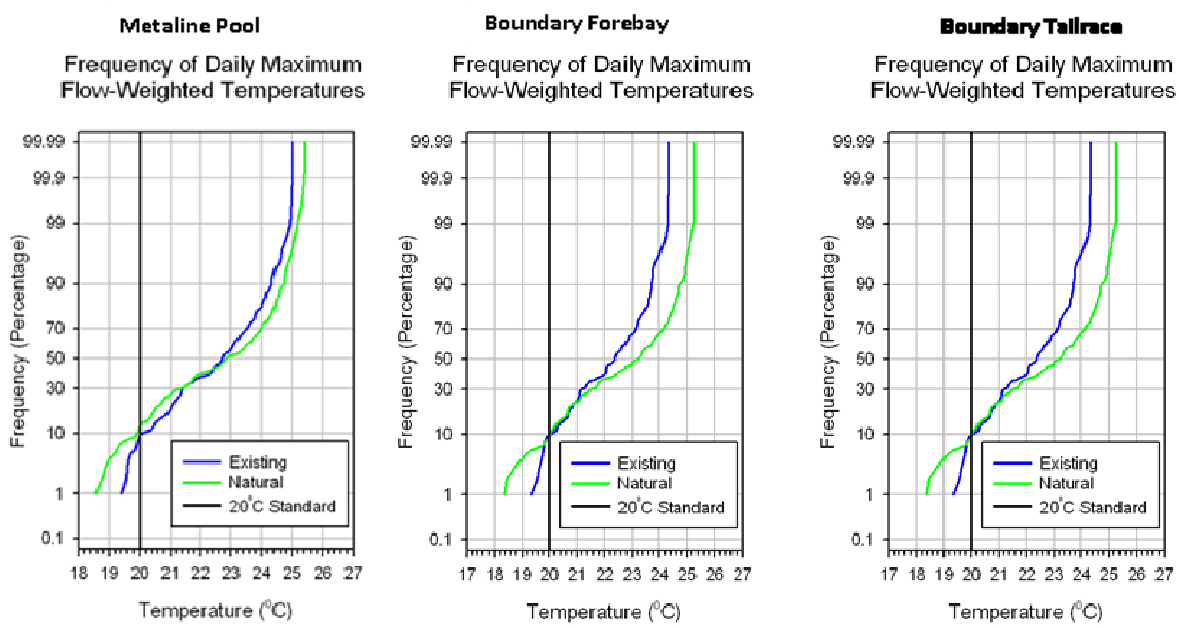


Figure E.4-22. Frequency distributions of the flow-weighted daily maximum temperatures for the Existing and Natural Conditions.

Figure E.4-23 presents the time-series comparison of surface daily maximum temperatures for the Existing and Natural Conditions at three sites. To remove the influence of the lag effect between Existing and Natural Conditions, Figure E.4-24 presents a plot of the frequency distribution of the surface daily maximum temperatures for the Existing and Natural Conditions. The frequency analysis method indicates that, for approximately half of the critical summer period

(i.e., the period when temperatures exceed the 20 ˚C water quality standard), surface daily maximum temperatures would be higher under the Natural Condition than they are under the Existing Condition at the Boundary Forebay station, and higher temperatures under Natural Conditions would occur more frequently at the other two stations analyzed. It is notable that for all temperatures above approximately 22.5 ˚C at the Metaline Pool, 23.6 ˚C at the Boundary Forebay, and 21 ˚C at the Boundary Tailrace, the Natural Condition is predicted to be above the Existing Condition. The frequency analysis method also predicts some conditions in which the Existing Condition would be higher than the Natural Condition, with maximum differences in surface maximum temperature of 0.50 ˚C, 0.76 ˚C and 0.19 ˚C at the Metaline Pool, Boundary Dam Forebay and Boundary Tailrace stations, respectively (Figure E.4-24). These increases include the influence of the upstream projects, Box Canyon Dam and Albeni Falls Dam. During the same analysis period in the Boundary Tailrace surface maximum temperatures are frequently over 1 ˚C cooler in the Existing Condition relative to the Natural Condition. Further analysis is required to identify the influence of the Project alone (described below in Temperature Effects of the Boundary Project).

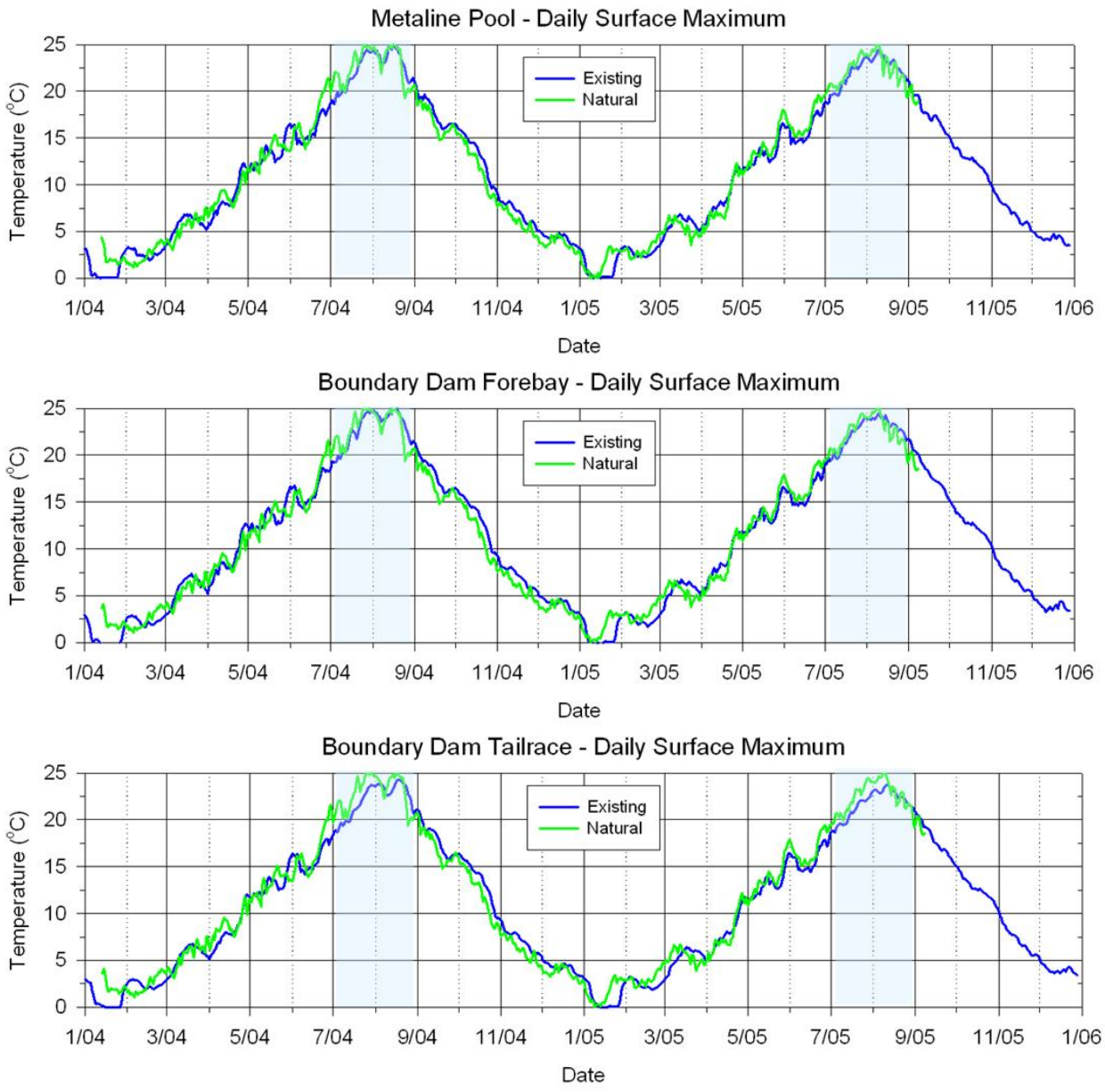


Figure E.4-23. Daily maximum surface temperatures for the Existing and Natural Conditions. The shading indicates the time periods during which the Existing Condition is greater than 20 ˚C.

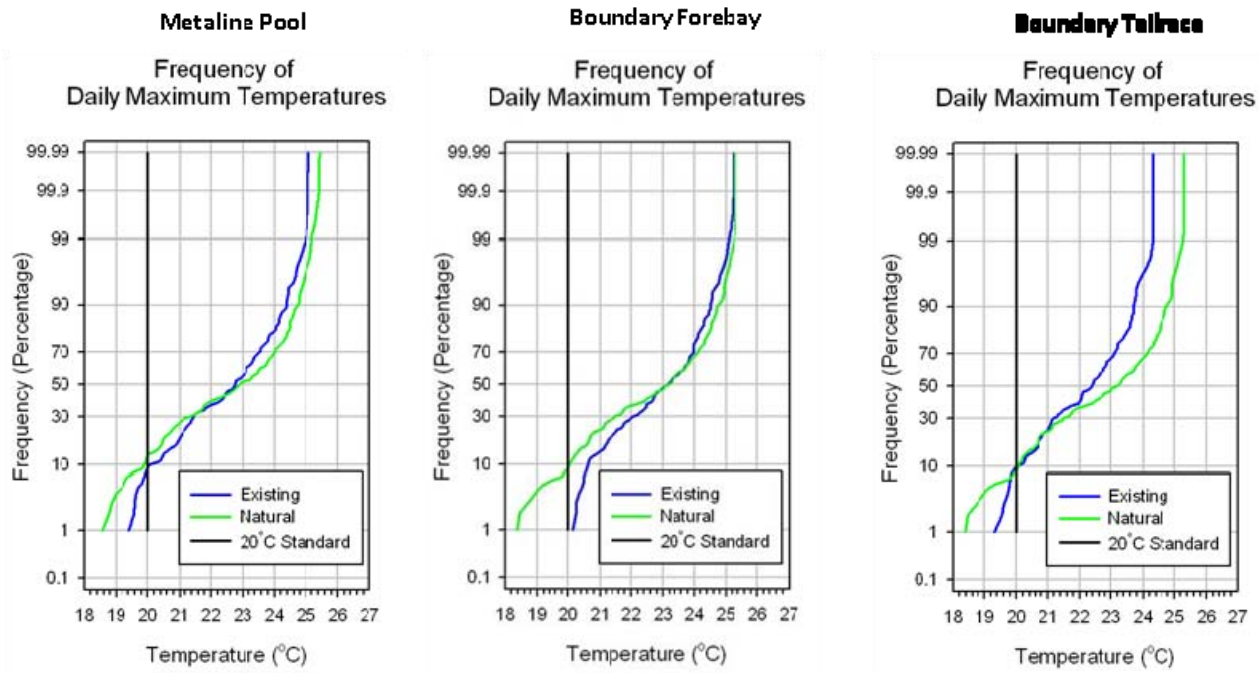


Figure E.4-24. Frequency distributions of the surface daily maximum temperatures for the Existing and Natural Conditions.

Temperature Effects of the Boundary Project

The contribution of the Boundary Project to temperatures under the Existing Condition can be assessed by comparing the Existing Condition to the Existing without Boundary Project Condition. The comparison of the time-series flow-weighted daily maximum temperatures between the Existing without the Boundary Project Condition and the Existing Condition is shown in Figure E.4-25. The frequency distributions of the flow-weighted daily maximum temperatures for the Existing without Boundary Project Condition and the Existing Condition are shown in Figure E.4-26. The results at all stations show that the flow-weighted daily maximum temperatures for the Existing Condition were generally lower than the flow-weighted daily maximum temperatures for the Existing without Boundary Project Condition, indicating lower daily maximum temperatures in the majority of the water column with the dam present than without it. These results show that removing Boundary Dam from the Existing Condition results in no improvement in flow-weighted daily maximum temperatures relative to the Existing Condition, but rather flow-weighted daily maximum temperatures became higher, i.e., Boundary Reservoir has a cooling effect on flow-weighted daily maximum temperatures of between 0.15 ˚C and 0.79 ˚C at the Boundary Forebay station, with a similar cooling effect at the Boundary Tailrace station and no distinguishable difference in temperatures at the Metaline Pool station.

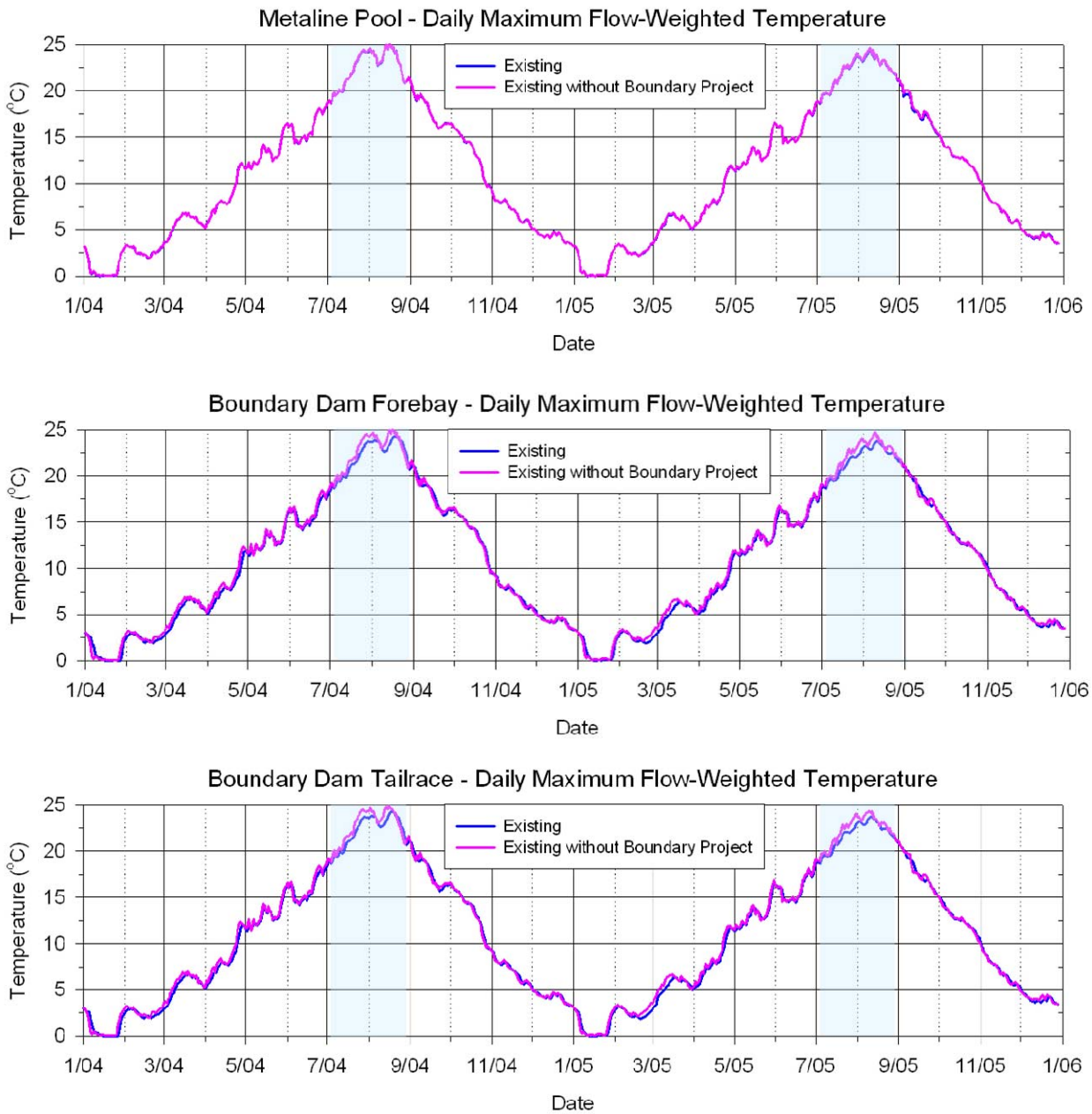


Figure E.4-25. Flow-weighted daily maximum temperatures for the Existing and Existing without Boundary Project Conditions.

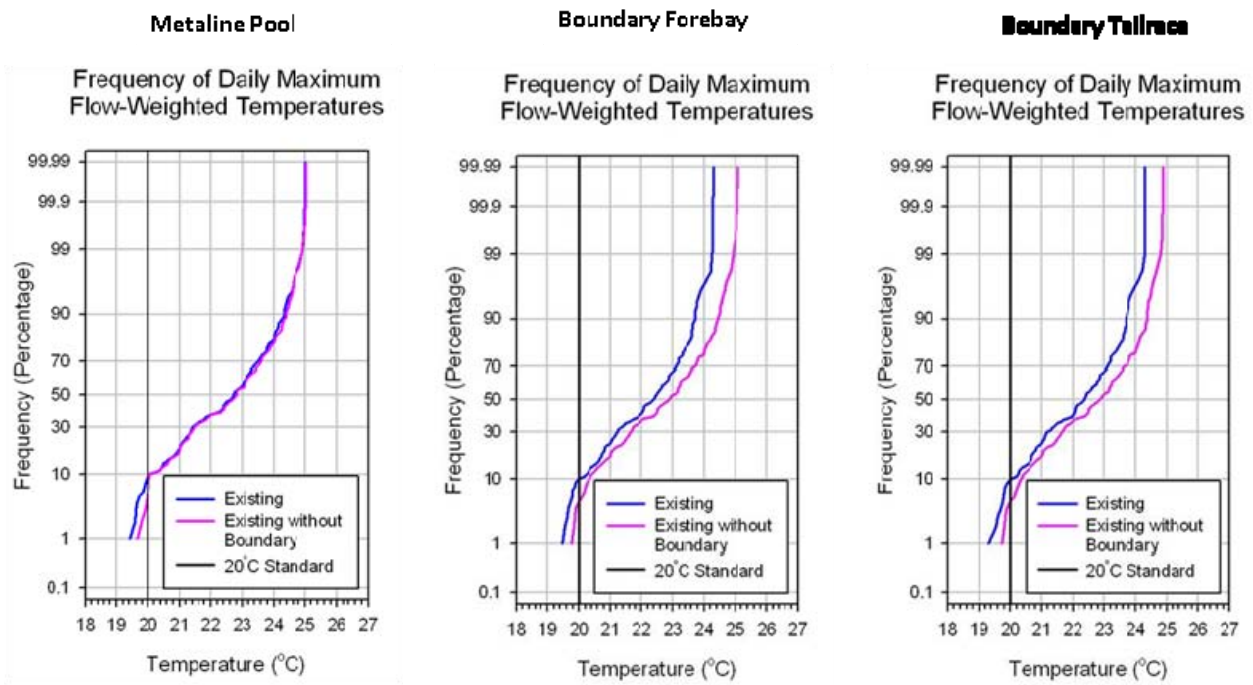


Figure E.4-26. Frequency distributions of the flow-weighted daily maximum temperatures for the Existing and the Existing without Boundary Project Conditions.

A comparison of the time-series surface daily maximum temperatures in the Existing Condition and the Existing without Boundary Project Condition is shown in Figure E.4-27. Frequency analysis in Figure E.4-28 shows that surface daily maximum temperatures at Metaline Pool are effectively identical under the two conditions, and that a decrease in surface daily maximum temperatures of between 0.14˚C and 0.88˚C in the Boundary Dam Tailrace may be attributable to the Boundary Project. In contrast, an increase in the surface daily maximum temperatures of between 0.01 ˚C and 0.58 ˚C may be attributable to the Boundary Project at the Boundary Forebay station, indicating that temperature changes attributable to the Project can be positive in one location and negative in another.

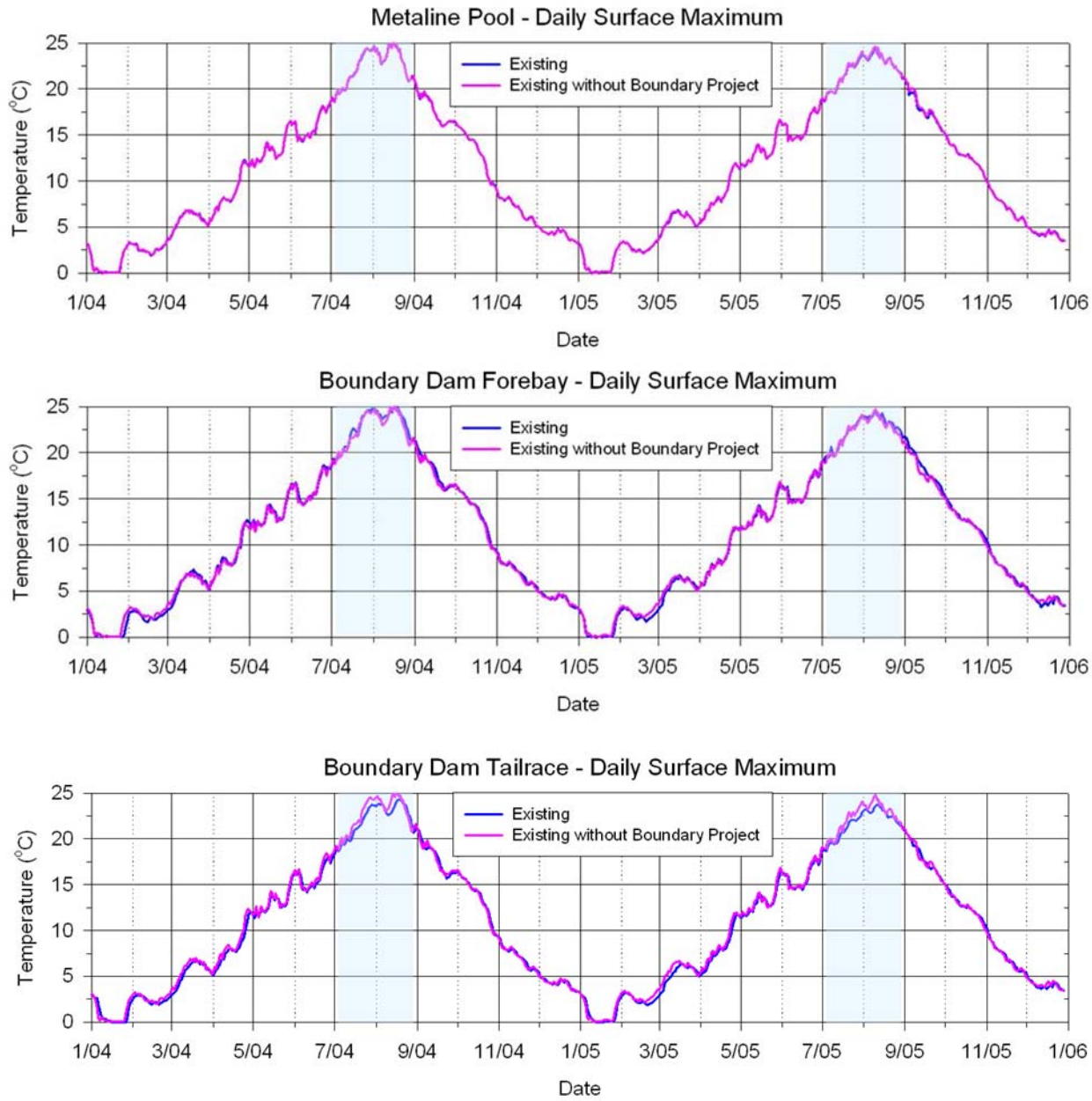


Figure E.4-27. Surface daily maximum temperatures for the Existing without Boundary Project and the Existing Conditions.

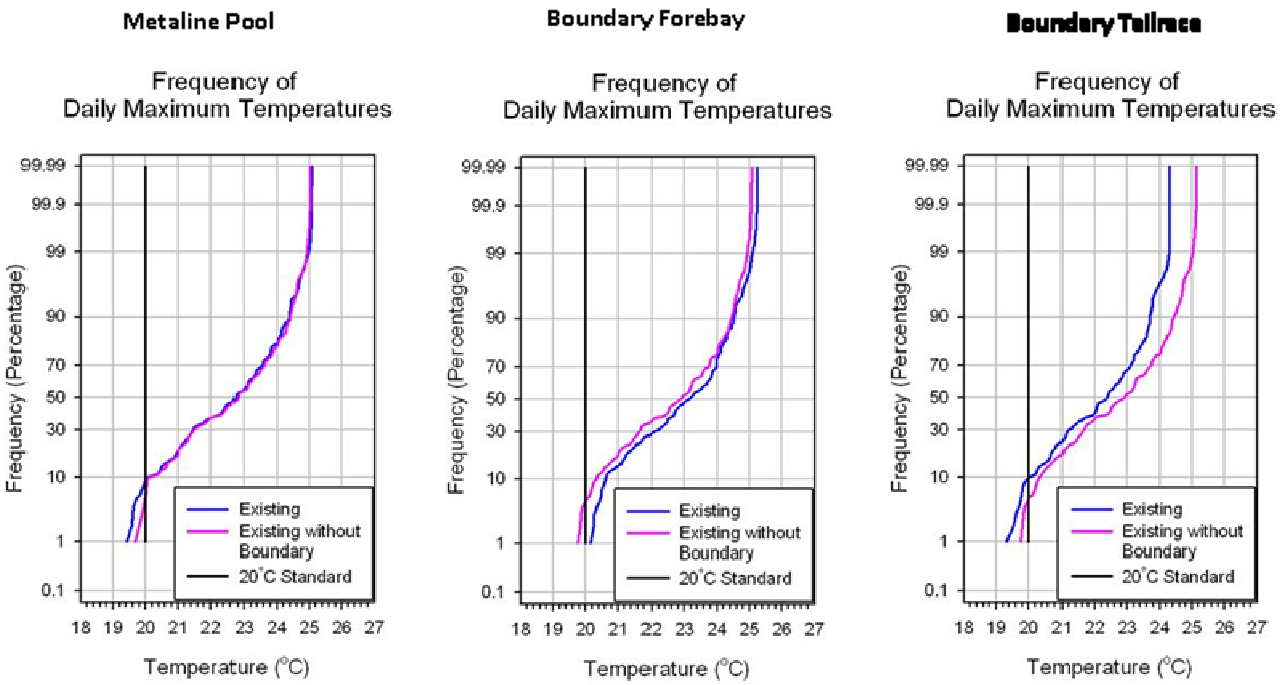


Figure E.4-28. Frequency distribution of surface daily maximum temperatures for the Existing without Boundary Project and the Existing Conditions.

Table E.4-10 summarizes analyses of daily maximum temperature differences at all three locations. Analysis of all three stations indicates that the Boundary Project is not causing flow-weighted daily maximum temperatures to be higher than they would be under Natural Conditions or under the Existing without Boundary Project Condition. Under some conditions, the Project results in slightly lower surface daily maximum temperatures, and in some conditions slightly higher surface daily maximums at the Boundary Forebay station. The frequency analysis using surface daily maximum temperatures shows that an increase of between 0.01 and 0.58 ˚C at the Boundary Forebay station may be attributable to the Boundary Project. Under the same conditions, a decrease in surface maximum temperatures in the Boundary Tailrace between 0.14 ºC to 0.88 ºC is seen. The existence of the Boundary Project does not cause the frequency distribution of surface daily maximum temperatures to be warmer at the Metaline Pool station, and surface daily maximum temperatures are cooler under Existing Conditions at the Tailrace station. Because the differences in temperature, both flow-weighted and surface, are both positive and negative, are of short-duration, and do not represent a significant temperature shift relative to normal seasonal variation, they do not reflect a significant net adverse effect of the Project. Further, because proposed Project operations would be the same as those associated with existing operations, it is anticipated that the Project would continue to have no net adverse effect on temperature during the term of the new license.

Table E.4-10. Summary of frequency analysis results regarding the temperature effects at the Metaline Pool, Boundary Forebay, and Boundary Tailrace stations.

Frequency Analysis Results	Flow-Weighted Daily Maximum Temperature (ΔT)	Surface Daily Maximum Temperature (ΔT)
Effects of All Sources Range of cumulative temperature differences between the Existing and Natural Conditions (Existing Condition - Natural Condition)	**Metaline Pool** Existing Condition difference is between -0.59 ºC (lower than Natural) and +0.50 ºC (higher than Natural) (Figure E.4-22).	**Metaline Pool** Existing Condition difference is between -0.59 ºC (lower than Natural) and +0.50 ºC (higher than Natural) (Figure E.4-24).
	Boundary Forebay Existing Condition difference is between -1.18 ºC (lower than Natural) and +0.20 ºC (higher than Natural) (Figure E.4-22).	**Boundary Forebay** Existing Condition difference is between -0.35 ºC (lower than Natural) and +0.76 ºC (higher than Natural) (Figure E.4-24).
	Boundary Tailrace Existing Condition difference is between -1.15ºC (lower than Natural) and +0.19 ºC (higher than Natural) (Figure E.4-22).	**Boundary Tailrace** Existing Condition difference is between -1.15ºC (lower than Natural) and +0.19 ºC (higher than Natural) (Figure E.4-24).
Effects of Removing Boundary Dam Range of cumulative temperature differences between the Existing Condition and Existing without Boundary Condition (Existing Condition – Existing without Project Condition)	**Metaline Pool** Existing Condition difference is between -0.30 ºC (lower than Existing without Boundary Dam) and +0.01 ºC (higher than Existing without Boundary Dam) (Figure E.4-26).	**Metaline Pool** Existing Condition difference is between -0.32 ºC (lower than Existing without Boundary Dam) and +0.07 ºC (higher than Existing without Boundary Dam) (Figure E.4-28).
	Boundary Forebay Existing Condition difference is between -0.79 ºC and -0.15 ºC (all lower than Existing without Boundary Dam) (Figure E.4-26).	**Boundary Forebay** Existing Condition is between +0.01 ºC and +0.58 ºC (all higher than Existing without Boundary Dam) (Figure E.4-28).
	Boundary Tailrace Existing Condition difference is between -0.14 ºC and -0.71 ºC (all lower than Existing without Boundary Dam) (Figure E.4-26).	**Boundary Tailrace** Existing Condition difference is between -0.14 ºC and -0.88 ºC (all lower than Existing without Boundary Dam) (Figure E.4-28).

Duration and Peak Temperature Analysis

Analysis of the number of days in which daily maximum temperatures exceeded the numeric water quality criterion of 20 ˚C and the peak annual temperatures experienced under the Existing Condition, Natural Condition, and the Existing without Boundary Project Condition confirms that the Project has no net adverse effect on flow-weighted or surface daily maximum temperatures.

At the Metaline Pool and Boundary Tailrace stations, Existing Condition summer surface and volume-weighted maximum temperatures are cooler (i.e., same or lower peak daily maximum temperatures and fewer days exceeding 20 ˚C) than the Existing Condition without the Boundary Project (Table E.4-11a, Table E.4-11c, Table E.4-12a and Table E.4-12c). At the Boundary

Forebay station, the number of days with surface maximum temperatures above 20 ˚C was similar under Existing and Existing without Boundary Project conditions, i.e., five days (2005), and one day (2004) more under the Existing Condition than the Existing without Boundary Project Condition (Table E.4-12b). Using flow-weighted maximum temperatures, there was the same number of days or fewer under the Existing Condition than under the Existing without Boundary Project Condition (Table E.4-11b). At all three stations, and using either surface or volume-weighted temperatures, the number of days with maximum temperatures greater than 20 ˚C, and the peak annual temperatures, are the same or higher in the Natural Condition relative to the Existing Condition and the Existing Condition without the Project (Table E.4-11a through E.4-12c).

Because proposed Project operations would be nearly the same as those associated with existing operations, it is anticipated that the Project would continue to have no significant adverse effect on temperatures during the term of the new Project license.

Compliance with Water Quality Standards

As noted above, because summer temperatures in the Pend Oreille River, including the Project area, would exceed the 20 ˚C temperature criterion in the modeled Natural Condition as well as in the Existing Condition, compliance assessment is based on increases in temperature relative to the Natural Condition +0.30 ˚C.[10] The modeling results discussed above indicate that the maximum difference in flow-weighted daily maximum temperatures between the Existing Condition (i.e., including the effects of the Boundary Project and all other dams) and the Natural Condition is + 0.20 ˚C at the Boundary Forebay station and +0.19 ˚C at the Boundary Tailrace station, which are in compliance with the Water Quality Standards. At the Metaline Pool station, the maximum difference of flow-weighted and surface maximum temperatures is 0.50 ˚C, which is above the natural conditions water quality standard, however, the Boundary Project does not contribute to the higher Existing Condition maximum temperatures (relative to Natural) at the Metaline Pool station (see Figures E.4-26 and E.4-28). The maximum difference in surface daily maximum temperatures between the Existing Condition and the Natural Condition is +0.76 ˚C at the Boundary Dam Forebay station, but this comparison is not reflective of the dominant aquatic habitat of Boundary Reservoir, as is required by the Washington Water Quality Standards.[11]

While not expressly stated in the water quality criteria, an alternative approach to assessing compliance under the Natural Condition criteria is through analysis of the number of days in which daily maximum temperatures are above 20 ˚C and analysis of peak annual temperatures. The model results indicate that, under the Existing Condition at all locations, there are fewer days with daily maximum flow-weighted temperatures above 20 ˚C than there would be under the Natural Condition, and lower peak annual temperatures. Similarly, under the Existing Condition at all locations, there are the same or fewer days with daily maximum surface temperatures above 20 ˚C than there would be under the Natural Condition, and lower peak annual temperatures. SCL believes that because the Existing Condition has the same or fewer days above 20 ˚C than the Natural Condition, and the same or lower peak annual temperatures,

[10] WAC 173-201A-602 (WRIA 62, note 1).
[11] WAC 173-201A-200(1)(c)(vi) requires that temperature measurements used to assess compliance "represent the dominant aquatic habitat." Accordingly, the regulation promotes use of samples from "well mixed portions" of rivers, and discourages use of samples from the surface.

the Existing Condition, including the effects of the Boundary Project and all other dams, is in compliance with the Water Quality Standards.

Table E.4-11a. Summary of the number of days flow-weighted daily maximum temperatures were above 20 ˚C and the annual peak flow-weighed temperatures at the Metaline Pool station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	60	60	25.43	25.14
Existing	53	53	25.01	24.40
Existing without Boundary Project	54	56	25.04	24.61

Table E.4-11b. Summary of the number of days flow-weighted daily maximum temperatures were above 20 ˚C and the annual peak flow-weighted temperatures at the Boundary Dam Forebay station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	63	60	25.29	25.15
Existing	52	54	24.29	23.72
Existing without Boundary Project	57	55	25.07	24.68

Table E.4-11c. Summary of the number of days flow-weighted daily maximum temperatures were above 20 ˚C and the annual peak flow-weighted temperatures at the Boundary Tailrace station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	63	60	25.29	25.15
Existing	52	54	24.31	23.71
Existing without Boundary Project	57	55	24.87	24.34

Table E.4-12a. Summary of the number of days surface daily maximum temperatures were above 20 ˚C and the annual peak surface temperatures at the Metaline Pool station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	60	60	25.44	25.17
Existing	54	53	25.07	24.41
Existing without Boundary Project	54	57	25.04	24.62

Table E.4-12b. Summary of the number of days surface daily maximum temperatures were above 20 ˚C and the annual peak surface temperatures at the Boundary Dam Forebay station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	63	60	25.29	25.15
Existing	58	60	25.25	24.55
Existing without Boundary Project	57	55	25.07	24.68

Table E.4-12c. Summary of the number of days surface daily maximum temperatures were above 20 ˚C and the annual peak surface temperatures at the Boundary Tailrace station.

Case	Number of Days Temperature Exceeds 20°C		Annual Peak Temperature (°C)	
	2004	2005	2004	2005
Natural	63	60	25.29	25.15
Existing	52	54	24.31	23.71
Existing without Boundary Project	57	55	25.14	24.77

Alternative Operations Temperature Analysis

Due to the surface temperatures seen at the Boundary Dam Forebay station, Ecology requested that SCL investigate whether there were operational changes that could lower surface daily maximum temperatures at that location. SCL developed an alternative operational scenario to model expected temperatures if the Project were to be operated under "run-of-river" conditions and at a constant forebay elevation of 1,974 feet NAVD 88 during summer months[12]. The 1,974-foot Run-of-River scenario is the most extreme variant on current operations possible given the

[12] The exact operational parameters used for this scenario are described in Khangaonkar et al. (2009).

physical constraints of the Project (i.e., it maintains the forebay level as low as possible without causing cavitation damage to the units from continued operation). It therefore provides an important outer bound to compare to the current operations scenario ("Existing Condition"). The scenario was designed to evaluate whether temperature benefits would be provided by reducing the surface area of the reservoir and reducing warm water accumulation in the forebay.

Figure E.4-29 presents a time-series comparison of simulated flow-weighted daily maximum temperatures and Figure E.4-30 presents the frequency analysis of flow-weighted daily maximum temperatures for the Existing Condition and the 1,974-foot Run-of-River scenarios. Figures E.4-31 and E.4-32 show the same time series and frequency analysis for surface daily maximum temperatures. There is no significant difference in temperature observed using flow-weighted maximum temperatures at any of the three stations analyzed. The only difference in temperatures seen was warming of surface daily maximum temperatures at the Boundary Forebay station under the Run-of-River scenario relative to the Existing Condition (Figure E.4-32). These results show that, rather than reducing or eliminating the limited surface daily maximum temperature effect observed at the Forebay station under the Existing Condition, the most extreme change in operations possible, consistent with physical constraints, would instead worsen conditions at the Forebay. Accordingly, the modeling results indicate that surface and flow-weighted maximum daily temperatures cannot be lowered using operational changes.

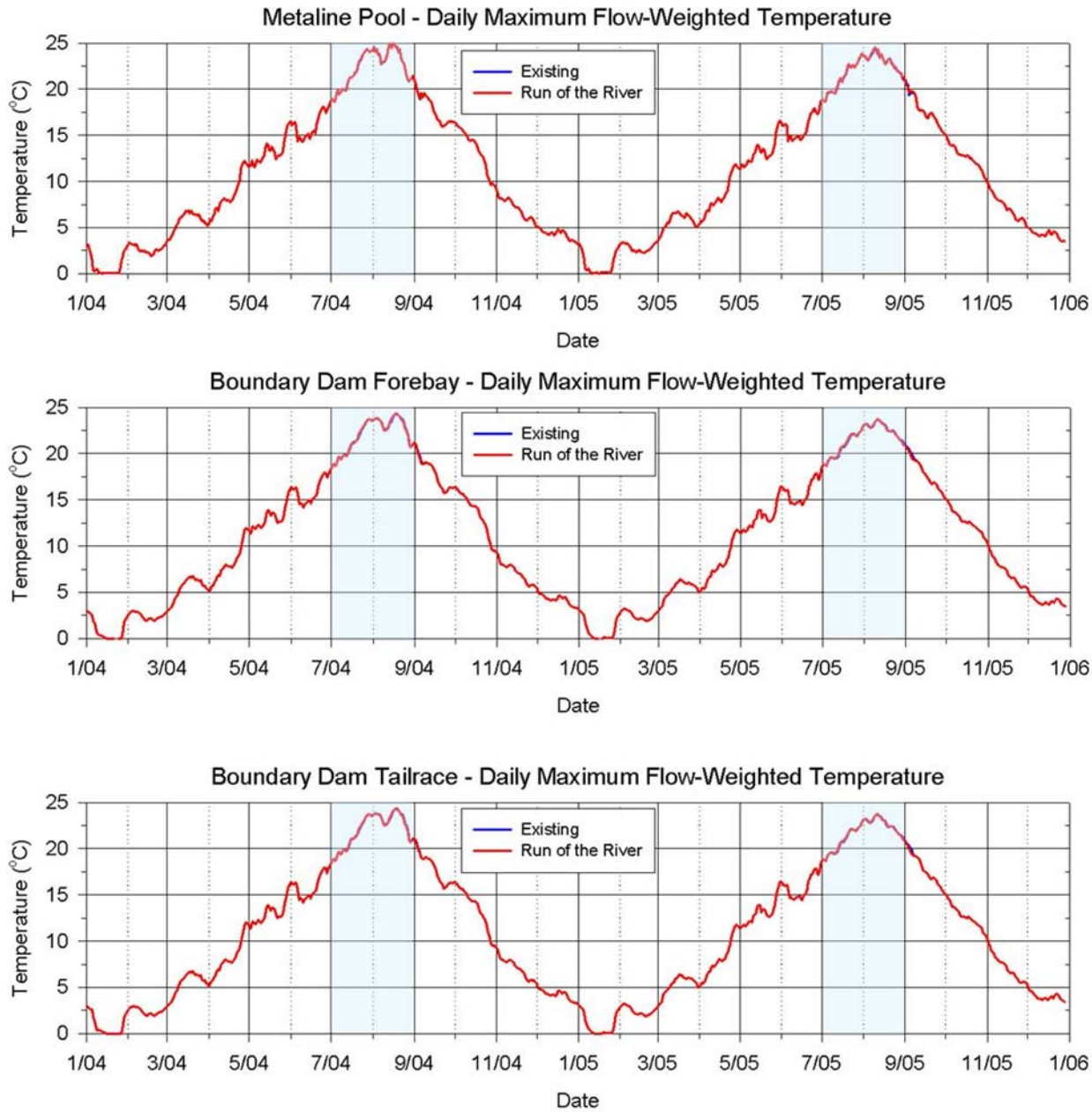


Figure E.4-29. Flow-weighted daily maximum temperatures for the Existing Condition and the 1,974-foot Run-of-River scenario.

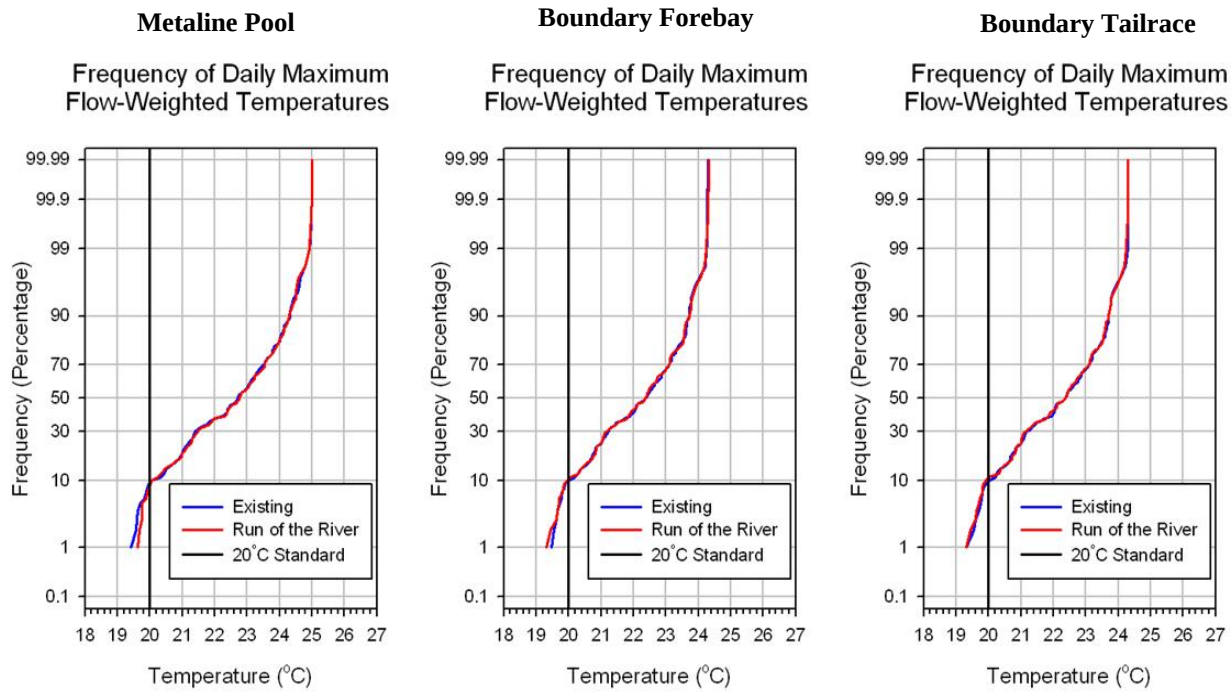


Figure E.4-30. Frequency distribution of flow-weighted daily maximum temperatures for the Existing Condition and the 1,974-foot Run-of-River scenario.

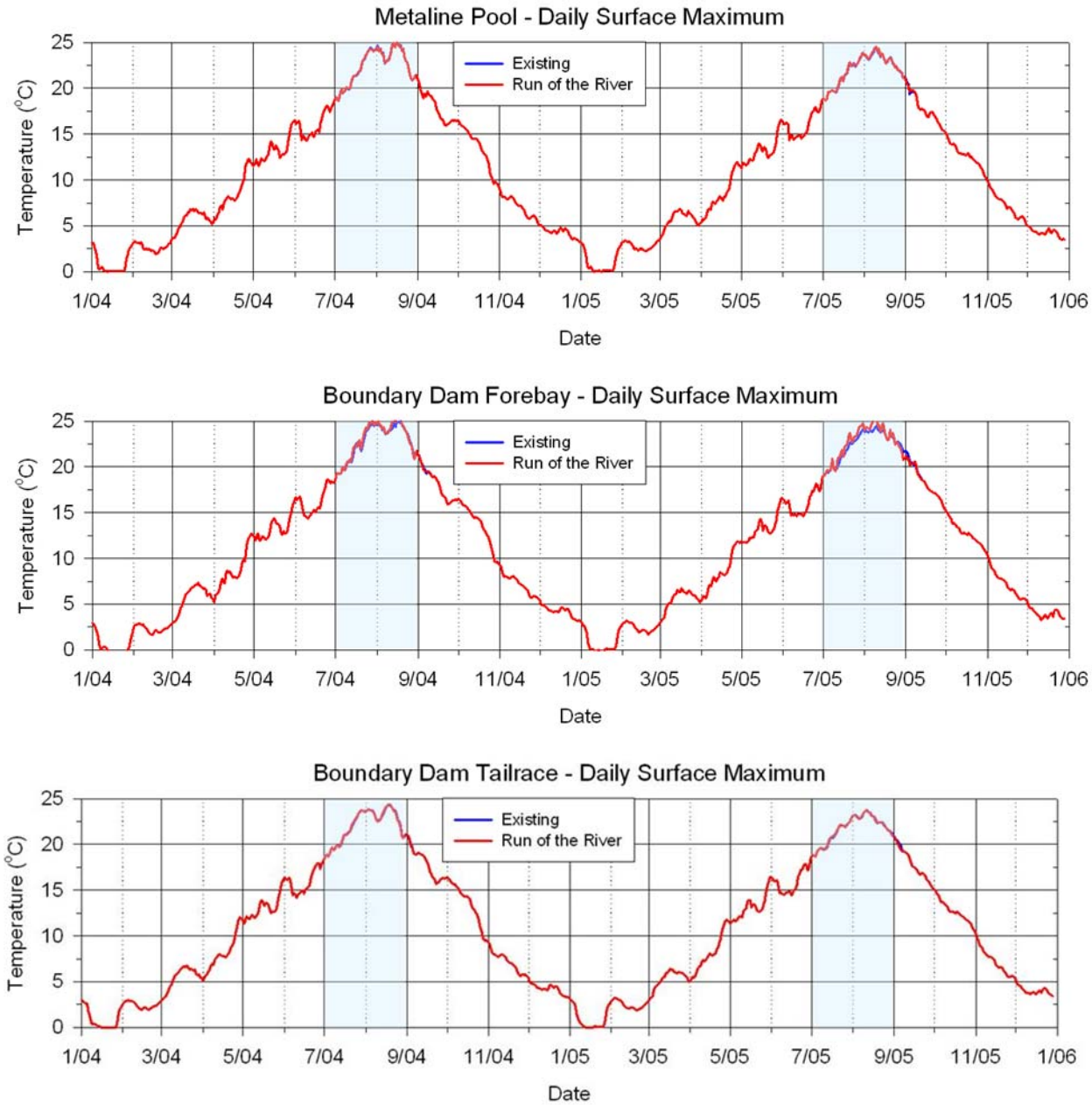


Figure E.4-31. Surface daily maximum temperatures for the Existing Condition and the 1,974-foot Run-of-River scenario.

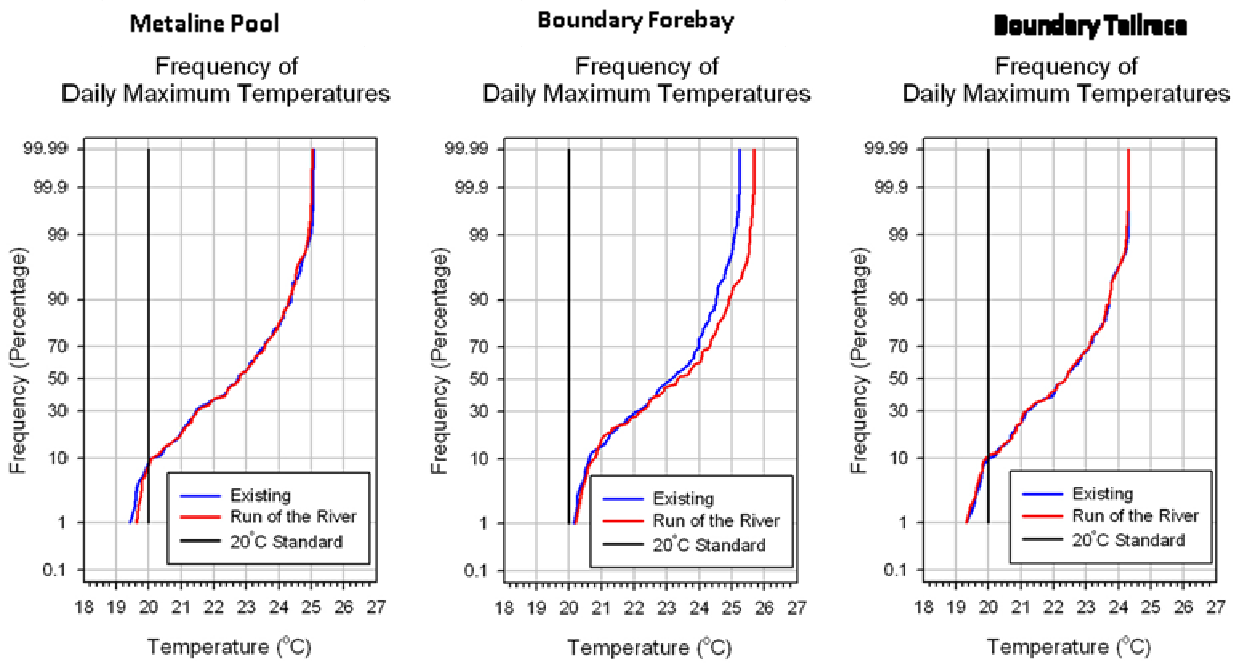


Figure E.4-32. Frequency analysis of surface daily maximum temperatures for the Existing Condition and the run-of-the-river scenario.

4.5.2.2.3. Total Dissolved Gas

The Project forebay TDG level is closely linked to inflow TDG levels, which are generated by the two projects located upstream of Boundary Reservoir, Box Canyon and Albeni Falls dams. Spill from these upstream projects causes high Boundary Dam forebay TDG at flows near and slightly above the Project power plant capacity (approximately 56,000 cfs). The Project tailrace TDG begins to increase slightly over the forebay level at flows above approximately 70,000 cfs (percent exceedance of approximately 2.6 percent, SCL 2008a), which corresponds to an average occurrence of approximately nine days per year). At flows greater than approximately 80,000 cfs, the incoming TDG levels decrease, due to removal of the spillway gates at Box Canyon Dam and corresponding elimination of overflow plunging into the tailwater at higher river flows.

Table E.4-13 summarizes the effects of Project spill on Pend Oreille River TDG levels below the Project. Data collected between 1999 and 2008 indicate that when the Project is spilling water, the Project reduces river TDG nine days per year on average. Data also indicate that the Project adds TDG to the river 7.4 days per year on average. On average, river flows are greater than the 7-day, 10-year (7Q10) river flow two days per year, during which time Ecology's TDG standard of 110 percent is not applicable.

Table E.4-13. Boundary Project spill influence on TDG.

Spill (cfs)	Days/Year	% TDG Stripped (Reduced) or Added
0–5,000	3.7	7 to 5% reduced
5,000–10,000	3.0	5 to 2% reduced
10,000–15,000	2.2	2% reduced to pass thru
15,000–53,300	7.4	pass thru to 24% added
53,300 +	1.9 (2)	110% TDG standard not applicable > 7Q10 flow

7Q10 = 7-day, 10-year frequency flood
cfs = cubic feet per second
TDG = total dissolved gas

Analysis of the historic record of TDG production indicates two primary modes of Project impact on increased tailrace TDG levels, air admission through power plant operations, and air entrainment during spill when flows exceed power plant capacity.

Air Admission

Historic data analysis shows that during low-flow Project operations when power plant Units 55 and 56 were throttled, air admitted through the turbine runner contributed to spikes in tailrace TDG (TDG Evaluation Final Report, SCL 2009a). Changes to Project power plant operations were introduced in September 2003 for these largest generating units (Units 55 and 56), resulting in a significant improvement in TDG performance to the point that there is minimal addition of TDG by the Project when not spilling. Before these changes, the power plant could increase tailrace TDG by 10 to 20 percent. Since the implementation of these operational changes, high TDG is seldom seen in years without spill at the Project. In fact, at releases below the Project power plant capacity (approximately 56,000 cfs) the Project tends to slightly reduce TDG below forebay levels.

Because proposed Project operations would involve operating Units 55 and 56 above 125 MW and sequencing their startup and shutdown so that they are the last units to be brought on line and the first units to be shut down, it is anticipated that during the new license term, TDG levels under non-spill conditions would be similar to those associated with existing operations. However, during the new license term, SCL plans to upgrade equipment at the Boundary Dam power plant (see Section 2.3.2). Proposed upgrades to the turbines may reduce or eliminate the conditions that in the past have led to TDG production during non-spill operations. When the proposed turbine upgrades are completed, SCL plans to reevaluate the need for the unit sequencing identified above and adjust the approach to, or eliminate, the sequencing restrictions if appropriate.

Project Spill

Table E.4-14 summarizes TDG increases and decreases under various spill and sluice gate operations between 1999 and 2008. Under present conditions, spillway flows of less than 15,000 cfs result in a decrease in tailrace TDG compared to forebay TDG, i.e., a net TDG reduction at the dam. Sluice flows of less than 5,000 cfs result in a decrease in tailrace TDG compared to forebay TDG, and combined spillway and sluice flows of less than 5,000 cfs result in a decrease in tailrace TDG compared to forebay TDG. However, as upstream projects reduce their TDG production in the future, which will result in lower TDG levels at the Project forebay, the ability to pass low volumes of spill at the Project without increasing tailrace TDG will become more difficult. TDG production under proposed operations for the term of the new Project license will be improved relative to that associated with existing conditions as the result of implementation of TDG abatement measures, which are discussed in Section 4.5.2.3, Proposed Environmental Measures, of this Exhibit E.

A database of spill and gate tests was developed between 2006 and 2008 to evaluate the tailrace TDG levels in relation to use of sluice and spill gates in test combinations. Table E.4-15 provides a summary of planned and opportunistic spill test conditions from 2006 - 2008. The TDG Evaluation Final Report (SCL 2009a) includes detailed analysis of these spill condition tests. Preliminary results indicate that implementing flow-dependent preferred spill and sluice gate operations may reduce tailrace TDG levels during spill compared to existing gate operations.

Table E.4-14. TDG increases and decreases under various spill and sluice gate operations, 1999 - 2008.

Category	Hours	Percent of Spill	Average Forebay TDG	Average Tailrace TDG	Average TDG Gain	Hours of +Gain	Hours of -Gain
Spill/sluice flow (any)	4,570	100	124.2	128.8	4.6	2,780	1,526
Spill flow only	4,103	89.8	125.0	128.7	3.7	2,426	1,447
Sluice flow only	85	1.9	120.2	121.3	2.0	35	35
Spill and sluice flow	382	8.4	119.6	131.9	12.4	319	44
Spill > 15 kcfs	2,331	56.8	123.5	132.0	8.5	2,013	145
Spill 10-15 kcfs	877	21.4	128.0	127.7	-0.4	308	469
Spill 5-10 kcfs	574	14.0	126.6	124.3	-2.4	90	444
Spill 1-5 kcfs	321	7.8	122.7	121.3	-1.4	15	389
Sluice > 15 kcfs	17	20.0	125.9	129.6	4.1	10	1
Sluice 10-15 kcfs	20	23.5	118.6	124.9	6.9	16	1
Sluice 5-10 kcfs	31	36.5	120.7	120.6	0.5	9	17
Sluice 1-5 kcfs	17	20.0	115.7	113.8	-1.1	0	16
Spill and sluice > 15 kcfs	321	85.8	118.1	131.4	13.3	306	4
Spill and sluice 10-15 kcfs	33	8.8	127.8	126.9	-0.8	12	21
Spill and sluice 5-10 kcfs	20	5.3	127.2	125.7	-1.5	1	19
Spill and sluice 1-5 kcfs	0	0	—	—	—	0	0

Table E.4-15. Summary of planned and opportunistic spill test conditions 2006–2008 at the Project.

% Spill	Number of Tests by Forebay TDG				Total Tests	Spill Flow Range for Tests to Date (cfs)
	<115%	115-120%	120-125%	>125%		
0 to 10	4	6	1	8	19	1,600 to 5,300
10 to 15	5	3	3	15	26	3,800 to 9,200
15 to 20	0	1	3	16	20	9,000 to 12,800
20 to 25	1	1	4	14	20	11,000 to 17,100
25 to 30	0	1	1	15	17	14,700 to 21,500
30 to 35	4	1	6	7	18	20,700 to 27,200
35 to 40	7	6	1	13	27	22,600 to 33,600
40 to 45	13	3	2	2	20	Range for forebay up to 120% was 33,700 to 43,100
45 to 50	21	1	1	0	23	39,700 to 47,500
50 to 60	17	0	0	1	18	45,200 to 59,500
Total	72	23	22	91	208	1,600 to 59,500

Forebay TDG, power plant flow gassing, and percent spill flow were all significant variables in determining tailrace TDG (SCL 2009a). Therefore, developing a statistically meaningful analysis of the gate database to determine the relative effects of different gate operations with a limited number of tests was not possible. To assess the impacts of operations on TDG gain, the tests within each percent spill range were compared to determine the preferred sluice or spill or sluice and spill combination operation for the range of forebay TDG. Results are summarized in Figures E.4-33 and E.4-34, with additional discussion and analysis presented in Section 5.2 of the TDG Evaluation Final Report (SCL 2009a).

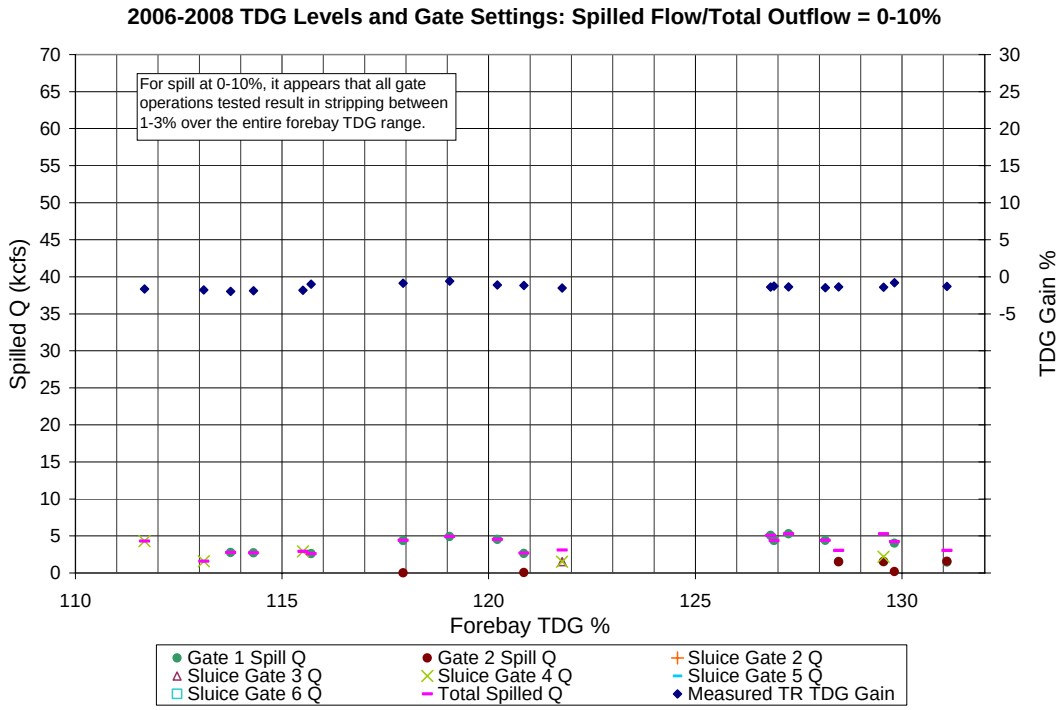


Figure E.4-33. Project 2006–2008 TDG levels and gate settings for Spill=0-10 percent.

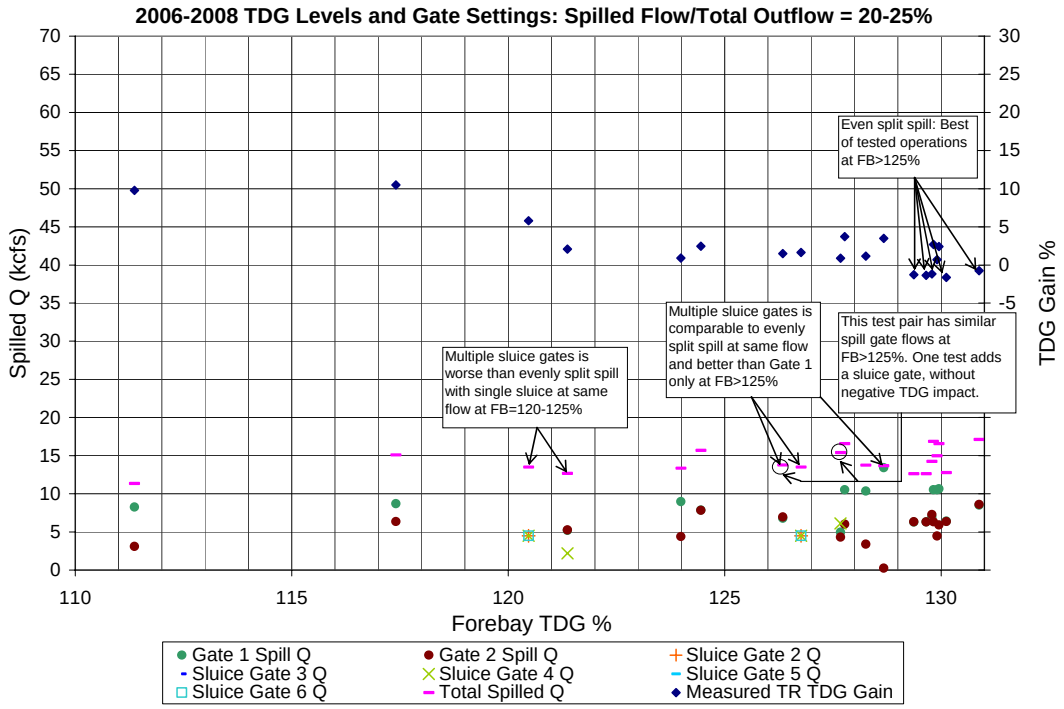


Figure E.4-34. Project 2006–2008 TDG levels and gate settings for Spill=20-25 percent.

Fish Gas Bubble Trauma

Gas bubble trauma may result from local TDG levels that can temporarily peak as high as 140 to 150 percent saturation at the water surface in the Boundary Dam tailrace and forebay during high flow conditions. However, the relative gas saturation level decreases approximately 10 percent for each meter of depth attained, so as long as average depths of 12 to 15 feet below the water's surface are available to fish in the immediate tailrace area and downstream, the likelihood of injury due to gas bubble trauma is reduced (R2 Resource Consultants 2006). During routine sampling for all fish and aquatics studies, fish were examined for gas bubble trauma and no specimens in the Boundary Dam tailrace were found to be impacted (Cupp, E., Terrapin Environmental, personal communication, November 26, 2008). However, due to the dangerous conditions in the tailrace, no sampling occurred during spill.

4.5.2.2.4. pH

Average, maximum, and minimum pH values measured at profiles at all sampling sites during 2007- 2008 are presented, by sampling month, in Table E.4-16. The pH values measured in the field were not recorded simultaneously at each site, and therefore are not directly comparable, but still allow for general longitudinal trends to be inferred for the entire sampling period.

According to Ecology's aquatic life criteria for fresh water, pH should be within the range of 6.5 to 8.5 for salmonid spawning, rearing, and migration, with a human-caused variation within this range of less than 0.5 unit (Ecology 2006a). Based on pH observed in the reservoir, this range was exceeded at several sampling stations in June, July, and August 2007. The pH of water entering the Project area at the Box Canyon Tailrace site (V7) exceeded the 8.5 standard in June, July, and August, with 9.1 as the highest value recorded. The Pend Oreille Mine (V3) and the Box Canyon Tailrace (V7) sites consistently had the highest pH values, with maximum observed levels of 9.1 at both stations.

High pH levels in the reservoir do not appear to be related to the Project or its operations. Longitudinal trends for the year (Table E.4-16) indicate that during the times when exceedances occur, pH entering the Project from Box Canyon Dam is as high or higher than pH in the Boundary Dam forebay, indicating that, if anything, pH appears to decline as water moves downstream through the reservoir. High pH levels entering the Project area during summer were likely due, at least in part, to photosynthetic activity occurring in Box Canyon Reservoir. Values of pH observed within Boundary Reservoir were also similar with depth; isopleths showing pH as a function of depth are presented for all sampling stations in the Water Quality Study Final Report (SCL 2009a). During the Water Quality Study, no correlation was observed between measured pH values and reservoir water surface elevation fluctuations resulting from Project operations. Because proposed Project operations would be the same as existing operations, it is anticipated that the Project would continue to have no effect on pH in the reservoir during the term of the new Project license.

Background geology may contribute to the high pH levels observed in the lower Pend Oreille River. The Boundary Reservoir watershed is underlain to a large extent by limestone bedrock, which could contribute to elevated pH levels even under natural conditions. Background pH values exceeding the water quality standard were measured in relatively unimpacted tributaries to the Pend Oreille River

by Ecology, with no human related pH influences identified in these streams, as reported in the Colville National Forest TMDL Report submitted by Ecology to EPA (Ecology 2005b).

4.5.2.2.5. Dissolved Oxygen

Average, maximum, and minimum values of DO measured at all sampling sites during 2007 - 2008 are presented, by sampling month, in Table E.4-17. The DO values measured in the field were not recorded simultaneously at each site, and therefore are not directly comparable, but still allow for general longitudinal trends to be inferred for the entire sampling period. Measured DO values, relative to chemical reactivity, nutrient availability, and habitat conditions, are discussed in the Productivity Assessment Final Report (SCL 2009a).

According to Ecology's aquatic life criteria in fresh water, the lowest one-day minimum DO value allowed for salmonid spawning, rearing, and migration is 8.0 mg/L (Ecology 2006a). DO concentrations in May and June and September through March were greater than 8.0 mg/L at all sampling stations (Table E.4-17). In July, DO concentrations were above the Ecology standard at all sampling stations, except for the Everett Creek Island (V5) and Boundary Forebay (V6) stations, where DO values at depths below 28.0 meters (7.0 mg/L minimum) and below 35.0 meters (7.7 mg/L minimum), respectively, were below the water quality standard. In August, DO concentrations were below the DO standard at the Metaline Old (V2), Boundary Forebay (V6), and Boundary Tailrace (V8) stations, where minimum DO concentrations were 7.9, 7.6, and 7.7 mg/L, respectively. DO values throughout the water column at Metaline Old (V2) and Boundary Tailrace (V8) stations were at or below 8.0 mg/L in August. Although slightly below water quality standards at select sites in the late summer, it is unknown to what extent such DO exceedances persist in the system.

DO values that were below the 8.0 mg/L standard were also often below saturation, which was about 7.9 mg/L in July and 8.5 mg/L in August. This means that DO was less than the maximum concentration the reservoir water could hold based on ambient temperature and atmospheric pressure. During sampling events in July, August, and September/October there was a slight (<1.0 mg/L) decline in DO values with depth. That decrease with depth was apparently due to respiration that exceeded re-aeration in the water column, and possibly in the sediment. DO profiles at each station are provided in the Water Quality Study Final Report (SCL 2009a). The saturation deficit (≈1.0 mg/L) increased with depth, indicating that much of the DO demand came from the bottom sediments and/or water column, in combination with extended retention time and lower re-aeration due to lower flows that caused lower vertical mixing velocities. A relatively small DO decrease of 1.0 mg/L with depth is consistent with oligotrophic (low-productivity) waters.

Table E.4-16. pH (Standard Units) data summary for each water quality monitoring site in Boundary Reservoir (May 2007 – March 2008).

Site	May			June			July			August			September/October			November			March		
	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min
V7	7.8	7.8	7.8	8.5	8.5	8.4	**8.6**	**8.6**	**8.6**	**9.1**	**9.1**	**9.1**	8.5	8.5	8.4	7.9	7.9	7.8	8.1	8.1	8.1
V1	8.0	8.0	8.0	8.3	8.4	8.3	8.4	**8.6**	8.2	8.5	**8.6**	8.5	8.4	8.5	8.3	7.8	7.9	7.8	7.8	7.8	7.7
V2	8.0	8.0	7.9	8.2	8.4	7.9	8.4	8.4	8.3	8.5	8.5	8.5	8.1	8.3	8.0	7.9	7.9	7.9	7.9	8.0	7.9
V3	7.9	7.9	7.9	**8.6**	**8.8**	**8.6**	**9.0**	**9.1**	**8.7**	8.5	8.5	8.5	**8.7**	**8.7**	8.5	8.1	8.2	8.0	8.0	8.2	7.9
V4	8.1	8.1	8.1	8.5	**8.6**	8.3	8.4	8.5	8.3	8.3	8.3	8.3	8.3	**8.6**	8.2	7.9	7.9	7.8	7.8	7.8	7.6
V5	7.9	7.9	7.9	8.5	**8.6**	8.1	**8.6**	**8.6**	8.4	8.3	8.3	8.3	8.3	8.3	8.2	7.8	7.9	7.8	7.9	7.9	7.7
V6	8.3	8.3	8.3	8.2	8.3	8.1	8.2	8.2	8.0	8.2	8.3	8.2	8.1	8.2	8.1	7.9	8.0	7.9	7.8	7.9	7.6
V8	8.4	8.4	8.4	8.2	8.2	8.2	8.3	8.4	8.2	**8.6**	**8.6**	**8.6**	8.3	8.4	8.3	7.9	7.9	7.9	7.8	8.0	7.7

Notes:
1 Averages represent the logarithmic average.
Bold text indicates when pH measurements were higher than the numeric standard range of 6.5 to 8.5.

Table E.4-17. Dissolved oxygen (mg/L) data summary for water quality monitoring sites in Boundary Reservoir (May 2007–March 2008).

Site	May			June			July			August			September/October			November			March		
	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max	Min
V7	11.0	11.0	11.0	10.0	10.0	10.0	8.6	8.6	8.5	8.4	8.4	8.4	9.6	9.7	9.6	12.4	13.6	12.0	12.8	12.9	12.4
V1	11.4	11.4	11.4	10.0	10.1	9.9	8.7	8.8	8.7	8.1	8.1	8.1	9.6	9.7	9.6	12.1	13.1	11.9	12.7	12.9	12.3
V2	11.3	11.3	11.2	10.0	10.1	9.9	9.2	9.7	8.9	**7.9**	8.0	**7.9**	9.6	9.7	9.5	11.8	11.9	11.8	12.7	12.8	12.7
V3	11.4	11.4	11.4	9.5	9.6	9.4	8.2	8.4	8.1	8.9	9.1	8.8	9.6	9.9	9.4	12.1	12.2	12.0	12.6	12.7	12.5
V4	11.3	11.3	11.3	9.2	9.3	9.1	8.5	8.7	8.4	8.8	9.0	8.6	9.6	9.9	9.4	12.1	12.3	12.0	12.7	12.7	12.6
V5	11.2	11.2	11.2	9.2	9.3	9.1	8.1	8.5	**7.7**	8.5	8.9	8.1	9.6	10.0	9.3	12.0	12.5	11.9	12.7	12.8	12.6
V6	11.2	11.2	11.2	9.0	9.3	8.8	**7.8**	8.4	**7.0**	8.0	8.4	**7.6**	9.4	9.9	9.1	11.8	12.3	11.7	12.5	12.6	12.4
V8	11.2	11.2	11.2	9.5	9.5	9.5	8.2	8.2	8.2	**7.7**	**7.7**	**7.7**	9.7	9.7	9.7	12.0	12.1	12.0	12.6	12.7	12.4

Note:
Bold text indicates when DO measurements were lower than the one-day minimum numeric standard of 8.0 mg/L.

DO values recorded show that DO does not vary greatly with depth (Figures 5.1-20 through 5.1-27 in the Water Quality Study Final Report, SCL 2009a) or longitudinally (Figures 5.1-28 through 5.1-33 in same report) in Boundary Reservoir. The slight decline in DO with depth during July, August, and September/October, as well as slight variations longitudinally during these months, can be attributed to respiration in the water column and sediments. These results indicate no correlation between DO and water surface elevation fluctuations related to Project operations in Boundary Reservoir. However, water depth and retention time would be less if the reservoir did not exist. A natural river would have higher potential for re-aeration than the existing condition, and DO levels would likely be more uniformly distributed and closer to saturation throughout the water column.

4.5.2.2.6. Aquatic Macrophytes, pH and DO

Macrophyte beds have the potential to influence localized pH and DO levels. SCL collected data in 2007 and 2008 at five macrophyte bed locations throughout the reservoir to determine whether pH and DO levels were similar among sampling sites located upstream, within, and downstream of macrophyte beds. Vertical profiles for DO and pH and continuously recorded data were collected from sites within macrophyte beds of varying densities as well as from sites upstream and downstream of these locations. These data are discussed in detail in the Evaluation of the Relationship of pH and Dissolved Oxygen to Macrophytes in Boundary Reservoir (Relationship of pH and DO Macrophytes Study) Final Report (SCL 2009a). Figures E.4-35 through E.4-40 display weekly pH and DO values from 2007 based on continuous monitoring data at stations upstream of, within, and downstream of a macrophyte bed located in the upper reservoir. Data from July through October 2008 revealed similar patterns as the 2007 data. In August 2007 through September 2007, there are breaks in data available at Buoy 2 as the buoy was dry due to extremely low drawdowns of the reservoir related to other study efforts. The drawdowns in September dried the beds through September 13, 2007. These drawdowns that occurred during the sampling season were extreme and the pH and DO data collected do not convey what would have happened at this location under a more normal range of Project operations; therefore, no data are reported for Buoy 2 during this period. The Hydrolab was replaced at Buoy 2 on September 17, 2007, and after the bed had been re-wetted for a few days, data logging resumed.

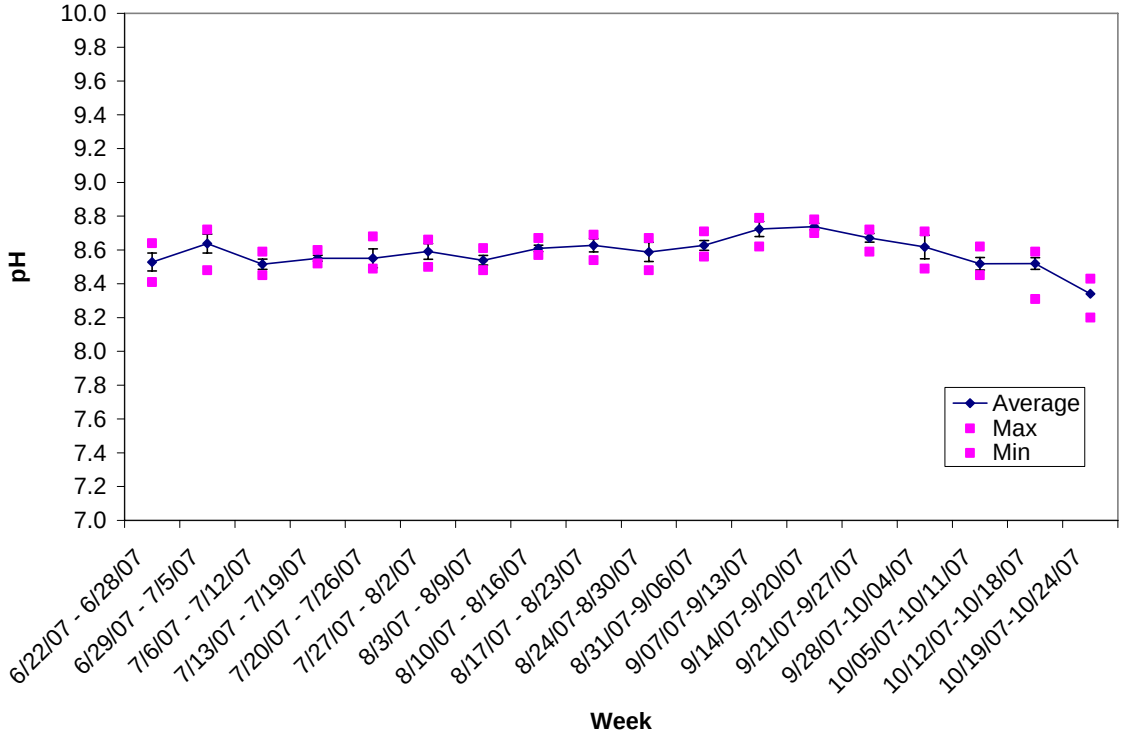


Figure E.4-35. Buoy 1 (upstream) weekly pH values from 6/22/07 to 10/24/07 at Site M6.

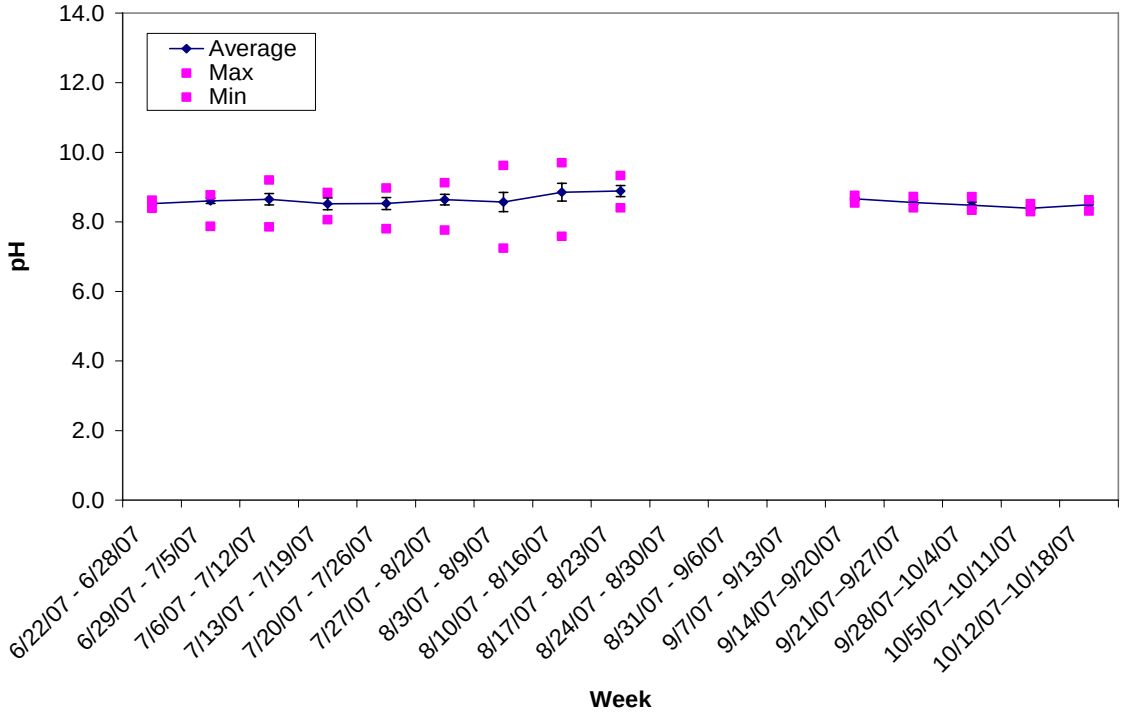


Figure E.4-36. Buoy 2 (macrophyte bed) weekly pH values from 6/22/07 to 10/24/07 at site M6.

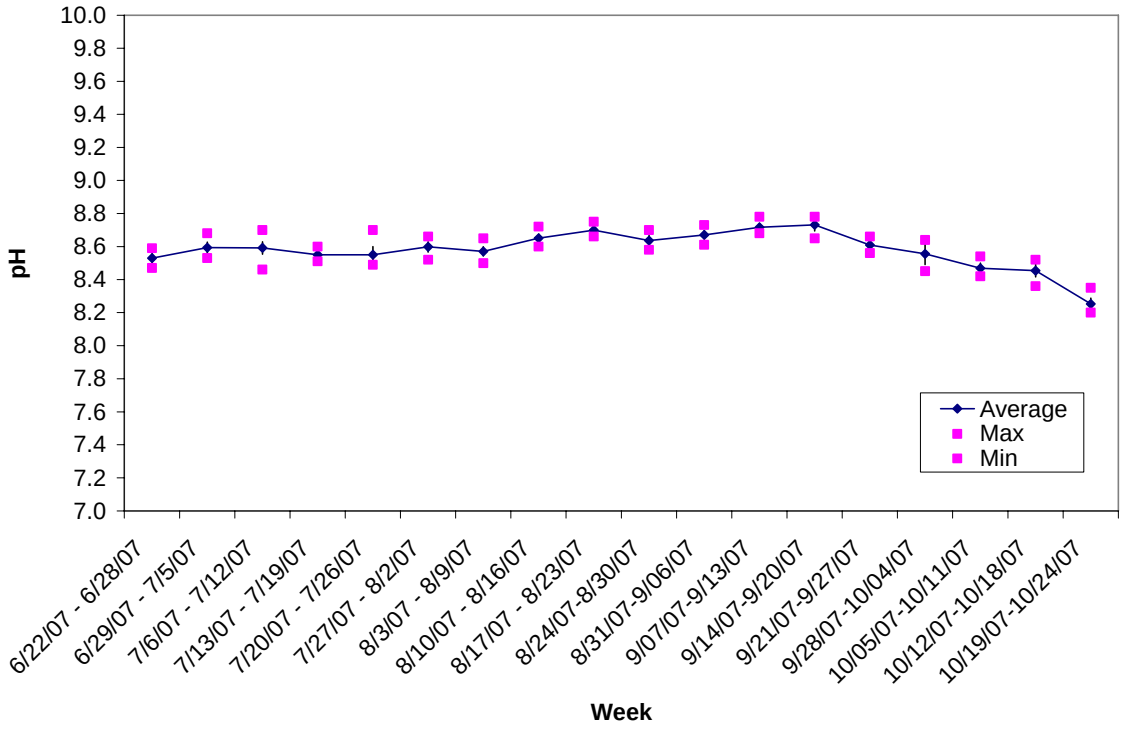


Figure E.4-37. Buoy 3 (downstream) weekly pH values from 6/22/07 to 10/24/07 at site M6**.**

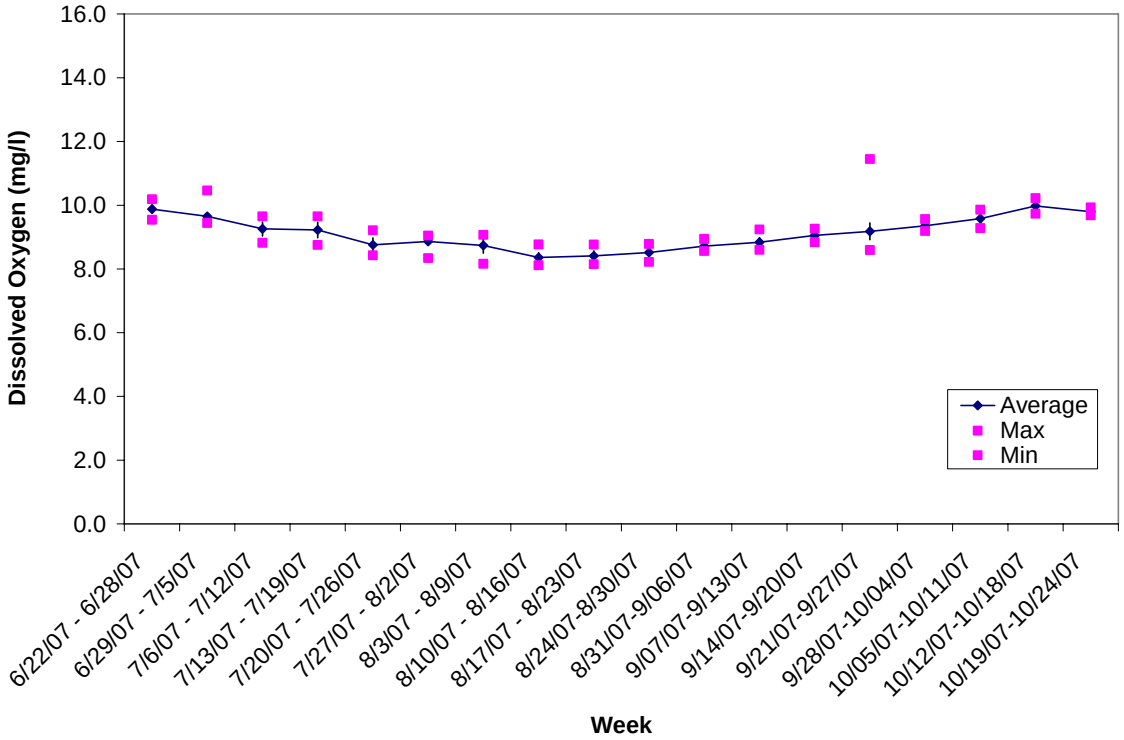


Figure E.4-38. Buoy 1 (upstream) weekly DO values from 6/22/07 to 10/24/07 at site M6.

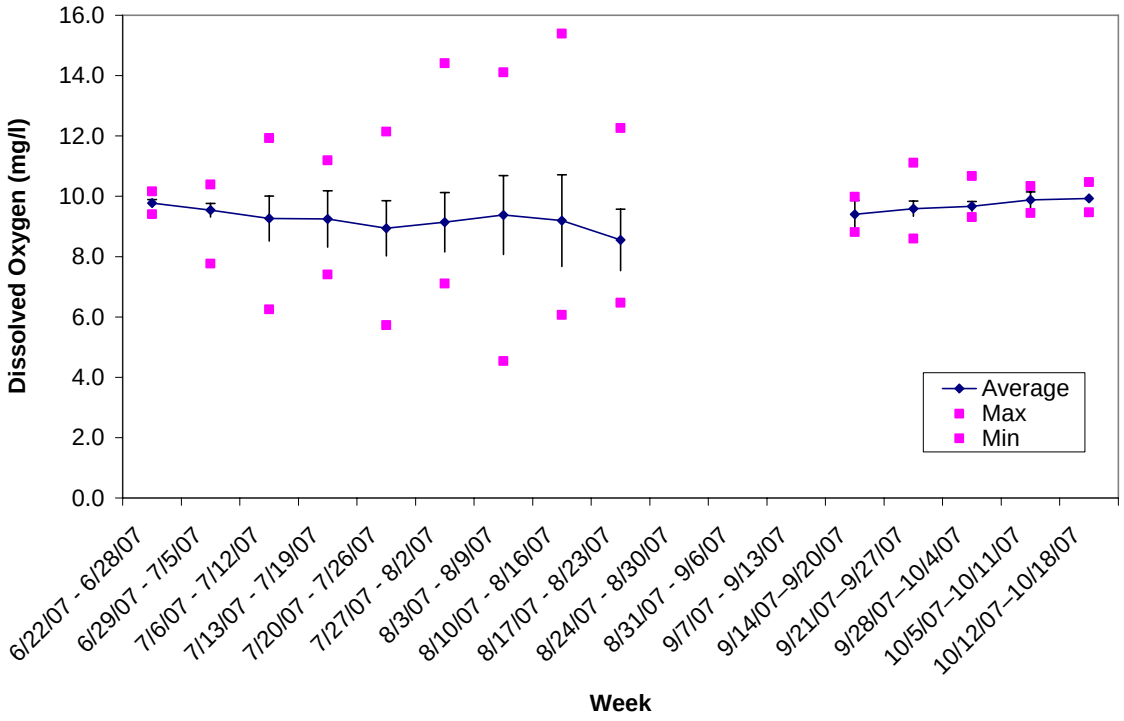


Figure E.4-39. Buoy 2 (macrophyte bed) weekly DO values from 6/22/07 to 10/24/07 at site M6.

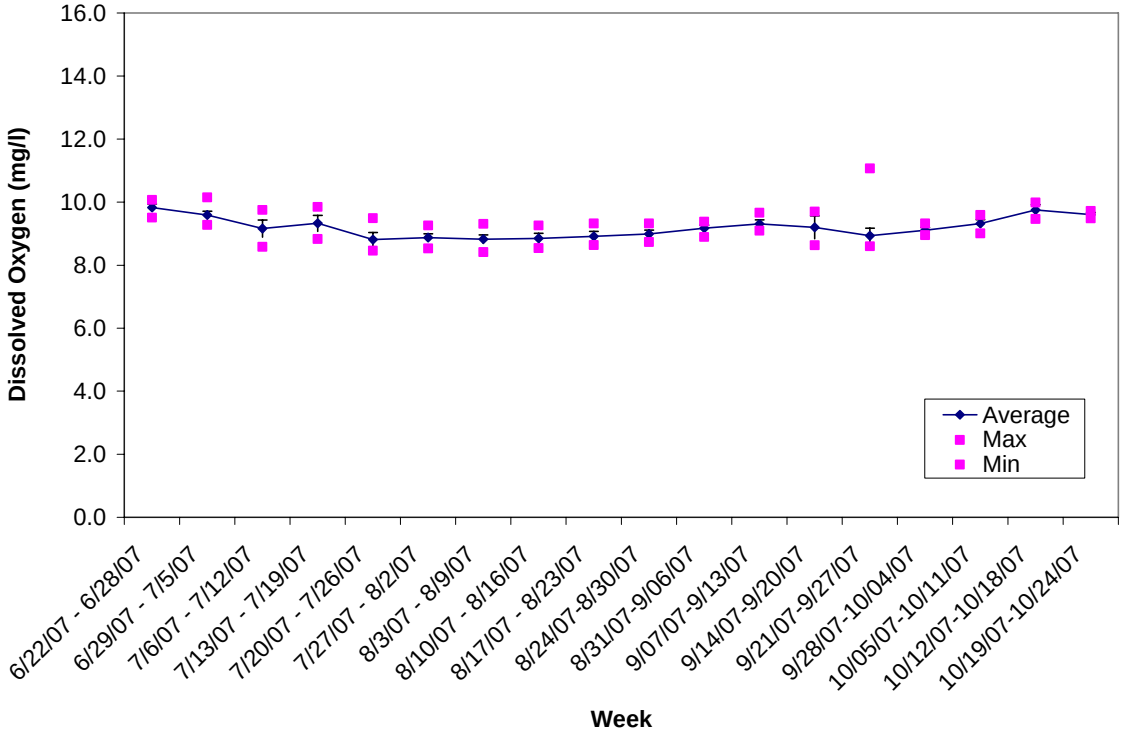


Figure E.4-40. Buoy 3 (downstream) weekly DO values from 6/22/07 to 10/24/07 at site M6.

Water quality data collected above, within, and below five macrophyte beds located throughout Boundary Reservoir show that macrophytes have only minor and localized (i.e., within the macrophyte bed itself) impact on reservoir pH and DO levels. This conclusion is supported by both 24-hour and 72-hour sampling events and continuous water quality monitoring with remote sensors. Fluctuations in pH and DO within the macrophyte beds had no influence on pH and DO values downstream of the beds. In addition, the diurnal variation of pH and DO levels within macrophyte beds showed no correlation with water surface elevation fluctuation. Instead, the variation of pH and DO levels within beds is attributed to macrophyte photosynthesis and respiration.

Because proposed Project operations would be the same as those associated with existing conditions, it is anticipated that macrophytes would continue to have no effect on reservoir-wide pH and DO during the term of the new Project license. Details about species composition and areal extent of macrophyte beds, and the relationship between macrophyte abundance and the existence of the Project, can be found in the Mainstem Aquatic Habitat Modeling Study (Mainstem Habitat Modeling Study) Final Report (SCL 2009a), the Productivity Assessment Final Report (SCL 2009a), and Section 4.5.3 (Fish and Aquatic Resources)of this Exhibit E. Potential effects on fish due to DO levels in macrophyte beds are also discussed in Section 4.5.3.

4.5.2.2.7. Toxics

SCL used several methods to evaluate the presence and potential for bioavailability of the toxics of concern (arsenic, cadmium, lead, mercury, PCBs, and zinc) throughout Boundary Reservoir, including direct sampling of media (water column, sediment, and sediment pore water), toxicological models (identified factors that could promote bioavailability of toxics), pathway models (how toxics move between media such as sediments, pore-water, and surface water), and a conceptual decision matrix (to identify potential Project effects). In addition to sampling the water column, pore water, and sediment, sampling was also conducted in surface water of the reservoir's fluctuation zone (i.e., upper 10 feet of the reservoir) during a period of declining water surface elevation, to assess potential mobilization of toxics from reservoir banks and movement of toxics in a down-gradient direction. Detailed results based on these methods, as well as conclusions regarding the Project's effect on toxics bioavailability, are documented in the Toxics Assessment: Evaluation of Contamination Pathways Final Report (Toxics Assessment) contained in the USR (SCL 2009a). Toxics sampling was conducted at 14 sites in the reservoir between the Boundary Dam forebay and Box Canyon Dam. Sampling sites were selected to assess potential longitudinal trends in toxics concentrations and to identify input from potential toxics sources, such as active and historic mines. Maps showing toxics sampling locations are provided in Figure 4.1-1 of the Toxics Assessment Final Report (SCL 2009a).

Overall, concentrations of toxics were either low or undetectable in sampled media (surface water, sediment, pore water) within the Project area; only isolated, localized exceedances were measured (SCL 2009a). Sampling conducted in the fluctuation zone during drawdown in March 2008 resulted in no detectable concentrations of toxics, indicating that Project operations are not drawing toxics-laden material into the reservoir (SCL 2009a). During the initial sampling, no exceedances of relevant criteria were detected in the sediment for any of the six toxics of

concern[13], and no exceedances were measured in any media for arsenic, cadmium, or mercury (SCL 2009a). Relevant criteria include LAETs for sediment, and surface water quality standards for pore water and surface water.

During the initial sampling, lead exceedances were detected at two water column sampling sites: Site 10, located just downstream of the town of Metaline and Site 11, located across the river channel from Metaline (Table E.4-18). At Site 10, a lead exceedance was detected in only one of three replicate samples, and at Site 11, lead exceedances were detected in two of three replicates. Approximately 83 percent of the samples collected in the water column resulted in non-detectable concentrations of all metals.

Table E.4-18. Measured exceedances of toxics criteria for lead and zinc reported for sites, 5, 8, 10, and 11 during 2008 sampling conducted for the Boundary Project Toxics Assessment: Evaluation of Contamination Pathways (Final Report contained in the USR [SCL 2009a]).

Site Number	Toxic	Sampled Medium	Concentration	Number of Replicates Above Relevant Criteria	Relevant Criterion[1]
March 2008					
5	Lead	Pore water	3.98 µg/L	1 of 3	Chronic = 2.0 µg/L
5	Zinc	Pore water	279.0 µg/L	1 of 3	Acute = 94.7 µg/L
8	Zinc	Pore water	566.0 µg/L	1 of 3	Acute = 94.7 µg/L
10	Lead	Surface water	3.46 µg/L	1 of 3	Chronic = 2.0 µg/L
11	Lead	Surface water	4.15 - 5.46 µg/L	2 of 3	Chronic = 2.0 µg/L
October 2008					
8	Lead	Pore water	2.45 - 5.69 µg/L	4 of 9	Chronic = 2.0 µg/L
8	Lead	Sediment	344 mg/kg	1 of 9	LAET = 335 mg/kg

Note:
1 LAETs for sediment; surface water quality standards for pore water and surface water.

During the initial sampling, exceedances were also detected at two pore-water sampling sites: lead and zinc at Site 5, located downstream of the Pend Oreille Mine, and zinc at Site 8, located downstream of the Grandview Mine (Table E.4-18). At Site 5 and Site 8, exceedances occurred in only one of three replicates taken at each site, i.e., in replicate #2 at Site 5 and replicate #1 at Site 8. Approximately 92 percent of the water quality observations from pore-water sampling resulted in non-detectable concentrations of dissolved arsenic and cadmium, and approximately 30 percent of pore water sampling observations resulted in non-detectable concentrations of dissolved lead and zinc. Mercury concentrations in pore water were well below the relevant criterion at all sites.

None of the exceedances suggested toxics sources originating from within the reservoir (SCL 2009a). Linkages that would indicate within-reservoir sources of toxics did not exist (i.e., sediment-pore water-surface water associations), and water chemistry factors that would promote

[13] PCB sampling was conducted in sediment only, as explained in the SAP (2007).

transfer of these toxics into bioavailable forms (i.e., low pH, low hardness, or low DO) were absent throughout the year (SCL 2009a). Moreover, toxics were not detected in significant concentrations at sampling locations adjacent to where exceedances were measured (i.e., upstream, downstream, or both), suggesting that transfer within the channel and in a down-gradient direction does not occur.

Additional sampling was conducted in October 2008 to re-examine exceedances of surface water criteria from pore water at sites 5 and 8 for zinc and site 5 for lead. More specifically, the purpose of this additional sampling was to verify the presence and spatial extent of zinc and lead concentrations at the sites where pore water exceedances had been detected in March 2008 and to compare concentrations of toxics concentrations at sites 5 and 8 to the reference sites at the farthest upstream (Box Canyon Dam tailrace) and downstream (Boundary Dam forebay) locations in the Project area. Results of the October 2008 sampling revealed no zinc exceedances in any of the media sampled (sediment, pore water, and surface water) at any of the sampled locations. Lead exceedances were found in four of nine replicates of pore water samples and in one of nine replicates of sediment samples at Site 8 (Table E.4-18). However, linkages that would indicate within-reservoir sources for lead did not exist (e.g., sediment-pore water-surface water associations), and water chemistry factors that would promote transfer of these toxics into bioavailable forms were absent. The appearance of elevated lead concentrations at Site 8 in October 2008, but not in March 2008, indicates the transient nature of the low-level concentrations that occurred. This transience, coupled with the lack of exceedances upstream of Site 8, indicate that exceedances were influenced by local sources outside of the reservoir, rather than from sediments upstream of Site 8.

Based on multiple lines of evidence evaluated within the context of toxicological models, pathway models, and a conceptual decision matrix, there appears to be no link between the operations of the Project and the transfer of toxics within Boundary Reservoir or toxics bioavailability (SCL 2009a). Because proposed Project operations would be nearly the same as those associated with existing conditions, it is anticipated that there would continue to be no link between operations and the transfer of toxics within the reservoir or toxics bioavailability during the term of the new Project license.

4.5.2.2.8. Other Water Quality Parameters

Conductivity, hardness, Secchi disk depth (i.e., water clarity), nutrients (total phosphorus [TP], SRP, TKN, and chlorophyll *a* levels are summarized in the Water Quality Study Final Report (SCL 2009a). There are no Washington water quality standards for these parameters. Turbidity samples were also collected and evaluated in the context of Ecology's water quality standard. Data reported below were collected between May 2007 and March 2008.

Conductivity in Boundary Reservoir ranged from 136.3 µS/cm to 170.8 µS/cm and followed a seasonal pattern. Hardness levels varied seasonally based on the availability of calcium carbonate resulting from the geochemical characteristics in the basin, and were measured between 64.7 – 84.2 µS/cm. Secchi disk depths were greatest (i.e., highest water clarity) during the summer months, with a maximum of 5.5 meters at the Slate Creek (V4) and Everett Island (V5) sampling sites. Secchi disk depth in the Boundary (V8) and Box Canyon (V7) tailraces during summer months extended to the bottom of the channel. Turbidity in Boundary Reservoir

was never greater than 5 NTUs; therefore, no exceedances of the numeric standard for turbidity occurred. No operational effects were observed on any of these parameters.

Nutrient levels were low throughout the reservoir. Both Secchi depths and N:P ratios (ranging from 16.4 to 94.7) indicate an oligotrophic system (SCL 2009a). The highest TP concentration (17.0 µg/L) was observed at the Pend Oreille Mine station (V3) in June 2007. TKN concentrations were highest in June and July, with the maximum TKN (909 µg/L) observed at the Wolf Creek station (V1) in July 2007. Both TP and TKN were influenced by inflows from Box Canyon reservoir. TP and TKN concentrations at sites throughout the reservoir were consistent. Soluble reactive phosphorus (SRP) was always near or below detection. Overall low levels of TP limit primary productivity in the reservoir. Nutrient levels do not appear to be influenced by Project operations.

Chlorophyll *a* concentrations, representing phytoplankton growth, ranged from 0.9 µg/L in the littoral zone at the Boundary Forebay station (V6) during August 2007 to over 5 µg/L at several stations and depths in March 2007. Seasonal differences in Boundary Reservoir chlorophyll *a* are evident: the highest chlorophyll *a* concentrations occurred in May and June 2007 and March 2008. Lower chlorophyll *a* concentrations during the summer and fall are likely due to a decline in inflow nutrient concentrations related to a decrease in flow, or simply a decrease in the inflow of phytoplankton densities from Box Canyon Reservoir. Lower light penetration and temperatures, as well as shorter reservoir retention times during spring, should show decreased primary production relative to warmer summer conditions with longer retention times, but this pattern was not observed. Therefore, springtime peaks in chlorophyll *a* production appear to be a function of upstream production flowing into Boundary Reservoir. Little difference in chlorophyll *a* was observed between littoral and pelagic areas. There was a direct relationship between surface pelagic chlorophyll *a* concentrations in Boundary Dam tailrace and Boundary Dam forebay. Data revealed no correlation between chlorophyll *a* concentrations and fluctuations in water surface elevations in the reservoir.

Seasonal patterns were observed in the zooplankton community structure of the reservoir. Zooplankton abundance and species composition in the reservoir are dictated to a large extent by inflows from Box Canyon Reservoir. The data show no longitudinal trends in zooplankton abundance and species composition, indicating that the Project is having minimal effect on zooplankton populations. Total zooplankton abundance in both Box Canyon and Boundary Dam tailraces followed a similar seasonal pattern compared to that observed in the monthly samples collected throughout the reservoir. The low retention time in Boundary Reservoir does not allow for significant increases or decreases in zooplankton, with conditions in Boundary Reservoir mirroring the inflow conditions from Box Canyon Dam.

Because proposed Project operations would be nearly the same as those associated with existing conditions, it is anticipated that the Project would continue to have no effect on nutrient levels, turbidity, or primary and secondary production in the reservoir during the term of the new Project license. The relationship between nutrient and phytoplankton and zooplankton productivity in the reservoir is discussed further in the Productivity Assessment (SCL 2009a).

4.5.2.3. Proposed Environmental Measures

4.5.2.3.1. Peak Flood Flow Conditions above Metaline Falls

SCL proposes to acquire flood easements from private landowners in the towns of Metaline and Metaline Falls to compensate them for the incremental component of flooding that is Project-related on rare occasions on their properties during high-flow events. Easement rights will restrict building, filling, or excavating in the easement areas. Because these easements are unnecessary for normal Project operations, SCL does not propose to include any provisions relating to these easements in the new license.

SCL arranged for the Real Estate Services (RES) Division of the Seattle Fleets and Facilities Department, which provides various real estate services to City of Seattle Departments, to provide estimates for the value of the easements, as well as an estimate of the costs associated with the steps to obtain the easements (costs provided in Exhibit D). SCL anticipates that RES will oversee acquisition of the flood easements.

4.5.2.3.2. Temperature

Modeled flow-weighted daily maximum temperatures in the Project area are within water quality standards. Under certain conditions the Project has a slight warming effect on surface daily maximum temperatures at the forebay, but has no effect at Metaline Pool and has a cooling effect at the Tailrace that is greater than the warming effect at the Boundary Forebay. Changes in Project operations would exacerbate rather than reduce the slight surface warming at the Boundary Forebay location. To address the minor temperature effects of the Project on surface water at the forebay, Ecology has indicated that improving fish habitat in tributaries to the reservoir and in tributary delta areas, including enhancing thermal refugia, will help meet Ecology's temperature improvement goals for the Pend Oreille River. The PM&E measures that SCL proposes to implement in Section 4.5.3.3 (Fish and Aquatics Resources, Proposed Environmental Measures) of this Exhibit E include a variety of measures that would improve habitat conditions, including thermal refugia, for aquatic species in the Pend Oreille River system. These measures include tributary riparian plantings, stream channel modifications, LWD supplementation, bank improvements, and culvert replacement.

4.5.2.3.3. Total Dissolved Gas

Following issuance of the new license for the Project, SCL will implement measures identified in its TDG Attainment Plan (Attachment E-4) that are designed to attain TDG compliance at the Project consistent with the approved TMDL for TDG. SCL will evaluate and implement as appropriate the following three gate alternatives for TDG abatement:

- Throttle Sluice Gates, which involves operation of sluice gates in partially open positions.
- Roughen Sluice Flow, which entails modification of the sluice gate outlets to break up and spread flow.
- Spillway Flow Splitter/Aerator, which entails modifying the spillways to aerate, break up, and spread flow.

The three gate alternatives all involve spilling flow through existing outlets (the seven sluice gates and two spillway gates) into the tailwater plunge pool and rely on reduction in TDG production by spreading the flow and limiting plunging effects of the confined water jets. The historic performance of these outlets at small gate openings indicates the potential for successfully reducing TDG levels in the Project tailrace.

To reduce TDG under normal, non-spill operations, SCL will operate Units 55 and 56 above 125 MW and sequence their startup and shutdown so that they are the last units to be brought on line and the first units to be shut down (see Section 5.4.7 of the Evaluation of Total Dissolved Gas and Potential Abatement Measures Final Report, SCL 2009a). Turbine unit sequencing to reduce TDG production will be accomplished by programming and documenting (Numbered Dispatching Memoranda) these measures as administered by SCL's System Control Center.

As noted above, during the new license term SCL plans to upgrade equipment at the Boundary Dam power plant (see Section 2.3.2). Proposed upgrades to the turbines may reduce or eliminate the conditions that in the past have led to TDG production during non-spill operations. When the proposed turbine upgrades are completed, SCL plans to reevaluate the need for the unit sequencing identified above and adjust the approach to, or eliminate, the sequencing restrictions if appropriate.

4.5.2.3.4. Dissolved Oxygen

Data collected during relicensing studies show that DO does not vary significantly longitudinally within the reservoir. Exceedances of Ecology's DO standard (i.e., below 8.0 mg/L) were observed at the forebay sampling site at depths greater than 28.0 meters (92 feet) during the warmest summer months, and occasionally at a few other sites. However, in instances where DO concentrations were below 8.0 mg/L, they were typically still greater than 7.6 mg/L. The extent to which DO exceedances of the observed frequency, spatial distribution, and magnitude would result in adverse effects on aquatic biota in the Project area is unknown but expected to be minor.

SCL proposes to conduct a monitoring program to better define the magnitude and spatial and temporal extent of DO concentrations below 8.0 mg/L in the Project area. Monitoring of DO and temperature will begin following issuance of the new FERC license; details are described in the attached Dissolved Oxygen Attainment Plan (Attachment E-5). In addition, pH will be measured simulaneously with DO to provide Ecology with pH trend data for the portion of the Pend Oreille River in the Project area. The purpose of the DO monitoring program is to verify the results of the relicensing study by monitoring more extensively during the warmer summer months when DO levels are more likely to be below 8.0 mg/L. SCL will report DO data to Ecology on an annual basis, and after five-years of monitoring, in consultation with Ecology, determine if any further actions or additional monitoring are needed. Data from the monitoring will be used to confirm that acceptable DO levels are attained in Boundary Reservoir under most conditions, and that DO levels continue to follow expected patterns for the Pend Oreille system. It is assumed that if current patterns of infrequent DO levels below 8.0 mg/L are verified (or DO levels are found to be compliant with water quality standards), that monitoring after the first five years of the license term will not be necessary.

4.5.2.3.5. Aquatic Macrophytes and Potential Invasive Species

The effect of Project operations on the abundance and distribution of submerged aquatic macrophytes in the various Project area reaches is addressed in Section 4.5.3.2 (Fish and Aquatic Resources) of this Exhibit E.

SCL proposes to install bottom barriers to reduce the risk of macrophyte-related fish stranding and trapping, benefit recreational use by creating boat lanes free of macrophytes, and reduce boat contact with invasive macrophytes to lower the risk of their dispersal to other locations (within and outside the Project area). In some locations in the reservoir, submerged macrophytes have been shown to reduce the ability of fish to escape from stranding and trapping areas by blocking routes of egress during periods of declining water surface elevation (see the Mainstem Aquatic Habitat Modeling Final Report, SCL 2009a).

Bottom barriers will be installed at the following four locations where milfoil is abundant:

- Everett Island side channel (PRM 19.4) - A bottom barrier will be placed to maintain a lane from the informal recreation site upstream (south) through the middle of the side channel to reduce the risk of fish stranding and trapping during reservoir drawdown, to reduce contact between boats and invasive macrophytes and thereby lower the potential for milfoil dispersal, and to improve boat transit in and out of the side channel.
- Metaline Pool, across from the Town of Metaline (PRM 28.7) - A bottom barrier will be placed to reduce boat contact with macrophytes where a dense macrophyte bed is located adjacent to a region of open channel. This area was identified by the field crews that conducted relicensing studies as a location where boats commonly come in contact with macrophytes.
- Fish Stranding and Trapping Region 9 (PRM 28.8) - A bottom barrier will be placed in a location beginning just downstream of the midpoint of the side channel, adjacent to the shoreline and extending downstream (north) through the channel thalweg to reduce the risk of fish trapping during reservoir drawdown.
- Fish Stranding and Trapping Region 11 (PRM 30.3) - To reduce the risk of fish trapping during reservoir drawdown, a bottom barrier will be placed beginning at the south shoreline to create an open channel through the middle of the trapping pool and end at the upper end of the narrow channel that drains the trapping pool. In addition to providing egress for fish potentially stranded or trapped in this area, it will reduce the risk of injury and mortality from potential oxygen depletion in trapping pools with dense macrophytes.

Greater detail regarding the proposed approach to the use of bottom barriers in the Project area, including maps of proposed deployment locations, deployment methods, timing of installation, estimated costs, and permitting, is contained in SCL's Aquatic Invasive Species Control and Prevention Plan (AISCPP) (Attachment E-6).

To monitor for zebra and quagga mussel colonization, SCL will install artificial substrate samplers at two public boat launches in Boundary Reservoir: i.e., the Forebay Recreation Area

boat launch and the Metaline Waterfront Park Boat Launch. Before deploying artificial substrates, SCL, in conjunction with the Water Quality Workgroup, will coordinate with the Center for Lakes and Reservoirs at Portland State University to ensure that the proposed design, placement, and monitoring regime associated with the artificial substrate samplers is appropriate. In addition to data gathered from the artificial samplers, field crews will opportunistically inspect hard structures in the vicinity of the boat launches for the presence of sessile bivalves. Greater detail regarding the proposed approach to zebra and quagga mussel monitoring, including methods, timing of monitoring, and estimated costs, is contained in SCL's AISCPP (Attachment E-6).

SCL will conduct New Zealand mudsnail surveys in the vicinities of two boat launches in Boundary Reservoir: i.e., the Forebay Recreation Area boat launch and the Metaline Waterfront Park Boat Launch. Mudsnail surveys will be conducted according to the same schedule as the zebra and quagga mussel monitoring. Greater detail regarding the proposed approach to mudsnail surveys, including methods, timing of monitoring, and estimated costs, is contained in SCL's AISCPP (Attachment E-6).

SCL proposes to implement an I&E program aimed at reducing the potential for the spread of invasive macrophyte species, zebra and quagga mussels, and New Zealand mudsnails (Attachment E-6). Signs will be installed at boat launches as part of a larger public education program, which is discussed in the RRMP (see Section 4.5.9.3 of Exhibit E).

SCL proposes to implement all measures identified above in coordination with a Water Quality Workgroup, as described in the attached AISCPP (Attachment E-6).

4.5.2.3.6. Oil Spill Prevention, Control, and Countermeasure (SPCC) Plan

Although not considered a proposed measure, SCL has provided its Oil Spill Prevention, Control, and Countermeasure (SPCC) Plan for reference (Attachment E-7). This document has not changed since its submittal as an attachment to the PLP. SCL will revise the SPCC Plan in accordance with Ecology’s regulatory requirements, as needed.

4.5.2.4. Cumulative Effects Analysis

In its SD2, FERC identified the following water quality parameters that could be cumulatively affected by the Project: summer water temperatures, pH and DO levels, accumulation of toxic compounds, and TDG levels (FERC 2006).

The Project has an overall cooling effect on flow-weighted daily maximum summer water temperatures under existing conditions and relative to natural conditions or existing conditions without the Project (see Section 4.5.2.2). The Boundary Dam tailrace analysis was limited to release temperatures (i.e., operational effects on water temperatures of the Seven Mile Project, located in Canada, were not modeled). Maximum water temperatures in the tailrace were cooler under Existing Conditions than under modeled Natural Conditions and Existing Conditions without the Project. These cooler temperatures would not be expected to have adverse impacts on downstream summer temperatures in Seven Mile Reservoir and, therefore, would not be expected to contribute to adverse cumulative effects in the basin.

Increased TDG levels due to the Project contribute cumulatively to elevated TDG levels downstream of the Project in the Pend Oreille River and the Columbia River. Until TDG abatement measures are fully implemented, increasingly smaller TDG impacts (i.e., impacts decreasing in proportion to the incremental implementation of TDG abatement measures) will continue to occur in the tailrace during high-flow events. These TDG impacts are expected only over the short-term, decreasing in magnitude from major (although rare) to minor impacts as abatement measures are implemented and refined. Over the long-term, TDG levels will be reduced significantly as SCL implements the attainment plan intended to bring the Project into compliance with Ecology's TDG standard, thereby reducing the Project's contribution to cumulative TDG impacts in the basin.

During periods when pH at some locations in the Project area exceeds Ecology's water quality criterion, pH levels measured at the downstream end of the Project area were consistently lower than levels entering the Project from Box Canyon Reservoir, indicating a net reduction in pH levels (i.e., no adverse impact on pH) in the Pend Oreille River as water passes through the Project area (see Section 4.5.2.2). As such, the Project does not appear to contribute to cumulative pH impacts in the basin.

DO levels were found to be slightly below Ecology's 8.0 mg/L water quality criterion during summer months in the Boundary Dam forebay and tailrace. These lower DO levels appear to be site-specific occurrences, with measurements throughout the reservoir nearly always at or above 8.0 mg/L. The relative influence of the Project on DO levels in the tailrace is unclear, due to effects associated with the operation of the Seven Mile Project. Reduced DO levels in water released from the Project could contribute infrequently to reduced DO levels in downstream waters over the new license term.

Based on multiple lines of evidence (i.e., data evaluated within the context of toxicological models, pathway models, and a conceptual decision matrix), there appears to be no link between the operation of the Project and the transfer of toxics or toxics bioavailability in Boundary Reservoir (see Section 4.5.2.2). As a result, the Project does not contribute to cumulative effects related to the accumulation of toxic compounds in the basin.

4.5.2.5. Unavoidable Adverse Impacts

Until TDG abatement measures are fully implemented, increasingly smaller TDG impacts (i.e., impacts decreasing in proportion to the incremental implementation of TDG abatement measures) will continue to occur in the tailrace during high-flow events. These TDG impacts are expected only over the short-term, decreasing in magnitude from major (although rare) to minor impacts as abatement measures are implemented and refined. Over the long-term, TDG levels will be reduced significantly as SCL implements the plan intended to bring the Project into compliance with Ecology's TDG standard.

Minor site-specific DO impacts (DO concentrations between 7.0 - 8.0 mg/L) may occur occasionally during summer months.

4.5.2.6. Consistency with Comprehensive Plans

The water resource related management goals and policies associated with comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

- Management Activities
  - Coordinate with other resources to provide support and advice that helps protect the soil and water resources.
  - Restore damaged soil and water resources.
  - Work with the Washington State Department of Ecology or others as needed to secure water rights.
  - Coordinate with other agencies or interested parties.
- Maintain water quality parameters within the range of good fish habitat conditions, and within state water quality standards.
- Comply with State of Washington requirements in accordance with the Clean Water Act for protection of waters of the state through planning, application, and monitoring of BMPs in conformance with the Clean Water Act, regulations, and federal guidance issued thereto.
- In watersheds where project scoping identifies an issue or concern regarding the cumulative effects of activities on water quality or stream channels, a cumulative effects assessment will be made. This will include land in all ownerships in the watershed. Activities on National Forest System lands in these watersheds should be dispersed in time and space to the extent practicable, and at least to the extent necessary to meet management requirements. On intermingled ownerships, coordinate scheduling efforts to the extent practicable.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

- Protect or enhance water quality with particular attention to those watersheds with major downstream water uses including anadromous and other sport fisheries and agriculture.

Northwest Power and Conservation Council. 2005. The fifth northwest electric power and conservation plan. Portland, Oregon. Council, Document 2005-07.

In 2004, the Northwest Power Planning Council (now the Northwest Power and Conservation Council) completed the Intermountain Province Subbasin Plan. The plan includes the following objectives related to aquatic macrophytes in the Pend Oreille River:

- Control the spread of Eurasian watermilfoil in the subbasin.
    - Inventory and map locations of milfoil occurrence.
    - Evaluate the impact of extended dewatering and exposure to freezing temperatures on milfoil shoots.

The Fifth Northwest Electric Power and Conservation Plan was released in 2005. As described in the plan, the Northwest Power Act requires that the Northwest Power and Conservation Program to have the goal of providing adequate, efficient, economical and reliable power while also protection, mitigation, and enhancement of fish and wildlife populations.

4.5.3. Fish and Aquatic Resources

4.5.3.1. Affected Environment

With a total drainage area of 26,260 square miles (25,090 square miles in the US and 1,170 square miles in Canada), the Pend Oreille River is one of the two main tributaries to the Columbia River, contributing about 10 percent of the Columbia River's flow on an annual basis (Muckleston 2003). The Pend Oreille River is approximately 120 miles long from its head at the outlet of Lake Pend Oreille to its confluence with the Columbia River. Average annual precipitation in the Pend Oreille River valley is approximately 27 inches, most of which occurs from November through February. Much of this precipitation is stored in the snowpack at higher elevations and subsequently released when temperatures rise in spring. The drainage area of the Pend Oreille River between Box Canyon Dam and Boundary Dam is 268.3 square miles, and inflow from Boundary Reservoir tributaries accounts for only a small fraction of flow in the Project area at any time during the year.

Boundary Reservoir has a small active storage capacity relative to mean daily river flow, and Project operations therefore have little effect on the annual, seasonal, or monthly storage and release of water to the Pend Oreille River. Retention time of water in Boundary Reservoir averages less than two days; consequently, the reservoir more closely resembles a riverine system according to WAC 173-201A, where the state defines lacustrine systems as those with retention times greater than 15 days. The Project is operated as a daily load-following facility, which primarily affects instream flow releases on a daily or hourly interval. Water surface elevations in Boundary Reservoir fluctuate in response to inflow variation, Project operations, and wind-induced waves. Daily water surface elevation fluctuations range from 1.15 feet to 18.02 feet in the Boundary Dam forebay and from 0.42 feet to 4.80 feet in the Box Canyon Dam tailrace (based on data from 1987 - 2005). Greater detail regarding existing Project operations can be found in Section 2.1.2, Existing Project Operation, of this Exhibit E and in SCL (2008).

A detailed description of hydrologic conditions in the Project area, and a description of the detailed hydrologic dataset and statistics compiled to evaluate hydrology and provide data to support relicensing studies, can be found in SCL (2008). Topics addressed in the report include a characterization of (1) overall basin hydrology, including long-term trends, impacts of upstream projects, and tributaries to the Pend Oreille River, (2) Boundary Reservoir hydrology, including reservoir inflows, water surface elevations, and ramping rates, and (3) hydrology of the river downstream of Boundary Dam, including inflows to Seven Mile Reservoir, water surface elevations in Seven Mile Reservoir, and ramping rates.

In summer, water temperatures in Boundary Reservoir often exceed 20 ˚C. Vertical temperature profile measurements indicate that the reservoir is largely vertically mixed throughout the year, although limited surface warming occurs in the forebay during summer and early fall. Data reveal no substantial longitudinal trends in temperature at any time during the year. Summer pH values at times exceed 8.5, and some spatial variability in pH occurs as a result of localized geochemistry. DO concentrations are typically at or above saturation. Turbidity, conductivity, and nutrient concentrations are low, with SRP and TKN concentrations often below detection limits. Greater detail regarding temperature and water quality in the Project area can be found in Section 4.5.2 of this Exhibit E and in Study No. 5, Water Quality Constituent and Productivity Monitoring Final Report (Water Quality Study), of SCL's USR (SCL 2009a).

For the analysis of Project effects on fish and aquatic resources, the Affected Environment extends from Redbird Creek, which is located 3.9 miles downstream of Boundary Dam in Seven Mile Reservoir, British Columbia, upstream to Box Canyon Dam (Figure E.4-41). The Project area was delineated into four reaches based on habitat characteristics that result from reservoir physiography: the Tailrace/Seven Mile Reservoir Reach, the Forebay Reach, the Canyon Reach, and the Upper Reservoir Reach (Figure E.4-41).

The Tailrace Reach extends from Boundary Dam downstream to the confluence with Red Bird Creek (PRM 13.1 - 17.0). At low Seven Mile Reservoir water surface elevations, riverine habitat is present in the Pend Oreille River downstream to the confluence with Red Bird Creek. At high Seven Mile Reservoir water surface elevations, the riverine habitat above the Red Bird Creek confluence becomes reservoir habitat. The Boundary Dam tailrace area is characterized by deep pools (> 75 feet) in the spillway and turbine afterbays but is generally less than 30 feet deep elsewhere. Downstream of the spillway and afterbay pools, the tailrace is relatively swift, with cobble and boulder substrates. Habitat diversity is provided primarily by instream boulders and alcoves along the channel margins. Varial zone habitat (≤ 10 feet) makes up between 12.9 percent and 33.3 percent of the total area of the Tailrace Reach, depending on flow.

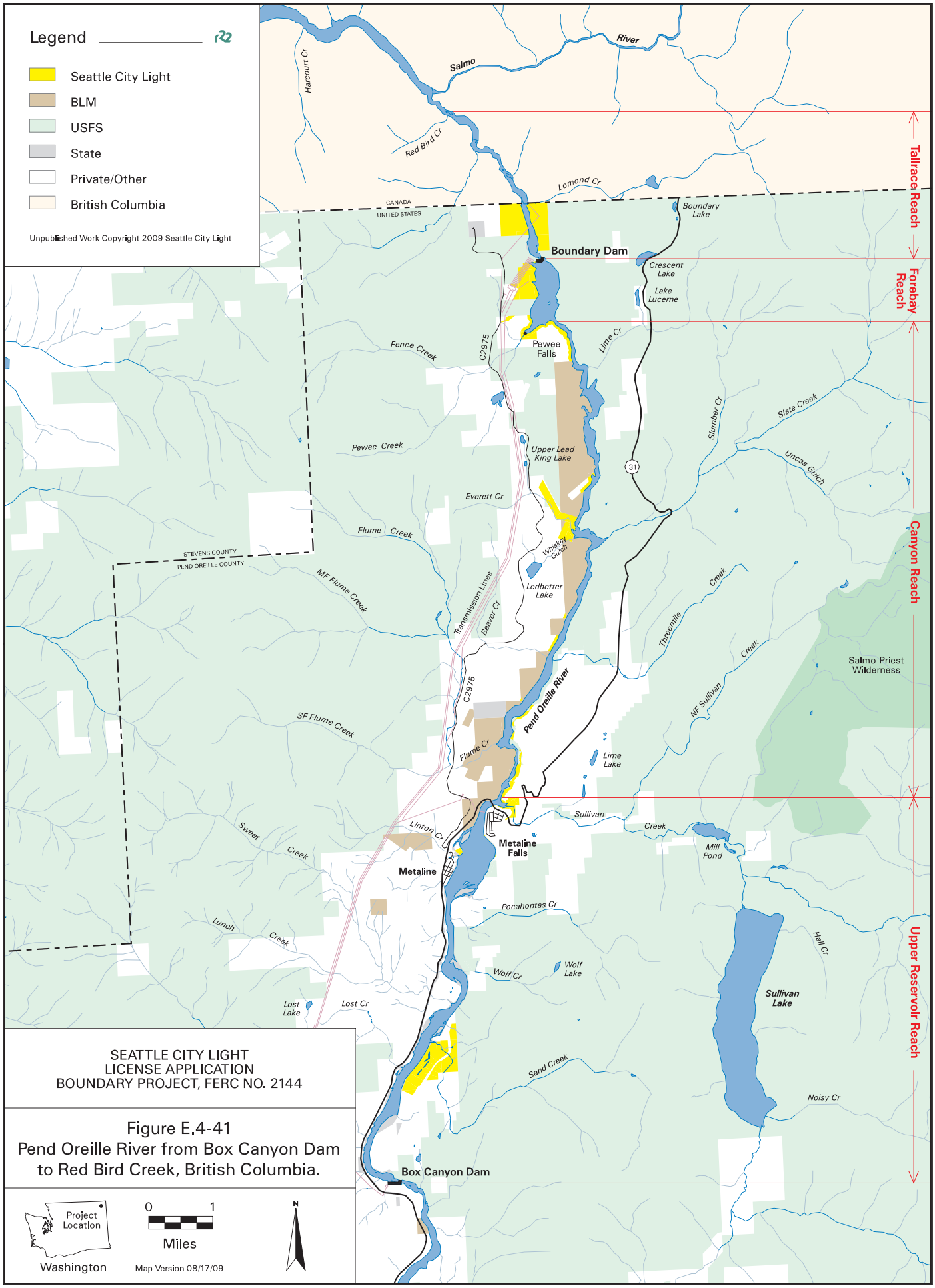


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Figure E.4-41
Pend Oreille River from Box Canyon Dam to Red Bird Creek, British Columbia.

The Forebay Reach, which extends from Boundary Dam upstream to the lower end of Z Canyon (PRM 17.0 - 18.0), is wide and deep, with steep-walled banks, and water depths to approximately 270 feet. There is little shallow, littoral habitat in this reach. A small island near the center of this reach provides some habitat complexity, although the shores of the island are also steep. Varial zone habitat (≤ 10 feet deep) makes up between 3.4 percent and 4.4 percent of the total area of the Forebay Reach, depending on flow and reservoir water surface elevation. One tributary, Pewee Creek (PRM 17.9), drains into this section of the reservoir. The mouth of Pewee Creek is a vertical 164-foot waterfall (McLellan 2001).

The Canyon Reach, which extends from the downstream end of Z Canyon to Metaline Falls (PRM 18.0 - 26.8), is predominantly narrow with steep rock walls. A few large embayments and backwater channels provide localized shallow habitats with aquatic macrophyte beds, and areas of rock outcroppings provide habitat complexity. Downstream of Slate Creek the canyon is more constricted, and water depths exceed 100 feet, whereas depths upstream of Slate Creek are typically 80 to 100 feet. Varial zone habitat (≤ 10 feet) makes up between 6.4 percent and 8.4 percent of the total area of the Canyon Reach, depending on flow and reservoir water surface elevation. In addition to Slate Creek, six other tributaries drain into the Canyon Reach, including Lime Creek (PRM 19.0), Everett Creek (PRM 21.9), Whiskey Gulch (PRM 21.9), Beaver Creek (PRM 24.3, west side), Threemile Creek (PRM 24.3, east side), and Flume Creek (PRM 25.8). The upstream end of the Canyon Reach is bounded by Metaline Falls, which is inundated by Boundary Reservoir when flows/water surface elevations are high.

The Upper Reservoir Reach, which extends from Metaline Falls to Box Canyon Dam (PRM 26.8 - 34.5), is relatively wide and shallow, with a combination of silt, sand, and hard substrates, and water depths typically ranging from 10 to 25 feet. Habitat diversity is provided primarily by islands, back channels, and near-shore aquatic vegetation. Varial zone habitat (≤ 10 feet) makes up between 14.8 percent and 52.5 percent of the total area of the Upper Reservoir Reach, depending on flow and reservoir water surface elevation. Sullivan Creek (PRM 26.9), the largest tributary that drains into Boundary Reservoir, is located in this reach just upstream of Metaline Falls. Other tributaries that drain into the Upper Reservoir Reach include Linton Creek (PRM 28.1), Pocahontas Creek (PRM 29.4), Wolf Creek (PRM 30.3), Lunch Creek/Sweet Creek (PRM 30.9), Sand Creek (PRM 31.7), and Lost Creek (PRM 32.2).

A brief discussion of physical habitat conditions, including macrophytes and large wood, is contained below in Section 4.5.3.1.3 (Physical Habitat). Greater detail regarding the Project reaches can be found in SCL's PAD (SCL 2006) and USR (SCL 2009a). SCL also produced maps based on recent (2006 - 2007) bathymetry surveys conducted from Box Canyon Dam to Seven Mile Dam.

Of the 28 tributaries that enter Boundary Reservoir, 14 are named (Table E.4-19). Sullivan Creek, with a drainage area of 142.46 square miles (about 57 percent of the total drainage area between Box Canyon and Boundary dams), is the largest tributary. None of the 28 tributaries, except Sullivan Creek, has a flow gage. Consequently, flow conditions in most tributaries are based on visual observations, infrequent measurements, and modeling. Flow in Sullivan Creek is modified by the operation of Sullivan Lake Dam.

Table E.4-19. Descriptive statistics for tributaries to Boundary Reservoir (SCL 2009a).

Stream Name	Project River Mile	Basin Area (mi^2)	Adfluvial Habitat Length (ft)	2000		2007		2008		Sport Fish Present[1]
				Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	
Unnamed No. 1	17.2	0.61	82			0.1	9/6	0.1	9/22	
Peewee Creek	17.9	10.37	0	0.4	09/25	2[2]	9/6	2[2]	9/22	CTT, EBT
Unnamed No. 2	17.9	0.02	129			0.004	9/6	Dry	9/22	
Lime Creek	19.45	2.93	6,746	2.8	09/26	2.7	9/6	0.5	9/22	EBT
Everett Creek	21.9	2.18	60			0.3	9/6	2	9/22	
Whiskey Gulch	21.9	0.70	547			Dry	9/6	Dry	9/22	
Slate Creek	22.2	32.33	3,474	10.9	07/31	6.8	9/6	8.3	9/22	CTT, EBT, RBT
Beaver Creek	24.3	1.77	0			0.9	9/7	3	9/22	
Threemile Creek	24.3	4.91	0			0.5	9/7	2	9/22	EBT, RBT
Unnamed No. 3	25.4	0.15	58			0.04	9/7	Dry	9/22	
Flume Creek	25.8	19.33	1,056[3,4]	8.8	09/06	5.0	9/7	6.6	9/5	EBT
Sullivan Creek	26.9	142.46	21,729	77.7	08/16	40.5	9/10	59.5	9/5	BBT, BRT, CTT, EBT, KOK, MWF, RBT
Unnamed No. 4	27.1	0.08	77			--[5]	--[5]	--	--	
Linton Creek	28.1	2.11	19,159			1.9	9/8	1.8	9/6	
Unnamed No. 5	28.9	0.62	130			0.1	9/8	--	--	
Unnamed No. 6	29.2	0.01	955			Dry	9/11	--	--	
Pocahontas Creek	29.4	3.92	16,480			Dry	9/9	Dry	9/22	
Unnamed No. 7	29.6	0.30	53			Dry	9/11	--	--	
Unnamed No. 8	30.1	0.07	66			Dry	9/11	--	--	
Wolf Creek	30.3	1.57	236			Dry	9/11	--	--	
Sweet Creek / Lunch Creek	30.9	11.12	2,659[3]	5.3	09/11	2.5	9/11	2.8	9/5	BRT, CTT, EBT, MWF, RBT
Unnamed No. 9	31.1	0.04	67			Dry	9/11	Dry	9/22	
Sand Creek	31.7	8.22	1,320[3]	0.4	09/07	Dry	9/11	Dry	9/22	CTT, EBT, RBT
Lost Creek	32.2	1.20	165			0.03	9/12	1.4	9/23	CTT
Unnamed No. 10	33.5	0.93	99			0.001	9/12	0.3	9/23	
Unnamed No. 11	33.6	0.23	78			0.002	9/12	Dry	9/23	
Unnamed No. 12	34.0	0.93	<100			0.06	9/12	0.5	9/23	
Unnamed No. 13	34.3	1.72	<100			0.4	9/12	1.5	9/23	

Notes:

1 Blanks = non-fish-bearing or unsurveyed streams: EBT, eastern brook trout; CTT, cutthroat trout; RBT, rainbow trout; MWF, mountain whitefish; KOK, kokanee; BBT, burbot; sources: USFS (2005); McLellan (2001); FERC (1998).

2 Flow rate at the base of Pewee Falls was visually estimated.

3 Adfluvial habitat based on distance from stream mouth to lowermost migration barrier reported in McLellan (2001) and/or Andonaegui (2003).

4 A series of cascades/falls within 100 feet of the mouth of Flume Creek may also be a barrier to upstream migration.

5 No tributary channel could be found in September 2007.

cfs – cubic feet per second

4.5.3.1.1. Existing Fish Communities

At least 28 species of fish occur in the Project area (Table E.4-20). Table E.4-21 provides a summary of periodicity, life history, and spawning and rearing habitat for fish species in the Project area. No anadromous fish are found in Boundary Reservoir or the tailrace. Some fish species found in the reservoir may have adfluvial life histories. Fish abundance and species diversity in Boundary Reservoir differ from that found in the reservoir's tributaries (as described below). Densities of all fish species are low in deep water of the reservoir, most of which occurs in the Forebay and Canyon reaches.

Table E.4-20. Species composition, distribution, and abundance of fish within Seven Mile and Boundary reservoirs; abundance codes are listed at the bottom of the table.

					Boundary Reservoir		
Species	**Family**	**Scientific name**	**Type**	**Seven Mile to Boundary**	**Forebay Reach**	**Canyon Reach**	**Upper Reach**
Longnose sucker	Catostomidae	*Catostomus catostomus*	Native Nonsport	O	O	O	C
Bridgelip sucker	Catostomidae	*Catostomus columbianus*	Native Nonsport	P	N	N	N
Largescale sucker	Catostomidae	*Catostomus macrocheilus*	Native Nonsport	A	A	A	A
Brown bullhead	Ictaluridae	*Ictalurus nebulosus*	Non-native Sport	N	O	P	C
Pumpkinseed	Centrarchidae	*Lepomis gibbossus*	Non-native Sport	O	C	C	A
Smallmouth bass	Centrarchidae	*Micropterus dolomieui*	Non-native Sport	A	A	A	A
Largemouth bass	Centrarchidae	*Micropterus salmoides*	Non-native Sport	P	O	O	O
Black crappie	Centrarchidae	*Pomoxis nigromaculatus*	Non-native Sport	O	O	O	C
Sculpin spp.	Cottidae	*Cottus spp.*	Native Nonsport	P	P	P	O
Peamouth	Cyprinidae	*Mylocheilus caurinus*	Native Nonsport	A	A	A	A
Northern Pikeminnow	Cyprinidae	*Ptychocheilus oregonenesis*	Native Sport	A	A	A	A
Longnose dace	Cyprinidae	*Rhinichthys cataractae*	Native Nonsport	P	N	N	N
Redside shiner	Cyprinidae	*Richarsonius balteatus*	Native Nonsport	A	C	A	C
Tench	Cyprinidae	*Tinca tinca*	Non-native Nonsport	P	O	C	C
Northern pike	Esocidae	Esox lucius	Non-native Sport	O	N	N	O
Burbot	Gadidae	*Lota lota*	Native Sport	P	O	O	O
Yellow perch	Percidae	*Perca*	Non-native Sport	O	A	A	A

Table E.4-20, continued…

					Boundary Reservoir		
Species	**Family**	**Scientific name**	**Type**	**Seven Mile to Boundary**	**Forebay Reach**	**Canyon Reach**	**Upper Reach**
		flavescens					
Walleye	Percidae	*Stizostedion vitreum*	Non-native Sport	O	O	O	O
Cutthroat trout	Salmonidae	*Oncorhynchus clarki*	Native Sport	O	O	O	O
Redband trout	Salmonidae	*Oncorhynchus mykiss*	Native Sport	O	P	P	P
Hatchery rainbow trout	Salmonidae	*Oncorhynchus mykiss*	Non-native Sport	C	C	C	C
Kokanee	Salmonidae	*Oncorhynchus nerka*	Non-native Sport	O	O	O	O
Mountain whitefish	Salmonidae	*Prosopium williamsoni*	Native Sport	C	O	O	C
Lake whitefish	Coregonidae	*Coregonus clupeaformis*	Native Sport	N	N	O	N
Brown trout	Salmonidae	*Salmo trutta*	Non-native Sport	O	O	O	O
Bull trout	Salmonidae	*Salvelinus confluentus*	Native Sport RTE	O	P	P	P
Eastern brook trout	Salmonidae	*Salvelinus fontinalis*	Non-native Sport	O	O	O	O
Lake trout	Salmonidae	*Salvelinus namaycush*	Non-native Sport	O	O	O	O

Abundance Codes: A = abundant, C = common, O = occasional, P = present, status unknown, N = not recorded in past or present studies (likely absent or rare).

Table E.4-21. Periodicity, life history, and spawning and rearing habitat of fish species in the Boundary Project area; sources listed at the bottom of table.

Species	Spawning Habitat	Spawn Period (month/day)	Time to Hatch or Emergence (days)	Optimal/Max Spawning Temperature	Juvenile Rearing Habitat	Optimal/Max Rearing Temperature	Typical Lifespan (year)	Max Size (inches)
Native species								
Longnose sucker	Rivers: swift riffles, gravel substrates	Apr 10 – Jul 15 (peak from Apr 30 - Jun 24)[1]	8 at 59 °F; 11 at 50 °F; 1–2 wks before emergence	41 – 48 °F	Lakes and streams; weedy shallows by day, deeper offshore by night	Max: 80.6 ° F	8 – 19	20.2 at Age 8
Largescale sucker	Riverine; Pool tailouts with fine gravel and sand substrate; occasionally along shoreline of lakes	Apr 10 – Jul 15 (peak from Apr 30 - Jun 24)[1]	14	46 – 55 °F	Lakes and streams; weedy shallows by day, deeper offshore by night	Max: 85 °F[1]	8 – 15	22.2 at Age 8
Sculpin spp.	Under rocks	Mottled: Feb – Jun Slimy: Spring	Mottled: 20 – 30 at 50–60 ° F Slimy: 28 at 46 °F	41 – 50 °F	Lakes and streams; benthic; rubble, gravel, or rocky substrates	55–65 °F/70 °F	4 – 5	Mottled: 5 at Age 5, Slimy: 2 – 3 at Age 4
Peamouth	Streams and shorelines with gravel or rubble substrate	May – Jun	7–8 at 54 °F	54 – 59 °F	Lakes and streams; young very shallow during spring to fall; over-winter in deep water		13	11.1 at Age 4

Table E.4-21, continued…

Species	Spawning Habitat	Spawn Period (month/day)	Time to Hatch or Emergence (days)	Optimal/Max Spawning Temperature	Juvenile Rearing Habitat	Optimal/Max Rearing Temperature	Typical Lifespan (year)	Max Size (inches)
Redside shiner	Gravel stream bottoms or vegetation along lake shorelines	Apr – Jul	3–7 at 70 – 73 °F	58 – 64 °F	Rivers and lakes, slow to moderate current; aquatic vegetation; in stratified waters at depth during summer; over-winter in deep water	Summer 55 – 68 °F/75 °F	4 – 5	5.7 at Age 5 in Box Canyon Reservoir (BCR)
Northern pikeminnow	Broadcast spawn over gravel, cobble, rubble in streams and lakes	May - Jun	7 at 65 ºF; free swimming in 14	57 – 65 °F	Lakes and streams, slow to moderate currents; shallows or surface of pelagic zone in summer; benthic during winter; YOY mud to rubble substrate then move to vegetated areas	68 – 73 °F	10+	22.9 at Age 10
Westslope cutthroat trout	Riverine; redds dug in gravel substrates found in pool tailouts	Mar 15 – Jun 15 (peak from Apr 1 - May 31)[1]	49 – 63	50°F/43 – 63°F	Resident: Stream pools, gravel, rubble, boulder, overhead cover Adfluvial: Same as resident for 1 to 4 yr, older fish lake habitats	60 °F/70 °F	4 – 5	12.6 at Age 5 BCR; 10.9 at Age 4 Pend Oreille tributaries
Redband trout	Rivers; redds in gravel, pool tailouts	Mar 1 – Jun 30 (peak from Apr 1 - May 31)[1]	50 at 50 °F	36 – 68 °F	Lakes and streams	<70 °F/32 – 80 °F	6	22.2

Table E.4-21, continued…

Species	Spawning Habitat	Spawn Period (month/day)	Time to Hatch or Emergence (days)	Optimal/Max Spawning Temperature	Juvenile Rearing Habitat	Optimal/Max Rearing Temperature	Typical Lifespan (year)	Max Size (inches)
Mountain whitefish	Gravel; riffles and runs in streams; shoals along lake shorelines	Oct 15 - Jan 15 (peak from Nov 1 - Dec 31)[1]	30 at 48 °F	40 – 45 °F	Riffles in summer, large pools or runs in winter in streams; Gravel bars at mouths of tributaries BCR	48 – 52 °F	8	17.1 at Age 8 in BCR
Bull trout	Riverine; redds in gravel, pool tailouts	Sep 15 – Dec 30 (peak from Oct 1 - Nov 30)[1]	165 – 235	35.6 – 39.2 °F	Small fish, benthic with cover; large fish, large pools and lakes	< 59 °F	5 – 7	Resident: 6 –12 Adfluvial: 23.8 at Age 7
Burbot	Lakes and rivers under ice, 1 – 9 ft of water, over sand and gravel	Winter – early spring	71 at 34 ºF, 28 – 35 at 39 ºF, 30 at 43 ºF	33 – 35 ºF	Shallows and stream channels		up to 15	45
Non-native species								
Brown bullhead	Lake shallows, depression in mud or sand near aquatic vegetation or woody debris	Apr to Jun	5 at 77 °F; 7 at 69 °F	70 °F	Shallow vegetation; benthic; lakes, ponds, sluggish areas of streams		5	12 – 14
Pumpkinseed	Lake shallows, depression in gravel, mud, or sand near aquatic vegetation	May15 – Aug 31 (peak from Jun 15 - Jul 31)[1]	3 at 82 °F	60 °F	Clear water; dense vegetation; sloughs, backwaters, slow moving rivers	> 70 °F	6	5

Table E.4-21, continued…

Species	Spawning Habitat	Spawn Period (month/day)	Time to Hatch or Emergence (days)	Optimal/Max Spawning Temperature	Juvenile Rearing Habitat	Optimal/Max Rearing Temperature	Typical Lifespan (year)	Max Size (inches)
Smallmouth bass	Lakes shallows, depressions	May 15 – Jul 31 (peak from Jun 1 - July 15)[1]	4 – 10	55 – 65 °F	Clear streams and lakes; coarse substrate, boulders and rocky reefs	70 °F – 80 °F	10	17 – 19 at Age 10
Largemouth bass	Lakes; sand, gravel, rubble 1 – 4 ft deep, max 8 ft deep	May 15 – Jul 31 (peak from Jun 1 - July 15)[1]	3 – 7	60 – 65 °F	Shallow vegetation and woody debris; lakes and backwaters of rivers	68 °F/75 °F	8	17.2
Black crappie	Lakes; shallow depressions in mud, < 8 ft	May15 – Aug 31 (peak from Jun 15 - Jul 31)[1]	2 – 3 at 65 °F	58 – 64 °F	Clear water; dense vegetation; large streams, lakes and reservoirs; sand, muck or organic		8	8.4
Yellow perch	Lakes; egg mass laid on vegetation, submerged brush, or sand, gravel, or rubble	Mar 15 – May 31 (peak from Apr 5 - May 15)[1]	8–10	45 – 52 °F	Lakes with vegetation; clear water	70 °F	8	8.3
Walleye	2-30 ft, shoreline areas, shoals	Mar – May	14 at 46 ºF	43 – 48 ºF	Associated with cover in depths < 50 ft	54 – 84 ºF	7 – 10	30
Northern pike	Vegetated littoral areas	Apr – May	31 at 42 ºF	40 – 59 ºF	Vegetated littoral areas		10 – 12	59
Rainbow trout	Rivers; redds in gravel, pool tailouts	Feb – Jun	50 at 50 °F	36 – 68 °F	Lakes and streams	<70 °F/32 – 80 °F	6	22.2

Table E.4-21, continued…

Species	Spawning Habitat	Spawn Period (month/day)	Time to Hatch or Emergence (days)	Optimal/Max Spawning Temperature	Juvenile Rearing Habitat	Optimal/Max Rearing Temperature	Typical Lifespan (year)	Max Size (inches)
Brown trout	Rivers; redds in gravel, pool tailouts	Oct – Dec	50 at 50 °F	45 – 55 °F	Lakes and streams	65 – 75 °F/81 °F	9 in BCR; 5 in Pend Oreille tributaries	20.4 in BCR; 13.6 in Pend Oreille tributaries
Eastern brook trout	Rivers; redds in gravel, pool tailouts	Aug – Dec	144 35 °F	40 – 50 °F	Spring fed headwater ponds and streams	55 – 66 °F/ < 77.5 °F	3	7.1
Kokanee	Riverine; redds in gravel, pool tailouts	Sep – Dec	56 – 84	41 – 55 °F	Lake pelagic zone	50 °F	4	16.7– 17.7
Lake trout	Lakes; gravel, boulders, rubble on clean shoals	Oct – Dec	105 – 147 at 32.5 – 33.8 °F	48 – 57 °F	Lakes 60 – 300 ft	50 °F	10 – 17	26.9 –3 5.5 at Age 10

Note:
1 Fish spawning periodicities for the Project area as reported in Appendix 3 of Mainstem Aquatic Habitat Modeling Final Report (SCL 2009a).
Sources: Bjornn and Reiser (1991); Bonar et al. (2000); Craig, J. F. (1996); McMahon et al. (1984); Rieman and McIntyre (1993); Scott and Crossman (1973); Wallus and Simon (2006).

Fish sampling results from the USFS (1998), R2 Resource Consultants (1998a), McLellan (2001), and SCL (2009d) provide the following general characterizations of fish communities in Boundary Reservoir; for a list of species found to date in each reach, see Table E.4-20. The Forebay Reach fish community is dominated by largescale suckers, northern pikeminnow, peamouth, yellow perch, and smallmouth bass. Hatchery-reared rainbow trout are commonly observed, cutthroat trout are rarely found, and no bull trout have been captured or observed. During 2007, a number of burbot were captured in fyke nets as part of the turbine entrainment study (SCL 2009e). Walleye, a non-native species not previously recorded in the Forebay Reach, were captured in 2007 (SCL 2009c). Hatchery-reared rainbow trout, yellow perch, and smallmouth bass are relatively abundant in the Forebay Reach varial zone (SCL 2009c). Smallmouth bass, lake trout, and triploid rainbow trout have also been captured in open waters of the Forebay Reach. Largescale suckers are commonly observed in both the varial and open water zones. During July and August in both 2007 and 2008, peak open water catches consisted predominantly of minnows and suckers (SCL 2009c).

The Canyon Reach is dominated by minnows and suckers, including northern pikeminnow, largescale sucker, redside shiner, and peamouth. Smallmouth bass of various sizes are abundant, typically from May to August. Mountain whitefish and hatchery-reared rainbow trout are commonly observed, but bull trout have rarely been captured near the mouths of some tributary streams (see Section 4.5.3.1.2 of this Exhibit E for detail regarding bull trout captures and observations in the Project area). One radio-tagged bull trout captured in Lake Pend Oreille near Memaloose Island and released at the Newport Boat ramp in Box Canyon Reservoir was detected in the Canyon Reach during July 2009 (Table E.4-22) (Olson, J. KDNR, personal communication, 2009). Yellow perch, pumpkinseed, suckers, and northern pikeminnow are abundant in the varial zone. In 2007, large numbers of tench were also captured in the varial zone (SCL 2009c). Similar to the Forebay Reach, smallmouth bass, lake trout, largescale suckers, and triploid rainbow have been captured in open waters of the Canyon Reach.

Fish species diversity is higher in the Upper Reservoir Reach than downstream of Metaline Falls, as the result of increased habitat diversity. The fish community in the Upper Reservoir Reach is dominated by minnows, suckers, tench, smallmouth bass; burbot, and brown bullhead are also commonly found. Yellow perch and mountain whitefish are found in greater abundance in the Upper Reservoir Reach than below Metaline Falls, and pumpkinseed are also common. Non-native northern pike and walleye, neither of which had been recorded previously in the Upper Reservoir Reach, were captured in 2007 (SCL 2009c), and are being captured with increasing frequency in the reservoir. The varial zone in the Upper Reservoir Reach provides extensive, gently sloping to flat off-channel and slough habitat, often with dense aquatic macrophyte beds in summer. These areas provide important spawning and young-of-the-year rearing habitat for a variety of species. Young-of-the-year sunfish, minnows, perch, and suckers are locally abundant. The presence of suckers and sunfish in the varial zone increases in summer, likely due to increased temperatures. Young-of-the-year mountain whitefish have also been observed in the varial zone during May and June (SCL 2009c). Adult mountain whitefish have been observed in the Upper Reservoir Reach varial zone in November, likely due to spawning. Northern pikeminnow and peamouth are present in the open water of the Upper Reservoir Reach.

Table E.4-22. Observations of bull trout in the Project area and tributaries, 1980 to 2008.

Location	No. of Fish	Size (mm)	Month and Year	Genetic Testing[1]	Comment	Source
Mouth of Sweet Creek	1	508	Fall 1980, 81 or 82	U		Andonaegui (2003)
Sweet Creek	1	864	Fall 1980, 81 or 82	U	Dead	Andonaegui (2003)
Sullivan Creek below natural chute at RM 0.65	1		1993	U	Char species ID not verified	Andonaegui (2003)
Boundary Reservoir at mouth of Slate Creek	2		1994	U		Andonaegui (2003)
Boundary Reservoir at mouth of Slate Creek	3	432-483	1995	U		Andonaegui (2003)
Sweet Creek below Falls	1	300	Sept 2000	N		McLellan (2001)
Sullivan Creek	1	757	Sept 1993	N	Gutted carcass	CES (1996)
Boundary Reservoir at mouth of Slate Creek	1	218	Aug and Nov 1997	N	This fish caught twice	R2 (1998)
Boundary Reservoir at mouth of Slate Creek	2	457, 508	Aug 1999	N		Terrapin (2000)
Boundary Tailrace	1	285	June 2007	Y	Population Source: Salmo R.	SCL (2009a)
Sullivan Creek	1		Sept 2007	N	Char species ID not confirmed	SCL (2009a)
Boundary Reservoir	1		April 2008	Y	bull/brook hybrid	SCL (2009a)
Boundary Reservoir	1	305	Aug 2008	N	Char species ID not confirmed	SCL (2009a)
Boundary Tailrace	2		Nov/Dec 2008	Y	Population Source: Tributaries to Lake Pend Oreille	SCL (2009a)
Boundary Tailrace	1[2]		2008	N	Detection of a radio-tagged fish from the Salmo River; confirmed bull trout	SCL (2009a)
Boundary Reservoir Canyon Reach	1	538	July 21, 2009	Y	Radio-tagged fish Population Source: Gold Cr	Olson J. (pers. comm. 2009)
Total for 29-year period	**21**	**218 - 864**	**-**	**-**	**-**	**-**

Notes:
1 Blanks U: Unknown, but unlikely that genetic testing occurred; N: No genetic testing occurred; Y: genetic testing occurred.
2 Radio-tagged individual detected by a receiver in the Boundary Dam tailrace.

As indicated above, summer water temperatures in Boundary Reservoir at times exceed 20 ºC (68 ºF), which is too warm to provide optimum summer habitat for trout species (i.e., generally less than 16 ºC [61 ºF], Bjornn and Reiser 1991). Triploid rainbow trout planted by SCL are by

far the most numerous trout species present in Boundary Reservoir accounting for 64 to 90 percent of the salmonid observations during relicensing surveys, depending on the reach (SCL 2009c). WDFW will no longer provide permits for triploid rainbow trout stocking into Boundary Reservoir after 2009 because of concern about potential competition with native salmonids, low catch rates, poor salmonid habitat conditions, and low survival and retention in the reservoir (Robison D., and N. Baker, WDFW, personal communication, March 20, 2009). Wild rainbow trout (redband and hatchery origin) and brown trout are the next most common trout species in the reservoir. Sampling conducted by SCL in 2007 and 2008 (SCL 2009c) showed that cutthroat trout are uncommon in Boundary Reservoir. One char was captured in Boundary Reservoir near Slate Creek by opportunistic angling during August 2008, but no tissue sample was taken to confirm its identity. Data collected in 2007 and 2008 also suggest that no cutthroat, bull trout, or rainbow trout spawning, and no bull trout fry rearing, occur in the reservoir (SCL 2009c). Cutthroat trout and rainbow trout young-of-the-year were captured exclusively in tributary streams near their confluences with the reservoir, whereas some mountain whitefish, smallmouth bass, and cyprinid species young-of-the-year were captured in the reservoir (SCL 2009c). Although not abundant, trout species in the reservoir show a summertime preference for habitat in tributary deltas, because the relatively low temperatures of the tributary inflows provide thermal refugia from warmer water in the mainstem reservoir (SCL 2009c).

The larger tributaries to Boundary Reservoir contain a variety of fish species, and most salmonids in the vicinity of the Project occur in the tributaries (SCL 2006, SCL 2009c). Surveys conducted by the USFS, WDFW, and Kalispel Tribe of Indians (Kalispel Tribe) show that the dominant sportfish in tributaries are Westslope cutthroat trout, eastern brook trout, rainbow trout (likely of mixed race but some could be pure redband trout), and to a lesser extent brown trout and mountain whitefish (SCL 2006). These surveys documented observations of bull trout (1 individual), kokanee, and burbot in Sullivan Creek and bull trout (1 individual) in Sweet Creek. The burbot and kokanee in Sullivan Creek were likely entrained from Sullivan Lake, where substantial sport fisheries exist for both species.

The fish community in the Tailrace Reach is also dominated by minnows and suckers including northern pikeminnow, largescale sucker, redside shiner, and peamouth. Smallmouth bass are the most abundant sportfish. Mountain whitefish and both wild and hatchery-reared rainbow trout are commonly observed. In the past, bull trout have rarely been captured. Three bull trout were captured in the Boundary Dam tailrace during 2007 - 2008 as part of fisheries studies conducted by SCL, and a fourth bull trout, radio-tagged as part of BC Hydro's Salmo River bull trout telemetry study, was detected by a receiver in the Boundary Dam tailrace in 2008 (Table E.4-22) (SCL 2009c). Two of the bull trout captured in the tailrace were large enough to radio-tag (SCL 2009c). Genetics analysis confirmed that two of the captured bull trout had originated in tributaries to Lake Pend Oreille and one had originated in the Salmo River (DeHaan, P., USFWS, personal communications, November 14, 2007 and January 12, 2009). Walleye, a non-native species not previously recorded in the Tailrace Reach, were captured in 2007 (SCL 2009c). Data collected in 2007 and 2008 suggest that little trout spawning occurs in the tailrace (in fall 2008, one brown trout redd was identified) (SCL 2009c). Suckers, smallmouth bass, and triploid rainbow trout accounted for nearly 85 percent of the varial zone catch during 2007 and 2008 sampling in the Tailrace Reach (SCL 2009c). Fish abundance in the Tailrace Reach varial

zone was highest in July (SCL 2009c). Suckers and triploid rainbow trout dominated the open water catch. Large northern pikeminnow were also commonly encountered in the deep waters of the spillway pools and afterbay. Walleye were occasionally found at depths of 10 to 20 feet. Aside from suckers and northern pikeminnow, no young-of-the-year fish were captured or observed in the Tailrace Reach. The highly variable and often swift flows over coarse substrates likely limited the spawning habitat potential for many species in this reach (SCL 2009c).

Seasonality of Fish Distribution and Abundance

Fish use of the shallow near-shore margins and off-channel areas of the Project reservoir appeared to be low during February through early May compared to summer months. From June through August, there was an increase in the relative abundances of juvenile suckers and minnows in near-shore areas. Large numbers of young-of-the-year fish are present in the Upper Reservoir Reach during this time period, and observations made during June through August 2007 revealed that very small young-of-the-year fish, swim-up fry, and larval fish were often observed near the shorelines throughout the Canyon and the Forebay reaches (SCL 2009c).

Wild rainbow trout capture rates in the reservoir and tailrace were highest during the early spring and late fall, likely in response to reduced water temperatures. Adult walleye were found in the Tailrace Reach primarily during April, when the species would be expected to spawn. The catch rate of adult smallmouth bass also increased during their anticipated spawning period of May and June in the Upper Reservoir Reach.

4.5.3.1.2. Target Fish Species

In 2006, RPs identified an interest in Project effects on native salmonids, other sportfish species, and forage species potentially preyed upon by native salmonids. As a result, the following species were identified as "target species" or "species of interest" for discussion of Project effects:

- Target Species
  - Bull trout
  - Westslope cutthroat trout
  - Mountain whitefish
- Species of Interest
  - Smallmouth bass
  - Cyprinid (minnows), catostomid (sucker), and percid (perch) fry and juveniles

The following paragraphs provide additional details on the life histories, abundance, distribution, and size of these target species.

Bull Trout

Bull trout have rarely been observed in Boundary Reservoir between the years 1980 to 2008 (Table E.4-22). Over the 29-year period for which data are available, only 21 bull trout were captured or observed, and all of these were greater than 218 millimeters (8.6 inches) in length. Nevertheless, they are listed as a Threatened species under the ESA within the Northeast

Washington Unit (NWU), and recovery goals have been identified for Slate Creek (25 to 75 adult fish) and Sullivan Creek (600 to 850 adult fish).

Bull trout populations in the Pend Oreille River basin are considered either resident populations that reside their entire lives in smaller tributary streams or adfluvial populations that spawn and rear for one to four years in tributary streams, but rear for a portion of their lives in the Pend Oreille River and/or Lake Pend Oreille. Outmigration to larger water bodies, such as the Pend Oreille River, generally occurs at age 2 to 3 and at a size of 6.7 to 11.8 inches (Scholz et al. 2005). Bull trout spawning migrations begin during late July and early August, spawning peaks during early September, and post-spawning migrations to overwintering habitat are completed by the end of November (Baxter and Nellestijn 2000).

The available information suggests that there are two, and perhaps four, populations of bull trout in tributaries to the Pend Oreille River. The Salmo River at RM 12.7 and the Priest River at RM 95.2 are known to sustain reproducing bull trout populations, and LeClerc Creek is suspected of having a small reproducing population of bull trout, but its status is unknown (Scholz et al. 2005). Baxter and Nellestijn (2000) consider the Salmo River bull trout population to be fluvial, i.e., fish from this population do not extensively use the Pend Oreille River. Five juvenile bull trout have been observed in Nine Mile Creek, which drains into Seven Mile Reservoir, but additional monitoring is needed to determine if a reproducing population is present. Prior to 2003, individual bull trout were periodically observed in the Pend Oreille River or its tributaries downstream of Albeni Falls, but the source of these individuals is unknown. However, during 2003 and 2004 at least 13 bull trout were captured or observed at several locations in the upper reaches of Box Canyon Reservoir, with most of these grouped in a localized area near a culvert releasing cool spring water. Gilbert and Evermann (1894) observed that bull trout were "abundant in the Pend d'Oreille River" during their surveys in the late nineteen century. Smith (2000) noted that "char" (presumably bull trout) were a component of the Kalispel Tribe's subsistence along with other resident fish (suckers, trout, chub, and whitefish) and salmon captured near the Salmo River and Kettle Falls. Scholz et al. (2005) implied it is reasonable to assume that local tributaries contributed at least some of the bull trout that historically used the mainstem Pend Oreille River because of documented bull trout observations in four tributaries to Box Canyon Reservoir. The degree to which tributaries above and below Albeni Falls Dam historically contributed to bull trout use in the mainstem Pend Oreille River downstream of Albeni Falls is unknown. Regardless of their source, bull trout numbers in the Pend Oreille River declined rapidly after construction of Albeni Falls Dam in 1952 (USFWS 2000).

Historically, Lake Pend Oreille had a large bull trout sportfishery with an average harvest of 2,924 bull trout between 1951 and 1958 (Scholz et al. 2005). Bull trout harvest declined to a low of 621 fish in 1985, and targeted capture of bull trout became illegal in 1996 (Scholz et al. 2005). Bull trout in Lake Pend Oreille exhibit an adfluvial life history pattern and historically spawned in the Priest River, the Clark Fork River, and the smaller tributaries to these rivers and in Lake Pend Oreille. Lake Pend Oreille and the Pend Oreille River were the historical foraging grounds for juvenile and adult bull trout, and the Pend Oreille River also functioned as a migratory corridor (Scholz et al. 2005). Lake Pend Oreille is currently used as foraging and overwintering habitat. The upper Pend Oreille River above Albeni Falls Dam is currently used as a migratory corridor and overwintering habitat, but its use as foraging habitat is limited (DuPont and Horner

2003; Geist et al. 2004; Scholz et al. 2005). Few bull trout currently use the mainstem Pend Oreille River downstream of Albeni Falls for rearing, and it is possible that the bull trout observed in the mainstem river, including Boundary Reservoir, may originate in the Priest River, Lake Pend Oreille, or their tributaries (Scholz et al. 2005).

Westslope Cutthroat Trout

Westslope cutthroat trout are found in Boundary Reservoir, but their abundance is very low. In contrast, Westslope cutthroat trout are found in nearly all of the larger tributaries that drain into Boundary Reservoir, the major exception being Flume Creek (USFS 2005). Along with rainbow trout and brook trout, cutthroat trout of both Westslope and Yellowstone genetic origin have been extensively stocked in tributaries to Boundary Reservoir (McLellan 2001). Genetic testing of cutthroat trout suggests that relatively pure strains of Westslope cutthroat trout occur in North Fork Sullivan Creek above the Town of Metaline Falls water supply diversion dam and in Harvey Creek upstream of Sullivan Lake, but some level of introgression from hatchery stocks is prevalent elsewhere in tributaries to Boundary Reservoir (Small and Von Bargen 2008). In its comments on SCL's PLP (Attachment E-2) the USFS reports that genetically pure Westslope cutthroat trout can also be found in Sweet Creek, Slate Creek, and Peewee Creek. The USFWS (1999) stated that Westslope cutthroat trout are usually found in the cooler upper extents of tributaries, but suggested this use was more likely driven by competition from other trout such as rainbow trout and brook trout that are less tolerant of cooler, higher gradient streams, rather than by habitat preference.

A total of 537 cutthroat trout were captured or observed in or adjacent to Boundary Reservoir during 2007 and 2008 during boat and backpack electrofishing, fyke netting, gill netting, and snorkel sampling. However, the vast majority (513 fish) was observed in the lower reaches or deltas of tributaries to the reservoir. The size of captured cutthroat trout ranged from 1.0 to 16.7 inches, but 58 percent of these fish were less than 4.7 inches, and 89 percent were less than 9.8 inches. Only about 7 percent of the observed or captured cutthroat trout could be considered of catchable size (greater than 9 inches). Westslope cutthroat trout spawn from March through July when water temperatures warm to approximately 50 °F (10 °C) (USFWS 1999). Fry emergence is usually complete by the end of August. Following emergence, fry disperse downstream. Juvenile cutthroat trout that exhibit the fluvial or adfluvial life history pattern usually spend one to four years rearing in natal streams before outmigration (McIntyre and Rieman 1995). The fyke net captures and snorkel sampling are consistent with fry dispersal and juvenile outmigration behavior patterns. Ninety cutthroat trout 1.1 to 9.8 inches were captured by fyke nets located in the lower reaches of Sullivan, Slate, Sand, and Sweet creeks. The peak catch of cutthroat trout (43 fish) by fyke netting occurred during July and August, and 81 percent were less than 4.7 inches in length.

Ten cutthroat trout 11.6 to 15.9 inches in length were tagged and tracked in the reservoir using biotelemetry, and three cutthroat trout 11.3 to 14.1 inches in length were tagged in the tailrace. Because of the relatively few fish that could be tracked and the variety of their movement patterns, plus indications that many of the fish were adversely affected by the tagging procedure, strong conclusions regarding their behavior are not possible. During the spring and summer, Westslope cutthroat trout were more frequently found in the Box Canyon Dam tailrace (spring primarily) and in association with stream mouths, including Sweet Creek, Sullivan Creek, and

Russian Creek (Canada), potentially using these areas for feeding or as thermal refugia. During the winter, Westslope cutthroat trout were located in the Boundary Dam tailrace and the area immediately downstream of the Box Canyon Dam tailrace near the USGS gage station. During 2007, two cutthroat trout with temperature and pressure (i.e., depth) sensing tags demonstrated small-scale movements that appeared to be associated with maintaining their position in thermal refugia at creek mouths. These biotelemetry observations coincided with visual observations of numerous floy-tagged triploid rainbow trout using a thermal refuge at the mouth of Sweet Creek (SCL 2009c).

Mountain Whitefish

Mountain whitefish spawning and incubation in the Project area occurs from mid-October through mid-January, with peak activity occurring in November and December. The relatively large adhesive eggs are usually laid on gravel riffles in streams, but occasionally spawning occurs on gravel shoals in lakes or reservoirs. The eggs hatch in about one month at 9 ˚C but require a longer incubation period at lower temperatures. Following hatching, fry drift downstream until they encounter suitable shallow, low-velocity habitats.

Mountain whitefish are the most frequently observed or captured native salmonid in Boundary Reservoir. Nevertheless, based on abundance (167 fish) in the samples during 2007 and 2008, they represent less than 1 percent of the fish community in the Project area. Tributary surveys suggest that mountain whitefish are only present in Sullivan Creek and Sweet Creek (McLellan 2001; R2 Resource Consultants 1998a; SCL 2009c). Passive and active sampling in Boundary Reservoir during 2007 and 2008 resulted in increases of mountain whitefish in the catch during May and June, particularly young-of-the-year and fingerlings. This sampling also demonstrated that most mountain whitefish reside in the Upper Reservoir Reach. During 2007 mountain whitefish were present in the fyke net catch during July in Sweet Creek and August in Sullivan Creek but were absent during other months, except for a single fish captured in August (Sweet Creek) and another captured in September (Sullivan Creek).

Ripe female and milt-flowing male mountain whitefish have been observed in the 1-mile reach downstream of Box Canyon Dam, and whitefish eggs were collected on egg mats in the Box Canyon Dam tailrace during winter 2008/2009 (SCL 2009d). Mature mountain whitefish were also observed staging in the Boundary Dam Tailrace, although they are believed to spawn farther downstream in Seven Mile Reservoir north of the U.S.-Canada border. Whitefish eggs were also collected on egg mats at the mouth of Sullivan Creek in winter 2008/2009.

Thirty mountain whitefish 12.3 to 17.2 inches in length were tagged and tracked in the reservoir using biotelemetry and 10 mountain whitefish 12.2 to 17.0 inches in length were tagged in the tailrace and tracked. Biotelemetry indicated that mountain whitefish were found in the tailraces of both Boundary Dam and Box Canyon Dam during the spring through fall and then were found in the deeper water areas downstream of the tailraces where they may have overwintered. Areas around Sullivan Creek in the Upper Reservoir Reach were used by mountain whitefish during almost all seasons. Reservoir areas near Slate Creek were also used by mountain whitefish, although use of the Canyon and Forebay reaches was low. Use of the Salmo River in the spring as well as the Boundary Dam Tailrace in fall was also identified. Fall use of both the Boundary and Box Canyon tailraces and Sullivan Creek delta was likely related to possible spawning in

these areas. During the summer of 2008 several mountain whitefish exhibited a distinct diel movement between shallow, cool tributary delta areas at night to deep, warm waters near the delta during daylight hours, as indicated by detections on acoustic and radio receivers located at the mouth of Sullivan Creek.

Smallmouth Bass

Smallmouth bass is a non-native species that has become a popular sportfish in Boundary Reservoir. Largemouth bass are also present in Boundary Reservoir, but at a much lower abundance than smallmouth bass. In contrast, largemouth bass are substantially more abundant than smallmouth bass in Box Canyon Reservoir. Smallmouth bass represented about 10.2 percent of the fish captured in the reservoir during 2007 and 2008, and largemouth bass represented about 0.1 percent. Smallmouth bass generally have a small home range during most of the year, but may move distances up to about 1.0 mile often returning later to their home site (Todd and Rabeni 1989; Wydoski and Whitney 2003). Prior to construction of the dams on the lower Snake River, smallmouth bass were observed to feed actively near current shears during the daytime, but settled motionless to the substrate surface or between rocks during the night (Munther 1970). Smallmouth bass spawn during May and June when water temperatures are 13 - 15.5 °C, building nests that are guarded until fry leave (Wydoski and Whitney 2003). Observations of gravid females and smallmouth bass nests during 2007 and 2008 generally confirm this spawning period for smallmouth bass in Boundary Reservoir.

Electrofishing and gillnet sampling show that smallmouth bass occupy all reservoir reaches but on a relative basis are more abundant in the Upper Reservoir Reach, least abundant in the Forebay Reach, and of intermediate abundance in the Canyon Reach. During 2007, smallmouth bass young-of-the-year appeared in the catch starting in July and were abundant during August and September. Some individual smallmouth bass tagged with floy tags, radio tags, or combined acoustic and radio tags (CARTs) displayed somewhat greater movements than reported by Todd and Rabeni (1989). During biotelemetry studies, smallmouth bass were most frequently located in the Box Canyon Dam tailrace, near Sand, Sweet, and Pocahontas creeks, and in the Boundary Dam Forebay Reach at all times of the year. During spring and summer they appeared to be more widely distributed throughout Boundary Reservoir. Depth and temperature sensing tags indicated that smallmouth bass feed over a large range of depths that likely represent where food resources are located at different times of the year. During high flows, bass were routinely found in shallow water, inundated creek deltas, and inundated terrestrial habitat, likely preying on fish displaced by the freshet. As the summer progressed and water temperatures warmed, some bass were consistently found at depths of around 40 feet or more, suggesting more preferable habitat characteristics or food resources had become available in deep water.

Minnows, Suckers, and Perch

Minnows that are sufficiently abundant in Boundary Reservoir to be important prey for predatory fish include northern pikeminnow (6.3 percent of catch) and peamouth (7.3 percent of catch). Abundant sucker species that could also act as a prey source include largescale sucker (28.1 percent of catch). Yellow perch were also abundant (13.3 percent of catch). With the exception of yellow perch, these prey species are generally broadcast spawners, with slightly adhesive eggs that filter in among gravel or rubble substrates. In contrast, yellow perch eggs are laid in long strands, usually on submerged vegetation. The spawning period is usually triggered by the

occurrence of suitable water temperatures and the relatively small eggs hatch after a short incubation period of less than two weeks (Wydoski and Whitney 2003). During 2008 swarms of non-salmonid fry were observed beginning in July along the reservoir shoreline and in backwaters and trapping pools. Generally, these young fish would not be susceptible to electrofishing and gill net sampling methods until August or September. Small fish are more susceptible to fyke net sampling, which resulted in relatively high catches (3.5 fish/hr) in the Upper Reservoir Reach compared to the Forebay (0.9 fish/hr) and Canyon (0.7 fish/hr) reaches.

4.5.3.1.3. Physical Habitat

Physical habitat varies by reach in Boundary Reservoir. In general, the Project area provides limited habitat for adult and juvenile salmonids. As noted above, data collected in 2007 and 2008 suggest that no cutthroat, bull trout, or rainbow trout spawning occurs in the reservoir or tailrace, and no bull trout fry rearing occurs in the reservoir (SCL 2009c). However, as described above, mountain whitefish spawn in the Box Canyon Dam tailrace and Boundary Dam Tailrace Reach north of the U.S.-Canada border.

As noted above, the Forebay Reach is wide and deep, with steep-walled banks, and water depths extending to approximately 270 feet. There is little shallow, littoral habitat in this area. A small island near the center of this reach provides some habitat complexity, although the shores of the island are also steep. The Canyon Reach is predominantly narrow with steep, rock walls. A few large embayments and backwater channels provide localized shallow habitats with aquatic macrophyte beds, and areas of rock outcroppings provide habitat complexity. Downstream of Slate Creek the canyon is more constricted and water depths exceed 100 feet, whereas depths upstream of Slate Creek are typically 80 to 100 feet. The Upper Reservoir Reach is relatively wide and shallow, with a combination of silt, sand, and hard substrates, and water depths typically ranging from 10 to 25 feet. Habitat diversity is provided primarily by islands, back channels, and near-shore aquatic vegetation.

LWD, which can be an important component of aquatic habitat in both riverine and reservoir habitats (Bjornn and Reiser 1991; Northcote and Atagi 1997), was mapped along the Boundary Reservoir shoreline in 2007. This mapping showed that large wood was distributed in concentrated areas throughout the reservoir, and some of these areas had remained stable since 2005. Table E.4-23 provides a summary of LWD abundance by reservoir reach in 2007; see Figure 5.3-1 of the final report, Large Woody Debris Management Study (LWD Management Study), for a map showing locations of LWD throughout the reservoir (SCL 2008b).

Table E.4-23. LWD abundance, by number of pieces and volume, in reaches of Boundary Reservoir during 2007.

		Large Wood	
Reach	**Reach Length (miles)**	**Total Count (no./mile)**	**Total Volume (ft^3/mile)**
Forebay	1.0	80	2.881
Canyon	8.9	118	4,706
Upper Reservoir	7.6	53	2,881

Based on field measurements made in 2007, macrophyte beds are much less extensive below Metaline Falls (18.6 acres) than in the Upper Reservoir Reach (137.6 acres). The number and size range of macrophyte beds measured in August 2007, by reach, are shown in Table E.4-24. Eurasian watermilfoil, *Potamogeton* species, and coontail are the dominant plant species found in Boundary Reservoir. Macrophytes can provide habitat and food for benthic macroinvertebrates (BMI) and fish (Engel 1995), particularly spawning fish, fry, and juveniles.

Table E.4-24. Number of macrophyte beds and macrophyte bed size range, by reach, in the Project area during August 2007.

Reach	Number of Macrophyte Beds	Macrophyte Bed Size Range (acres)
Forebay Reach	4	0.008 – 2.83
Canyon Reach	28	0.0006 – 5.34
Upper Reservoir Reach	25	0.017 – 55.66
Tailrace Reach	0	0

Tributaries to Boundary Reservoir, and consequently most of the tributary fish habitat, are managed primarily by the USFS and BLM; only small portions of the tributaries are located on private land. Many tributaries to Boundary Reservoir have natural upstream fish migration barriers within close proximity of the reservoir (SCL 2006). Some tributaries have no potential adfluvial habitat, whereas Sullivan Creek has nearly 22,000 linear feet of adfluvial habitat, the most of any Boundary Reservoir tributary.

Physical habitat varies among tributary mouths in Boundary Reservoir. SCL conducted a detailed characterization of tributary deltas in Boundary Reservoir during September 2007, which is summarized in Table 5.1-5 in the Sediment Transport and Boundary Reservoir Tributary Delta Habitats Final Report (Sediment Transport and Tributary Delta Study) (SCL 2009a). For tributaries where flow was present at the mouth during September (many tributaries were dry in September at the point of confluence with the reservoir) stream temperatures ranged from 8 - 15 ºC, and flows ranged from 0.001 - 40.5 cfs (40.5 cfs in Sullivan Creek). Results of continuous monitoring of water temperatures conducted from July - October 2007 in select tributaries and their deltas are shown in Table 5.1-4 of the Sediment Transport and Tributary Delta Study (SCL 2009a), and tributary thermal plume characteristics are shown in Table 5.1-6 of the Sediment Transport and Tributary Delta Study (SCL 2009a). As noted above, total tributary inflow accounts for only a small fraction of flow in the Project area at any time during the year.

4.5.3.1.4. Recreational Fishery

Access to Boundary Reservoir for recreational fishing occurs primarily from three boat ramps: one operated by SCL at the Forebay Recreation Area, one in Metaline (operated by the town), and one near Box Canyon Dam (operated by the Pend Oreille County PUD). Creel surveys conducted in the summer of 1997 indicated that the Upper Reservoir Reach was the most heavily fished area of the reservoir (R2 Resource Consultants 1998a). Northern pikeminnow and rainbow trout were the two most commonly caught sportfish in the 1997 summer recreational

fishery, although rainbow trout were caught at a much lower frequency than pikeminnow. Angler surveys conducted by SCL in 2007 and 2008 (SCL 2009a) showed that rainbow trout and smallmouth bass were the species most commonly targeted by anglers. As indicated previously, smallmouth bass have developed a robust population in the reservoir and attract substantial attention by anglers, including the very popular "Bassin' Assassin" tournament that is hosted annually by a business in the Town of Metaline.

Trout have been stocked into the Pend Oreille River by WDFW on a sporadic basis since 1946, but stocking records do not always specify where releases occurred, and releases have varied dramatically in size. Except for 600 eastern brook trout released into the Pend Oreille River in 1999, all salmonid plants have been rainbow trout. In addition to plantings by WDFW, SCL has stocked triploid rainbow trout into Boundary Reservoir beginning in 2001. Because they are sterile and have high growth rates, triploid rainbow trout provide a benefit to the recreational fishery, but do not pose a threat to the genetic integrity of naturally spawning trout populations.

Based on returns of tags deployed as part of a tagged fish reward program implemented by SCL in 2007 (Recreational Fishery Study Final Report, SCL 2009a), the specific catch location most commonly identified for triploid rainbow trout was the Box Canyon Dam tailrace, followed by the Boundary Dam Forebay Reach. Tributary streams or stream mouths also accounted for a large portion of the identified capture locations for triploid rainbow trout. Tag return data suggest that triploid rainbow trout released in both the Forebay Reach and the Box Canyon Dam tailrace tended to remain near their release site until summer, after which downstream dispersal was observed. Examination of length-frequency data from spring sampling suggests that relatively small percentages of the fall and spring releases survive to the following autumn, which is consistent with the findings of other studies of triploid trout (Havens et al. 1995). Limited data from radio- and CART-tagged fish indicate that triploid rainbow trout moved into cold water refugia when mainstem reservoir temperatures increased in summer. Use of cold water refugia by triploid rainbow trout was also reliably confirmed through visual observations.

4.5.3.1.5. Reservoir Productivity

As noted above, productivity is low in Boundary Reservoir. Phosphorous and nitrogen concentrations are low throughout the year, with SRP and TKN concentrations often below detection limits. Nitrogen-phosphorus ratios indicate that the reservoir is phosphorus limited. Phytoplankton chlorophyll *a* concentrations (at times < 2.8 µg/l) also indicate that the system is oligotrophic. The zooplankton community is limited by food availability in the Project area, which is dictated to a large degree by input from Box Canyon Reservoir. Because zooplankton densities are very low, McLellan (2001) suggested that BMI are likely the primary food source for many fish in Boundary Reservoir.

As noted above, based on field measurements made in 2007, macrophyte beds are much less extensive below Metaline Falls (18.6 acres) than in the Upper Reservoir Reach (137.6 acres) (Table E.4-24). Eurasian watermilfoil, *Potamogeton* species, and coontail were the dominant plant species found in Boundary Reservoir. Greater detail regarding factors affecting productivity in the Project area can be found in the Water Quality Study Final Report, and the Productivity Assessment Final Report (2009a).

4.5.3.1.6. Rare, Threatened and Endangered Fish Species

The only federally- or state-listed rare, Threatened, and Endangered (collectively RTE) fish species present in the Project area is bull trout, which is federally listed as a Threatened species, and Westslope cutthroat trout, which is a USFWS species of concern and USFS sensitive species. WDFW includes several resident fish species on the state endangered list for Region 1 (eastern Washington): three minnows (lake chub, leopard dace, and Umatilla dace), mountain sucker, and pygmy whitefish. Neither the minnows nor the sucker have been documented in Boundary Reservoir or elsewhere in the Project vicinity. Pygmy whitefish are known to be present in Sullivan Lake, which is in the Project vicinity, but have not been documented in Boundary Reservoir.

4.5.3.1.7. Federally Designated Habitat

In its final rule (70 FR 56212), the USFWS identified short sections of lower Slate Creek and Sullivan Creek as critical habitat for bull trout. All impoundments behind dams that have a primary purpose of providing flood control, energy production, or water supply for human consumption were excluded from designation as critical habitat because disruption of these functions could adversely affect human health and safety or would have been inconsistent with the President's energy policy (70 FR 56212) at the time. Consequently, Boundary Reservoir is not considered critical habitat for bull trout. Except for very small reaches near their mouths, Slate and Sullivan creeks are located on NFS lands. There is no federally designated critical habitat for Westslope cutthroat trout in the Project vicinity because this species is not currently listed under the ESA.

4.5.3.2. Environmental Analysis

4.5.3.2.1. Species and Habitats

This section of Exhibit E discusses the effects of proposed Project operations under the new FERC license in comparison to effects associated with current Project operations under representative wet year (1997), dry year (2001), and average year (2002) flow conditions. Under the Proposed Action, SCL will formalize the current voluntary summertime forebay water surface elevation restrictions as follows: Memorial Day weekend (starting Friday evening) through Labor Day weekend (on Monday evening) forebay water surface elevations will be maintained at or above 1,984 NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use. From 8:00 pm through 6:00 am, forebay water surface elevations will be maintained at or above elevation 1,982 feet NAVD 88 (see Section 2.3.1 of this Exhibit E). SCL also proposes a suite of non-operational PM&E measures related to fish and aquatic resources that are described in Section 4.5.3.3.

Aquatic biota and habitats immediately upstream and downstream of Boundary Dam are influenced by Project operations, hydrologic conditions, and releases from upstream hydroelectric and water storage projects. The effects of Project operations on aquatic habitat were assessed using a Physical Habitat Model to generate indices reflecting habitat conditions within Boundary Reservoir and Boundary Dam tailrace.

SCL developed a suite of models and post-processing analyses to support the evaluation of existing conditions and alternative operations. These models/analyses included the Scenario Tool (ST), Hydraulic Routing Model (HRM), mainstem habitat model, trapping and stranding models, mainstem sediment transport model, and tributary delta habitat models. The ST optimized Project energy production using historic hydrologic data and resource criteria input to provide a consistent foundation for the comparison of resource impacts or benefits (see Section 4.4). Simulation by the ST allowed the output (water surface elevation and flows) to be readily used as input data to the HRM. The HRM was used to translate hourly changes in forebay water surface elevations to changes at locations upstream and downstream of Boundary Dam. The HRM computes water surface elevations, average velocities, and timing of water surface fluctuations at locations throughout Boundary Reservoir and Boundary Dam tailrace.

To model existing conditions, the summer recreational pool constraints were modified by allowing the ST to exceed the forebay pool level constraints according to the magnitude and frequency of excursions observed historically during the representative wet, dry and average years. Under the Proposed Action, modeling assumptions included SCL implementing the summer recreational pool level constraints as a firm obligation (hard constraint of the new Project license).

The mainstem habitat model used water surface elevations and average velocities from the HRM, along with specific velocity measurements within habitat cells at various habitat transects, to determine depths and velocities for each habitat cell for each hour of simulated operation. In addition to depth and velocity, substrate and cover were incorporated into the habitat model and compared to Habitat Suitability Indices/Criteria (HSI/HSC) for lifestages and fish species of interest (native salmonids, smallmouth bass, and forage species) and other aquatic organisms (macrophytes, periphyton, and benthic macroinvertebrates [BMI]). The integration of hydraulic, channel morphology, and biological response data was used to calculate the relative amount of potential habitat, termed WUA, at each transect for lifestages and species of interest for each hour of simulated Project operation. The mainstem habitat model was also used to track the effect of fluctuating water surface elevations on potential mountain whitefish and smallmouth bass spawning areas to evaluate which cells of potential spawning habitat remain inundated through the subsequent incubation period (Effective Spawning Index [ESI]).

This approach assumes the abundance of aquatic species is at least partially reflected in the availability of suitable habitat and that populations, on a qualitative basis, would reflect positive or negative changes in the amount of suitable habitat represented by the index. A habitat-based modeling approach was taken because assessing direct changes in fish, macrophyte, periphyton, and BMI populations could not be done within the time period available for relicensing studies, and habitat-based modeling allows assessment of alternative operation scenarios. Details of the Physical Habitat Model methods are provided in the Mainstem Aquatic Habitat Modeling Study (Mainstem Habitat Modeling Study) Final Report (SCL 2009a). The factors considered for each index are provided in Table E.4-25.

Calculation of fish trapping and stranding and macrophyte, periphyton, and BMI HSC is complicated by water surface fluctuations that result from Project operations. The varial zone is defined as the area of the channel alternately inundated (wetted) and dewatered (dried) by water

surface elevation fluctuations. The upper limit of the analysis was the top of the varial zone, and the lower limit extended to 50 feet below the lowest typical extent of the euphotic zone.

Table E.4-25. Factors considered for development of aquatic habitat indices

Index	Factors Considered
Fish habitat,	• Depth • Velocity • Substrate • Cover
Juvenile fish trapping	• Trapping area • Contributing basin factor • Duration of trapping • Cover
Juvenile fish stranding	• Stranding area • Cover
Macrophytes and Benthic macroinvertebrates	• Depth • Velocity • Substrate • Duration of inundation • Duration of dewatering
Periphyton	• Depth of light (water clarity) • Velocity • Substrate • Duration of inundation • Duration of dewatering

Water surface fluctuations are further complicated by the presence of a natural hydraulic control at Metaline Falls and gradient changes in the river's thalweg (Section 2.1.2). Water surface elevation fluctuations within the varial zone are dependent on three factors: Project operations, location within the Project area, and upstream inflows (releases from Box Canyon Dam). During low inflow conditions when the forebay water surface elevation is relatively high, above approximately 1,987 feet NAVD 88, the Box Canyon USGS gage elevation fluctuations typically follow those in the Forebay within about 1 foot or less (Figure E.4-42). However, at flows above approximately 56,000 cfs, Project load-following operations cease as the capacity of the power plant is exceeded (e.g. following May 28, 2003, Figure E.4-43). At this point, forebay elevations are primarily controlled by the spillway gates, and elevations at the Box Canyon USGS gage become increasingly governed by the releases from Box Canyon Reservoir.

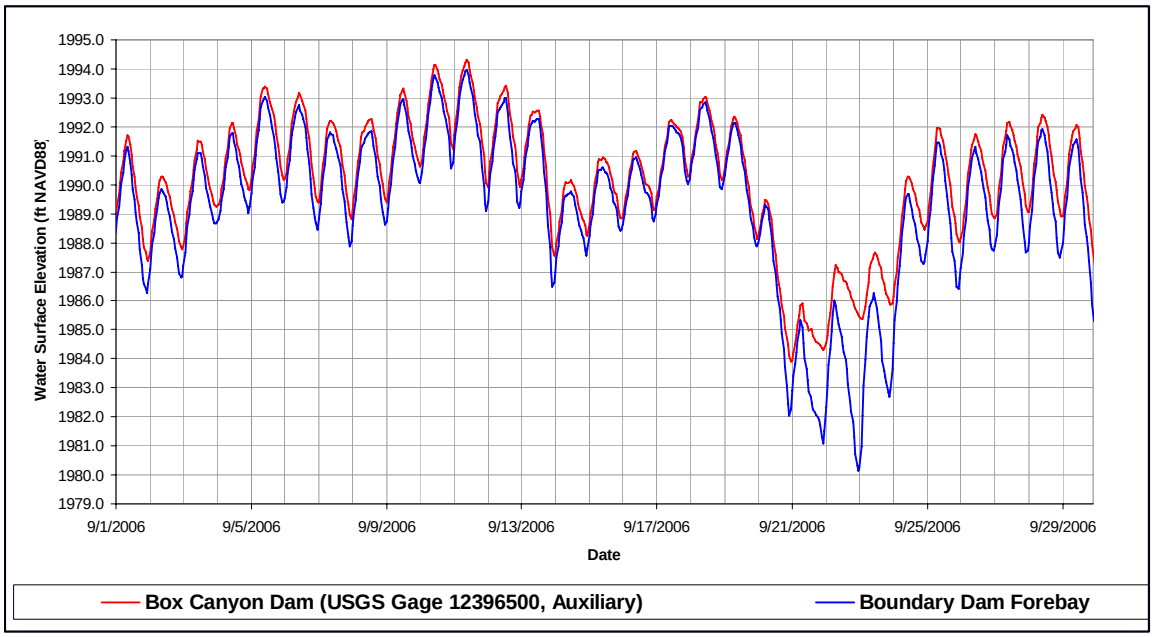


Figure E.4-42. Example water surface elevation fluctuations below Box Canyon Dam and in Boundary Dam Forebay during low flow conditions, September 2006.

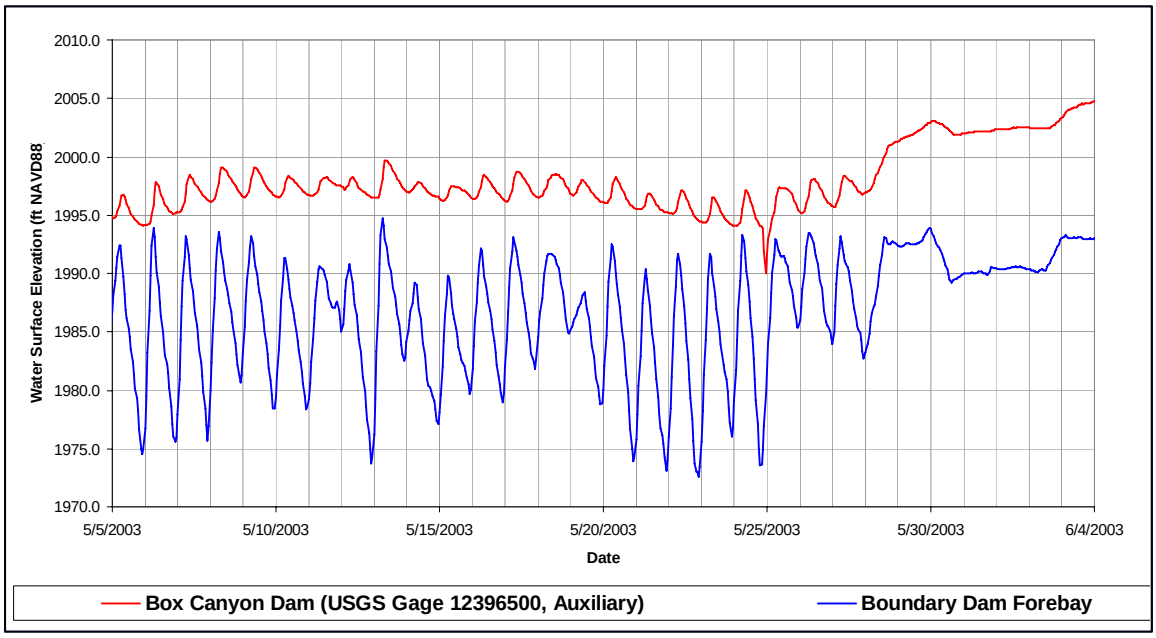


Figure E.4-43. Example water surface elevation fluctuations below Box Canyon Dam and in Boundary Dam Forebay during high flow conditions, early May though early June 2003**.**

The following sections summarize the results of the Physical Habitat Model in each of the four mainstem reaches of the Project area under existing conditions. Under the Proposed Action,

model results are identical to existing conditions for wet and average year types. During dry years most indices are also identical between the two scenarios, and with few exceptions the remaining indices are within 5 percent of each other. The anticipated effects of the Proposed Action on fish and aquatic resources relative to Existing Conditions are discussed in more detail below.

Tailrace Reach

The 3.1-mile-long Tailrace Reach is situated below Boundary Dam, extending into Canada to the confluence with Redbird Creek. Fisheries surveys conducted during relicensing occurred only in the first mile of the reach, i.e., the portion located within the United States. The reservoir behind Seven Mile Dam in Canada at times inundates the entire reach to the base of Boundary Dam, depending on its forebay elevation. This creates complex hydraulic conditions in the Tailrace Reach, because tailrace water surface elevations vary with both changes in releases from Boundary Dam and changes in the forebay elevation at Seven Mile Dam. The Tailrace Reach can exhibit both reservoir-like and riverine-like conditions depending on the releases from Boundary Dam and the forebay elevation of Seven Mile Dam.

The distribution of downramping rates below Boundary Dam in the Tailrace Reach is substantially different from rates upstream of the dam (Figure E.4-44). Below the dam, the most frequent downramping rate is 0 to 2 inches per hour, which is indicative of slow changes in water surface elevation. However, the Tailrace Reach also has a much higher proportion of occurrences of the highest downramping rate, greater than 12 inches per hour, compared to the upstream reservoir reaches.

The stranding index area for the Tailrace Reach is very low (Figure E.4-45), representing about 4.8 to 8.1 feet of the channel width for mountain whitefish fry between February 16 and August 15 and 6.1 to 8.9 feet of the channel width between July 1 and October 31 for smallmouth bass fry. The Tailrace Reach stranding indices are similar to the Forebay and Canyon reaches for mountain whitefish fry and slightly lower for smallmouth bass. However, stranding indices for the tailrace are substantially lower than for the Upper Reservoir. The trapping index also suggests a low level of risk in the tailrace, with a very low overall magnitude of l71.2 x 10^4 to 125.4 x 10^4 square feet for mountain whitefish fry and less than 85 x 10^4 square feet for smallmouth bass fry (Figure E.4-46). The three reaches in the Project area downstream of Metaline Falls account for approximately 23 percent of the total Trapping or Stranding Index area, indicating the relatively high importance of the Upper Reservoir Reach with regard to the risk of trapping. The risk of fish trapping and stranding in the Tailrace Reach is relatively low based on the areal extent of trapping pools and topography present in the reach, but the relatively high levels of downramping rates greater than 12 inches per hour increase this risk to a moderate level.

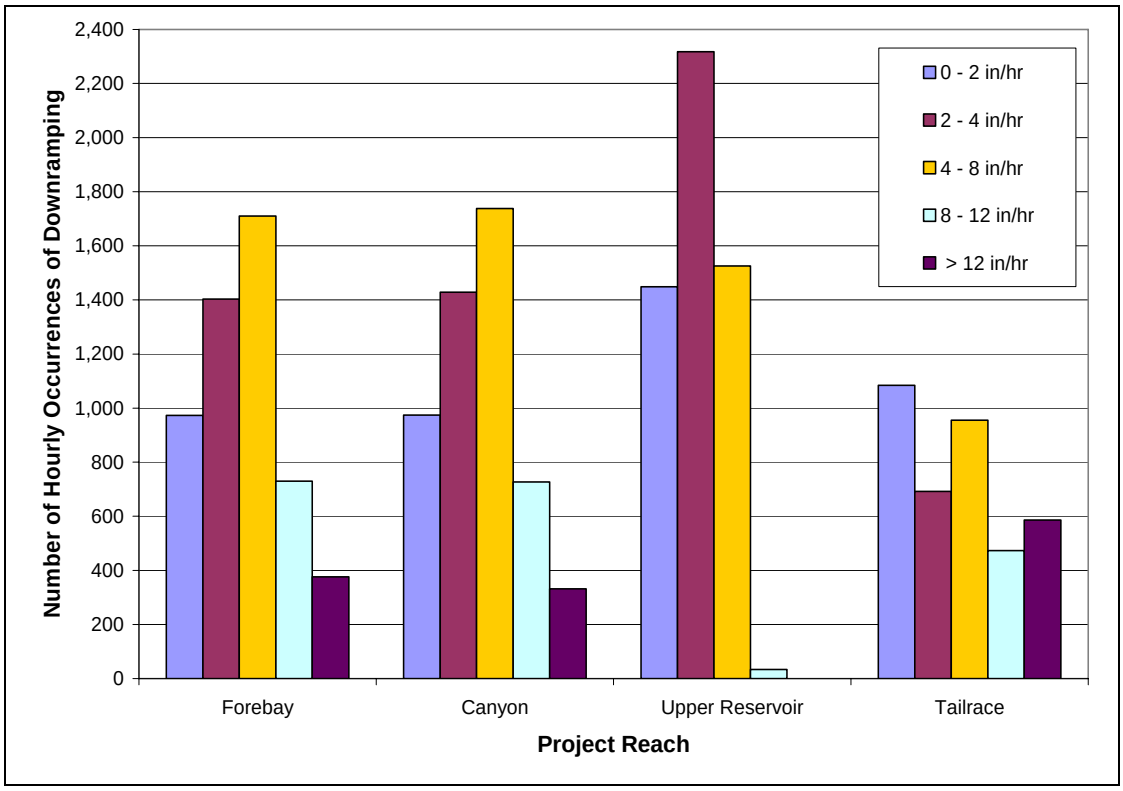


Figure E.4-44. Annual transect-weighted reach average downramping rate distribution by Project reach for the representative average year (2002).

WUA values for adult mountain whitefish in the Tailrace Reach are the second lowest of all reaches, with about 15 percent of the total WUA index area, regardless of year type (Figure E.4-47). This is in contrast to observations of adult mountain whitefish in the Tailrace Reach that were second only to the Upper Reservoir Reach, including observations in the late fall and early winter when their presence was likely related to spawning. In part this may be explained by the relatively short length of the Tailrace Reach. On a per-linear-foot basis, WUA for adult mountain whitefish was the next highest after the Upper Reservoir Reach. The mean of year types was 203 square feet of WUA per foot of Tailrace Reach length compared to 342 square feet of WUA per foot of Upper Reservoir Reach length, which are both 2 to 4 times higher than the Forebay and Canyon reaches. In other words, the density of suitable habitat is relatively high in the Tailrace Reach, which may explain why mountain whitefish were more commonly observed using the reach. On a proportional basis, the Tailrace Reach had the second lowest WUA values of the four reaches for mountain whitefish fry and the areal values were extremely low, ranging from 25 x 10^4 to 35 x 10^4 square feet. The calculated mountain whitefish effective spawning index values for the Tailrace Reach (65 feet) were about one-fifth of those determined for the Upper Reservoir Reach (336 feet) under the average year type condition. This is partially due to the high level of water surface elevation fluctuations in the Tailrace Reach compared to the Upper Reservoir Reach.

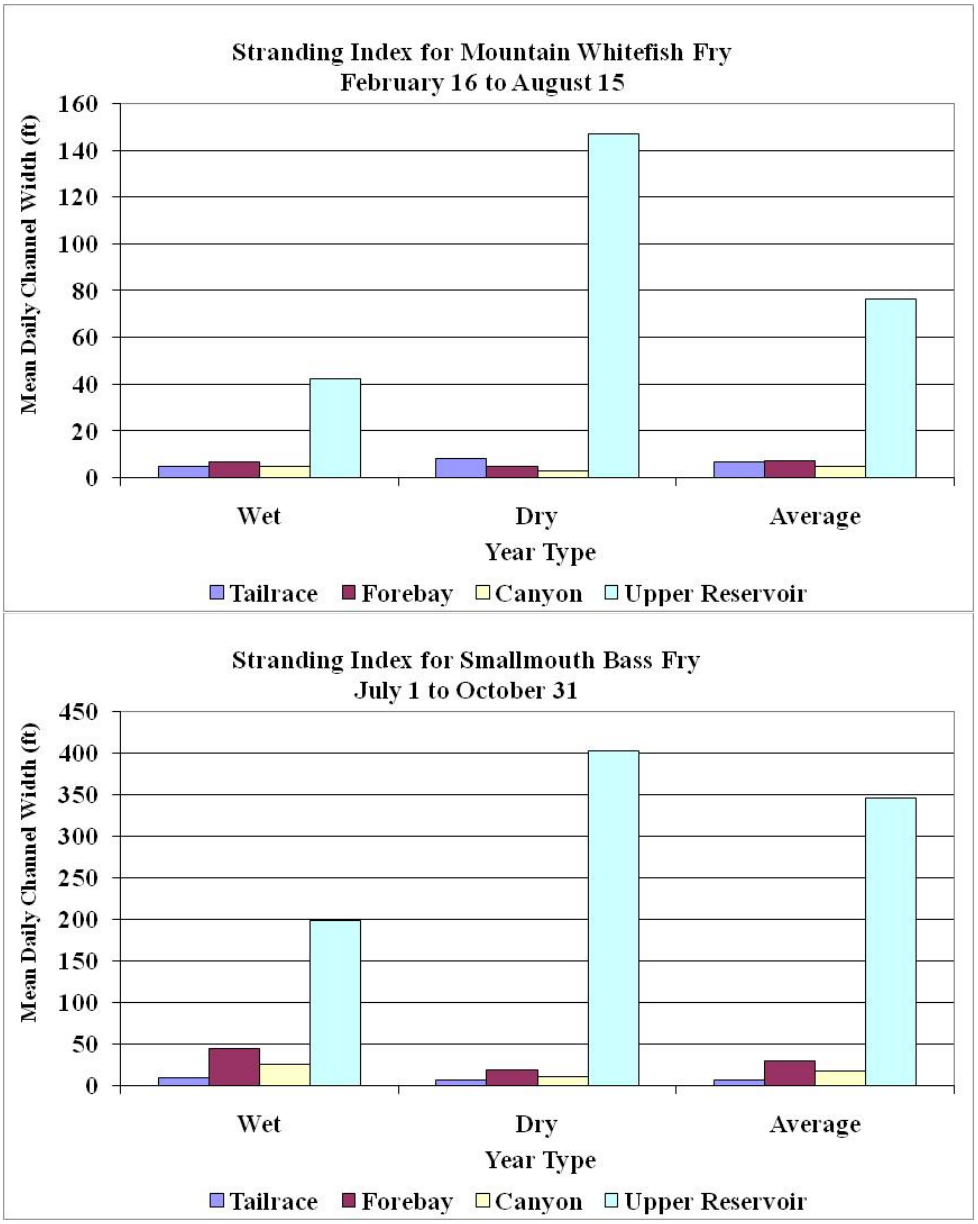


Figure E.4-45. Stranding indices by reach and year type for mountain whitefish fry and smallmouth bass fry.

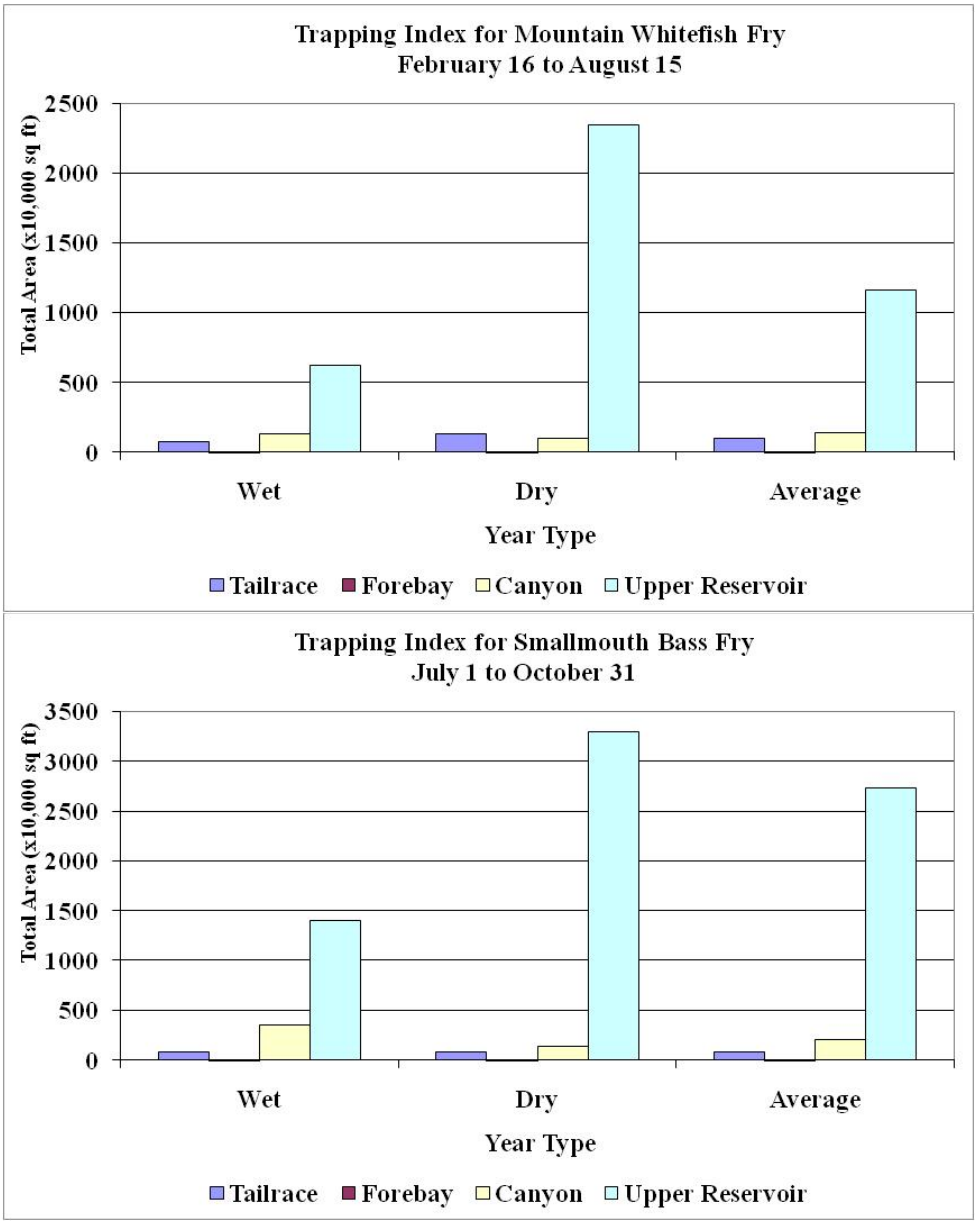


Figure E.4-46. Trapping indices by reach and year type for mountain whitefish fry and smallmouth bass fry.

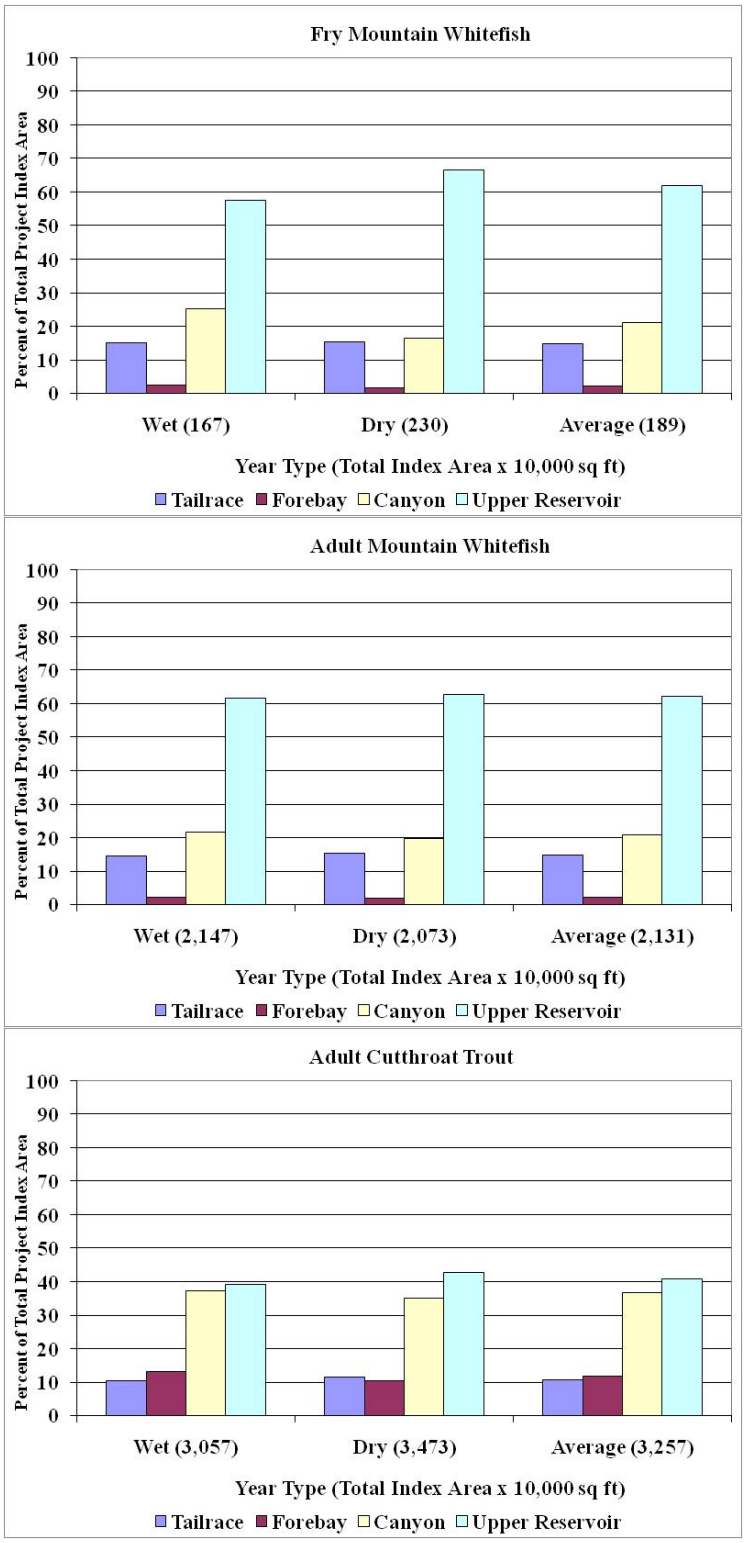


Figure E.4-47. Weighted useable area as a proportion of the total Project Area WUA for mountain whitefish fry and adults, and adult cutthroat trout.

Adult cutthroat trout WUA values in the Tailrace Reach, as a percentage of total Project WUA, were similar to the Forebay Reach but substantially lower than those in the Canyon and Upper Reservoir reaches (Figure E.4-47). However catch rates of cutthroat trout were greater in the Tailrace Reach than in the other reaches. Upper Reservoir Reach cutthroat trout catch rates ranked second among the reaches. The riverine-like conditions of the sampling sites in both the Tailrace and Upper Reservoir reaches may in part account for the discrepancy between the WUA indices and observed relative abundance. The redband trout WUA values in the Tailrace Reach were very similar to the cutthroat trout values (Figure E.4-48).

The Tailrace WUA values for adult smallmouth bass were the second lowest of the four reaches (Figure E.4-48). Smallmouth bass composed approximately 15 percent of the Tailrace catch and were most prevalent during the spring and summer months. The distribution of WUA for generic fry and juvenile forage fish (cyprinids and other species) followed a pattern similar to that of smallmouth bass, with the tailrace accounting for 12 percent or less of the total Project WUA (Figure E.4-48).

There were no mapped macrophyte beds in the Tailrace Reach, which is consistent with the extremely low macrophyte WUA estimates (Figure E.4-49). Several factors likely limit the establishment of any macrophyte beds in this reach. The reach has high velocities, large substrate, and relatively high water surface elevation fluctuations. Each of these contributes to preventing macrophyte bed establishment and maintenance. Periphyton WUA estimates were similar among the three hydrologic year types (e.g., wet, dry, and average) in the Tailrace Reach (Figure E.4-49). Substrate sizes were larger (i.e., gravel and cobble) in this reach and were suitable for colonization of periphyton, but other factors like dewatering disturbance and high water velocities affect the suitability of much of the shallow water habitat in the Tailrace Reach. The percentage WUA for periphyton in the Tailrace Reach is about the same as the Canyon Reach, higher than the Forebay Reach, and substantially lower than the Upper Reservoir Reach (Figure E.4-49). The Tailrace Reach is characterized by uniformly low BMI WUA estimates for all year types (Figure E.4-49). The same disturbance factors suppressing periphyton growth (e.g., frequent dewatering and high water velocity) are likely the reason for poor BMI habitat suitability in this reach.

Forebay Reach

The Forebay Reach is the most lacustrine of the four reaches. Depths reach 270 feet, and because the channel is wide (nearly 2,000 feet) average water velocities are generally a few tenths of a foot per second or less, except during high flows. Shallow water habitat (0 to 20 feet at median pool and median flow) is 2,553 x 10^4 square feet, about 4 percent of the shallow water habitat in Boundary Reservoir. Shallow water habitat generally occurs as a narrow strip along the edge of the reservoir, equivalent to an average of 204 feet (about 10 percent) of the overall wetted width of the Forebay Reach. This is similar to the Tailrace Reach (231 feet) and represents more shallow water habitat on an average width basis than the Canyon Reach (68 feet), but far less than the Upper Reservoir Reach (654 feet). The low water velocities and lack of shallow habitat in the Forebay Reach support a fish community dominated by suckers, yellow perch, triploid rainbow trout, and northern pikeminnow.

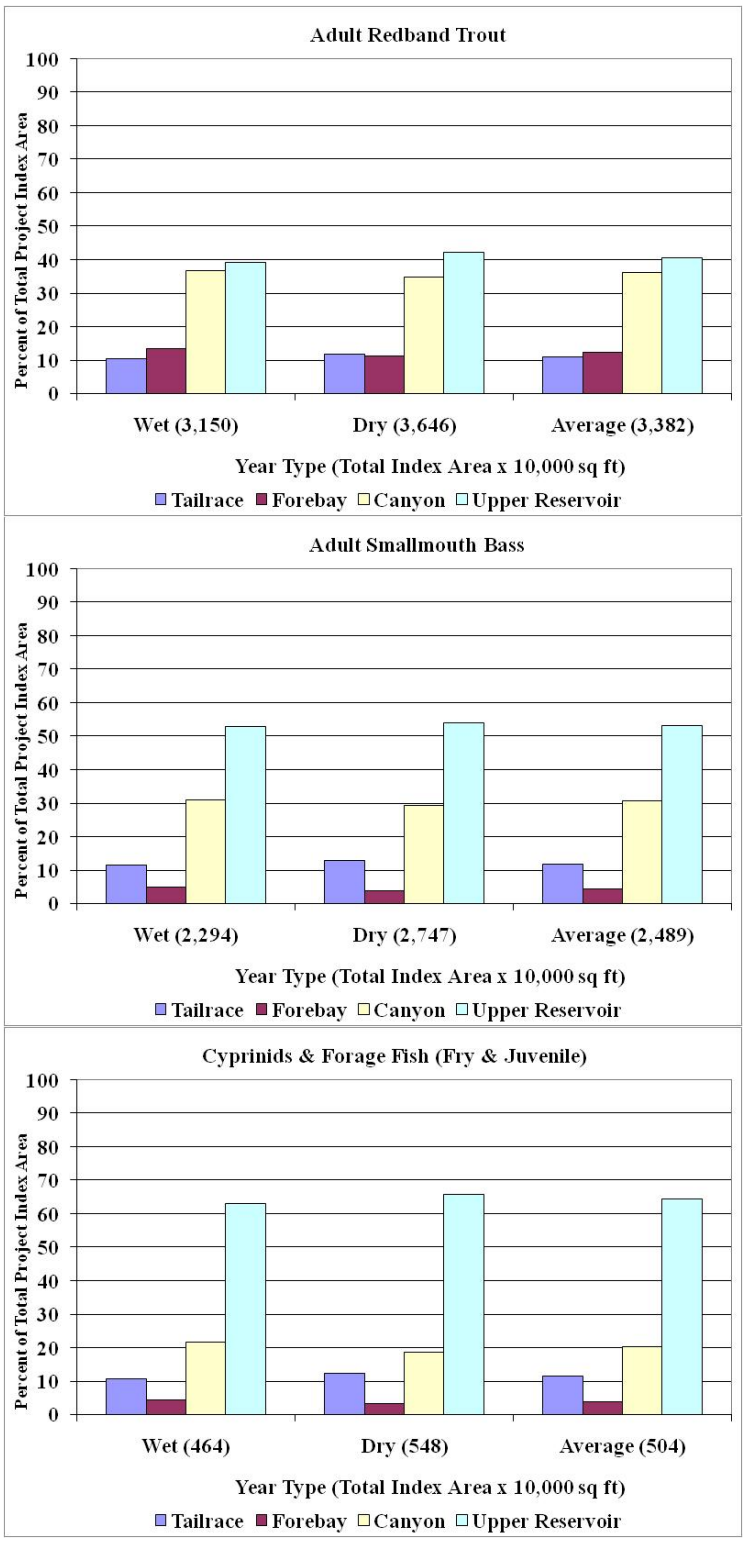


Figure E.4-48. Weighted useable area as a proportion of the total Project Area WUA for adult redband trout, smallmouth bass, and forage fish.

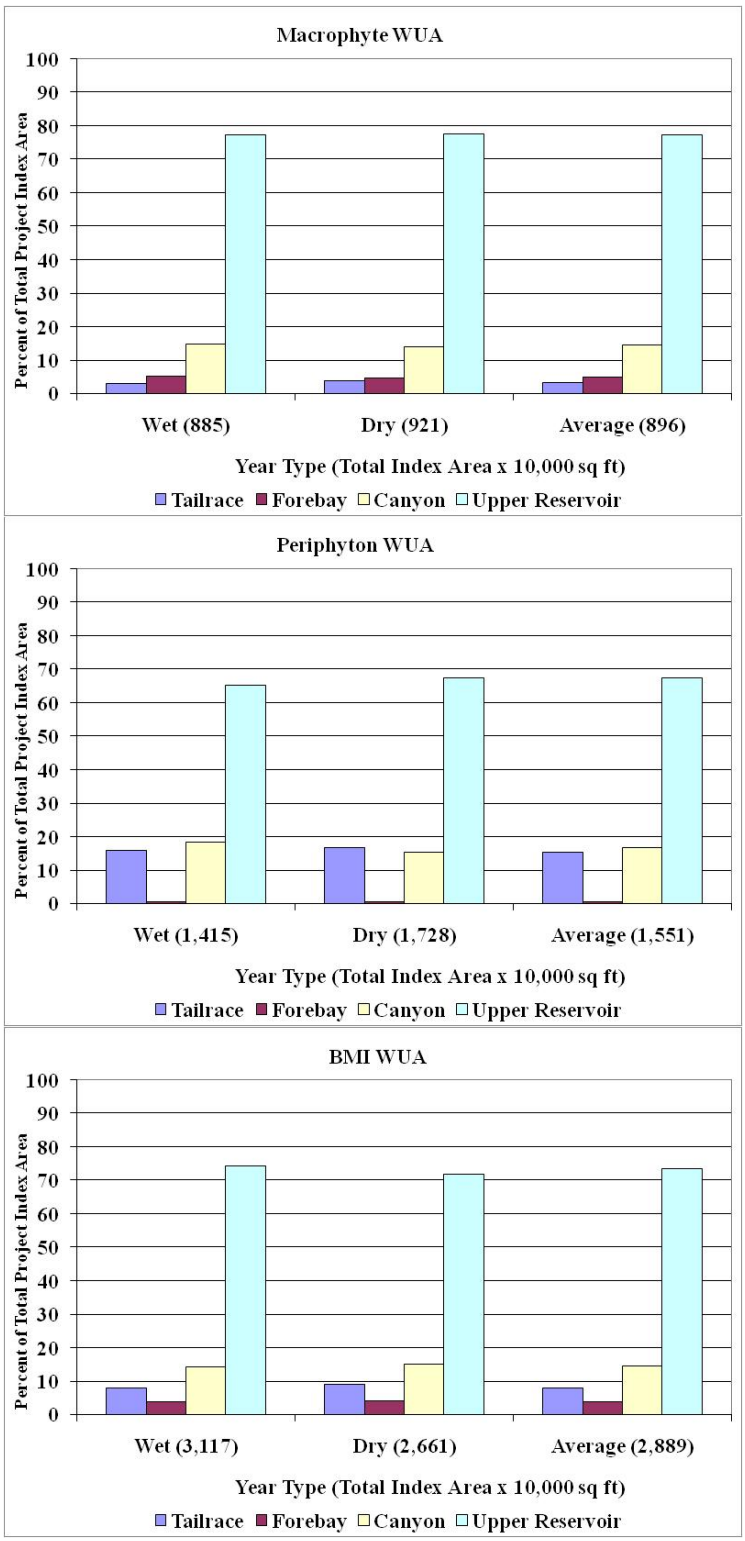


Figure E.4-49. WUA as a proportion of the total Project Area WUA for macrophytes, periphyton, and BMI**.**

Stranding and trapping indices in this reach were relatively low for smallmouth bass fry (stranding 19.1 to 44.6 feet; trapping 2.8 x 10^4 to 5.6 x 10^4 square feet) and reflect the relatively small amount of shallow water habitat with gently sloping profiles and limitations to macrophyte bed establishment (Figures E.4-45 and E.4-46). For mountain whitefish fry, the stranding and trapping indices were also relatively low (stranding 4.8 to 7.2 feet; trapping 1.4 x 10^4 to 4.2 x 10^4 square feet) (Figures E.4-45 and E.4-46). Additionally, low numbers of mountain whitefish, cutthroat trout, smallmouth bass, and northern pikeminnow were found in shallow water habitats in the Forebay Reach, which reduces their vulnerability to trapping and stranding impacts associated with Project operations. The stranding and trapping indices suggest there is little potential for fish stranding and fish trapping in the Forebay Reach. Additionally, low numbers of native salmonids are present in shallow water habitats in the Forebay Reach, which reduces the risk for either stranding or trapping of these species.

The total fish WUA values for the three representative years do not vary greatly, although the wet years are always the highest and the dry years are always the lowest for all six species and life stages (Figures E.4-47 and E.4-48). Compared to other reaches, the Forebay Reach has the lowest WUA values for mountain whitefish fry and adult. The mountain whitefish fry values are similar to the Canyon Reach. This is due to the dominance of deep water in these reaches. Mountain whitefish catch rates reflected trends in the WUA values, as they represented nearly a fivefold lower catch rate than that observed in the Upper Reservoir Reach. Adult cutthroat trout WUA values were also low in the Forebay Reach relative to the Canyon and Upper reaches, but about the same as the Tailrace Reach. The WUA values for smallmouth bass in the Forebay Reach are the lowest of Project area reaches, which is consistent with the low catch rates during fish surveys. Similarly, the WUA values for generic fry and juvenile forage fish (cyprinids and other species) were also lowest in the Forebay Reach.

Macrophyte WUA estimates were lower in the Forebay Reach than any other reaches in Boundary Reservoir (Figure E.4-49). Macrophyte habitat in this reach is limited by the presence of unsuitable substrate types (e.g., gravel, cobble, and shale), steeper slopes along the shoreline, and overall depths that exceed optima for the establishment of macrophyte beds. The percentage of shallow water habitat optimal for macrophyte bed establishment was lowest in the Forebay Reach under all pool flow conditions among the reservoir reaches. Periphyton and BMI WUA estimates were also lower in the Forebay Reach than in the other Boundary Reservoir reaches (Figure E.4-49). Similar to other reaches, depth and dewatering appear to be factors controlling WUA estimates for periphyton and BMI in the Forebay Reach.

Canyon Reach

The Canyon Reach is generally reservoir-like, but because it is much narrower than the Forebay Reach, velocities are higher, especially near the upstream end of the reach. The steep canyon walls in this reach limit the amount of shallow water habitat. Within the 8.8-mile length of the Canyon Reach, there are 302 x 10^4 square feet (average width of 68 feet) of shallow water habitat at the median pool, median flow condition, which is about one-third of the values for the Forebay and Tailrace reaches and about one-tenth of the Upper Reservoir Reach value.

The stranding index (stranding 11.1 to 25.1 feet) in this reach was relatively low for smallmouth bass fry while the trapping index was low to moderate (134.1 to 353.4 x 10^4 square feet)

depending upon year type (Figure E.4-45 and E.4-46). Similarly, for mountain whitefish fry the stranding index was also relatively low (2.6 to 5.0 feet) while the trapping index was relatively low (93.8×10^4 to 133.7×10^4 square feet) (Figure E.4-45 and E.4-46). Field studies indicate that the significant stranding and trapping risks within the Canyon Reach are concentrated in one area, the side channel to the west of Everett Island. The side channel contains several potential trapping pools that are exposed when reservoir levels fluctuate between elevation 1,984 feet and 1,977 feet NAVD 88. Surveys conducted in both 2007 and 2008 observed considerable trapping here, although mortality was very low until the pools had been isolated for over 48 hours. No mountain whitefish fry were observed during surveys of the trapping pools in this area during 2007 and 2008. Stranding observations were largely associated with the dense macrophyte beds that dewatered as water surface elevations receded below 1,984 feet NAVD 88. Such events require considerable decline in reservoir levels and do not typically occur during the summer voluntary drawdown restrictions.

Figure E.4-47 shows that WUA for mountain whitefish adults and fry in the Canyon Reach are similar to those in the Tailrace Reach. This is due to the predominance of deep water habitats in these reaches. Mountain whitefish fry WUA ranged from 17 to 25 percent of total WUA in the Canyon Reach depending upon the year type, and adults ranged from 20 to 22 percent of total WUA. A total of 14 mountain whitefish were captured in the Canyon Reach. However, no mountain whitefish fry were captured in the Canyon Reach or Forebay Reach, as the shallow, cobble and gravel substrates they prefer are limited by the very steep, bedrock and boulder dominated shorelines. Moreover, aside from limited habitat associated with the Flume Creek delta, the shorelines of the Canyon Reach provide little potential spawning habitat for mountain whitefish, and they are not known to inhabit the tributaries that drain into the Canyon Reach.

Adult cutthroat trout WUA in the Canyon Reach is slightly lower than in the Upper Reservoir Reach, and about three times higher than the Forebay and Tailrace reaches (Figure E.4-47). As with elsewhere in the reservoir, very few cutthroat trout were encountered in the Canyon Reach during the relicensing surveys. Only two of the 25 cutthroat trout captured in the reservoir were encountered in the Canyon Reach; both were juvenile fish less than 7.9 inches in length found in shallow water habitat associated with steep shorelines.

The proportion of WUA for smallmouth bass in the Canyon Reach is substantially higher than in the Tailrace and Forebay reaches, but lower than in the Upper Reservoir Reach (Figure E.4-48). However, the Canyon Reach smallmouth bass catch rates for boat electrofishing exceeded all other reaches, owing largely to the prevalence of yearling and adult fish captured during the summer months. In August, smallmouth bass (< 1.4 inches) began to appear in the catch. Both observations indicate that rearing and possibly spawning by smallmouth bass occur in the Canyon Reach. Several bass nests were located in the Everett Island side channel during 2008 bass nest surveys. Adult smallmouth bass were also captured in open water habitat at depths greater than 60 feet. The effective spawning index for smallmouth bass was relatively low for dry years (2 feet), but relatively high for average (36 feet) and wet (32 feet) years. Notably, for both average and wet years the smallmouth bass effective spawning index for the Canyon Reach was more than double the value for the Upper Reservoir Reach (Figure E.4-50). The Canyon Reach affords smallmouth bass a variety of habitat conditions in the form of boulders, bedrock ledges, and attendant velocity shears. The amount of WUA for generic forage fish is fairly small

in the Canyon Reach as a result of the preference by small fish for shallow depths and low water velocities. On a relative basis, the amount is double or more than that found in the Tailrace and Forebay reaches, but only about a third as much as the Upper Reservoir Reach.

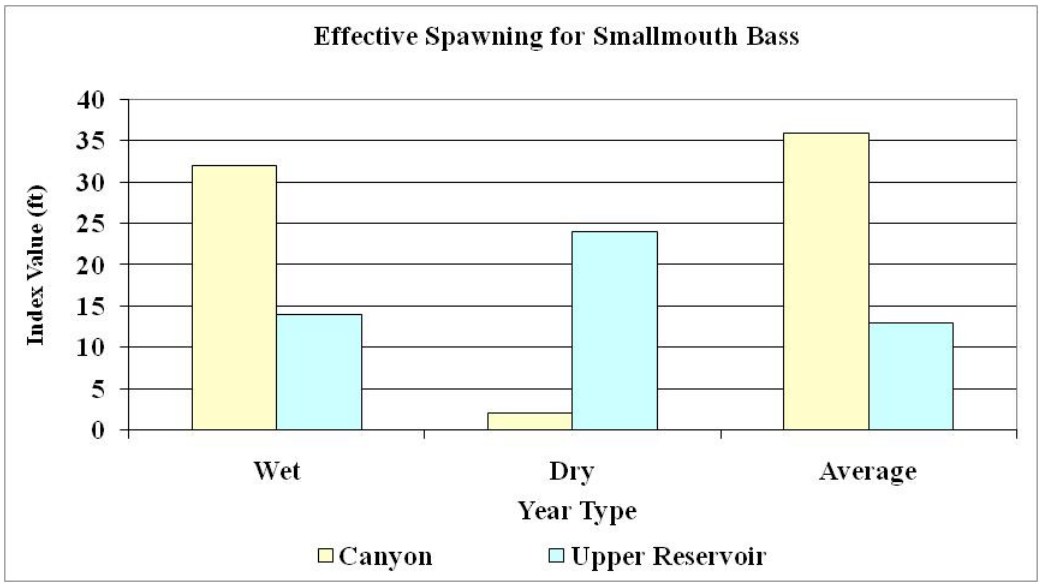


Figure E.4-50. Effective spawning index for smallmouth bass.

Macrophyte WUA estimates in the Canyon Reach were greater than in the Forebay Reach (Figure E.4-49). The margins of the Canyon Reach are dominated by rock faces along the shoreline, which preclude aggregation of suitable substrate and depth ranges. Pool elevation fluctuations in this reach do not appear to be a primary limiting factor for macrophyte bed establishment as in other reaches of Boundary Reservoir.

Periphyton and BMI WUA follow similar spatial patterns as macrophytes (Figure E.4-49). WUA in the Canyon Reach is about the same as the Tailrace Reach, substantially higher than the Forebay Reach and substantially lower than the Upper Reservoir Reach. Periphyton colonizes hard substrates that are not easily moved by current. The Canyon Reach is dominated by substrate sizes larger (e.g., gravel and cobble) than sand, so it has a predictably greater amount of suitable habitat for colonization. The WUA estimates for BMI were slightly higher than those for periphyton because BMI have a wider range of depth suitability and consequently the suitable area exceeds the colonized area of the periphyton food base. Even though substrate sizes present a greater area for potential colonization by periphyton and BMI in the Canyon reach, the occurrence of frequent dewatering and higher mean channel velocities has a greater influence on the periphyton WUA than BMI WUA.

Upper Reservoir Reach

The Upper Reservoir Reach has several unique aspects that are discussed in this section. It is the most riverine of all the reaches and at times experiences little influence from Project operations

on hydraulic conditions and resulting habitat indices. The gradient is relatively low in the downstream 4 miles of the reach, but then increases farther upstream. The different gradients in the Upper Reservoir Reach are reflected in the hydraulics. The lowest mean channel velocities occur in the wide section adjacent to the Town of Metaline, where they range from about 0.5 to 1 foot per second (fps) at the median flow of 19,500 cfs, depending on the forebay elevation. For most of the remainder of the reach, the velocities at the median flow vary between 1 to 3 fps, depending on the location and forebay elevation, while in the upstream mile of the reach, the steepest section, the velocities range between about 2 and 5 fps.

The Upper Reservoir Reach is the most physically diverse reach within the Project area. The Upper Reservoir Reach has over 86 percent of the shallow water habitat in Boundary Reservoir. Within this 7.7-mile reach, variable habitat conditions are provided by several islands, back channels, and near-shore aquatic vegetation. Many of the off-channel areas away from the mainstem currents contain widespread and seasonally dense concentrations of submerged aquatic vegetation, bordered by less dense emergent vegetation and flooded grasses in near-shore areas and flooded swales. These areas serve as both spawning and rearing habitat for various fish species present in the reach. Near-shore areas within the more confined, steeper portions of the reach provide gravel and cobble bedded habitats, often in conjunction with swifter velocities that are more representative of riverine systems supportive of native salmonids. The shallow water zone is quite extensive under most flow conditions. The open water zone rarely exceeds 40 feet in depth, even at normal maximum water surface elevation.

Because of the potential for fish to spawn in the Upper Reservoir Reach, the effective spawning index analysis was conducted for both mountain whitefish and smallmouth bass. The mountain whitefish effective spawning index values are similar for all three representative years, with the highest value of 343 feet for the wet year and the lowest value of 259 feet for the dry year (Figure E.4-51). The small range is a result of the similar water level fluctuations during the potential spawning and incubation period for mountain whitefish, which occurs during the late fall and winter. In contrast, the smallmouth bass effective spawning index exhibits a higher degree of variability, with a high of 24 feet for the dry year and a low of 13 feet for the average year (Figure E.4-50). The smallmouth bass spawning and incubation period typically carries into the spring freshet. The high values in the dry year reflect the lack of increased water surface elevations during low runoff. During the wet and average years, potential spawning nests are exposed when the high flows recede. During the wet and average years the effective spawning index is relatively high for the Canyon Reach compared to the Upper Reservoir Reach, while during dry years the opposite occurs with a relatively high effective spawning index for the Upper Reservoir Reach. Spawning of smallmouth bass, as well as other centrarchids, has been documented in off-channel areas or on the downstream ends of cobble bars in the Upper Reservoir Reach during the spring and summer months. Additionally, mountain whitefish are known to spawn in the upper 0.5 miles of the Upper Reservoir Reach below Box Canyon Dam and in the vicinity of Sullivan Creek.

Due to the presence of low-gradient bars as well as side channels, the Upper Reservoir Reach has the highest stranding and trapping indices for both smallmouth bass and mountain whitefish fry of all the reaches (Figure E.4-45 and E-4.46). Trapping indices are substantially higher during dry years, with indices up to 3294.6 x10^4 feet for smallmouth bass fry and 2344.6 x 10^4 feet for

mountain whitefish fry. The Upper Reservoir Reach also has about 90 percent of the submerged aquatic macrophyte cover, which increases the potential for stranding and trapping. Field studies conducted in 2007 and 2008 confirm that the Upper Reservoir Reach poses the greatest risk of trapping and stranding in the Project area. Smallmouth bass and northern pikeminnow are the sportfish species most at risk of trapping and stranding in the Upper Reservoir Reach, as they were commonly encountered during shoreline backpack electrofishing, boat electrofishing, and fyke net sampling targeting the 0 to 10 foot depths of the shallow water zone. Presence of fish in areas prone to trapping and stranding during the winter months was low.

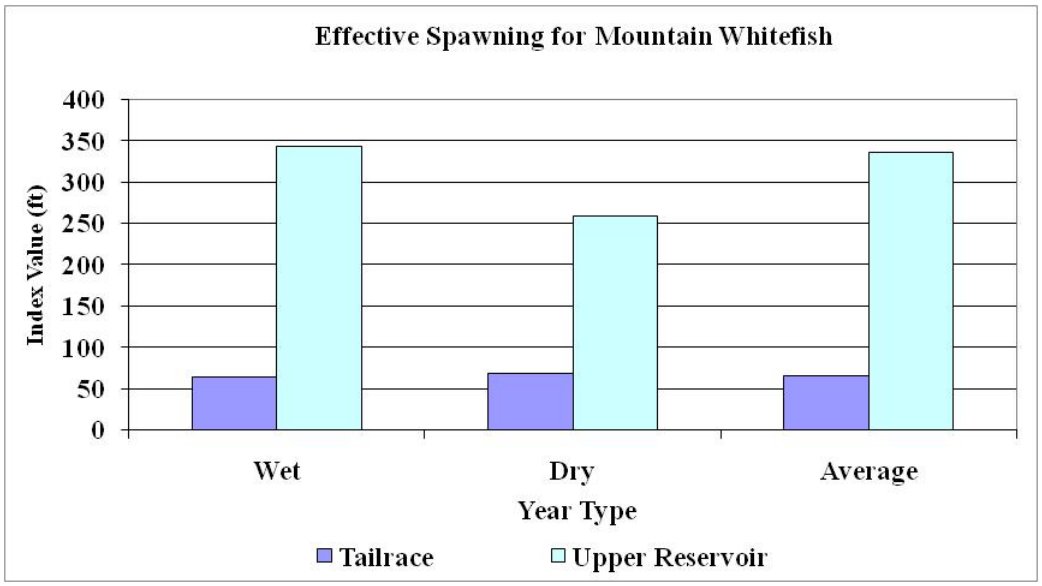


Figure E.4-51. Effective spawning index for mountain whitefish.

Fish WUA values for the Upper Reservoir Reach generally reflect the presence of shallow water habitat. For mountain whitefish, WUA in the Upper Reservoir Reach is higher than in any of the other three reaches for all hydrologic conditions (Figure E.4-47). Adult mountain whitefish catch rates generally corresponded to the trends in WUA indices, as they were highest in the Upper Reservoir Reach in both the shallow and open water habitats. Although the Upper Reservoir Reach mountain whitefish fry WUA values are similar to the Forebay and Canyon reaches, catch rates of young-of-the-year were much higher than in any other mainstem reach. Higher mountain whitefish catch rates in the Upper Reservoir Reach may be due to several factors, including the fact that the primary suitable spawning habitat in terms of mainstem areas, as well as tributary delta and tributary channel habitat, occurs in this reach. In addition, the Upper Reservoir provides extensive, moderately sloping cobble and gravel armored substrates, with moderate velocities that provide riverine like conditions to which the species is adapted.

WUA values for adult cutthroat trout were similar to the Canyon Reach and about 3 times higher than in the Tailrace and Forebay reaches (Figure E.4-47). However, only eight cutthroat trout were captured in Upper Reservoir Reach. Similar to the Canyon Reach, the Upper Reservoir Reach has tributaries that appear to provide a source of cutthroat trout production. Juvenile

cutthroat trout were captured moving downstream via fyke nets in Sweet and Sand creeks during July and August of 2007. However, similar to elsewhere in Boundary Reservoir and tailrace, few native trout were observed in mainstem Upper Reservoir Reach habitats. Adult cutthroat trout do not appear to be using the available habitat in the Upper Reservoir Reach, and this could be due at least in part to the high water temperatures that typically occur during the summer months in the mainstem Pend Oreille River.

Smallmouth bass WUA values were also highest in the Upper Reservoir Reach (Figure E.4-48) and are supported by consistent catches of smallmouth bass as well as other centrarchid species, such as pumpkinseed, largemouth bass, and black crappie, which have generally similar habitat preferences. Although smallmouth bass catch rates were higher in the Canyon and Tailrace reaches, the species was commonly encountered in the Upper Reservoir Reach, especially during May through July when the water temperatures are favorable for spawning activity. The amount of WUA for generic forage fish species is highest in the Upper Reservoir Reach as a result of the shallower depths and accounted for 63 to 66 percent of the total Project WUA, depending on year type.

The Upper Reservoir Reach is shallower than the other reaches of the reservoir, and the substrate consists of finer particles, both of which make the Upper Reservoir Reach more suitable to macrophytes. Consequently, macrophyte WUA estimates are greater in the Upper Reservoir Reach than in the other reaches of Boundary Reservoir or the tailrace (Figure E.4-49). Water surface elevation fluctuations resulting from Project operations are the lowest in this reach and similar during all hydrologic years. The dewatering factor has a smaller influence on potential WUA estimates in the Upper Reservoir Reach, as water surface elevation fluctuations are generally smaller compared to other reaches. Macrophytes provide important habitat for many fish and BMI species. Macrophytes are found in only thirteen percent of the total area in the reservoir, with most of the beds found in the Upper Reservoir Reach.

Similarly, WUA estimates for periphyton and BMI were highest in the Upper Reservoir Reach (Figure E.4-49), but with results more closely related between wet and average years than during the dry year. The physical setting of the Upper Reservoir Reach is more favorable for growth of periphyton and BMI than in the other reaches, because of light availability and shallower depths that promote their production.

Summary

The results of aquatic habitat modeling are best used as a relative index of potentially suitable habitat for fish that can be compared in time and space. Abundance of native salmonids and other target species in the Project area is limited by factors other than microhabitat variables, such as the temperature regime of the Pend Oreille River, predation by birds or other fish species, and the availability of spawning and juvenile rearing habitat in tributaries. For example, the amount of WUA for adult cutthroat trout in the Project area during an average year (3,257 x 10^4 square feet) is about a third higher than for adult smallmouth bass (2,489 x 10^4 square feet). However, smallmouth bass represented about 10.5 percent of the fish community during surveys conducted in 2007 and 2008, whereas cutthroat trout represented less than 0.1 percent. On a relative basis, the results of aquatic habitat modeling are generally consistent with the results of fish, macrophyte, periphyton, and BMI field studies. The Upper Reservoir Reach generally has a

higher diversity and abundance of these fauna because it contains more shallow and complex habitat, a wider variety of substrate types, and is less affected by fluctuations in water surface elevation. In contrast, the Canyon Reach and Forebay Reach are deep, with narrow strips of shallow water habitat adjacent to the shorelines, relatively coarse substrates, and fluctuations in water surface elevation that occur frequently and can be substantially larger than those in the Upper Reservoir Reach. Habitat in the Tailrace Reach is similar to the upper 1 mile of the Upper Reservoir Reach (i.e., Box Canyon Dam Tailrace), except that habitat is more greatly affected by fluctuations in water surface elevations as a result of operations at Seven Mile Dam and Boundary Dam.

4.5.3.2.2. Tributary Delta Habitat

Tributary deltas are transition areas between the tributaries and reservoir that, depending on their physical characteristics, provide a variety of ecological functions. Fish congregate at tributary confluences to feed on aquatic organisms transported downstream in the tributary flow, use the deltas as temperature refugia, or stage in delta habitats prior to spawning runs. Fry and juvenile fish rear in complex habitats associated with the deltas, and the influx of tributary water may provide protection from dewatering associated with fluctuations in reservoir water surface elevation; portions of tributary deltas are present in the varial zone and therefore are affected by these fluctuations. Portions of the deltas change from stream habitat to lacustrine habitat and back again as water levels rise and fall.

As noted previously, there are 28 tributaries to Boundary Reservoir. Most of these are very small, and some contain no measurable surface flow during late summer. Following a screening process that included both desktop GIS and field assessments, delta habitat modeling analysis was limited to only those tributary deltas with substantial potential salmonid habitat. Habitat modeling was conducted for seven tributary deltas: Slate, Flume, Sullivan, Linton, Pocahontas, Sweet, and Sand creeks. Physical habitat modeling of major tributary deltas translated hourly fluctuations in Boundary Reservoir water surface elevations estimated from the hydraulic routing model into estimates of a habitat quality rating (HQR) for native salmonids. The HQR model was applied to three historical river flow conditions to evaluate representative tributary delta habitat for wet, dry, and average years.

The HQR (measured in square feet) was calculated as the product of the areas of lacustrine and riverine habitat (Figure E.4-52) and weighted by their respective riverine or lacustrine Habitat Suitability Index (HSI) scores. HSI values were calculated for individual representative tributary delta areas for three life stages (i.e., adult, juvenile, and fry) of “generic” native salmonids using the species-habitat relationships developed for cutthroat trout by Hickman and Raleigh (1982). The riverine HSI model uses three or four of the following parameters depending on life stage: thalweg depth, percent cover, percent cobble/boulder substrate, percent pool, pool quality (size and depth), and percent fines. The lacustrine HSI model relies on three water quality parameters: water temperature, DO, and pH. To aid in interpretation of the model results, the HQR values for lacustrine habitat and for riverine habitat for various salmonid life stages were plotted on hourly and cumulative bases over the course of the wet, dry, and average years. Details of the HQR modeling are provided in the Sediment Transport and Boundary Reservoir Tributary Delta Habitats (Sediment Transport and Tributary Delta Study) Final Report (SCL 2009a).

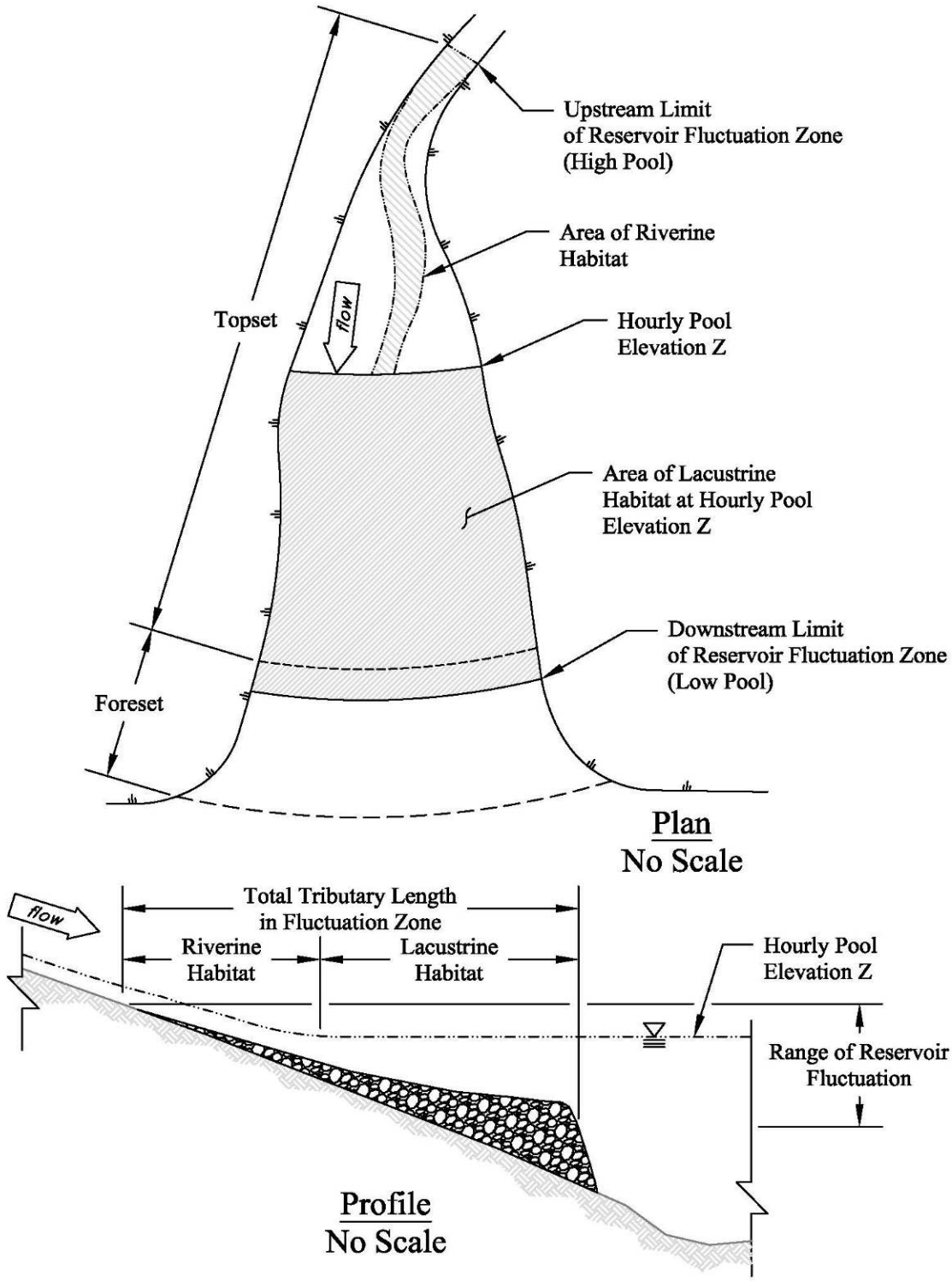


Figure E.4-52. Conceptual model for determination of riverine and inundated habitat, example high pool and low pool conditions.

Results of the Hickman and Raleigh (1982) riverine model for cutthroat trout show that the Slate Creek delta had the highest HSI scores for each of the three different life stages of trout (Table E.4-26), whereas Flume Creek and Sullivan Creek (during periods of regulated flow) deltas had the next highest HSI values. The Pocahontas and Sand creek deltas were rated as unsuitable during some periods because of their dry channel beds (and associated zero depth of thalweg). For low-flow periods, the suitability is low on both these creeks for adult salmonids at an HSI of 0.1.

Table E.4-26. List of tributaries, their calculated Habitat Suitability Indices, and their relative ranking for generic "salmonid" adult, juvenile, and fry life stages in the tributary delta areas of Boundary Reservoir derived from the Hickman and Raleigh (1982) riverine model.

Tributary Name	Adult "Salmonid"		Juvenile "Salmonid"		"Salmonid" Fry	
	HSI	Rank	HSI	Rank	HSI	Rank
Slate Cr.	0.924	1	0.923	1	0.877	1
Flume Cr.	0.820	3	0.900	2	0.739	2
Sullivan Cr. (low flow)	0.703	4	0.340	6	0.340	6
Sullivan Cr. (regulated flow)	0.840	2	0.823	3	0.673	3
Linton Cr.	0.300	5	0.300	7	0.000	8
Pocahontas Cr. (dry)	0.000	9	0.000	9	0.000	8
Pocahontas Cr. (low flow)	0.100	6	0.300	7	0.589	5
Sweet Cr.	0.100	6	0.577	5	0.600	4
Sand Cr. (dry)	0.000	9	0.000	9	0.000	8
Sand Cr. (low flow)	0.100	6	0.703	4	0.160	7

Note:
HSI – Habitat Suitability Index, 0 indicates unsuitable habitat whereas 1 indicates optimal habitat

The Hickman and Raleigh (1982) lacustrine model for salmonid habitat in the shallow water areas of the deltas during periods of inundation suggests a range of habitat quality throughout the year. The model results were driven primarily by the variability in average monthly water temperature (range 1.2ºC to 22.6ºC) (Table E.4-27). Monitoring data suggested that DO and pH were relatively stable over the year with values generally greater than 8.0 mg/L and between 8.0 and 9.0, respectively. Consequently, DO and pH values (8.54 m/L and 8.79, respectively) and suitabilities (0.15 and 0.65, respectively) were not varied over the year as part of HSI calculations. During the month with the greatest average water temperature (August), the HSI was zero (unsuitable habitat) because the water temperature value (22.6 °C) exceeded the maximum suitable value (22.0°C). Conversely, in May and October when the average monthly water temperature is between 11.5 and 15 °C, pH becomes the limiting factor, and the HSI values approach 0.90. As temperature fluctuated between the unsuitable values in August and the near optimal values in May, June and October, the HSI values change accordingly. Because

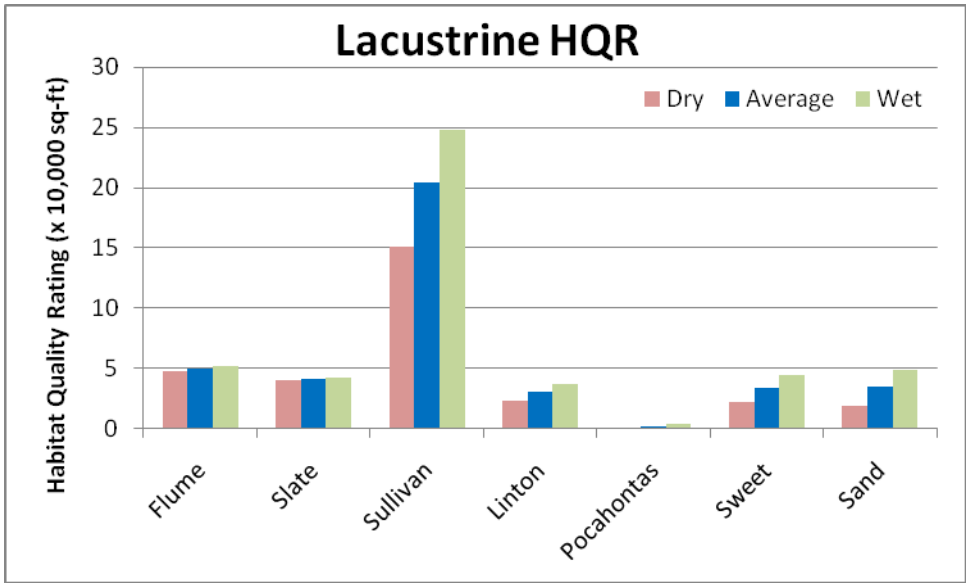
of the influence of the potential presence of thermal plumes at the tributary mouths, the suitability for a portion of the lacustrine area may be greater than 0 during times when water temperatures are unsuitable for salmonids; however the HSI model results do not reflect these small-scale thermal characteristics.

Table E.4-27. Boundary Reservoir average monthly temperatures, their associated suitability, and final reservoir Habitat Suitability Index using Hickman and Raleigh's (1982) lacustrine model.

	Temperature (ºC)		
Month	**Value**	**Suitability**	**HSI**
January	1.2	0.15	0.15
February	1.9	0.24	0.24
March	3.9	0.48	0.67
April	7.5	0.83	0.81
May	11.7	1.00	0.86
June	15.3	0.99	0.86
July	21.3	0.16	0.16
August	22.6	0.00	0.00
September	18.9	0.66	0.75
October	13.0	1.00	0.86
November	6.7	0.77	0.79
December	2.4	0.30	0.30

Deltas for two of the tributaries, Slate Creek and Flume Creek, are expected to expand over an anticipated 50-year license period because these tributaries are located in inlets and protected from sediment mobilizing mainstem current velocities. Consequently, HQR values are expected to change over the next 50 years for Slate and Flume creeks. In contrast, the other five tributary deltas are currently in equilibrium and unlikely to change their current physical characteristics.

A number of patterns are apparent from the results of the HQR modeling. Each of the modeled tributary deltas had minimum lacustrine HQRs of 0 because water temperatures during August were considered unsuitable. With the exception of Slate, Sullivan, and Sweet creeks, minimum fry, juvenile and adult riverine HQR values were also 0 under all year types, but different factors were limiting at different tributaries. Average lacustrine HQR values increased from dry, to average, to wet hydrologic conditions, although differences among years were small for Flume and Slate creeks (Figure E.4-53). Although not displayed, maximum lacustrine HQR values demonstrated a similar pattern to average HQR values.



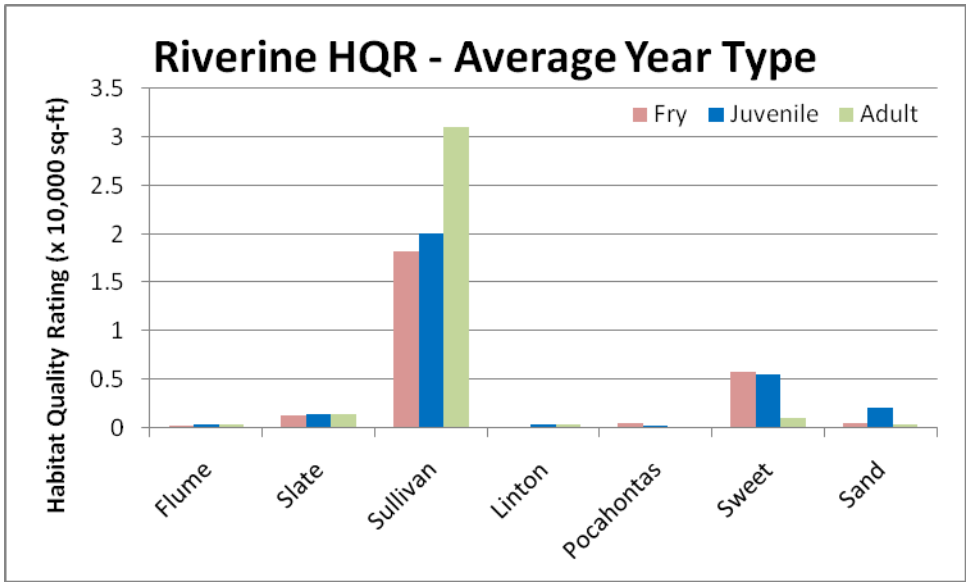


Figure E.4-53. Average lacustrine and riverine HQR values. HQR values for Slate and Flume creeks are for Years 1-17 of the 50-year evaluation period.

Under the modeled historic conditions, the lacustrine HQR results followed the same general temporal pattern for all tributaries, which is a function of water temperature. Under the proposed operations for the new license, it is anticipated that trends would be similar to the historic conditions. In the months of April and October when temperature is within the optimal range, the HQR values peak. Between these two maximums, HQR values rise and fall as water temperatures warm (prior to April), become unsuitably hot (August), and then cool (after October). In the wet (1997) and average (2002) years, the lacustrine HQR values reach a maximum at each delta during high mainstem flows because reservoir water surface elevations

exceed the upper extent of the delta. Under these high flow conditions, the delta is fully inundated, including areas at higher elevations than the delta, so the lacustrine area is held constant at the maximum. Under these same conditions, the riverine HQR values go to zero because no free-flowing stream habitat exists on the delta.

The Sullivan Creek delta supplies substantially more lacustrine and riverine habitat than any of the other tributaries, with average HQRs of 20.4 x 10^4 square feet and 2.0 x 10^4 square feet for lacustrine and riverine juvenile habitat, respectively. For all tributaries, average lacustrine HQR values are about an order of magnitude or higher than riverine HQR values. From highest to lowest, the ranking of tributaries based on lacustrine HQR values was as follows: Sullivan, Flume, Slate, Sand, Sweet, Linton, and Pocahontas creeks. From highest to lowest, the ranking of tributaries based on riverine HQR values was as follows: Sullivan, Sweet, Slate, and Sand creeks (Figure E.4-53). Flume, Linton, and Pocahontas creeks had nearly negligible suitability, with riverine HQR values all less than 600 square feet.

Daily water surface elevation fluctuations from Project operations change the location and extent of the thermal plumes during the summer months. Continuous temperature data collected during 2007 and 2008 at five tributary deltas that flow throughout the summer months (Sullivan, Slate, Sweet, Flume, and Linton creeks) demonstrated that the positions of thermal plumes were dynamic, yet they typically persisted throughout the range of daily water surface fluctuations. The thermograph data clearly show that temperature ranged between the cool water of the tributary flow and the warm water of the mainstem and that the temperatures varied as the water surface elevation of the mainstem fluctuated.

The thermal plume mapping and the analysis of the mapping results indicated that at all the tributary deltas except Slate Creek, the size of the thermal plume at the tributary delta increased with an increase in mainstem water surface elevation adjacent to the tributary delta. In some cases, such as at Sweet Creek, the relationship is less clear, as factors other than mainstem water surface elevation apparently influence the area of the thermal plume. In the case of Flume Creek, a strong relationship exists between the mainstem water surface elevation and thermal plume area. For Linton and Sullivan creeks, the trend was also fairly strong, but there was more variability between mapped plume areas for a given mainstem water surface elevation. Based on the data collected, over the long term, lower mainstem water surface elevations would result in smaller average thermal plume areas than higher mainstem water surface elevations. Therefore, higher Project operating elevations for a given Project inflow tend to increase the area of the thermal plumes.

For three of the tributary deltas (Flume, Sullivan, and Sweet creeks), cold inflow from the tributaries quickly mixes with mainstem flow when the mainstem water surface elevation adjacent to the tributary delta falls below the top of the delta foreset slope. These conditions are anticipated to rarely occur during normal operations under the summer water surface elevation restriction proposed for the new license and are similar to the recent voluntary summer water surface elevation restriction. The substantial reduction of the thermal plume area is a result of mainstem current sweeping the cold tributary flow away and quickly mixing it with the warm mainstem water. Slate Creek and Linton Creek plumes are protected by morphological features that reduce the sweeping action of the mainstem flows. The results of thermal plume modeling

under existing conditions indicated that there are substantial differences between the estimated mean daily minimum area of combined thermal plume areas for Sullivan, Sweet, Flume, and Linton creeks for wet (6.0 x 10^4 square feet), dry (3.5 x 10^4 square feet), and average years (5.2 x 10^4 square feet). In general, the thermal plume areas were fairly similar for the wet and average years, but the average minimum area in dry years is about 29 percent smaller than average years and about 39 percent smaller than wet years. During dry years Sweet Creek and Sullivan Creek have the highest risk of thermal plumes disappearing, but modeling suggests these occurrences would be rare. Complete disappearance of thermal plumes requires a combination of low Project inflow and unusually low forebay water surface elevations, which are uncommon events. Although the Project has no control over inflows and the year type, formalizing the summertime water surface elevation restriction is anticipated to result in a small reduction in the potential occurrences of low thermal plume areas during dry years, with a modeled mean daily minimum area of 3.7 x10^4 square feet.

Fish passage at tributary deltas was evaluated considering both the existence of potential barriers and the frequency and duration that a potential barrier was exposed under existing Project operations. Fish passage can become an issue at tributary deltas if the mainstem water surface exposes the steep leading edge or face of the delta deposits, referred to as the foreset slope. On this slope, fish passage can be jeopardized because water drains into the loose delta sediment deposits, the stream becomes too steep and/or shallow, or the stream divides into multiple small channels that become impassable. Within the tributary deltas, no barriers were identified that would affect fish passage to upstream tributaries. Even where potential barriers exist (e.g., the Pocahontas Creek foreset slope), they are not exposed for a long enough duration (typically no longer than a single day) to substantially affect upstream fish movement.

4.5.3.2.3. LWD Recruitment and Transport

LWD can be an important component of aquatic habitat in both riverine and reservoir habitats (Bjornn and Reiser 1991, Northcote and Atagi 1997). LWD provides habitat complexity, cover, and substrate for fish and macroinvertebrates. As LWD decomposes, it may also provide nutrients to the water column and sediments (Harmon et al. 1986). LWD in reservoirs can be divided into three categories, each with distinct biological functions, based upon location: (1) submerged LWD, (2) floating LWD, and (3) shoreline LWD.

No generally recognized criteria for LWD size and distribution in Pacific Northwest reservoirs are available. Nevertheless LWD that remains in place on the shoreline has the potential to create water velocity breaks, fish cover, complex habitat structure, and surface area for the production periphyton and macroinvertebrates that prefer woody substrate over rock substrate.

The Project affects the abundance, distribution, and quality of LWD as a component of aquatic habitat within the reservoir and downstream of the Project. Water surface elevation fluctuations in Boundary Reservoir may affect wood recruitment indirectly by affecting the development of riparian trees adjacent to the varial zone. Wood recruitment mechanisms adjacent to lakes or reservoirs are primarily windthrow, senescence, or mass wasting events. Recruitment may also occur by transport from tributaries or passage over Box Canyon Dam during periods of spill, but the size of most of the tributaries draining to Boundary Reservoir is too small to transport large wood pieces that could provide substantial habitat structure. LWD that collects in the Boundary

Forebay is currently removed from the river and used as firewood, sold as commercial timber, or disposed of in other ways.

The increase in LWD collected at the trashrack during the 2008 high flow year compared to 2007 indicates that peak flows are important for the redistribution of LWD in the Pend Oreille River (Table E.4-28). If LWD is delivered to Boundary Reservoir from tributaries or Box Canyon Reservoir, a portion could eventually become stranded on the floodplain or gravel bars and, when inundated during high pool conditions, serve as littoral habitat for aquatic invertebrates and fish. As reservoir levels recede, some of the non-anchored pieces could float off of these areas and into the main portion of the reservoir.

Table E.4-28. Summary of LWD collected at Boundary Dam during 2007 and 2008.

	Diameter at Large End	5 to 17 ft	17 to 50 ft	Greater than 50 ft	Total	Number with Root Wads
March 22 and July 29, 2007	4 to 12 in	130	36	2	168	17
	12 to 24 in	10	19	6	35	15
	24 to 32 in	1	1	2	4	2
	> 32 in	0	0	1	1	1
	Total	141	56	11	208	35
June 2–17, 2008	4 to 12 in	1084	194	23	1301	109
	12 to 24 in	82	41	23	146	12
	24 to 32 in	3	6	5	14	5
	> 32 in	3	1	0	4	2
	Total	1172	242	51	1465	128

Reservoir fluctuations can affect the portion of time that a given piece of LWD provides habitat. LWD that is stranded on mid-channel bars or along the shoreline during peak runoff periods may be at elevations above the water surface during other parts of the year. Other pieces of LWD may be located within the varial zone affected by Project operations and may intermittently provide aquatic habitat.

Removal of LWD at the Boundary Forebay trashrack results in the potential depletion of shoreline wood farther downstream in the Boundary tailrace or within Seven Mile or Waneta reservoirs. Similarly, removal of LWD at Albeni Falls Dam and Box Canyon Dam depletes the amount that enters Boundary Reservoir.

Mapping conducted during 2007 demonstrated that LWD was distributed in concentrated areas throughout the reservoir, and some of these areas have remained stable since 2005. Throughout the reservoir, 1,531 pieces of LWD were counted, which had a total volume of 63,350 cubic feet. The LWD counted was primarily along the shoreline because submerged wood was difficult to observe. However, some of the LWD would be submerged for part of the year, depending on the flow from Box Canyon Reservoir and operation of the Project. The volume and number of pieces of shoreline LWD per mile of reservoir was highest in the Canyon Reach (118

pieces/mile), lowest in the Upper Reservoir Reach (53 pieces/mile), and intermediate in the Forebay Reach (80 pieces/mile). Stumps inundated when the Project was created accounted for 141 pieces (about 8 percent) of the LWD counted along the shoreline. The number of stumps counted in the inventory is considered an underestimate, because additional stumps were likely submerged and not visible during the survey. Floating LWD generally ends up at the trash rack and is removed from the reservoir (LWD Management Study, SCL 2009a).

Mapping indicated that LWD in the largest diameter category (i.e., greater than 32 inches) is extremely rare (about 0.4 percent if the numerical total and 1.3 percent of the volume) and LWD in the largest length category is numerically low (399 pieces, 26 percent of total) but provides the most wood volume (40,717 cubic feet, 64 percent of total). Records of LWD removal at Boundary Dam indicate the proportion of wood in the largest length and diameter categories transported during 2007 and 2008 is also very low, so its removal reduces even further the amount of a rare resource that could potentially benefit aquatic habitat in the Pend Oreille River. Notably, 164 pieces of LWD greater than 12 inches in diameter were removed at Boundary Dam during 2008, which is about 29 percent of the LWD standing crop of those size categories that were counted along the shoreline during 2007. Consequently, LWD removal at Boundary Dam, particularly during high flow years, appears to potentially have a substantial effect on the number and volume of LWD pieces downstream of Boundary Dam in the Pend Oreille River.

Mass wasting events along the reservoir shoreline can result in the recruitment of new LWD to the system. However, areas with chronic erosion problems will not grow new trees. An erosion study conducted as part of relicensing (Erosion Study Final Report, SCL 2009a) inventoried 132 erosion sites along 15.5 miles of reservoir shoreline using GIS and aerial photos (LWD Management Study, SCL 2009a). Trees and LWD were observed at only a few locations. Consequently, little high value potential LWD is available for recruitment. Of inventoried erosion sites, 60 were visited with RPs to evaluate site-specific effects and the potential need for erosion control measures. Of these, only one of the sites considered for erosion control measures, near Sullivan Creek (site 26E112), was identified as having a substantive effect on riparian habitat. Overall, Project-related mass wasting along the reservoir shoreline is considered to have a minor effect on LWD that could contribute to aquatic habitat.

4.5.3.2.4. Aquatic Productivity

The physical characteristics and chemical constituents of the water, such as water temperature, DO, pH, and nutrients (nitrogenous and phosphorus compounds), in Boundary Reservoir can affect fish and aquatic productivity. Details of water quality and chemistry are described in Section 4.5.2. This section addresses operational effects on water quality that are pertinent to fish and aquatic resources.

Water temperatures in Boundary Reservoir are cold in the winter and warm in the summer (Figure E.4-54). The wide range of temperatures in Boundary Reservoir tends to limit the productivity of both cold water fish (e.g., trout) and warm water fish (e.g. pumpkinseed), which prefer summer temperatures less than 65º F (18.3 ºC) and greater than 75 ºF (23.9 º C), respectively (Holton 1990). Cool water fish species such as smallmouth bass that prefer intermediate temperatures and tolerate relatively wide extremes are not limited by the temperatures present in Boundary Reservoir. Water temperature modeling (CE-QUAL-W2)

conducted as part of the application for 401 certification and TMDL processes demonstrated that water temperatures under existing conditions are similar to what they would have been under natural conditions (see Section 4.5.2.2 for detail regarding the results of temperature modeling).

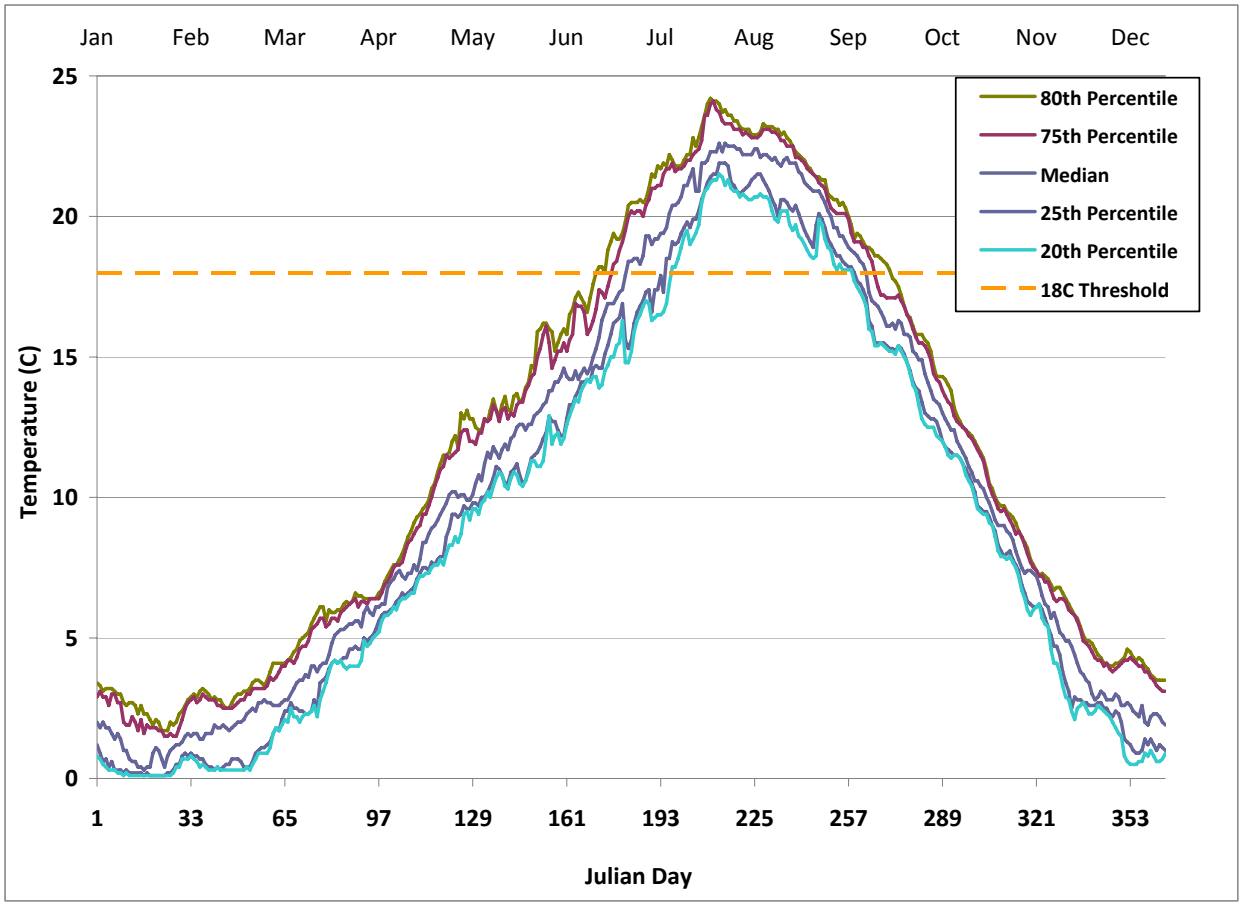


Figure E.4-54. Median, 75th, and 80th percentile of average daily temperature at USGS gage 12398600 located at the international boundary for water years 1974 through 2007**.**

DO is strongly influenced by, and inversely related to, water temperature and can be affected by plant and animal respiration and the amount of mixing in the water column. DO monitoring conducted in 2007 and 2008 indicated that Boundary Reservoir is generally above the state standard of 8.0 mg/L, but several exceedances were recorded for July and August of 2008 within deeper portions of the Canyon and Forebay reaches, and at a shallow water site near the Town of Metaline. In addition, observations indicated DO decreased about 1.0 mg/L from the surface to the deepest measurement between July and October 2008, and these decreases were more prevalent at the Forebay Reach.

Macrophyte beds have a localized diurnal effect on DO levels as a result of photosynthesis and respiration. Monitoring of DO levels upstream, downstream, and within macrophyte beds revealed low variability at the upstream and downstream locations but high variability within the

macrophyte beds. During periods of high photosynthesis/respiration, monitoring indicated that DO levels at night would frequently drop below 8 mg/L in the macrophyte bed, with the lowest DO level recorded at 2.7 mg/L (Evaluation of the Relationship of pH and Dissolved Oxygen to Macrophytes in Boundary Reservoir [Relationship of pH and DO to Macrophyte Study] Final Report, SCL 2009a). Vertical profiles taken across the channel from Metaline during August demonstrated DO levels at or less than 8 mg/L throughout the water column. This area has the most extensive macrophyte beds in the reservoir. However, despite some indications of low DO levels in the reservoir near to and within macrophyte beds, DO nearly always remains above the state standard and is suitable for both salmonids and non-salmonids.

DO levels less than 8 mg/L in the reservoir could adversely affect pelagic and demersal fish species living in deeper waters during the late summer. Deep-water gillnets deployed in the Forebay Reach during June through September captured 154 fish, including yellow perch (30.5 percent of catch), largescale suckers (26.6 percent), northern pikeminnow (18.8 percent), smallmouth bass (9.7 percent), and peamouth (7.8 percent). Tench, rainbow trout, lake trout, burbot, and walleye were also represented in the deepwater gillnet catch, but in relatively low proportions. Bull trout, while not captured in the Forebay sampling, are known to use deeper lacustrine waters based on radio telemetry studies conducted in Lake Pend Oreille (Bassista et al. 2005). Other trout species such as cutthroat and brown trout may be found in pelagic waters, but typically reside in relatively shallow waters and would therefore be at less risk of adverse effects from low DO levels in deeper portions of the northern part of the reservoir.

EPA (1986) reports that DO levels less than 8 mg/L for salmonids, other than embryos, results in some level of impairment, with severe impairment occurring below 4 mg/L and the limit to avoid acute mortality at 3 mg/L (Table E.4-29). Levels are somewhat lower for non-salmonids, with impairment starting at levels less than 6.5 to 6.0 mg/L and acute levels occurring below 3 to 4 mg/L for early life stages and older fish, respectively. The monitoring data suggest that at some times and locations DO levels may result in temporary stress to fish and invertebrates in Boundary Reservoir. Some fish may be able to avoid stressful conditions by moving to more suitable conditions, for example from the interior of a macrophyte bed to its edge, but such movements, particularly for young-of-the-year fish, may also expose them to predators that typically inhabit areas outside of or at the fringe of macrophyte beds.

Table E.4-29. Dissolved oxygen (mg/L) levels and fish and invertebrate impairment (EPA 1986).

	Salmonid		Non-salmonid		
Impairment Level	**Embryos**	**Other Life Stages**	**Early Life Stages**	**Other Life Stages**	**Invertebrates**
No production impairment	11	8	6.5	6	8
Slight production impairment	9	6	5.5	5	
Moderate production impairment	8	5	5	4	5
Severe production impairment	7	4	4.5	3.5	
Limit to avoid acute mortality	6	3	4	3	4

According to Ecology's aquatic life criteria in fresh water, pH should be within the range of 6.5 - 8.5 for salmonid spawning, rearing, and migration, with a human-caused variation within this range of less than 0.5 unit (Ecology 2006a). The pH level is important to fish and other aquatic fauna because it affects physiological processes such as blood chemistry, ion balance, and respiration, and affects the toxicity of other compounds, such as ammonia and heavy metals, in the water (Bone and Marshall 1982; EPA 1986; Haines 1981). The pH level can also indirectly affect fish by reducing the abundance or diversity of BMI (EPA 1986). Based on pH measured in the reservoir in 2007 and 2008, this range was exceeded at several sampling stations in June, July, and August (SCL 2009a). The pH of water entering the Project area from Box Canyon Dam exceeded the 8.5 standard in June, July, and August, with 9.1 as the highest value recorded. Stations in the Upper Reservoir Reach consistently had the highest pH, with maximum observed levels of 9.1, which could mean there are occasional, localized effects on pH due to macrophytes. However, system-wide pH in the Project area appears to be dictated by inflows from Box Canyon Reservoir and may also be affected by background geology. In macrophyte beds, pH is elevated at times due to photosynthesis, but these effects are localized and do not appear to influence pH downstream of the beds (see Section 4.5.2.2 for greater detail regarding high pH measurements and their causes).

Nutrient monitoring conducted in 2007 and 2008 indicated that Boundary Reservoir is oligotrophic, which means that nutrient levels are relatively low. The observed seasonal pattern of nutrient concentrations in Boundary Reservoir suggests that Project inflows are an important contributing factor to aquatic primary productivity, while no correlations could be found between nutrient concentrations or phytoplankton production and Project operations.

Phytoplankton primary production was assessed through measurement of chlorophyll *a* in the water column and found to be in low concentrations throughout the reservoir. Overall, no definable difference was observed between littoral and pelagic sampling stations, and no correlation was observed between chlorophyll *a* concentrations and water surface fluctuations related to Project operations (Water Quality Study Final Report, SCL 2009a).

Primary production in the form of macrophytes can be important to the aquatic ecosystem by providing food, substrate, cover, and habitat structure. However, the vast majority of macrophytes in Boundary Reservoir are fast-growing non-native species, primarily Eurasian watermilfoil and curly pondweed, which tend to out-compete native macrophyte species. Many of the fish species that inhabit Boundary Reservoir use macrophyte beds during one or more of their life history stages, but these are primarily the non-salmonid or non-native fish species.

Macrophytes can be affected by water surface elevation during spring and fluctuations in water surface due to Project operations. Pool elevations during early spring control macrophyte bed distribution. According to habitat suitability information developed for modeling macrophyte colonization (SCL 2009c), if young plants are exposed to air for more than 72 hours they will die. In contrast, if water levels rise, young plants that colonize lower elevations may receive insufficient light for adequate growth. These effects are related more to the magnitude of the spring runoff than to Project operations. Exposure to air during hot summer periods may also affect macrophytes; however established macrophytes are relatively hardy during these periods and the short dewatering periods associated with Project operations have little effect on them. Even extreme drawdowns

conducted in 2007 and 2008 as part of relicensing studies did not reduce the areal extent of macrophyte beds, indicating that summer pool fluctuations have at most a minor effect on macrophyte beds. On a relative basis, Project operations would have a smaller effect on macrophytes in the Upper Reservoir Reach than in the Canyon and Forebay reaches because of the partial decoupling of upper and lower reservoir water surface elevations that results from the channel constriction at Metaline Falls.

Productivity of zooplankton and BMI is also low in Boundary Reservoir. Larger, more desirable zooplankton species that are preferentially consumed by fish (e.g., cladocera) are more abundant in summer than in winter. The zooplankton community is primarily defined by inflow populations from Box Canyon Reservoir and low primary production. Comparison of the zooplankton community sampled hourly over 24-hour periods below Box Canyon Dam and Boundary Dam demonstrated that flow releases had no definable effect on the zooplankton community in the Boundary Dam tailrace.

Periphyton and BMI require appropriate substrate for production. Periphyton biomass is primarily controlled by nutrient availability and secondarily by light levels, while BMI biomass is controlled by food availability (periphyton production). Fluctuations in reservoir water surface elevation affect periphyton and benthic macroinvertebrate production through desiccation, influencing light penetration, and substrate availability. Repeated exposure to air and inundation associated with changes in water surface elevation result in alternating periods of impaired conditions and recovery/recolonization. The decline in suitability of habitat for periphyton and BMI communities occurs rapidly and at about the same rate during desiccation periods, with nearly all periphyton and BMI habitat becoming unsuitable in about 24 hours. Habitat suitability curves developed for the habitat model suggest that suitability remains relatively high (0.8 or greater) for desiccation periods of 10 hours or less. The time required for complete recovery of periphyton and BMI communities is also about the same at about 56 days, but the rate of periphyton recovery is initially somewhat higher than for BMI (Mainstem Habitat Modeling Study Final Report, SCL 2009a). In either case, rates of decline in habitat suitability are substantially higher than rates of recovery. Consequently, Project operations that frequently dewater shallow areas of the reservoir reduce the potential for periphyton and the BMI community to achieve maximum biomass.

4.5.3.2.5. Fish Entrainment and Habitat Connectivity

As described in Section 2.1.1 of this document, Boundary Dam is situated in a narrow canyon at PRM 17.0 on the Pend Oreille River. Although anadromous fish no longer have access to the Pend Oreille River, potential fish connectivity between habitats upstream and downstream of Boundary Dam, and potential injury or mortality of fish that may be entrained in Project facilities, have been identified as issues.

There are three pathways through which fish pass downstream through Boundary Dam: turbines, spillways, and, possibly, sluiceways. The likelihood that fish would pass through one of these pathways is related to the percentage of the river flow moving through a given pathway, the relative depth of the pathway entrance, the time of year, and the habitat use and periodicity of particular fish species that places them in the vicinity of the pathways and at risk of entrainment. The risk of injury or mortality associated with each pathway is a function of fish occurrence in

the vicinity of the pathway and hydraulic conditions experienced by the fish during passage and upon reintroduction to the tailrace.

Entrainment Mortality

Fish experience injury or mortality when exposed to a variety of hydraulic or physical conditions when passing through hydroelectric facilities. These include (1) physically contacting solid structures at high velocity (strike), (2) exposure to shearing water velocities, (3) grinding between moving and stationary mechanical components of a turbine, (4) exposure to turbulent conditions that can result in disorientation of the fish and, as a result, a greater risk of predation, (5) exposure to cavitation from the rapid formation and collapse of small air bubbles at extremely high water velocities, (6) exposure to rapid pressure changes that can result in bursting of the swim bladder or blood embolisms, (7) and exposure to supersaturated TDG levels. Each of these mechanisms was considered in the evaluation of entrainment mortality rates at Boundary Dam, except TDG, which is discussed in Section 4.5.2.2.

The mortality estimates provided below are based on a range of field studies performed at projects throughout North America and laboratory studies of fish injury and mortality associated with hydraulic conditions likely to occur during passage. Although these estimates are based on the best available information, the unique characteristics of any hydroelectric project make estimates based on studies performed at other projects somewhat speculative. Therefore, the estimates are provided in terms of probable ranges of mortality. Details of the analysis described below can be found in R2 Resource Consultants (2006).

Turbines

When inflow to the Project is less than the total power plant capacity (approximately 56,000 cfs), the Project is operated as a load-following facility. Because of a large total power plant capacity relative to normal flows in the Pend Oreille River, spill generally occurs only during spring runoff. This results in turbine passage being the only existing pathway for fish to move downstream through the Project most of the time.

Mortality studies have been performed at a large number of hydroelectric projects throughout North America. In conjunction with the U.S. Department of Energy's Advanced Hydro Turbine System Program (AHTSP), hundreds of turbine mortality study results were compiled and used to develop predictive equations of turbine mortality based on specific turbine characteristics (Franke et al. 1997). The predictive equation for mortality through Francis turbines was used to estimate the likely mortality rate through the turbines at the Project.

Strike and shear are the major factors that are addressed by the predictive equation, which uses turbine size, rotational speed, head, number of buckets (or vanes), flow, mechanical efficiency, and the length of the fish entrained to estimate the probability that a fish of a given size will come near to or in contact with a structural element as it passes through the turbine. There is a greater confidence in estimates of mortality for salmonids than for other species because the large majority of field survival studies at hydroelectric projects in North America, which are the basis for the predictive equations, have been focused on salmonid species.

The analysis considered three sizes of salmonids: 100 millimeters (3.9 inches) to represent juveniles, 250 millimeters (9.8 inches) to represent moderate size adult trout and whitefish, and 600 millimeters (23.6 inches) to represent large trout. One consideration with respect to fish size is that the trashrack bars have spaces 5.5 inches wide and the mortality analysis assumed that this spacing would not physically preclude any of the target sizes of fish from being entrained in the turbine flow. However, studies at hydroelectric projects have shown that the majority of fish entrained in turbines are smaller, juvenile fish, even if larger fish are present and theoretically able to pass through the trashrack spacing, because larger fish have adequate swimming capacity to avoid entrainment (Stone & Webster 1992).

Based on the characteristics of the six turbine units at the Project, and the fish sizes being considered, the AHTSP predictive equations estimated that the new turbines in Units 55 and 56 should have slightly greater survival for salmonid species passing through them than the older Units 51 through 54 because they have fewer buckets within the turbines (Table E.4-30). These estimated mortalities were found to remain relatively constant from turbine flow rates slightly below the best efficiency point all the way up to the maximum unit flow capacity. This is because increasing flow generally increases fish survival by creating smoother hydraulics and moving the fish through the system more rapidly, whereas decreasing turbine efficiency tends to decrease survival by creating greater turbulence and shear zones. The two factors of increasing flow and decreasing efficiency tend to balance each other out through the high end range of turbine operation (from best efficiency point to maximum flow). However, operations below the best efficiency point, when flow and efficiency are both reduced, are estimated to increase mortality rates to levels greater than those in Table E.4-30.

Table E.4-30. Estimated mortality through the Project turbine units based upon the AHTSP predictive equation.

Turbine Units	Percent Mortality by Fish Length		
	100 mm	**250 mm**	**600 mm**
51- 54	6 – 15	13 – 33	26 – 65
55 and 56	5 – 12	11 – 28	23 – 59

Spillways

Boundary Dam has two spillways, one on either side of the main arch dam section that (see Section 2.1.1, Figure E.2-1). The spillway chutes do not extend to the tailwater; consequently, water is released into open air and plunges into a pool in the tailrace. Of the seven potentially damaging conditions listed above, the two that are major considerations associated with spill flow are shear and strike. Damaging shear occurs when the plunging spill flow enters the tailrace and there is a substantial difference in velocities where the two flows come together. Although there is also potential for shear zones along the periphery of the flow within the concrete spillway chute, laboratory tests of the effects of localized shear have shown there is little to no injury at differential velocities of up to approximately 60 fps (PNNL 2000). The length and height of the spillway chutes at Boundary Dam should result in maximum velocities

of less than 60 fps prior to flow release from the end of the chutes. Therefore, shear conditions should not be injurious within the initial flow through the spillway chutes.

Strike can occur if the spill flow comes in contact at high velocity with projections within the spillway chute, or with rock along the bank or the bottom of the plunge pool. Although the flip bucket at the end of the Spillway 1 chute is a projection into the flow path it is well rounded and the flow should generally follow the shape of the chute floor without producing damaging strike potential. No projections are readily apparent within the chute of Spillway 2.

Grinding, cavitation, and rapid pressure changes are not generally problems associated with spill flow. Turbulence in the tailrace for the fish that survive the plunge could be a concern as the fish are likely to be initially disoriented upon entry into the tailrace; however, there does not appear to be any significant aggregations of the predatory fish or birds in the Boundary Dam tailrace that usually take advantage of disoriented fish.

The greatest impact on fish passing through spill is expected to occur upon entrance of the plunging flow into the tailrace. Based on the height of the spillways above the tailrace (155 to 170 feet from the point of flow release from the spillway chute to the plunge pool, depending upon tailwater level), the velocity of the plunging flow immediately downstream of Boundary Dam is estimated to exceed 100 fps upon impact with the tailrace plunge pool. Estimated mortality ranges for spillway downstream passage routes are shown in Table E.4-31. Descriptions of potential passage outcomes are described below.

- No field studies estimating mortality from spillway passage have been performed at Boundary Dam. However, a number of field and laboratory studies were reviewed to understand the effects of passage by spillway and shear on fish and the associated mortality levels (Hamilton 1955; R2 Resource Consultants 1998b; PNNL 2000; Normandeau Associates 2002). Based on this review, the following conclusions are made concerning the mortality of fish of passing through the spill flow at Boundary Dam (Table E.4-31). *Extremely low spill flow rates where the flow passes down or plunges onto the rock and does not reach the open water of the tailrace*: Near 100 percent mortality for fish of all sizes is likely.
- *Relatively low spill flow rates, but high enough that the majority of the flow reaches the plunge pool*: If roughly half the flow dissipates into mist before reaching the tailrace, and half the fish leave the flow and freefall in air to the tailrace, then small fish (approximately 100 millimeters) would likely experience a 60-70 percent mortality rate. Small fish that remain in the jet would likely experience near 100 percent mortality due to exposure to shear, while small fish that leave the jet and freefall to the tailrace would likely experience low mortality. The larger salmonids (approximately 600 millimeters) are expected to experience similar or slightly lower mortality rates of 40-50 percent, but for the opposite reasons: fish that leave the jet would be expected to experience very high mortality while those that remain in the jet would likely experience lower mortality due to a greater resistance to shear forces.
- *Larger spill flows where the large majority of the flow remains in a coherent jet to the tailrace:* If fish do not impact the bottom of the plunge pool, which seems reasonable because the plunge pools exceed 75 feet in depth, the major source of mortality would

likely be due to the shear effects on fish near the periphery of the jet. The greater the magnitude of the spill the more likely the fish will be in the body of the flow and not exposed to the peripheral shear effects, so there is a range of mortality probability with decreasing estimated mortality associated with increasing spill flow rates. For smaller fish this range is estimated to be about 50-80 percent, which would be similar to the results of field studies at Upper Baker Dam with similar spillway characteristics (Hamilton 1955), whereas for larger fish the mortality could be as low as 20-40 percent.

Table E.4-31. Estimated mortality ranges for spillway and sluiceways downstream passage routes.

Passage Route	Range of Estimated Mortality by Fish Length			Comments
	100 mm	250 mm	600 mm	
Spillways	50% - 80%	35% - 65%	20% - 50%	• Depends on spill flow rate • Spillway 1 better for smaller fish • Spillway 2 better for larger fish
Sluiceways	40% - 70%	25% - 55%	10% - 40%	• Expert opinion based on reduction from spill estimates • Assumes adjacent sluiceways are not operated simultaneously • Does not consider influence of TDG impacts

Sluiceways

Boundary Dam has seven sluiceways located at about mid-height of the dam that release flow into the plunge pool below the dam (Figure E.2-1). The sluiceways are generally used to supplement spill flow during extreme high-flow events. Given the flow capacity and the dimensions of the sluiceway outlet, a greater percentage of the entrained fish are likely to remain in the body of the flow through a sluiceway and not be exposed to the shear conditions of the periphery as the jet enters the tailwater. Additionally, the water jets from the sluiceways are closer to a horizontal trajectory than the spillways upon entry into the tailwater, which should reduce the likelihood of fish striking the bottom of the plunge pool compared to passage via the spillways, which as described above, is considered low. These two conditions suggest that the mortality of entrained fish in the sluiceway flow should be somewhat lower than is estimated for the flow through the spillway at the same magnitude of flow and result in the estimated range of mortality in Table E.4-31. Also, because the sluice gates are located at depth in the reservoir, many fewer fish are exposed to sluiceway entrainment than to spillway entrainment.

Effects of Potential Changes to Spillways and Sluiceways to Reduce TDG

Under the Proposed Action, SCL will evaluate and implement as appropriate a variety of measures designed to attain TDG compliance at the Project: throttle sluice gates, which involves operation of sluice gates in partially open positions; roughen sluice flow, which entails modification of the sluice gate outlets to break up and spread flow; spillway flow splitter/aerator, which entails modifying the spillways to aerate, break up, and spread flow. The three gate

alternatives all involve spilling flow through existing outlets (the seven sluice gates and two spillway gates) into the tailwater plunge pool and rely on reducing TDG production by spreading the flow and limiting plunging effects of the confined water jets.

Each of the proposed measures may have both beneficial and adverse effects on fish. The beneficial effects would be higher likelihood of attaining TDG compliance levels in the Boundary Dam tailrace. However, the measures could also result in increased injury or mortality to fish entrained through the spillways or sluiceways (although the depth of the sluiceways likely makes them a route through which few fish would pass) due to the increased risk of fish strikes into the added roughening elements. Fish strikes could result in blunt-force trauma to fish and loss of scales. Spreading the flow and reducing the size of water jets could be beneficial for small fish and adversely affect large fish during their contact with the tailrace water surface. As described above, small fish (approximately 100 millimeters [≈ 4 inches]) that leave a water jet and free fall to the tailrace should survive at a higher rate than small fish that experience strong shear forces while plunging in a water jet. In contrast, large fish (approximately 600 millimeters [≈ 24 inches]) have low survival if they leave a water jet. Substantial uncertainty surrounds the magnitude of both the potential beneficial and adverse effects of the proposed TDG mitigation measures resulting in substantial uncertainty regarding the overall net effect to fish, in general, and native salmonids in specific.

Timing, Magnitude, and Species Composition of Fish Entrainment

During 2007 and 2008 SCL conducted hydroacoustic and fyke net sampling at Boundary Dam to estimate the number, size, species, and timing of fish that may be entrained within the Project turbine intakes and spillways. The limited frequency, duration of use, and flow conditions associated with the use of the sluiceways reduces the need to quantify the number of fish potentially entrained through these pathways and consequently no field studies were performed at the sluiceways. However, changes in the future use of sluiceways or spillways being considered as a potential measure to reduce TDG concentrations could affect the degree to which fish are influenced by these potential entrainment pathways.

Hydroacoustic data collection was initiated at Boundary Dam on May 2, 2007. Hydroacoustic target entrainment data were collected and analyzed using split-beam target tracking techniques as described by Ehrenberg and Torkelson (1996), and following the scientific acoustic sampling principles outlined in MacLennan and Simmonds (1992). Transducers were mounted above each turbine intake and aimed down to monitor the water column immediately upstream of each turbine intake opening. In addition, to monitor targets passing through the spill bays during spill events, transducers were deployed at each spill bay. All entrained target detections were weighted for unsampled time and space, and the resulting estimates represent total hourly target passage at each intake or spillway.

Fyke nets were initially deployed in the Unit 54 draft tube gatewell downstream of the turbine unit in October 2007. Substantial testing and net modifications were needed; consequently, routine fyke net sampling was not initiated until February 16, 2008. Fyke netting generally occurred each weekend for a 24-hour period beginning on April 1, 2008. The fyke net array consisted of two frames of eight net panels each, and was designed to screen the entire draft tube downstream of turbine Unit 54.

The fyke netting procedures involved shutting down Unit 54, deploying the two net frames in the draft tube, restarting the turbine, sampling for a fixed period, and then stopping the unit again and retrieving the net frames. All routine fyke net tests were conducted at a 90 MW unit loading. Sampling could not occur at flows higher than 90 MW without excessive net damage, and lower flows are not representative of typical operating loads (maximum Unit 54 output is 150 MW). Hydroacoustic data indicate that flows associated with 90 MW loadings entrained targets at rates generally consistent with higher loadings. Operations data from 2007 indicated that loadings less than 80 MW only occurred during about 7 percent of the operating hours at Unit 54, so using 90 MW was selected as the standard loading for fyke net tests. The typical duration of individual fyke net tests within each 24-hour sampling period was approximately 3 hours, although individual tests varied from about 1 to 4 hours in duration. The duration was selected to ensure the integrity of the captured fish. In general, three to four individual fyke net tests could be completed within each weekly 24-hour sampling period. While fishing the fyke nets, the hydroacoustic system was switched to sample continuously at Unit 54 to maximize temporal sampling coverage.

The fyke net deployment was designed to provide complete net sampling coverage across the Unit 54 draft tube. However, the very high flow rates and variable hydraulic conditions encountered by the nets resulted in incomplete sampling due to net damage, potential gaps between the nets and frame, and other factors. To establish measures of fish capture efficiency, neutrally-buoyant targets (NBT), i.e., radishes, carrots, and potatoes, were introduced in the Unit 54 penstock at the head gates during most fyke net tests. It was assumed that NBT targets were distributed within the draft tube in a manner similar to fish, and had the same net retention characteristics as fish with lengths greater than 4 inches (equivalent to the minimum size fish included in the hydroacoustic target estimates). The capture efficiency tests indicated that a mean of 61.0 percent of released NBTs were collected in the fyke nets. Live fish tests using triploid rainbow trout were also undertaken to verify that NBTs were suitable fish surrogates. The spatial distribution among the individual fyke nets and capture percentages were found to be statistically equivalent. Other important assumptions were that the calibration of hydroacoustic sampling numbers with fyke net sampling numbers at Unit 54 could be used for other turbine units, could be used to draw conclusions regarding the species mix and size of fish vulnerable to entrainment by the spillways, and could be used to estimate the magnitude of entrainment Project-wide. The FERC-approved study plan recognized that if discrepancies were identified between hydroacoustics and fyke net sampling results, fyke net results would be expected to provide a better estimate of fish entrainment, by species, size, and number, than that provided by hydroacoustics sampling.

Hydroacoustic and fyke net data collected concurrently between March 2008 and February 2009 indicate that fish entrainment is occurring at the Boundary Dam power plant. Details of the methods and results of the entrainment study are provided in the Fish Entrainment and Habitat Connectivity Study Final Report (SCL 2009e). Periodic statistical comparisons between the hydroacoustic and fyke net entrainment results were conducted to identify potential sampling biases of each method and select an approach that was judged to provide the best estimates of entrainment. A significant correlation between the fyke net and hydroacoustic estimates was not observed over the concurrent sampling period, suggesting that both hydroacoustic and fyke net

sampling were providing imperfect estimates of absolute fish entrainment. Consistent with the approach outlined in the RSP, a fish entrainment estimator combining the sampling strengths of both methods was selected. Consequently, the results of the two techniques were combined using statistical methods derived by Dr. John Skalski at the University of Washington. The hydroacoustic sampling, which provided a continuous measure of relative entrainment at all operating turbines and spill gates, was used to scale the fish entrainment rates measured by the fyke net sampling at Unit 54. Fish entrainment rates measured at Unit 54 by the weekly fyke net sampling were extrapolated to all operating downstream passage routes (turbines and spill gates) on a monthly basis, based on the proportions of relative hydroacoustic passage observed at each location for the period.

Monthly fish passage over the March 2008 through February 2009 monitoring period increased steadily from March through July 2008, reaching a peak in July, with 13,278 fish estimated to have passed downstream through the dam during that month (Figure E.4-55). A marked decrease in total Project entrainment was observed in August, followed by a slight increase in September. Beginning in October 2008, Project entrainment rates decreased sharply and remained low over the winter months, through the end of sampling on March 1, 2009. A total of 54,597 ±5,176 fish (90 percent confidence interval) was estimated to have been entrained through all operating turbines and spill gates at the Project over the one-year period between March 2008 and February 2009.

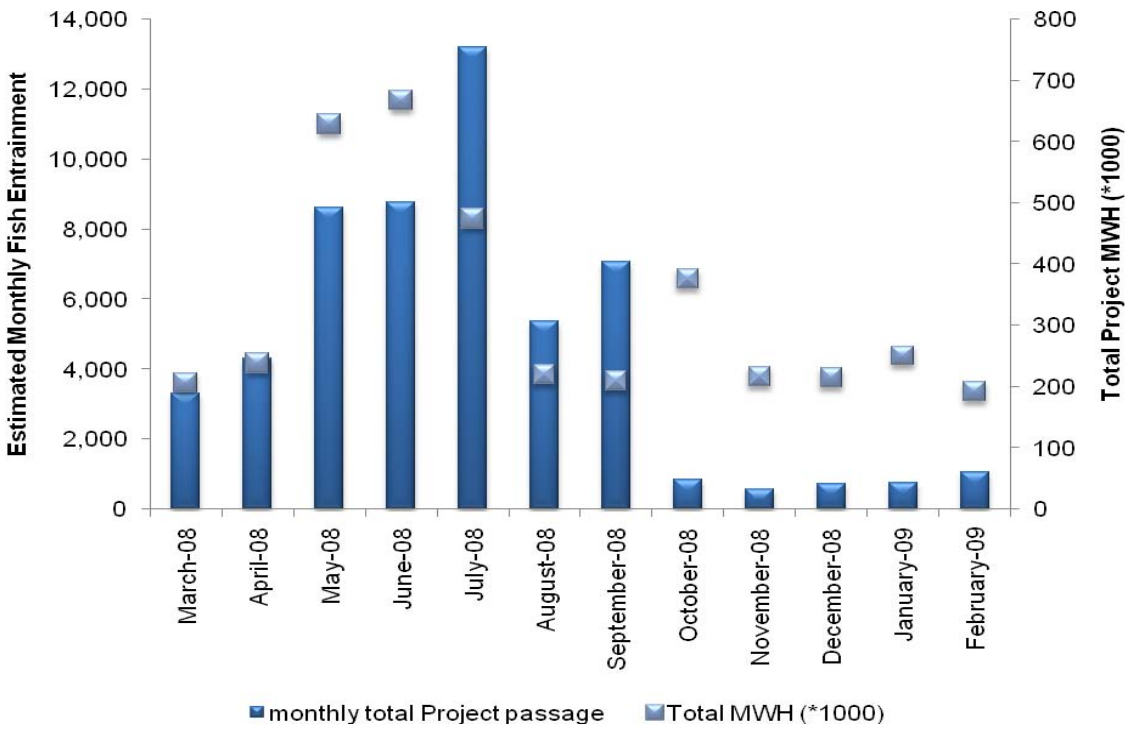


Figure E.4-55. Estimated total Project fish entrainment through all operating turbines and spill gates on a monthly basis for the March 2008 to February 2009 sampling period.

Suckers, pumpkinseed, and yellow perch dominated the fyke net catch in the draft tube of turbine Unit 54 between February and October 2008 (Figure E.4-56). No native salmonids were captured. The fyke net catch over the same approximate period was generally consistent with the composition of catch from electrofishing and gillnetting in the Forebay Reach. Notable exceptions were the higher proportions of burbot, pumpkinseed, and kokanee in the fyke net catch, which may indicate that suitability of habitat or their behavior patterns near to or downstream of the trashrack make them more vulnerable to entrainment than their representation in the catch from elsewhere in the Forebay Reach would suggest. During November 2008 through March 1, 2009 an additional 30 fish from six species were captured by fyke net in the draft tube of turbine Unit 54, but no comparable data are available from the forebay during the same period. During the November 2008 - March 1, 2009 period burbot (37 percent), black crappie (30 percent), and pumpkinseed (13 percent) dominated the fyke net catch. Kokanee (10 percent) were captured during November and December, and yellow perch (7 percent) and suckers (3 percent) were captured from February through March 1. The catch during this period tends to support the hypothesis that burbot, pumpkinseed, and kokanee may be more vulnerable to entrainment than other species.

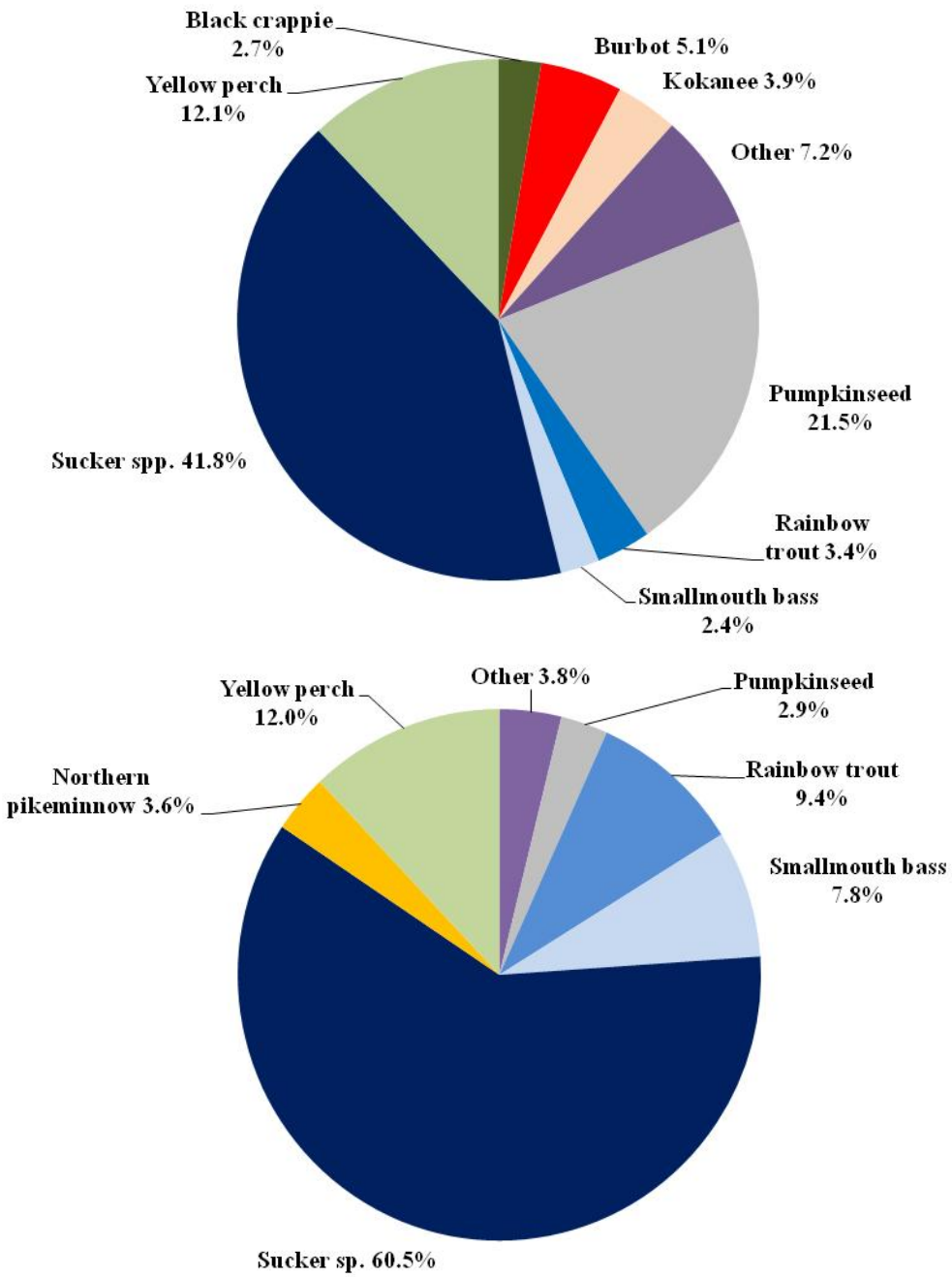


Figure E.4-56. Species composition of 414 fish captured during fyke net sampling in the turbine draft tube of Unit 54 of Boundary Dam power plant, February through October 2008 (top) and 4,018 fish captured via gillnetting and electrofishing at standard sampling sites in the Forebay from March 2007 through September 2008 (bottom).

The length frequency of fish captured by fyke netting in the Unit 54 draft tube revealed two distinct size modes, one centered at about 100 millimeters (3.9 inches) and the other at about 340 millimeters (13.4 inches) (Figure E.4-57). Examination of the length-frequency histograms for individual fish species indicates that the smaller group of fish consisted primarily of pumpkinseed (50-140 millimeters in length [2-5.5 inches]) and yellow perch (80-190 millimeters [3.1-7.5 inches]), but also included some salmonids (90-200 millimeters [3.5-7.9 inches]), whereas the larger group of fish sizes consisted primarily of suckers (270-400 millimeters [10.6-15.7 inches]) and a few triploid rainbow trout (220-390 millimeters [8.7-15.4 inches]). Fish larger than 400 millimeters (15.7 inches) were suckers and burbot.

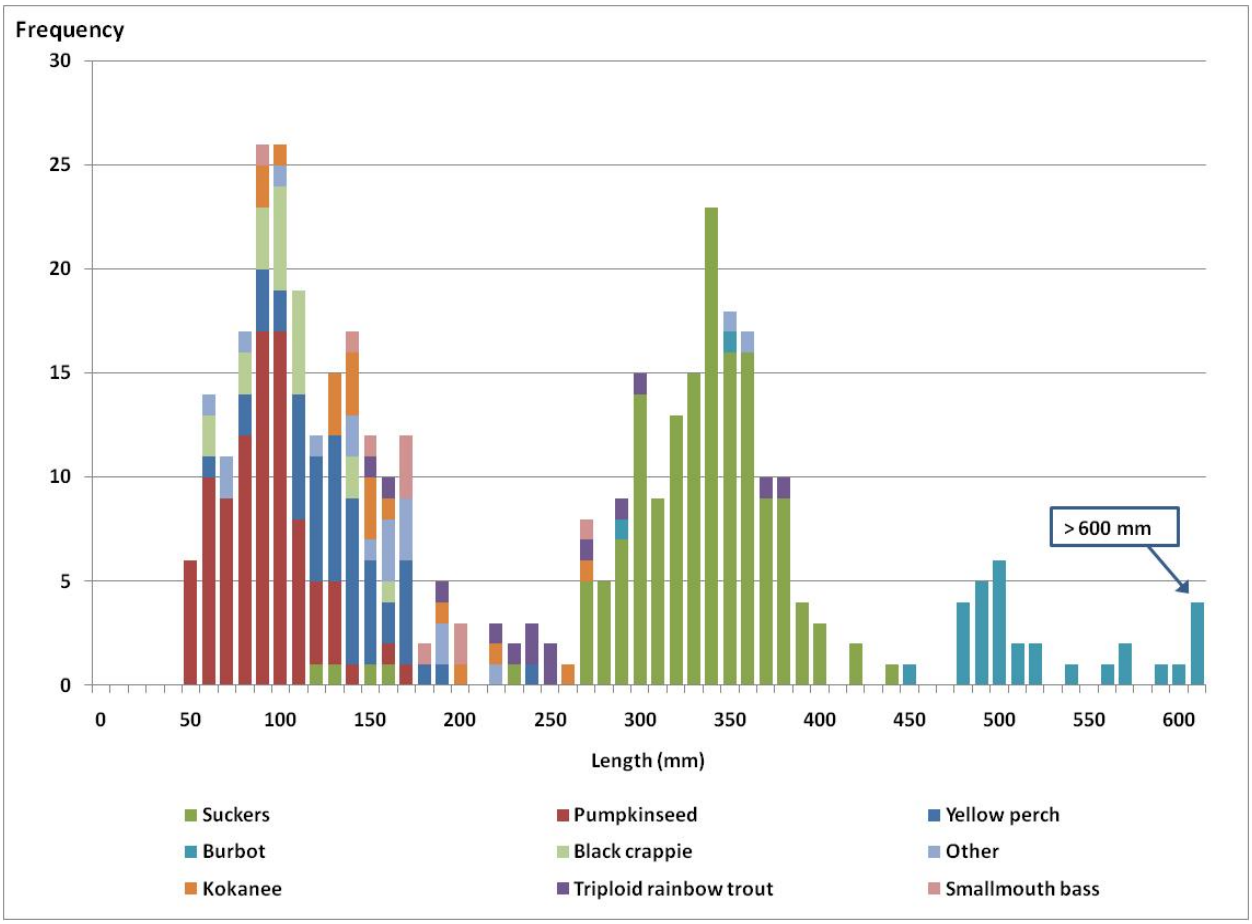


Figure E.4-57. Length frequency, by species, of fish captured by fyke net in the Unit 54 draft tube.

Habitat Connectivity

Habitat fragmentation has been cited as an important concern to the maintenance and recovery of bull trout and Westslope cutthroat trout populations (69 FR 59996; USFWS 1999; Rieman and McIntyre 1993; Rieman et al. 1997; McIntyre and Rieman 1995). The available survey information reviewed by Rieman et al. (1997) and McIntyre and Rieman (1995) indicates that in most regions bull trout and Westslope cutthroat trout distribution is discontinuous or patchy. A variety of biological and anthropogenic factors has been suggested as contributing to the patchy

distribution of bull trout and Westslope cutthroat trout. The most important of these are the species' narrow habitat requirements, habitat degradation, exotic fish introductions, and passage barriers, such as natural falls, dams, and stream crossings (primarily culverts) by roads and railroads (Rieman and McIntyre 1993; McIntyre and Rieman 1995).

The draft recovery plan for bull trout recognizes their patchy distribution (USFWS 2002). The plan describes a metapopulation, or core population, as a set of local populations that have some level of gene exchange between them. Local populations can be extirpated, but can also be reestablished by straying of individuals from other local populations. The risk of losing the core population is decreased because the likelihood of losing all subpopulations simultaneously is low. Long-term survival of a core population depends on having an adequate distribution of local populations with relatively robust abundance and habitat quality.

Passage barriers are clearly an isolating mechanism for local populations. Types of barriers are waterfalls, landslides, water withdrawals, road crossings, and dams. A local population that lives above a barrier can only contribute individuals (and their genes) in a downstream direction. Recent advances in genetic characterization have allowed the development of genetic libraries for some salmonid populations (e.g., Young et al. 2004; Spruell et al. 2003), and the genetic similarities and differences between these populations, and between individuals in these populations, can be assessed. Young et al. (2004) found that NF Sullivan Creek had Westslope cutthroat trout with relatively little genetic similarity to hatchery cutthroat trout stocked elsewhere in the area, whereas cutthroat trout in Slate Creek, which had direct plants to the stream, were very similar to Kings Lake Hatchery cutthroat trout. In both circumstances, they suggested that barriers were the isolating mechanism for the genetic differences observed.

If a local population upstream of a passage barrier is extirpated, there is virtually no opportunity for the local population to become re-established in the near future, unless other local populations are present farther upstream or there is human intervention. The likelihood of re-establishing local populations is greatly enhanced if upstream populations include migratory life history forms, which are more likely to disperse. In some areas, including the nearby Salmo River drainage, the migratory form of bull trout is in decline, even though resident forms remain (Nelson et al. 2002, Baxter 1999). Nelson et al. (2002) suggested that the loss of the migratory form in some areas increases the risk that local populations could go extinct.

Passage barriers may isolate local populations, but they can also prevent the spread of non-native species such as brook trout, which are also considered a threat to native salmonids (Andonaegui 2003). Most of the tributaries to Boundary Reservoir and the Pend Oreille River have been stocked with non-native salmonid species such as brook trout, brown trout, and rainbow trout. However, Lost Creek and at least two subwatersheds, the NF Sullivan Creek and Lunch Creek, have apparently been unaffected by non-native species (USFS 2005; R2 Resource Consultants 1998a; McLellan 2001). The cutthroat trout population in NF Sullivan Creek has been isolated by the presence of a low head dam that supplies domestic water to the city of Metaline Falls. McLellan (2001) suggested that high gradients in the lower reaches of Lunch Creek may have slowed or prevented the expansion of brook trout from Sweet Creek. Populations of exotic coolwater fish species such as smallmouth bass, walleye, and northern pike, which are highly

predatory, have become established in Boundary Reservoir and could compete with large bull trout or cutthroat trout for prey or could forage on fry and juvenile trout.

The NWU Recovery Team for bull trout has designated the Pend Oreille River and its tributaries from Albeni Falls Dam to the U.S.-Canada border as a core area. To develop recovery criteria, the NWU Recovery Team used professional judgment, knowledge of the NWU, and guidance from Rieman and McIntyre (1993) and Rieman and Allendorf (2001). Nine tributaries were identified as local populations with numeric recovery goals for adult migratory fish with an overall core area recovery goal of 1,575 to 2,625 fish. As described in Section 4.5.3.1, two of these tributaries drain into Boundary Reservoir: Slate and Sullivan creeks. The remaining seven, Cedar Creek; Ruby Creek, LeClerc Creek, Mill Creek, Tacoma Creek, Calispell Creek, and Indian Creek, drain into Box Canyon Reservoir. Of the Box Canyon tributaries, LeClerc Creek has the largest goal of 400 to 500 adult fish. Detailed population or habitat information used as the basis for including or excluding specific tributaries as local populations is not available or identified in USFWS (2002), nor is the mechanism for establishing bull trout populations where none currently exist. Nevertheless, connectivity between spawning, foraging, and overwintering habitat for these local populations, once established, and the maintenance of migration corridors is an important objective of the Recovery Team (USFWS 2002).

The Recovery Team stated that recovery in the NWU was contingent upon reconnecting the Pend Oreille River with the Lower Clark Fork River Subunit that lies upstream of the Pend Oreille Core Area and Albeni Falls Dam (RM 86.9), which was completed in 1952 and operated by the U.S. Army Corps of Engineers (USACE). The Priest River, located about 5.0 miles upstream of Albeni Falls Dam, has a self-sustaining population of bull trout and is likely the most important source of bull trout in the Pend Oreille River downstream of Albeni Falls Dam. The USFWS Biological Opinion (USFWS 2000) concluded that completion of Albeni Falls Dam was responsible for the “abrupt decline” of bull trout in the Pend Oreille River.

Currently none of the hydroelectric projects on the Pend Oreille River, including Boundary Dam, has upstream or downstream passage facilities. Consequently, any potential gene flow by native salmonids can only occur in a downstream direction by fish that survive entrainment and successfully reproduce in non-natal streams. The Waneta and Seven Mile projects currently have no plans to provide fish passage in the future. As part of its new Project license, Pend Oreille County PUD is planning to construct an upstream fish passage facility at Box Canyon Dam for future captures of cutthroat trout, bull trout, and mountain whitefish. The ESA Section 7 consultation for the federal Columbia River Power System included as a reasonable and prudent measure the need to provide passage at Albeni Falls Dam, but the feasibility and funding source are uncertain.

4.5.3.2.6. Recreational Fisheries

As described in Section 4.5.3.1, a variety of cold-water and cool-water sportfish exist in Boundary Reservoir (Table E.4-20). Based on surveys conducted during 2007 and 2008, anglers primarily target triploid rainbow trout and smallmouth bass, and to a lesser extent other trout (wild rainbow trout, cutthroat trout, and brown trout). SCL has sponsored the stocking of triploid rainbow trout in Boundary Reservoir since 2001. During 2009, WDFW determined it would no longer approve permits for releasing triploid rainbow trout into Boundary Reservoir.

WDFW concluded that (1) the program was ineffective in terms of return to the creel, i.e., the number of fish caught relative to the number planted, (2) too many triploid rainbow trout are passed downstream of Boundary Dam, (3) triploid rainbow trout might compete with native salmonids for food or habitat, and (4) anglers targeting triploid rainbow trout at the mouths of tributaries during summer might increase the inadvertent harvest of native salmonids and impact native fish recovery efforts (2009a, pers. comm. D. Robison and N. Baker, WDFW, March 20, 2009). However, due to the local community's concerns regarding recreational fishing opportunities in 2009, SCL and WDFW agreed to stock a reduced number of triploid rainbow trout (approximately 2,000 fish) during the spring in Boundary Reservoir in 2009 and stock additional trout (approximately 2,000 fish) into Crescent Lake, Big Meadow Lake, and two other lakes in the vicinity. It is anticipated that triploid trout stocking in Boundary Reservoir will cease beginning in 2010.

Changes in the fish community due to introductions of non-native species and management policies are likely to change how recreational anglers use Boundary Reservoir in the future. Some anglers that prefer to fish for trout may reduce the number of future angling trips to Boundary Reservoir and use other lakes stocked with trout. Some anglers may also shift their effort to smallmouth bass, which undoubtedly will become the most important sportfish targeted by recreational anglers in the reservoir. While the northern pike population is currently relatively small, some anglers may also begin to more frequently target this sportfish in the future. Ironically, many of the non-native fish species that have become the mainstay of recreational fishing in Boundary Reservoir are often identified as major predatory threats to native salmonids. The proposed I&E program (see Section 4.5.9.3) will provide information related to fish and aquatics themes, including information for anglers about native salmonids and the negative repercussions of releasing non-native fish into the reservoir.

The effects of Project operations on the abundance and distribution of sportfish independent of the recreational fishery were described above. Project operations can also affect the distribution of anglers in the reservoir and how they expend their effort. Because boats are often used to fish in Boundary Reservoir, Project operations that affect boating access also affect angling. Changes in water surface elevations can affect the ability of anglers to launch or retrieve their boats and also their ability to safely pass upstream or downstream of Metaline Falls (see Section 4.5.9.2).

Recreational fishing for trout and the use of cold water refugia during warm summer periods may interact to increase fishing pressure on native salmonids in Boundary Reservoir. As described above, triploid rainbow trout, non-native trout, and native salmonids such as bull trout, cutthroat trout, and mountain whitefish, begin to congregate in cold water refugia when mainstem water temperatures rise above 18 ºC, and at temperatures above 20 ºC the congregations of fish become readily apparent. Congregations of fish, primarily triploid rainbow trout, were commonly observed during relicensing studies in the vicinity of Sweet Creek, Slate Creek, and Sullivan Creek when mainstem water temperatures were high. Anglers, aware of these congregations, often focus their fishing effort at these tributary mouths during summer. Because of the focused habitat use and angler effort, the risk of capture for native salmonids is increased. Assuming that angler effort for trout is reduced in the future because triploid trout

will no longer be stocked, the risk of harvest or incidental capture of native salmonids should decrease in the future.

4.5.3.2.7. Tributary Habitat Productivity

Tributary streams are a source of nutrients, sediment, LWD, and water. In addition, they support biological processes by potentially providing spawning, rearing, and over-wintering habitat to resident fish residing in the tributaries year-round, as well as to adfluvial fish that may migrate between the reservoir and tributary streams during their life cycle. As such, some fish species found in Boundary Reservoir are directly dependent upon tributary productivity for a part of their life cycle. In addition, some predatory fish species living in the reservoir, such as smallmouth bass or northern pike, may partially rely on tributary productivity for forage fish that either actively emigrate from tributaries or are flushed out during high flow periods.

At a broad scale, Boundary Reservoir tributaries provide a relatively small amount of habitat for salmonid populations that exhibit either adfluvial or fluvial life history traits compared to tributaries to other reservoirs in the region, such as the Priest River and the Salmo River. Sullivan Creek is the third largest tributary draining into the Pend Oreille River, but at 143 square miles is substantially smaller than the Priest River drainage at 979 square miles and Salmo River drainage at 502 square miles. The relatively small watershed sizes (except Sullivan Creek), presence of natural barriers, high stream gradients, and basin hydrology in these tributaries all contribute to limiting the amount of habitat available for salmonid populations. Nevertheless, as described in Table E.4-19, salmonid populations reside in the majority of Boundary Reservoir tributaries.

Bull trout do not have a documented reproducing population in any of the tributaries to Boundary Reservoir; however, the NWU Recovery Team for bull trout has identified Slate Creek and Sullivan Creek as having conditions suitable for bull trout and designated them as local populations with numeric recovery goals for adult migratory fish. Individual bull trout have occasionally been observed at the mouths of several tributaries (Slate and Sweet creeks) or in their lower reaches (Sullivan and Sweet creeks). Despite intensive sampling in the lower tributary reaches and deltas as part of relicensing studies, only one fish in lower Sullivan Creek was suspected of being a bull trout. Because of water depth and difficult viewing conditions during the snorkel survey, identification of this suspected bull trout could not be confirmed.

Fyke net sampling, and backpack electrofishing and snorkeling surveys were conducted in Sullivan Creek, Slate Creek, Sweet Creek, and Sand Creek during 2007 and 2008 as part of relicensing studies. Fyke net sampling during 2007 demonstrated the highest catch-per-unit-effort (CPUE in fish per percent discharge per net-hour) in Sullivan Creek (about 0.15) and lowest in Slate and Sand creeks (about 0.05), whereas Sweet Creek was intermediate (about 0.09). Catch in Sullivan Creek and Sweet Creek was highest during July (about 0.30 and 0.18, respectively) and August (about 0.48 and 0.21, respectively), and low to moderate during other months sampled (up to 0.09). Catch rates were substantially lower during 2008 but followed the same general pattern as 2007, with catch rates peaking in Sullivan Creek during July (0.11) and during August in Sweet Creek (0.03). Fourteen species of fish were captured in the fyke nets and mountain whitefish and cutthroat trout dominated the catch (Figure E.4-58). Similar to the fyke net catch, observations of fish by snorkeling were highest during July and August and low

during the spring and fall. The species observed by snorkeling overlapped those captured by fyke net. A notable exception was the observation of brook trout in the tributary channels upstream of the Sullivan, Flume, and Slate creek deltas. Most, but not all, salmonids captured or observed upstream of the deltas were young-of-the-year and fingerling-sized fish less than 4.7 inches in length. Occasionally native and non-native salmonids greater than 10 inches were observed during snorkeling surveys.

Fyke net, snorkeling, backpack electrofishing, and angling efforts conducted as part of relicensing support the hypothesis that salmonids produced in the lower reaches of tributaries to Boundary Reservoir are primarily small fish, and outmigrants are generally young-of-the-year and fingerlings (Figure E.4-59). Similar results were found by McLellan (2001), R2 Resource Consultants (1998a), and Terrapin (2000) during backpack electrofishing and snorkel surveys. Overall, the rare cutthroat trout or mountain whitefish 10 inches or more in length would be considered a large fish in tributaries to Boundary Reservoir. It is possible that the low numbers of salmonids greater than 12 inches is partially the result of angling pressure, particularly within Sullivan Creek, which has relatively good access over a majority of its length.

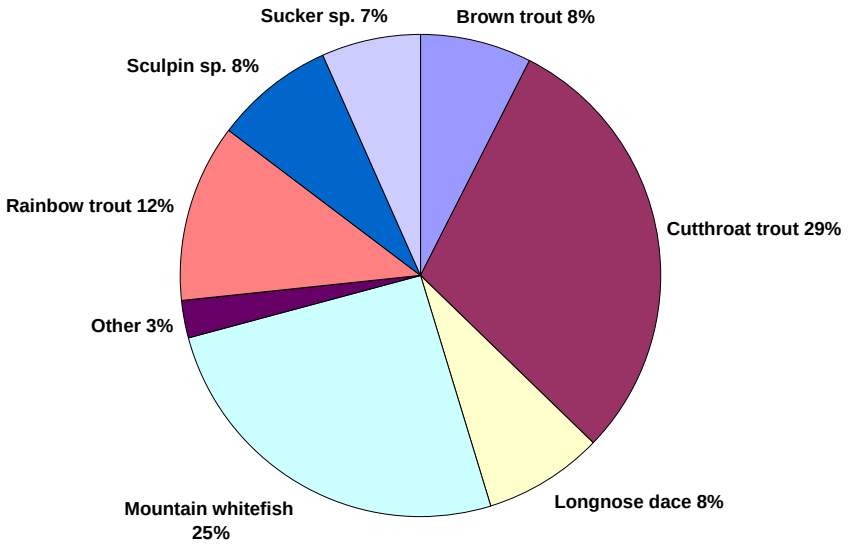


Figure E.4-58. Species composition of fish capture by tributary fyke nets during 2007 and 2008**.**

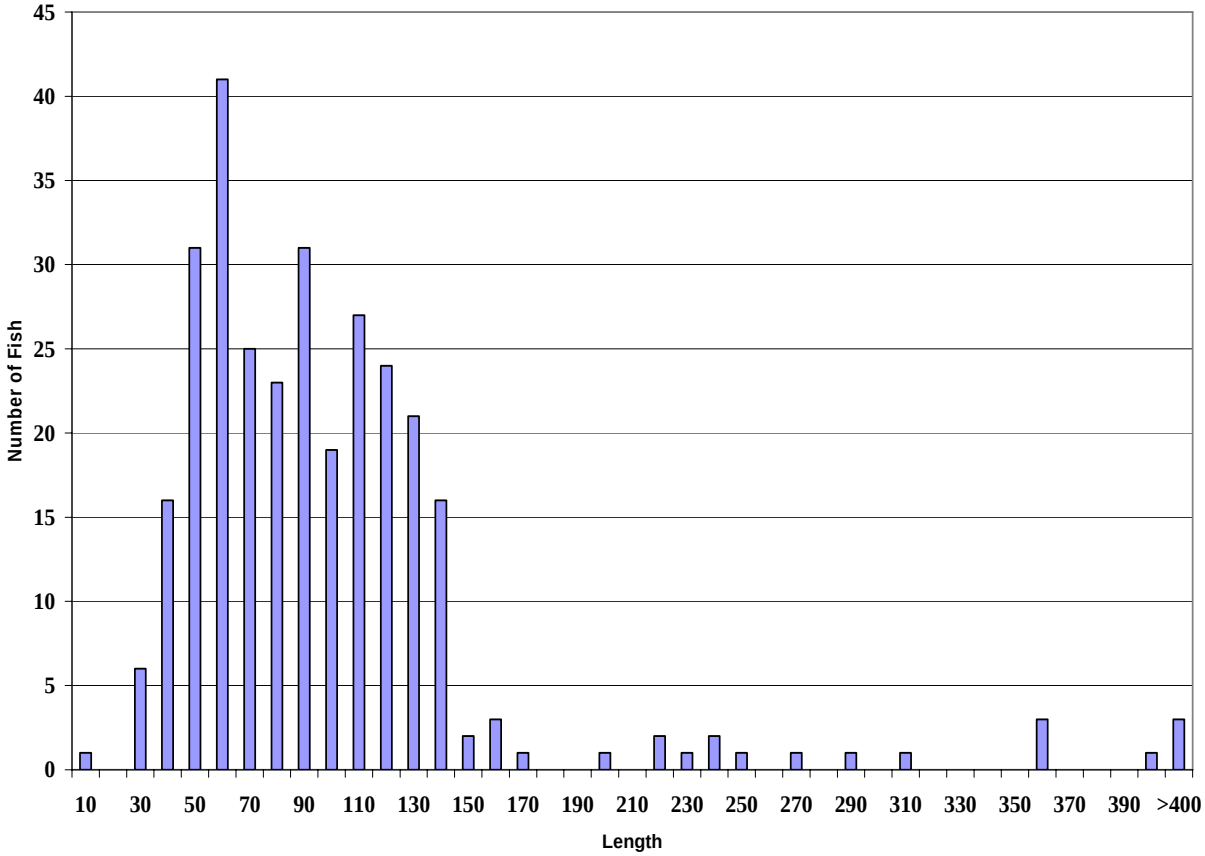


Figure E.4-59. Length frequency of fish captured in tributary fyke nets during 2007 and 2008.

A number of physical and biological factors have been identified as being important to the generally low production of bull trout and other native salmonids in the region, such as habitat degradation, fish passage barriers, and competition with non-native species of fish (Andonaegui 2003). The presence of brook trout has been suggested as a serious threat to native salmonids as a result of interbreeding and competition for habitat and food resources (Andonaegui 2003). Other non-native salmonids that have a documented presence in one or more tributaries to Boundary Reservoir are brown trout, rainbow trout, and kokanee.

A screening process was conducted to categorize tributaries into three levels of potential productivity: primary, secondary, and excluded from evaluation based the amount of adfluvial habitat (more or less than 250 feet) and watershed area (more or less than 1 square mile) (see Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats [Tributary Productivity Assessment] Final Report, SCL 2009a). Tributaries with watersheds less than 1 square mile in size and less than 250 feet of adfluvial fish habitat were considered to have low potential productivity and were excluded from further evaluation. Primary tributaries were considered to have the highest potential productivity and the highest potential for implementing habitat improvement or rehabilitation measures that could increase their productivity and were the focus of additional investigation. The following eight streams were categorized as primary:

Sullivan Creek, Slate Creek, Sweet Creek, Flume Creek, Lime Creek, Linton Creek, Pocahontas Creek, and Sand Creek.

For primary tributaries, the available information was compiled, reviewed, and cataloged into 13 categories affecting productivity including artificial barriers, riparian conditions, streambank condition, floodplain connectivity, channel stability, LWD, pool frequency and quality, pool depth, off-channel habitat, water quality, water quantity, and non-native fish species presence. The resulting data table facilitated development of a summary of the aquatic conditions in Boundary Reservoir primary tributaries that documented limiting factors to productivity and identification of critical data gaps. Many data gaps identified for primary streams during 2007 were filled during the 2008 field season. Relatively large data gaps still remain for Flume Creek and Lunch Creek, but these were determined to not be critical. Minor data gaps also remain for North Fork Slate Creek (artificial structures), North Fork Sullivan Creek (streambank condition), and Sand Creek (water quantity).

The information review (SCL 2009a) indicated the two most common tributary limiting factors were artificial barriers and the presence of exotic fish species, which were limiting factors in each of the eight primary tributaries. Pool quality and quantity were also frequently cited as limiting factors (seven tributaries), as were riparian and substrate conditions (four tributaries each). The following text describes the limiting factors for the three largest and most important tributaries draining into Boundary Reservoir: Sullivan, Slate, and Sweet creeks.

Information on Sullivan Creek from the mouth to RM 3.25 and North Fork Sullivan Creek to RM 2.35 indicated that artificial structures, channel stability, LWD, water quality and quantity, and the presence of non-native fish were limiting factors. As the largest tributary to Boundary Reservoir, Sullivan Creek is considered to be one of the most important and to have the highest potential aquatic productivity. In addition to a number of artificial passage barriers, natural cascades and chutes between RM 0.60 and 0.65 might prevent upstream fish passage under some stream flows (CES 1996; Andonaegui 2003). A recent study by a regionally recognized expert in salmonid fish passage concluded that the series of cascades and chutes under low flow (99 cfs) conditions would be passable by bull trout 18 inches (457 millimeters) or larger, but at high flows (1,528 cfs) the falls is a complete barrier (Powers 2008). Turbulence makes passage difficult at flows higher than 300 to 500 cfs. Mill Pond Dam is a complete upstream passage barrier at RM 3.25 of the mainstem, and a low-head dam supplying municipal water to the Town of Metaline Falls is an upstream barrier on North Fork Sullivan Creek. This barrier plus channel substrate conditions (high embeddedness) were the only factors considered limiting in North Fork Sullivan Creek. Unlike other tributaries, North Fork Sullivan Creek has not been impacted by the presence of brook trout. Channel stability, LWD, and water quality and quantity were considered limiting factors for lower Sullivan Creek. The presence of Mill Pond Dam was at least partially implicated for the poor condition of these four factors. Similar to other tributaries, the presence of non-native salmonids, including brook, rainbow, and brown trout, is considered a limiting factor.

Information on Slate Creek from the mouth to RM 6.2 was reviewed, as was information on portions of Slumber Creek, Uncas Gulch, Styx Creek, South Fork Slate Creek, and North Fork Slate Creek. The presence of artificial structures, low pool frequency and quality, channel

substrate, and the presence of eastern brook trout were identified as limiting factors for some reaches in the basin. Overall, Slate Creek is considered to be in relatively good condition compared to other tributaries to Boundary Reservoir and because of its size has a relatively high potential for aquatic production. A series of falls, cascades, and chutes beginning at RM 0.75 and continuing for approximately 0.5 mi upstream has been identified as a complete barrier to upstream fish passage by McLellan (2001). Other sources have suggested some of these channel features may be passable under some flow conditions (USFS 1999; R2 Resource Consultants 1998a). Artificial barriers (culverts) were identified as limiting for Slumber Creek and the Styx Creek. Channel substrate was also identified as limiting in Slumber Creek, with high levels of embeddedness and percent fines, which similar to Lime Creek have been attributed to drainage through decomposed limestone (USFS 1998a). Pool frequency and quality were considered to be low in Uncas Gulch and the Styx Creek. The available information suggested that Westslope cutthroat trout throughout Slate Creek are adversely affected by the presence of eastern brook trout.

Information on Sweet Creek from the mouth to RM 0.60 indicated artificial structures, pool quality and quantity, and the presence of non-native fish were limiting factors. The available information on the lowermost 1.4 miles of Lunch Creek, which joins Sweet Creek at RM 1.4, was also reviewed and artificial structures, pool quality and quantity, and water quality (temperature) were identified as limiting factors; however, information on most other productivity factors in Lunch Creek was not available. The major limiting factor on Sweet Creek is the presence of a large box culvert under Highway 31 at RM 0.5 that is out of compliance with Washington State criteria. In addition, a series of four natural falls beginning at RM 0.6 and ranging in height from 19.7 to 26.9 feet are complete upstream passage barriers to salmonids. Habitat conditions upstream of the series of waterfalls are considered to be fair to good and not limiting productivity. Brown trout, eastern brook trout, and rainbow trout have been found within Sweet Creek, but only cutthroat trout have been observed in Lunch Creek.

The Project does not affect any of the limiting physical factors described above. However, there could potentially be indirect biological effects on native salmonid life stages that exhibit an adfluvial life history pattern and use Boundary Reservoir during a portion of their lives. Potential adverse effects include fishing pressure on outmigrants and non-native fish species such as smallmouth bass, northern pike, and northern pikeminnow, entrainment past Boundary Dam and potential mortality, and exposure to warm mainstem summer water temperatures, but temperature effects are not attributable to Project operations. The magnitude of these potential ecological interactions is extremely difficult to gauge. Based on analysis of genetic information, it is clear that tributaries supply at least some of the native salmonids inhabiting Boundary Reservoir.

Salmonids in Boundary Reservoir may exhibit adfluvial behavior, but evidence of upstream movement by adults, observations of spawning fish in lower tributary reaches, or collection of gravid fish is limited despite significant field efforts during 2007 and 2008. A few gravid mountain whitefish have been captured near the mouth of Sullivan Creek, and juveniles have been captured by fyke nets at both Sullivan and Sweet Creeks, suggesting that adfluvial mountain whitefish use Sullivan Creek and probably Sweet Creek. Definitive evidence for an adfluvial life history type for Westslope cutthroat trout in Boundary Reservoir is lacking.

Dispersal of cutthroat trout from the tributaries was documented through capture in fyke nets, but no gravid cutthroat have been captured or spawning behavior observed within or near the mouth of any tributary streams. Given the low numbers of adult cutthroat trout in the reservoir and limitations to the amount of sampling that could be conducted, it is not surprising that no evidence for an adfluvial life history was obtained. Consequently, the status of this life history type in the Project area is uncertain. Adfluvial behavior has been documented for radio-tagged brown trout in Box Canyon Reservoir, which used tributaries when mainstem temperatures became unsuitable and were also suspected of spawning in tributary streams (Garrett and Bennett 1995).

4.5.3.3. Proposed Environmental Measures

SCL proposes 13 PM&E measures related to fish and aquatic resources:

- Gravel augmentation below Box Canyon Dam
- Channel modifications for mainstem trapping pools at PRM 30.3
- Upstream fish passage
- Mainstem engineered large woody debris jams at tributary deltas
- Boundary Reservoir fish community monitoring
- Habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek from RM 0.00 to RM 0.54
- Riparian, streambank, and channel improvements in Sullivan Creek from RM 2.30 to 3.93
- Culvert replacements in Slate Creek tributaries Slumber Creek at RM 0.2 and Styx Creek at RM 0.1
- Riparian planting in Linton Creek RM 0.0 to 0.2
- Channel improvements in Sweet Creek from RM 0.4 to 0.5
- Riparian Buffer Protection and Improvement in Sweet Creek from RM 0.0 to 0.5
- Tributary non-native trout suppression
- Native trout supplementation facility

These PM&E measures are summarized below and described in more detail in the Fish and Aquatics Management Plan (FAMP; Attachment E-8). The FAMP also provides details concerning implementation, monitoring, adaptive management, reporting, and funding related to the PM&E measures. Of the 13 PM&E measures, eight would be implemented in tributaries draining into Boundary Reservoir, and five would be implemented in the reservoir, tailrace, or tributary deltas. There is a preponderance of tributary PM&E measures because there are more non-operational opportunities to benefit native salmonids in the tributaries than there are in the mainstem. In addition, operational changes in the reservoir would have adverse impacts on SCL's ability to produce hydroelectric power but uncertain benefits for aquatic organisms, particularly for native salmonids. Numerous recovery and enhancement opportunities are available in tributaries to the reservoir, primarily on NFS lands.

As noted previously, aquatic productivity is relatively low in the Pend Oreille River and water temperatures during summer are naturally too warm for salmonids. The available information

suggests that use of the mainstem Pend Oreille River by bull trout and Westslope cutthroat trout is primarily by individuals with a fluvial life-history pattern. Under this life-history pattern spawning and juvenile rearing occurs for two to three years in tributaries, and older fish would use the mainstem river during late fall, winter, and spring for feeding and overwintering, but enter tributary streams or use tributary deltas at least temporarily during summer periods when water temperatures are too warm to occupy the mainstem.

Most tributaries that drain into Boundary Reservoir have natural barriers near their mouths and/or are relatively small and a have a limited capacity to provide sufficient habitat for robust fluvial fish populations. Notably, the NWU Recovery Team has identified only Slate Creek and Sullivan Creek, two of the 28 streams draining into Boundary Reservoir, as having the potential to sustain populations of fluvial bull trout (USFWS 2002), and neither of these streams is known to currently or historically have had bull trout populations. With the exception perhaps of summertime coolwater plumes, habitat modeling conducted as part of relicensing suggests there is a more-than-adequate quantity of rearing habitat based upon depth, velocity, and substrate for the few Westslope cutthroat trout and bull trout that currently use Boundary Reservoir. Coolwater plumes at tributary mouths were found to be heavily used by triploid rainbow trout stocked by SCL to provide angling opportunities. The potential for competition with native salmonids at coldwater plumes was cited as one of the reasons WDFW decided to reduce the number of catchable-sized rainbow trout released into Boundary Reservoir for angling during 2009 and deny future permits entirely (2009a, pers. comm. D. Robison and N. Baker, WDFW, March 20, 2009).

Although the historical fish community that occupied the Project area and its tributaries is poorly understood, especially in regard to the relative abundance of native species, the current fish community in the mainstem Pend Oreille River is substantially different from the historical one, in part because of the introduction of non-native species. Most introduced species occupy higher trophic levels and are primarily piscivorous in the older age classes. In order of their relative abundance in the mainstem fish community, these relatively large piscivorous, non-native species include yellow perch (14.9 percent), smallmouth bass (10.5 percent), brown trout (0.6 percent), largemouth bass (0.4 percent), walleye (0.3 percent), northern pike (0.2 percent), and lake trout (<0.1 percent). The substantial smallmouth bass population and recently established northern pike population are of particular concern as predators. In contrast, the higher trophic level native species include northern pikeminnow (6.0 percent), burbot (0.2 percent), cutthroat trout (<0.1 percent), and bull trout (<0.01 percent). Notably, only one of the non-native species (brown trout) relies on the tributaries for a portion of its life history, whereas two of the four native species, both salmonids, rely on tributaries for the spawning and juvenile rearing life stages. The forage base for piscivorous fish species is also substantially altered in the mainstem due in part to the presence of non-native species such as pumpkinseed, black crappie, and tench, which in combination account for nearly 10 percent of the fish community in the mainstem. While the direct effects of non-native fish on native salmonids in Boundary Reservoir are unclear, it is apparent that non-native fish species currently play a much larger role than native species as top level predators in the fish community.

The relative importance of competition, predation, forage base, and habitat access and availability that are part of the ecological relationships between native species and non-native

species are typically complicated and difficult to discern and unknown for the Boundary Project. Nevertheless, the scientific literature largely suggests that non-native species have an adverse effect on native salmonids (e.g., Sanderson et al. 2009). An important consideration expressed by some RPs was that non-operational mainstem PM&E measures be beneficial to native salmonids without also encouraging proliferation of non-native fish species (IRA Meeting Summary; March 24-25, 2009).

4.5.3.3.1. Gravel Augmentation below Box Canyon Dam

SCL proposes to increase mountain whitefish spawning opportunities by augmenting gravel levels by a total area of 4,500 square yards split among three sites in the Upper Reservoir between RM 29.1 and Box Canyon Dam. Tentative sites have been identified at PRM 33.7 (0.8 mile below Box Canyon Dam) (Figure E.4-60), but final site selection will be developed following license issuance in coordination with the Fish and Aquatics Workgroup (FAWG). Average depth of augmented gravel/small cobble would be 1 foot, resulting in a total augmented volume of 1,500 cubic yards. For planning purposes, SCL assumed that 25 percent of the initial volume at each site (i.e., 375 cubic yards) would be replenished every 5 years. SCL will complete an implementation planning study, developed cooperatively with the FAWG, within three years of obtaining a new license that would identify depth, velocity, and any other criteria used for site selection. The implementation plan would also identify if boulder weirs or other structures would be needed to help retain the augmented gravel at the proposed sites. Conceptually, large boulders would be placed in horseshoe-shaped clusters. Implementation would occur within two years following completion of the planning phase. Compliance and effectiveness monitoring will be conducted to document implementation and identify the appropriate frequency of gravel replenishment, as described in the FAMP (Attachment E-8). Egg mats will be used to evaluate the effectiveness of the gravel as spawning habitat.

Rationale

The available information from relicensing studies suggests that mountain whitefish spawn in the Box Canyon Dam tailrace. SCL conducted surveys to locate staging mountain whitefish congregations and individuals ripe for spawning, and egg mats were deployed at a number of locations to better understand the timing of mountain whitefish spawning. Although the overall catch of mountain whitefish by boat electrofishing in the Upper Reservoir between February 2007 and December 2008 was low at 175 fish, the surveys generally support the hypothesis that mountain whitefish spawn in the Upper Reservoir during November and December. Furthermore, egg mats successfully collected a small number of eggs believed to be those of mountain whitefish. The addition of high quality spawning substrate in areas with suitable depths and velocities is anticipated to increase the spawning opportunities and success of mountain whitefish in Boundary Reservoir.

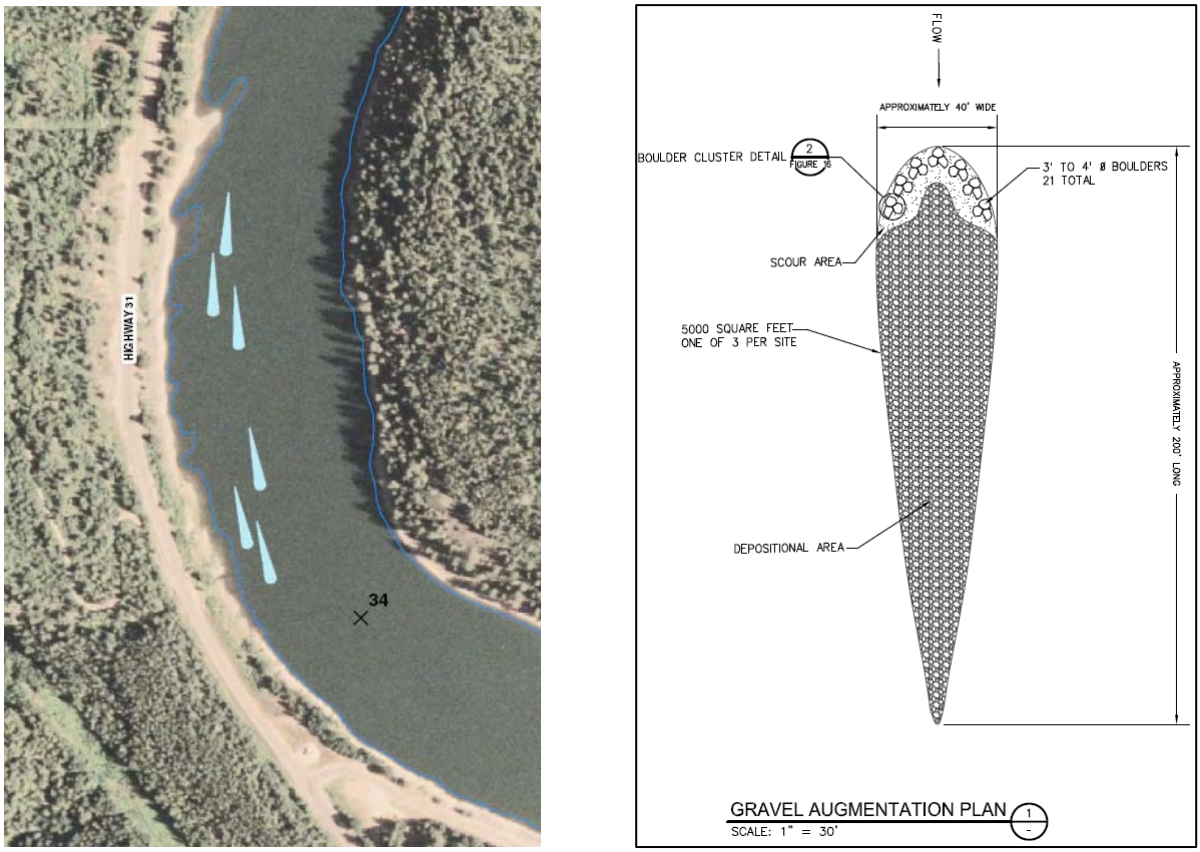


Figure E.4-60. Tentative location of gravel augmentation near PRM 33.7 (left); conceptual design of boulder cluster and augmented gravel (right).

4.5.3.3.2. Channel Modifications for Mainstem Trapping Pools at Project RM 30.3

SCL proposes to modify four pools, totaling about 67,320 square feet, within the Cobble Sisters area of the reservoir near PRM 30.3 (i.e., Stranding and Trapping Region 10). The modifications would include excavation of a 1,800-foot channel to connect three of the trapping pools and using spoils from excavation to fill one of the pools (Figure E.4-61). The objective of this measure would be to maintain a wetted connection to mainstem flows in the constructed channel under proposed operations. The measure would reduce the current risk to fish of being trapped within pools during periods of declining reservoir water surface elevations.

SCL, in collaboration with the FAWG, will prepare an implementation plan within three years following license issuance. The implementation plan would provide design specifications for the channel excavation and dispersal of spoils based on field surveys at the Cobble Sisters area. The design would include drawings that specify the current and planned topography and shape of the site. The thalweg of the excavated channel would be at elevation 1,979 feet NAVD 88, which would result in it being wet under all but the most extreme drawdowns and thus allow fish egress to the mainstem under nearly all flow and operating conditions. Compliance and effectiveness monitoring will be conducted as described in the FAMP (Attachment E-8).

Figure E.4-61. Location of trapping pools (left) and conceptual plan (right) for modification at Cobble Sisters.

Rationale

Relicensing studies during 2007 and 2008 suggested that fry and young-of-the-year fish may become trapped in pools during periods of declining reservoir water surface elevations and under some conditions may suffer injury or mortality during these events. While nearly all of the trapped fish observed during 2007 and 2008 were non-salmonids, such as suckers, perch, or smallmouth bass fry, these trapping mechanisms could also potentially adversely affect native salmonids if they are present in the trapping areas when water surface elevations decline.

During 2008, the Cobble Sisters area was identified as a location with a high occurrence of fish trapping (Mainstem Aquatic Habitat Modeling Final Report [SCL 2009a]). The pools and depressions at the site are the result of aggregate mining that occurred prior to completion of the Project. The excavated depressions have persisted since construction of the Project, which suggests that the area is geomorphically stable. SCL is proposing the excavation of connecting channels at Cobble Sisters because these habitats are man-made and stable.

4.5.3.3.3. Upstream Fish Passage

SCL proposes to develop a trap-and-haul facility that provides upstream passage for native salmonids 3.9 inches (100 millimeters) and larger because Boundary Dam is too high (340 feet) for a traditional fish ladder. Because of the low abundance of native salmonids in the tailrace and the high level of uncertainty regarding the feasibility of implementing a permanent upstream passage solution, SCL is proposing a phased approach to addressing the need for upstream passage. Similar approaches have been used for the recently relicensed Clark Fork River (FERC No. 2058) and Box Canyon projects (FERC No. 2042). SCL intends to work collaboratively with the FAWG to implement the passage program.

Phase I will last seven years and result in the design and construction, during Years 6 and 7 following license issuance, of a temporary trap-and-haul facility and provide biological information needed to identify locations and periods for deploying the temporary facility. Phase

II, which will last 10 years, will involve deploying the temporary facility at the locations and periods identified in Phase I. During Phase II, the best location(s) for deploying a permanent trap-and-haul facility will be identified. For planning purposes, SCL assumed that design and construction of a permanent trap-and-haul facility would occur during Years 16 and 17 following license issuance; however at any time between Year 13 and Year 16 of Phase II, SCL, in collaboration with the FAWG, could transition to Phase III. Phase III will involve operation of a permanent trap-and-haul facility at a fixed location or a long-term temporary trap-and-haul facility that could be deployed on a seasonal basis and operated at various locations. Greater detail regarding the upstream fish passage PM&E measure is provided in the FAMP (Attachment E-8).

Rationale

Boundary Dam prevents upstream movement of fish, including native salmonids. However, relicensing studies indicate that the abundance of native salmonids in the Tailrace Reach is very low, representing about 2 percent of the fish community. From March 2007 to December 2008, 29 native salmonids (three bull trout [a fourth bull trout was detected via radio telemetry in 2008], 12 Westslope cutthroat, and 23 mountain whitefish) were captured during monthly electrofishing and gillnet sampling in the Boundary Dam tailrace or observed while snorkeling. The available information suggests that the number of native salmonids prevented from accessing habitat upstream of Boundary Dam or contributing to the upstream gene pool is relatively small, and their significance as a proportion of the total population is uncertain. Nevertheless, the NWU Recovery Team for the bull trout considers passage at hydroelectric projects on the Pend Oreille River a high priority for recovery (USFWS 2002).

4.5.3.3.4. Mainstem Engineered Large Woody Debris at Tributary Deltas

SCL proposes to enhance tributary delta habitat by providing additional cover for salmonids through placement of engineered LWD jams in the upper delta regions of four tributaries to Boundary Reservoir: Sullivan, Sweet, Slate, and Linton creeks. The upper delta regions were selected to address RPs' concerns that measures be located to benefit native salmonids without also encouraging proliferation of non-native fish species. Sullivan Creek would receive two LWD jams and Slate, Sweet, and Linton creeks would each get one LWD jam. LWD jams would be sized based on tributary size: each LWD jam in Slate Creek, Sweet Creek, and Linton Creek would have a target volume of 529 cubic feet (one key piece and 5 large pieces), and jams would have a target size of 1,700 cubic feet for the Sullivan Creek Delta. Each LWD jam would include at least one key piece based on sizes recommended in Fox and Bolton (2007), at least one piece with an attached rootwad that could also count as the key piece, and additional LWD pieces to meet the target volume for the LWD jam. LWD jam designs would follow the engineering guidance provided in WDFW (2003) and Saldi-Caromile et al. (2004). SCL assumes that maintenance or replacement structures will be needed every seven years, i.e., up to six full replacements during the new license term for each structure.

A relicensing study also examined the size and amount of LWD removed at Boundary Dam, which is used as firewood at the Forebay Recreation Area or sold as saw logs by the removal contractor (Large Woody Debris Management Study, Final Report, SCL 2008b). SCL proposes that LWD collected at the Boundary Dam trash rack be managed to retain and stockpile wood suitable for this PM&E measure and other stream enhancement measures to be implemented in

the channelized portions of Sullivan Creek and Sweet Creek. Wood to be stockpiled would be a minimum of 12 inches in diameter and 17 feet in length (medium-size categories in Peck et al. 2003). The target size of the site would be sufficient to stockpile approximately 10,000 cubic feet of LWD (approximately 34 logging truck loads). It is unlikely that sufficient sizes and number of LWD pieces can be collected at Boundary Dam over the near term to provide all the LWD needed for PM&E measures. Consequently, purchase of LWD from outside sources will likely be needed.

Activities at the Sullivan Creek delta associated with this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the Pend Oreille County PUD's Sullivan Lake Hydroelectric Project (FERC No. 2225) license. The Sullivan Creek Project includes the Mill Pond Dam. Removal of Mill Pond Dam could adversely affect downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently, implementation of SCL's proposed PM&E measure in Sullivan Creek will not occur until the disposition of Mill Pond Dam has been determined. Following implementation of SCL's proposed PM&E measure, compliance and effectiveness monitoring will be conducted at each of the tributary delta sites. Greater detail regarding this PM&E measure is provided in the FAMP (Attachment E-8). If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the LWD jams and related activities are determined.

Rationale

Relicensing studies indicate that native and non-native salmonids use tributary deltas during summer to take advantage of coldwater refugia (SCL 2009c). Deltas also serve as transition areas between the reservoir and tributaries and must be used by fish moving between these two habitat types. Habitat studies indicate that there are scarce amounts of LWD (e.g. Figure E.4-62) or other forms of cover in these tributary delta habitats (Large Woody Debris Management Study, SCL 2008b).

Figure E.4-62. Downstream view of Sweet Creek in the upper delta area (left) and looking upstream at Sullivan Creek during early September 2007.

4.5.3.3.5. Boundary Reservoir Fish Community Monitoring

SCL proposes to conduct fish community surveys in Boundary Reservoir, Boundary Dam Tailrace, and selected tributaries at five-year intervals to obtain information on trends in the abundance and species composition of the fish community. Information for Boundary Reservoir will be collected for each of the three major reaches: Forebay, Canyon, and Upper Reservoir. Tributaries to be surveyed include Slate Creek, Flume Creek, Sullivan Creek, Sweet Creek, Linton Creek, and Sand Creek. SCL anticipates that the level of effort and techniques used would be similar to those of McLellan (2001) so that trend data would be comparable across years. At a minimum, the techniques to be used will include electrofishing, gill netting, and snorkeling. A study plan will be prepared in collaboration with the FAWG prior to each field season and a survey completion report prepared within one year following surveys to document compliance with the study plan and PM&E measure (Attachment E-8).

Rationale

Trend information on fish communities in the Project area is important for resource management agencies so they can identify necessary changes in management direction. For example, McLellan (2001) collected information on the composition of the fish community and species relative abundance in Boundary Reservoir during 2000, and SCL collected similar information during 2007 and 2008 (SCL 2009c). The trend information from these two studies demonstrated the establishment of a northern pike population in Boundary Reservoir. During 2000 McLellan (2001) observed no northern pike, but SCL (2009c) documented both adult and juvenile northern pike in areas considered suitable for spawning. Although northern pike numbers in Boundary Reservoir are considered to be relatively low, a self-reproducing population has been established, and there is the potential for increasing numbers in the future. If predator fish, such as northern pike, proliferate significantly in the Project area, they could become a threat to already uncommon native salmonids. Trend information could help management agencies in the development of strategies for the recovery of native salmonids and for setting priorities and schedules for implementing these strategies. For example, WDFW could consider changes in harvest regulations to reduce the number of northern pike. Trend information might also be helpful in adaptive management associated with PM&E measures being implemented by SCL as part of the new license.

4.5.3.3.6. Habitat Protection, Riparian Improvement, and Stream Channel Enhancement in Sullivan Creek from RM 0.00 to 0.54

This measure has three components to be implemented between the mouth of Sullivan Creek and RM 0.54 (downstream of the Highway 31 Bridge and the Sullivan Creek Hydroelectric Project boundary). Each of the following components is described separately: habitat protection, riparian planting, and stream channel enhancement.

Habitat Protection

The objective of this component is to protect up to 54.7 acres within the stream corridor and a 300-foot buffer adjacent to Sullivan Creek from RM 0.0 to 0.54 through a combination of conservation easements or land acquisition (Figure E.4-63). Protection measures reduce the risk of future adverse effects to existing habitat. SCL owns land adjacent to this reach of Sullivan Creek, of which 29.8 acres lie within the stream corridor or proposed buffer. A variety of state,

local, and private entities accounts for the remaining ownership. Protection of non-SCL lands would require willingness of other landowners to enter into conservation agreements or sale of lands within the buffer zone. SCL proposes to place all of its ownership within the buffer under protected status throughout the duration of the new license. In addition, SCL will pursue conservation easements or land acquisitions from willing owners within the buffer zone (Attachment E-8).

Figure E.4-63. Sullivan Creek from RM 0.00 to 0.54 with a 300-foot buffer.

Riparian Improvement

This component would implement riparian improvement along the left and right banks for up to 3,000 feet of stream, with the objective of improving riparian functions (shade, potential instream large woody debris, and erosion control), improving riparian habitat for wildlife, and decreasing the presence of invasive plant species. Activities in some sections of the reach would depend on the successful implementation of the habitat protection component involving non-SCL landowners. This measure assumes that improvements would be made to approximately 60 percent of the 13.8-acre area within a 100-foot buffer on each side of the stream, resulting in improvements to approximately 8.3 acres. Current riparian conditions are variable, with some portions devoid of riparian trees or brush (i.e., very sparse), some having a moderate density of mixed brush, herbaceous plants, and hardwoods with some conifers (moderately sparse), and

some having a relatively dense hardwood forest cover with some conifers (sparse). This measure assumes that approximately 3.8 acres of riparian buffer with very sparse existing vegetation would require a high density of plantings, 2.0 acres of riparian buffer would require plantings interspersed among moderately sparse existing vegetation, and 2.5 acres of riparian buffer would require plantings interspersed among sparse existing vegetation. This component assumes approximately 5.5 acres of riparian area is in good condition and does not need improvement. Non-native vegetation found in the PM&E reach would be removed and replaced with native vegetation. Selection of specific plants and planting locations would be determined as part post-license planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). However, it is anticipated that plants would be a mix of native coniferous and deciduous trees, shrubs, and herbaceous plants or ground cover.

Stream Channel Enhancement

The objective of this component would be to improve instream spawning and rearing habitat and channel conditions along 1,450 feet of stream by adding a combination of structural elements, primarily in the form of groins, barbs, porous boulder weirs, boulder clusters, and LWD. Addition of structural elements would contribute to pool formation and retention of LWD and coarse sediment suitable for salmonid spawning. Structural elements along the left bank would help stabilize the stream bank, protecting downstream property owners and decreasing bank erosion. This component assumes up to 100 boulders averaging 3 feet in diameter would be placed in the stream. This component proposes to supplement LWD to approximate the median key piece and total LWD densities estimated as reference conditions for the Douglas fir – Ponderosa Pine Region in Fox and Bolton (2007), which are 1.2 key pieces per 1,000 feet and 52 LWD pieces per 1,000 feet. LWD placement could take place in conjunction with some of the boulder placements for anchoring or increasing structure size. For planning purposes, SCL assumes that one engineered LWD jam will be designed and placed in the reach; the LWD jam will have a target volume of 1,800 cubic feet and will include at least one key piece (minimum volume of 344 cubic feet [Fox and Bolton 2007]), at least one piece with an attached root wad that could also count as the key piece, and additional LWD pieces to meet the target volume for the LWD jam. Other LWD pieces will be placed individually, grouped, or placed in conjunction with boulders to meet the target of 75 pieces of LWD in the reach (existing plus supplemented LWD).

SCL anticipates that LWD may need replenishment because of loss from transport or degradation. Furthermore, SCL anticipates that woody debris structures such as log jams will have a five- to 10-year life span and will occasionally need repair or replacement. LWD replenishment would occur on a five-year basis throughout the term of the license to meet minimum LWD target density. SCL commits to replacing each instream LWD structure up to six times over the course of the license term. Individual boulders and structures built using boulders are not expected to need replacement, but localized scour and other fluvial processes could result in the need for repair or repositioning of boulders.

Activities associated with this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the license for the Sullivan Creek Hydroelectric Project (FERC No. 2225), which includes the Mill Pond Dam and is operated by the Pend Oreille

County PUD. If Mill Pond Dam is removed, it could adversely affect the effectiveness of any existing downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently implementation of this component will not occur until the disposition of Mill Pond Dam has been determined. Implementation of this component along some portions of the reach will likely require landowner permission for access or modification of the stream bank on their property. Compliance and effectiveness monitoring would be performed as part of this PM&E measure and is detailed in the FAMP (Attachment E-8). If this PM&E is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

Rationale

Sullivan Creek is the largest tributary draining into Boundary Reservoir. Biological surveys conducted during relicensing indicated that the delta region and lower reaches of Sullivan Creek are used for rearing by cutthroat trout and rainbow trout. The delta has also been identified as a location of known mountain whitefish spawning. Although few bull trout have been observed in Sullivan Creek, the lower 0.66 mile of Sullivan Creek is designated as "critical habitat" by the USFWS.

The presence of the Town of Metaline Falls and existing commercial and residential development adjacent to this lower reach of Sullivan Creek suggests there is a relatively high risk of future development compared to USFS lands farther upstream. A channel assessment from RM 0.47 to RM 0.68 was conducted during mid July 2008. The habitat conditions in the surveyed reach were described as poor for fish migration, rearing, and overwintering. Spawning conditions are poor because appropriate sized gravel is lacking, and during high flows there is a high potential for any redds to be scoured. The bed conditions of the reach have been influenced by suction dredge mining and the Highway 31 Bridge. The dominant bed surface pattern was riffles and rapids. LWD was rare throughout the surveyed reach and primarily present above the water surface at the time of the survey and is consequently only an active component of fish habitat at higher flows. LWD functions relative to channel conditions observed during the survey primarily included bank stability and small pool scour. No LWD jams were present during the July 2008 survey. The riparian zone was described as composed of young (< 40 years) mixed vegetation. Several riparian sections within the PM&E reach are currently not forested and other sections have patches dominated by low brush and herbaceous vegetation (Figure E.4-64).

Figure E.4-64. Sullivan Creek downstream of Highway 31 Bridge.

4.5.3.3.7. Riparian, Streambank, and Channel Improvements in Sullivan Creek from RM 2.30 to 3.93

This PM&E measure would enhance Sullivan Creek from approximately 265 feet downstream of the confluence of Sullivan Creek and North Fork Sullivan Creek to the Sullivan Creek Hydroelectric Project boundary downstream of Mill Pond Dam and will focus primarily on streambank and channel enhancement, but will also include a limited amount of riparian planting in conjunction with the streambank enhancement. The objective would be to deflect water from the right bank to the left bank in areas hydrologically connected to Sullivan Lake Road, decrease bank erosion on the right bank, provide instream structure to promote pool creation and deposition and retention of spawning gravel, decrease the channel width-to-depth ratio, and promote the riparian buffer along right bank.

Selection of specific structural elements and their placement would be determined as part of post-license planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). This measure would implement the design and construction of up to seven engineered LWD jams. Each LWD jam would have a target volume of 1,100 cubic feet and include at least one key piece (minimum volume of 344 cubic feet [Fox and Bolton 2007]), at least one piece with an attached root wad that could also count as the key piece, and additional LWD pieces to meet the target volume for the LWD jam. Up to 100 boulders averaging 3 feet in diameter would be placed in the stream, primarily in boulder clusters, but would also be used to anchor LWD pieces.

Activities associated this PM&E measure could be affected by activities required pursuant to the pending surrender proceeding for the license for the Sullivan Creek Hydroelectric Project (FERC No. 2225), which includes the Mill Pond Dam. If Mill Pond Dam is removed, it could adversely

affect the effectiveness of any existing downstream enhancement projects through short- or long-term changes in sediment supply and LWD recruitment and transport. Consequently implementation of this component will not occur until the disposition of Mill Pond Dam has been determined. Implementation of this component along some portions of the reach will likely require USFS permission for access or modification of the stream bank. Compliance and effectiveness monitoring will be performed as part of this PM&E measure and is detailed in the FAMP (Attachment E-8). If this PM&E measure is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

Rationale

Two reaches, from RM 2.30 to 2.60 and from RM 2.74 to 3.02, had channel assessments as part of relicensing studies (Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Final Report, SCL 2009a). Habitat quality was described as low for salmonid spawning in both survey reaches, moderate for migration and rearing habitat in both reaches, and low and moderate, respectively, for overwintering habitat. The reaches were described as being adversely impacted by the presence of Mill Pond Dam, which starves the reach of coarse substrate and LWD, and the presence of Sullivan Lake Road along its right bank, which is hydraulically connected in several locations, limits lateral movement of the channel, and reduces riparian function (Figure E.4-65). LWD density in the two reaches was lower than regional reference levels reported by Fox and Bolton (2007). No LWD jams were observed in one reach and one was observed in the other. Riparian vegetation was described as a mixture of hardwoods and conifers, with the left bank having both young (< 40 years old) and mature (40-80 years old) trees, while the right bank had primarily young vegetation. Channel morphology was described primarily as plane-bed, with few rearing pools available. McLellan (2001) surveyed one site in the reach from North Fork Sullivan Creek to Mill Pond Dam and observed low numbers of cutthroat trout (1 fish, < 1 fish/100 square meters) and rainbow trout (26 fish, 1 fish/100 square meters). Increasing channel structure, decoupling the Sullivan Lake Road from the stream, and enhancing riparian conditions is expected to benefit trout in the stream.

Figure E.4-65. Section of Sullivan Lake Road hydraulically connected to right bank of Sullivan Creek.

4.5.3.3.8. Culvert Replacements in Slate Creek Tributaries Slumber Creek at RM 0.2 and Styx Creek at RM 0.1

Under this PM&E measure culverts at Slumber and Styx creeks (RM 0.2 and 0.1, respectively), will be replaced with new culverts that meet Washington State criteria within four years following license issuance. The objective of the PM&E measure is to provide passage for juvenile, sub-adult, and adult salmonids at all flow levels and provide access to more than 0.3 miles of resident trout habitat available in Slumber Creek and more than 1.9 miles available in Styx Creek. A secondary objective is to improve downstream transport of LWD. As part of culvert replacement, riparian planting will occur as needed in disturbed areas to control erosion and provide shade. Maintenance of the replacement structures will be the responsibility of the USFS. Compliance monitoring will be implemented as part of this PM&E measure to ensure 80 percent survival of riparian plantings during the first three years following implementation (Attachment E-8).

Rationale

Slumber Creek and Styx Creek are tributaries to Slate Creek, with their confluences at RM 2.0 and 4.9, respectively. USFS roads cross these tributaries near their mouths (RM 0.2 and 0.1, respectively). During 2008, habitat surveys were conducted upstream and downstream of these culverts for 492 feet in conjunction with evaluation of the culverts (Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Final Report, SCL 2009a). Neither of the culverts currently meets Washington State criteria for fish passage. Both tributaries are relatively small with wetted widths less than 7.5 feet, but contain suitable salmonid habitat over a portion of their length that will be available under all flow conditions following replacement.

4.5.3.3.9. Riparian Planting in Linton Creek RM 0.0 to 0.2

Linton Creek flows through the Town of Metaline and the mouth is located in Metaline Park. This PM&E measure would implement riparian improvements along the left and right banks for up to 655 feet of stream upstream of the mouth of Linton Creek, with the objective of improving riparian functions (e.g., shade, potential instream large woody debris, leaf and needle litter, erosion control, etc.), improving riparian habitat for wildlife, and decreasing the presence of invasive plant species. Any non-native vegetation found in the PM&E reach within a 100 foot buffer on both sides of the stream (total area approximately 3.0 acres) will be removed and the buffer planted with native vegetation. Selection of specific plants and planting locations will be determined as part of post-license planning and design work conducted in collaboration with the FAWG the Town of Metaline and following WDFW guidelines in Saldi-Caromile et al. (2004). It is anticipated that plants will be a mix of native coniferous and deciduous trees, shrubs, and herbaceous plants or ground cover. Implementation of this PM&E measure depends on permission from the Town of Metaline. If permission is not obtained, the funds allocated to riparian planting along Linton Creek will be allocated, in collaboration with the FAWG, to other PM&E measures. Compliance monitoring will be implemented as part of this PM&E measure to ensure 80 percent survival of riparian plantings during the first three years following implementation (Attachment E-8).

Rationale

A channel and habitat survey from RM 0.0 to 0.25 (Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Final Report, SCL 2009a) indicated that habitat in this reach predominantly consisted of low-gradient riffles, with an average channel slope of 2 percent (Figure E.4-66). Riparian and rearing habitat conditions within the survey reach were found to be poor. SCL (SCL 2009c) observed cutthroat trout, rainbow trout, brown trout, brook trout, pumpkinseed, and largescale sucker using the tributary channel during July through September 2008. Because Linton Creek is relatively small, with a mean wetted width of 10.6 feet, improvements to the riparian zone would likely provide substantial increased shade within five to 10 years and increases in LWD recruitment to the channel over the long-term.

Figure E.4-66. Riparian and channel conditions in lower Linton Creek.

4.5.3.3.10. Channel Improvements in Sweet Creek from RM 0.4 to 0.5

The objective of this PM&E measure would be to increase channel complexity and gravel retention through LWD placement over a 558-foot reach downstream of the Highway 31 culvert. The bankfull width of Sweet Creek is approximately 33 feet in this reach, making it suitable for placement of channel-spanning LWD. Up to 10 channel-spanning structures would be installed. Each structure would have one to three LWD pieces, of which at least one would be a key piece with a minimum volume of 88.2 cubic feet, preferably with a rootwad attached (Fox and Bolton 2007). Selection of the specific location and design of the spanning structures would be determined as part of post-license planning and design work conducted in collaboration with the FAWG and following WDFW guidelines in Saldi-Caromile et al. (2004). The presence of eroding stream banks would be considered during this process and streambank reshaping could be implemented as part of structure placement to reduce erosion. As part of post-license planning, other types of structural elements, such as partial spanning structures, porous boulder weirs, or boulder clusters, could be substituted for proposed elements.

The design-life for engineered log structures in streams is anticipated to be five to 10 years; consequently, for planning purposes it is anticipated that maintenance or replacement structures will be needed every seven years during the new license term or up to three full replacements for each structure. Compliance and effectiveness monitoring will be performed as part of this PM&E measure and are detailed in the FAMP (Attachment E-8). If this PM&E is approved, SCL will propose any necessary revisions to the Project boundary after the specific locations of the related activities are determined.

Rationale

Sweet Creek is the fourth largest tributary draining into Boundary Reservoir, with a drainage area of 11.1 square miles. A series of natural falls begin at RM 0.6 that are a complete upstream fish passage barrier. The stream also passes through a large box culvert under Highway 31 at RM 0.5. The culvert appears to block transport of LWD based on the buildup of wood and retention of gravel on the upstream side, and streambank erosion is occurring downstream of the culvert (Assessment of Factors Affecting Aquatic Productivity in Tributary Habitats, Final Report, SCL 2009a). The culvert does not meet WDFW criteria for fish passage, but cutthroat trout, mountain whitefish, rainbow trout, brown trout, and brook trout have been observed upstream of the culvert (McLellan 2001), suggesting the culvert is passable under some conditions. Fish habitat and channel surveys conducted from the mouth to the lowermost falls suggest riparian and instream substrate and LWD conditions are relatively good; however, the reach is dominated by riffles and has relatively few pools (SCL 2009a; McLellan 2001). The addition of channel spanning drop-structures should result in more pool habitat for fish using the stream.

4.5.3.3.11. Riparian Buffer Protection and Improvement in Sweet Creek from RM 0.0 to 0.5

SCL will pursue acquisition of or protective land easements for 11.8 acres within a 100-foot buffer (excluding existing roads) on either side of Sweet Creek from the mouth to RM 0.5, which is the location of the Highway 31 culvert (Figure E.4-67). In addition, SCL proposes to remove non-native vegetation and plant native brush and trees over 3.3 acres within that buffer. The majority of plantings would occur over a 3-acre area near the mouth of Sweet Creek, where trees are mostly lacking, but would also include a 0.3-acre area north of the access road near the high school football field. Implementation of the protective portion of this PM&E measure is dependent on the willingness of current owners (three private owners, the Selkirk School District, Washington State Department of Natural Resources, and Washington Department of Transportation) to sell a portion of their land or enter into easement agreements. Similarly, implementing riparian plantings would require permission from the owners, even if long-term protection could not be provided. If owners are unwilling to sell or provide easements within the 100-foot buffer, long-term protection will not be provided. If owners do not grant permission for riparian plantings, then funds equal to the cost of these plantings would be allocated to other PM&E measures as determined in collaboration with the FAWG. Compliance and effectiveness monitoring will be performed as detailed in the FAMP (Attachment E-8).

Rationale

The coolwater plume at the tributary delta to Sweet Creek has been identified as an important area for salmonids during warm summer months. Bull trout, Westslope cutthroat trout, and mountain whitefish have all been observed in lower reaches of Sweet Creek (SCL 2009c). Although most of the riparian zone of Sweet Creek downstream of Highway 31 is in relatively good condition (SCL 2009a; McLellan 2001), several areas could be improved through riparian planting, which could increase future shade and LWD recruitment potential. Protection of the existing high-quality riparian habitat and improvement of some areas would benefit native salmonids within the stream channel and would help maintain cool water temperatures in the tributary delta.

Figure E.4-67. Riparian buffer area adjacent to Sweet Creek proposed for protection.

4.5.3.3.12. Tributary Non-native Trout Suppression

SCL will conduct non-native trout suppression activities over an average of 5.8 miles of stream annually using a single-pass of backpack electrofishing equipment. The basis for this amount of stream is the assumption that suppression would occur over 2.4 miles of Sweet Creek, between the barrier falls at RM 0.92 and the fish bearing headwaters, except for Lunch Creek, on a three-years-on/two-years-off cycle. Suppression will also occur over 7.3 miles of Slate Creek, between the barrier chutes and falls at RM 0.75 and the fish bearing headwaters, also with a single-pass of a backpack electrofishing unit on a three-years-on/two-years-off cycle. SCL selected these two creeks because they have barrier falls that prevent immigration of non-native fish residing downstream, Westslope cutthroat trout are present at low to moderate densities, and non-native trout densities appear to be relatively low (McLellan 2001).

The basis of the 5.8-mile average is as follows: suppression activities will be conducted for three years and then discontinued for two years over 2.4 miles of Sweet Creek and 7.3 miles of Slate Creek, for a total of 9.7 miles per year, and 29.1 miles over three years (i.e., 9.7 miles x 3 years = 29.1 miles). Annualized over the five-year on/off cycle, this will yield an average of 5.8 miles per year (29.1 miles ÷ 5 years). As stated above, SCL's commitment is an average of 5.8 miles

per year, but the total could be implemented in different ways, including doing the total of 9.7 miles during three out of five years, which follows the recommendations of Peterson et al. (2008). Compliance and effectiveness monitoring would be conducted as part of this PM&E measure is described in more detail in the FAMP (Attachment E-8).

Rationale

Most of the tributaries to the Pend Oreille River, including those to Boundary Reservoir, have been stocked with non-native salmonid species such as brook trout, brown trout, and rainbow trout (McLellan 2001). The presence of non-native trout, especially brook trout, has been suggested as a serious threat to native salmonids as a result of interbreeding (with bull trout) and competition for habitat and food resources (Andonaegui 2003). The USFWS (1999) stated in its status review that Westslope cutthroat trout are usually found in the cooler upper extents of tributaries, but suggested this use was more likely driven by competition from other trout such as rainbow trout and brook trout that are less tolerant of cooler, higher gradient streams, rather than a preference for that habitat type. Cutthroat trout, mountain whitefish, rainbow trout, brown trout, and brook trout have been observed downstream of the series of impassable falls beginning at RM 0.6 in Sweet Creek; however only brook trout and cutthroat trout were observed above the series of falls (McLellan 2001). No brook trout were observed in Lunch Creek or the uppermost reach surveyed in Sweet Creek.

Slate Creek has been identified as a stream important to the recovery of bull trout by the NWU Recovery Team for the bull trout and reduction of non-native fish species as a priority action (POSRT 2005). Surveys in Slate Creek conducted by McLellan (2001), R2 Resource Consultants (1998a), and the USFS (1998) have documented the presence of eastern brook trout. Rainbow trout have also been documented in Slate Creek downstream of the chute and falls barrier located at RM 0.75, but it is unclear if they are native redband trout or descendents of hatchery rainbow trout stocked in the creek, because no genetic tests have been conducted on rainbow trout from Slate Creek. Tests of a small number of rainbow trout captured in Boundary Reservoir suggest that some had genetic characteristics similar to other native inland rainbow stocks, but the low sample size and lack of a baseline genetic library from nearby native redband populations for comparison precluded unequivocal conclusions (Small and Von Bargen 2009).

4.5.3.3.13. Native Trout Supplementation Facility

SCL proposes to fund the construction and operation of a hatchery for the production of native salmonids to supplement tributaries draining into Boundary Reservoir. The initial target species would be Westslope cutthroat trout, but the facility would be designed to simultaneously propagate two species of fish, which could include bull trout, Westslope cutthroat trout, redband trout, or mountain whitefish. The target capacity for the hatchery would be up to 45,000 eyed eggs, fry, or fingerling (3 to 4 inch) fish per year (approximately 1,000 lbs per year if all were reared to fingerling-size). Selection of species, stocks, and lifestages to be produced would be developed in coordination with the FAWG. In addition, the hatchery would have the capacity to sustain the necessary numbers of broodstock fish to produce this number of eggs, fry, or fingerlings. Because mature Westslope cutthroat trout tend to be small in Boundary Reservoir tributaries (few fish exceed 12 inches; McLellan 2001), SCL estimates broodstock requirements could be 200 to 300 fish, assuming 500 eggs per female. Assuming an average size of 2.2 pounds per fish, broodstock rearing capacity would need to be approximately 440 to 660 pounds.

For planning purposes, it is assumed that the propagation facility will be located at the 40-acre WDFW parcel near Indian Creek that was formerly occupied by the Usk Hatchery. WDFW currently holds a 7-cfs water right to a natural spring. The water supply could require heating to be appropriate for some species or life stages.

Rationale

The larger tributaries to Boundary Reservoir contain a variety of fish species, and most salmonid species in the Project area occur in the tributaries (SCL 2006, SCL 2009a). Surveys conducted by the USFS, WDFW, and Kalispel Tribe show that the dominant sportfish in tributaries are Westslope cutthroat trout, eastern brook trout, rainbow trout, and to a lesser extent brown trout and mountain whitefish (SCL 2006). These surveys documented bull trout (1 dead individual apparently caught by an angler), kokanee, and burbot in Sullivan Creek and bull trout (1 individual) in Sweet Creek. The burbot and kokanee in Sullivan Creek were likely entrained from Sullivan Lake, where substantial sport fisheries exist for both species.

Currently, no reproducing bull trout populations occur in any tributaries to Boundary Reservoir. Nevertheless, the NWU Recovery Team has identified Sullivan and Slate Creeks as local bull trout populations under a recovered condition based on habitat survey data and professional judgment (USFWS 2002).

Westslope cutthroat trout are widely distributed in the Project area but threatened by the presence of non-native brook trout. Peterson et al. (2004) found the survival of age-0 and age-1 cutthroat trout at mid-elevations (approximately 8,200 to 8,858 foot elevation) to be 13 times and two times higher, respectively, when brook trout abundance was suppressed. Lower elevations similar to tributaries surrounding Boundary Reservoir (fish bearing waters are generally less than 5,000 feet elevation) were not sampled in Peterson et al. (2004). Suppression of non-native trout in Slate and Sweet creeks is proposed as a PM&E measure (Section 4.5.3.3.12). SCL hypothesizes that supplementation of Westslope cutthroat trout in streams can complement brook trout suppression activities and result in higher recruitment to the cutthroat trout population than would result from suppression alone.

4.5.3.3.14. Operations

As explained in Section 2.3.1 of this Exhibit E, during the next license term SCL proposes to formalize its currently voluntary summer forebay water surface elevation restrictions as follows: From Memorial Day weekend (starting Friday evening) through Labor Day weekend (on Monday evening), forebay water surface elevations will be maintained at or above 1,984 NAVD 88 from 6:00 am through 8:00 pm to facilitate recreational access and use. From 8:00 pm through 6:00 am, forebay water surface elevations will be maintained at or above elevation 1,982 feet NAVD 88. Under SCL's proposed operation, the 1,984- and 1,982-foot NAVD 88 elevations would be license requirements that could not be violated except for conditions such as equipment failures, maintenance activities, electrical and mechanical device limitations, safety inspections, testing, natural disasters (e.g., lightning), compliance with WECC and NERC requirements, capacity and energy emergencies, and any event that triggers the Project Emergency Action Plan (EAP).

This forebay water surface elevation restriction is anticipated to reduce the incidence of trapping and stranding of fish and provide a small increase in productivity within the varial zone under the Proposed Action as compared to the No Action alternative. Under existing voluntary restrictions there were 4 hours of daytime excursions and no nighttime excursions during the representative wet year (1997), 136 hours of daytime and 63 hours of nighttime excursions during the representative dry year (2001), and 9 hours of daytime and no nighttime excursions during the representative average year (2002). While the excursions were usually small (less than 1 foot), the size of excursions was occasionally fairly large. For example, during 2001 the maximum excursion was 5.7 feet below the target elevation. Under SCL's proposed operation, the 1,984 and 1,982 foot NAVD 88 elevations would be license requirements that could not be violated, except under the conditions identified in the preceding paragraph. Consequently, fish and other aquatic fauna would benefit from formalizing the summer pool restrictions, especially during dry years.

Project operation and maintenance also require periodically drawing down the reservoir to remove or repair Project components such as turbines and gates. For example, approximately every 10 years SCL would draw down the reservoir to 1,970 feet NAVD 88, three times over a two-year period, for maintenance of the sluice maintenance gate.

4.5.3.4. Cumulative Effects Analysis

A number of aquatic resources could be cumulatively affected by the Project because it is the third of five hydroelectric projects along the Pend Oreille River between Lake Pend Oreille and the Columbia River. Project effects that could contribute to cumulative effects include:

- Disruption of sediment transport
- Disruption of LWD transport
- Lack of habitat connectivity for native salmonids

The Pend Oreille River between Boundary Dam and Box Canyon Dam has two distinct segments in terms of sediment transport. The section from the Boundary Dam upstream to Metaline Falls, consisting of the Forebay and Canyon reaches is a depositional environment created as a result of inundation caused by Boundary Dam. Upstream of Metaline Falls, in the Upper Reservoir Reach, the Pend Oreille River is at times influenced by a backwater effect from Boundary Dam, but it often experiences riverine conditions, particularly when forebay water surface elevations are low or inflows are high.

The operation of Box Canyon Dam, located at the upstream extent of Boundary Reservoir, limits the supply of bed material to the Upper Reservoir Reach to flow rates that exceed 80,000 cfs. At flows above 80,000 cfs, the leaves at Box Canyon Dam are opened and bed material (primarily coarse gravel-sized particles) stored behind the dam moves into Boundary Reservoir. The hydraulic influence of Boundary Dam also affects the transport of sediment through Boundary Reservoir; however, the effect of Project operations on sediment transport is negligible. The Project ceases to operate in a load following mode when flows into the reservoir exceed power plant capacity (approximately 56,000 cfs). In general, most sediment is transported by flows approaching or greater than the “channel forming” flow (the estimated two-year recurrence

interval peak flow magnitude is 85,800–107,000 cfs [SCL 1997]). The operation of the Box Canyon Project can create a temporary deficit of coarse sediments if the peak flows do not reach 80,000 cfs for an extended period of years because the leaves at the dam will not be lifted to release the temporarily stored bedload.

The cumulative effect of the two dams is to disrupt the transport of coarse sediment into Boundary Reservoir and Seven Mile Reservoir, resulting in tailrace conditions that are depleted of gravel suitable for spawning by some fish species. Of the native salmonids in the Project area, mountain whitefish appear to spawn in the 1-mile reach downstream of Box Canyon Dam and stage in the Boundary Dam tailrace prior to spawning farther downstream. In both of these areas, mountain whitefish spawning habitat could be adversely affected by the disruption of gravel-sized particles suitable for spawning.

Each of the hydroelectric projects collects and removes LWD from its forebay, because debris can be destructive to project facilities. The overall LWD budget in terms of the amount of wood that enters the river from Lake Pend Oreille and tributary streams and the amount of wood that is removed is unknown. Nevertheless, the overall trend is the cumulative loss of LWD that could otherwise provide aquatic habitat along the river shorelines or at islands and cobble bars. SCL's proposed measures related to gravel augmentation and LWD augmentation would reduce this effect.

None of the five dams on the Pend Oreille River has upstream or downstream fish passage or screening facilities. Consequently, all fish entrained over or through the projects are at risk of injury or mortality. Because the level of mortality at each of the dams is unknown, the cumulative level of injury or mortality for fish that pass multiple facilities is also unknown. However, it is known that at least some fish survive passage, as evidenced by the capture and release of healthy fish in the Boundary Dam tailrace that had been tagged upstream of a dam. In addition, genetic analysis of tissue from two bull trout captured in the Boundary Tailrace Reach indicates that these fish were derived from populations in tributaries to Lake Pend Oreille and survived passage at Albeni Falls, Box Canyon, and Boundary dams.

Status reviews for bull trout (Rieman and McIntyre 1993) and Westslope cutthroat trout (McIntyre and Rieman 1995) suggest that the lack of habitat connectivity (i.e., fish passage) is an important factor contributing to the patchy distribution and low viability of these species in the Pend Oreille River. The lack of passage facilities at the Boundary Project contributes to cumulative adverse effects to habitat connectivity for migratory native salmonid species. SCL proposes to institute upstream passage under the new license, but no downstream passage or protection facilities are proposed due to a lack of feasibility.

From Lake Pend Oreille downstream to the U.S.-Canada border, federal, state, tribal, and conservation groups are collaborating on the development of plans and projects designed to help recover bull trout populations and conserve and improve habitat and populations of other native salmonids. Pertinent plans and actions include:

- The Land and Resource Management Plan for the Colville National Forest (USFS 1988)

- The Inland Native Fish Strategy (INFISH; USFS 1995)
- Joint WDFW/Tribal Wild Salmonid Policy (WDFW and Western Washington Treaty Tribes 1997)
- Draft Bull Trout Recovery Plan (USFWS 2002)
- The NWPPC Intermountain Province Subbasin Plan (GEI Consultants 2004)
- Watershed Management Plan for watershed resource inventory area (WRIA) 62 (Golder Associates, Inc. 2005)
- Implementation of License Articles for Box Canyon Hydroelectric Project (FERC No. 2042)

The goals, objectives, and strategies for these plans are generally consistent with, if not similar to, each other in regard to aquatic habitat and native salmonid species in and around the Project area and its tributaries. In general, there is a regional desire expressed in the various plans to reduce the effects of ongoing anthropogenic activities on water quantity and quality and habitat quantity, quality, and accessibility to improve the beneficial uses of water and aquatic fauna that use that water. Several of the plans are specific to either bull trout or native salmonids, in general, but many similarities are present in the types of specific strategies that are proposed. However, most of the plans did not have specific on-the-ground projects identified for implementation at the time of publication and are also dependent on uncertain funding such as private, state, or federal grants, or regular state or federal agency funding requiring authorizations on an annual or bi-annual basis that have substantial fluctuations depending upon economic conditions. Implementation of these plans should tend to improve some aspects of water quality, riparian habitat, fish habitat, and native salmonid populations, but the rate at which improvements would occur in the future is uncertain.

The Pend Oreille County PUD is likely to provide passage to native salmonids at Box Canyon Dam in the foreseeable future. The Box Canyon Project has passage requirements as part of its recently acquired FERC license, which should be implemented by July 2018, for upstream passage using a trap-and-haul facility, and by 2015 for downstream passage facilities. The 2000 Biological Opinion for Federal Columbia River Power System Operations (USFWS 2000) called for investigating the feasibility of providing passage to bull trout, and the USFWS (2002) recovery plan for bull trout suggested passage would be necessary to recover bull trout in the NWU. The USACE and other federal, state, and tribal agencies continue to study the feasibility of passage at the Albeni Falls Project, but currently there are no specific plans for passage facilities.

The provision of downstream passage at Box Canyon Dam could likely increase the number of native salmonids entering Boundary Reservoir from upstream, assuming that upstream tributary spawning populations maintain or increase in size. If the number of native salmonids entering Boundary Reservoir increases as a result of successful implementation of the listed plans and tributary improvements throughout the Pend Oreille River basin, including PM&E measures proposed by SCL for Boundary Reservoir tributaries, and passage improvements at upstream hydroelectric projects, then the number of native salmonids that could be at risk from trapping or stranding or entrainment at Boundary Dam could also increase. Use of coldwater plumes by native salmonids at tributary mouths would also increase. Because releases of triploid rainbow trout into Boundary Reservoir will not occur under the Proposed Action, competition for space at

coldwater plumes would likely not occur initially under the new license until, or if, native salmonid populations increase substantially in size.

4.5.3.5. Unavoidable Adverse Impacts

Some potential effects of the Project are unavoidable or cannot be completely mitigated by proposed in-kind mitigation measures, and consequently, a number of out-of-kind mitigation measures are proposed for tributaries draining into Boundary Reservoir to provide complete mitigation (Section 4.5.3.3). These unavoidable or partially mitigated potential adverse impacts to aquatic resources include:

- Reduced productivity in near-shore areas due to fluctuating water surface elevation, to the extent fluctuation is caused by Project operations
- Injury and mortality of fish entrained at Boundary Dam
- Disruption of sediment transport
- Disruption of LWD transport
- Trapping and stranding of fish and other aquatic organisms due to fluctuating water surface elevation, to the extent fluctuation is caused by Project operations
- Fluctuations in aquatic habitat and thermal plume characteristics in tributary delta regions, to the extent fluctuation is caused by Project operations

All of the unavoidable adverse potential impacts identified above are long-term and would occur throughout the term of the new license. The magnitude of these effects on native salmonids is difficult to evaluate because few native salmonids reside in Boundary Reservoir and many out-of-Project factors also affect native salmonid population abundance.

Disruption of sediment and LWD transport are both partially the result of transport disruption at Box Canyon and Albeni Falls dams and are therefore cumulative in nature. PM&E measures proposed to provide areas with high quality substrate conditions for mountain whitefish (Section 4.5.3.3.1) and LWD jams at tributary deltas (Section 4.5.3.3.4) are anticipated to partially mitigate for sediment and LWD transport disruptions at the Project. Trapping and stranding of fish and fluctuations in aquatic habitat and thermal plume characteristics are site-specific and occur episodically. Trapping and stranding impacts are largest during large drawdowns that occur infrequently. A PM&E measure (Section 4.5.3.3.2) is proposed to reduce the effects of stranding and trapping at one of the major locations in Boundary Reservoir where trapping was identified, and placement of bottom barriers for macrophyte control is proposed to reduce the risk of stranding and trapping at two other locations (see Section 4.5.2.3). Thermal plume characteristics are important primarily during summertime periods when mainstem water temperatures exceed 18 ˚C. Although some thermal plumes are generally available to fish seeking cool water temperatures, load following operations result in continuous changes to the shape and location of the thermal plumes, which means fish must frequently adjust their locations to remain in desirable thermal conditions. For native salmonids, and particularly bull trout, which prefer relatively low temperatures, these effects could be substantial, to the extent that these species occur in the Project area. Because no bull trout were captured, resulting in no biotelemetry being conducted for this species during relicensing studies, the magnitude of these

effects on both a short-term basis and on the overall status of bull trout in Boundary Reservoir is highly uncertain.

4.5.3.6. Consistency with Comprehensive Plans.

The fish and aquatics resource related management goals and policies associated with relevant comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The CNF land and resource management plan includes a number of forest management goals relevant to fish and aquatic resources:

- Fisheries - Provide a diversity of high quality aquatic habitats, which insures viable populations of fish in sufficient numbers to meet angler demands.
- Water - Provide for the continued supply of high quality water which meets established standards.
- Riparian - Provide and manage for riparian plant communities which maintain a high level of riparian dependent resources.

The CNFP includes the following standards and guidelines for fisheries, to be followed when evaluating or implementing management activities:

- Protect existing fish habitat from degradation where feasible. Rehabilitate habitats which have been degraded as a result of management activities where degradation is unavoidable. Mitigation will be at the affected site, when possible, but may be through off-site habitat enhancement when on-site mitigation is not possible.
- Emphasize management of native fish species habitat. Non-native species may be managed for in waters where they can be expected to provide at least 15 percent more biomass production or 15 percent more angler days recreation than native species. Non-native species may be used to provide diversity only where they will not adversely affect native fish or other native organisms in the affected or adjacent waters.
- Road crossings of Class I and II streams and fish-bearing Class III streams will be the minimum necessary. Existing crossings will be used whenever possible. New crossings will be located at areas of the least possible stream gradient. Stream crossing structures will provide the least resistance to upstream fish passage. Bridges or bottomless arches will be used instead of culverts unless the culvert can be installed in a manner that will allow passage of native trout during their spawning period. Drainage from roads will be dispersed prior to entering streams.

- Maintain the general character of aquatic and riparian habitat features. Maintain a natural source of large woody debris to provide structural fish habitat.
- In-stream migration barriers will normally be removed unless desired to prevent immigration by non-native, invasive fish or other aquatic organisms or when their removal would cause degradation to the stream and/or aquatic habitat.
- Maintain water quality parameters within the range of good fish habitat conditions, and within State water quality standards.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

The goal of BLM's resource management plan is to "Provide a variety of uses within the sustained yield capability of the resource." General management objectives pertinent to fish and aquatic species include:

- Protect or enhance water quality with particular attention to those watersheds with major downstream water uses including anadromous and other sport fisheries and agriculture.
- Consider the protection and/or enhancement of state listed threatened or endangered species habitat.

U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

The USFWS's goals for aquatic ecosystems are as follows:

- Protect, enhance, or restore diverse high-quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed, and mitigate for loss or degradation of these habitats.
- Maintain and/or restore aquatic habitat connectivity in the watershed to provide movement, migration, and dispersal corridors for salmonids and other aquatic organisms and provide longitudinal connectivity for nutrient cycling processes.
- Restore naturally reproducing stocks of resident fish to historically accessible riverine habitat, using native stocks where feasible, with priority given to the restoration of listed native stocks.
- Provide an instream flow regime that meets the spawning, incubation, rearing, and migration requirements of wild salmonids and other resident fish and amphibian species, throughout the Project area.
- Meet or exceed federal and state regulatory standards and objectives for water quality in the basin.

- Minimize current and potential negative Project operation effects on water quality and downstream fishery resources.

Northwest Power and Conservation Council. 2005. The fifth northwest electric power and conservation plan. Portland, Oregon. Council, Document 2005-07.

In 2004, the Northwest Power Planning Council (now the Northwest Power and Conservation Council) completed the Intermountain Province Subbasin Plan. The plan includes the following objectives related to aquatic macrophytes in the Pend Oreille River:

- Control the spread of Eurasian Watermilfoil in the subbasin.
    - Inventory and map locations of milfoil occurrence.
    - Evaluate the impact of extended dewatering and exposure to freezing temperatures on milfoil shoots.

The Fifth Northwest Electric Power and Conservation Plan was released in 2005. As described in the plan, the Northwest Power Act requires that the Northwest Power and Conservation Program has the goal of providing adequate, efficient, economical and reliable power while also protecting, mitigating, and enhancing fish and wildlife populations.

4.5.4. Botanical Resources

4.5.4.1. Affected Environment

The Affected Environment for botanical resources includes the entire area within the FERC Project boundary (Project area). Information on botanical resources was obtained primarily from three field efforts: (1) vegetation association mapping for the PAD (SCL 2006); (2) Inventory of Riparian Trees and Shrubs (Riparian Study) Final Report (SCL 2009a); and (3) the Rare, Threatened, and Endangered Plant Species Inventory (RTE Plant Study) Final Report (SCL 2009a). The study area varies slightly for each of these technical reports and extends beyond the range of the Project's influence. Collectively, these study areas are referenced in this section as the Project vicinity. References to the Project area include only lands within the FERC Project boundary.

Areas common to all of these studies include:

- *Downstream of Metaline Falls* — The reservoir, fluctuation zone (as defined in each technical study) and land within the FERC Project boundary (Project area), which includes most Project facilities, the area 200 horizontal feet (i.e., perpendicular to the shoreline) beyond the high water level along both reservoir shorelines, and the transmission line right-of-way from the power plant to the BPA substation.
- *Upstream of Metaline Falls* — The reservoir, fluctuation zone (approximately 1,986 –2,020 feet NAVD 88, as measured at the USGS gage below Box Canyon Dam), and the land within approximately 200 horizontal feet above the high water level (approximately 2,020 feet NAVD 88) along both reservoir shorelines extending to the FERC project boundary for the Box Canyon Project.

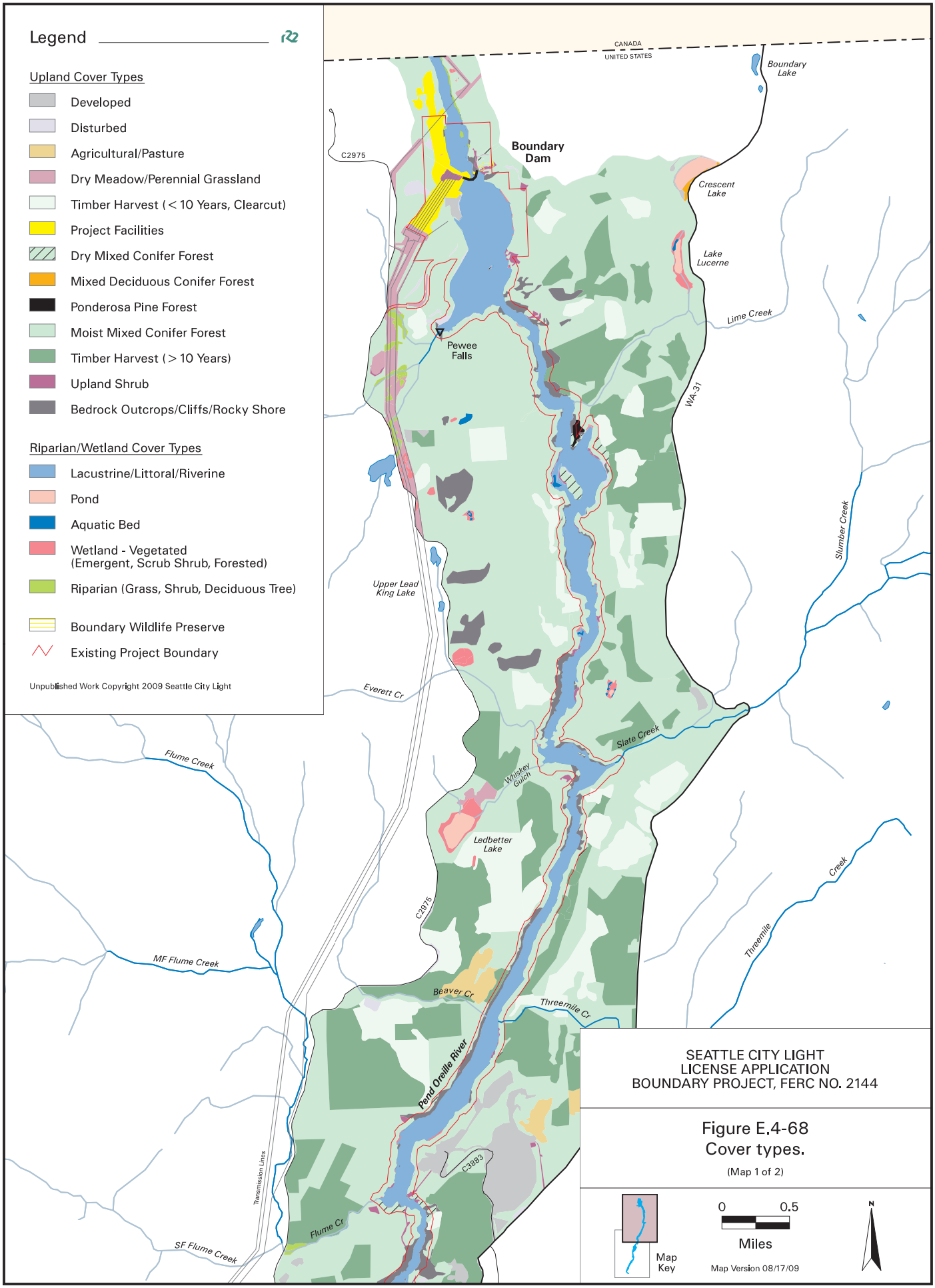
- The BWP (149 acres) and adjoining SCL-owned property (89 acres).
- 100 horizontal feet along both sides of the river from Boundary Dam to the U.S.-Canada border (approximately 0.9 mile).

In addition, the RTE Plant Study includes:

- 100 feet around any Project works area that extends outside the Project boundary.
- 50 feet along both sides of Project-related roads, which includes the road between the Boundary Dam and the Vista House, the road to the dam off county Road 2975, and the road from the Vista House to SR31.

The larger area included in the PAD vegetation association (cover type) mapping (Figure E.4-68) also includes:

- From Boundary Dam to Metaline Falls, the areas between Highway 31 (on the east side of the reservoir) and County Road 2975 (on the west side of the reservoir).
- From Metaline Falls to the Box Canyon Dam tailrace, the area between Highway 31 (on the west side of the reservoir) and 0.25 mile east of the reservoir shoreline.


Legend
Upland Cover Types
Developed
Disturbed
Agricultural/Pasture
Dry Meadow/Perennial Grassland
Timber Harvest (< 10 Years, Clearcut)
Project Facilities
Dry Mixed Conifer Forest
Mixed Deciduous Conifer Forest
Ponderosa Pine Forest
Moist Mixed Conifer Forest
Timber Harvest (> 10 Years)
Upland Shrub
Bedrock Outcrops/Cliffs/Rocky Shore
Riparian/Wetland Cover Types
Lacustrine/Littoral/Riverine
Pond
Aquatic Bed
Wetland - Vegetated (Emergent, Scrub Shrub, Forested)
Riparian (Grass, Shrub, Deciduous Tree)
Boundary Wildlife Preserve
Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Boundary Lake
Boundary Dam
C2975
Crescent Lake
Lake Lucerne
Lime Creek
Pewee Falls
WA-31
Slumber Creek
Upper Lead King Lake
Everett Cr
Slate Creek
Flume Creek
Whiskey Gulch
Ledbetter Lake
C2975
Threemile Creek
MF Flume Creek
Beaver Cr
Threemile Cr
Pend Oreille River
C3883
Transmission Lines
Flume Cr
SF Flume Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-68
Cover types.
(Map 1 of 2)
Map Key
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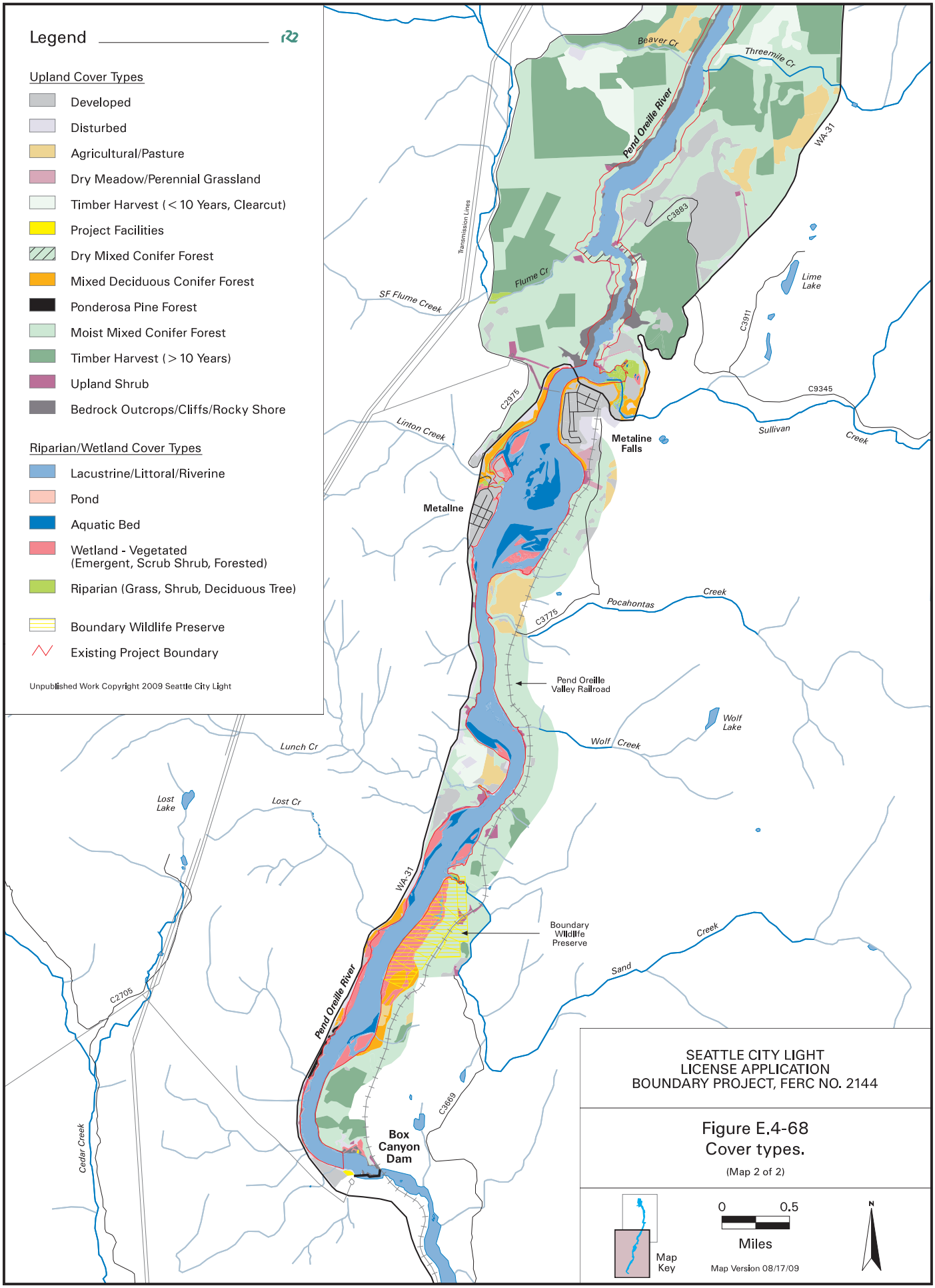
0.5
Miles
Map Version 08/17/09
N


Legend
Upland Cover Types
Developed
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Agricultural/Pasture
Dry Meadow/Perennial Grassland
Timber Harvest (< 10 Years, Clearcut)
Project Facilities
Dry Mixed Conifer Forest
Mixed Deciduous Conifer Forest
Ponderosa Pine Forest
Moist Mixed Conifer Forest
Timber Harvest (> 10 Years)
Upland Shrub
Bedrock Outcrops/Cliffs/Rocky Shore
Riparian/Wetland Cover Types
Lacustrine/Littoral/Riverine
Pond
Aquatic Bed
Wetland - Vegetated (Emergent, Scrub Shrub, Forested)
Riparian (Grass, Shrub, Deciduous Tree)
Boundary Wildlife Preserve
Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
Beaver Cr
Threemile Cr
Pend Oreille River
WA-31
C3683
Transmission Lines
Flume Cr
SF Flume Creek
Lime Lake
C3911
C9345
Sullivan
Creek
C2975
Linton Creek
Metaline Falls
Metaline
Pocahontas
Creek
C3775
Pend Oreille Valley Railroad
Wolf Lake
Wolf Creek
Lunch Cr
Lost Lake
Lost Cr
WA-31
Boundary Wildlife Preserve
Sand
Creek
C2705
Pend Oreille River
C3669
Box Canyon Dam
Cedar Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-68
Cover types.
(Map 2 of 2)
Map Key
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Map Version 08/17/09
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Upland Cover Types

Table E.4-32 summarizes acreages of upland cover types found in the Project area. Moist mixed conifer forest is the most abundant cover type, occupying 566 acres. The forestlands vary in forest cover and species composition resulting from timber harvest and forest fires that have occurred over the past 100 years. Deciduous hardwood species such as paper birch (*Betula papyrifera*), aspen (*Populus tremuloides*), and Douglas maple (*Acer douglasii*) are relatively more abundant in open conifer stands, along forest edges, and disturbed locations.

Table E.4-32. Acreage of upland cover types within the Project area.

	Acreage [1]
Developed/Disturbed Upland Cover Types	
Agricultural (AGR)	0.0
Dry Pasture (DP)	0.1
Irrigated Pasture (IP)	0.0
Disturbed (DIS)	1.0
Timber Harvest < 10 yrs (TH<10)	4.6
Boundary ROW – Managed (M-ROW) [2]	27.0
BPA ROW Dry Meadow (DM-ROW)	9.8
BPA ROW Perennial Grassland (PGL-ROW)	0.1
BPA ROW Upland Shrub (US-ROW)	5.7
Industrial (IND)	0.0
Mining Facility (MINE)	0.5
Box Canyon Facility (BCF)	0.0
Recreation (REC)	13.5
Project Facility (PF) [3]	50.8
Residential (RES)	0.5
Commercial (COM)	0.0
School/Theater (SCH)	0.0
Sewage Treatment (SEW)	3.9
Developed/Disturbed Upland Total	**117.5**
Forested	
Dry Mixed Conifer (DMC)	30.3
Mixed Deciduous Conifer (MDC)	1.0
Ponderosa Pine (PP)	4.1
Moist Mixed Conifer (MMF)	566.2
Timber Harvest >10 years old (TH>10)	11.3
Forested Total	***612.9***
Non-forested	
Dry Meadow (DM)	0.0
Perennial Grassland (PGL)	0.6
Upland Shrub (US)	17.9
Non-forested Total	***18.4***

Table E.4-32, continued…

	Acreage [1]
Sparsely Vegetated Upland	
Eroded (ER)	22.1
Bedrock Outcrops/Cliffs (RC)	121.2
Sparsely Vegetated Upland Total	***143.3***
Undeveloped/Undisturbed Upland Total	**774.7**
Totals	**892.2**

Notes:
1 Includes 149 acres of the BWP managed as part of the Project.
2 Characterizes vegetation in the 1,673 feet of the Boundary transmission line ROW between County Road 2975 and the BPA substation.
3 Includes approximately 929 feet of the Boundary transmission line from the top of the cliff above the power plant to County Road 2975.

4.5.4.1.1. Lacustrine/Littoral Cover Types

Lacustrine/Littoral cover types cover about 1,650 acres in the Project area (Table E.4-33). Littoral Emergent Wetlands are wetland areas that are inundated or have a very high water table when the forebay elevation is at 1,994 feet NAVD 88. Littoral Emergent Wetlands cover approximately 15 acres along the reservoir, primarily upstream of Metaline Falls.

4.5.4.1.2. Wetland Cover Types

Palustrine Emergent Wetlands occupy 87 acres in the Project area (Table E.4-33). These habitats are often fed by groundwater seepage, in contrast to the Littoral Emergent Wetlands, which are almost exclusively supported by shallow groundwater associated with the reservoir. Several Palustrine Emergent Wetlands along the reservoir have very low species diversity and are dominated by dense swards of reed canarygrass (*Phalaris arundinacea*). Overall, species diversity is high in the Palustrine Emergent Wetlands, with more than 150 taxa recorded during surveys conducted in 2005 (SCL 2006).

Palustrine Forested Wetlands occur primarily at the BWP, where open stands of mature black cottonwood grow on the broad floodplain. The main side channel in the terrace receives backwater during floods. In years with high spring runoff, all but the highest elevations on the floodplain are inundated.

4.5.4.1.3. Riverine/Riparian Cover Types

The five cover types associated with riverine/riparian habitats include Riverine Unconsolidated Bottom, Riverine Unconsolidated Shoreline, Riparian Grass, Riparian Shrub, and Riparian Deciduous Tree (Table E.4-33).

The mouth of Sullivan Creek is an exceptional area with extensive stands of riparian vegetation and alluvial features. Substantial amounts of Riparian Shrub and Riparian Deciduous Tree cover types also occur in the upper portion of Peewee Creek where it crosses the BPA transmission line ROW. Small amounts of riparian vegetation are associated with the mouths of several other tributary streams, including Slate, Lime, Sand, Lost, Lunch, and Linton creeks.

Riverine/Riparian cover types along the Pend Oreille River downstream of Boundary Dam include the river itself, alluvial sediments (Riverine Unconsolidated Bottom cover type), and the coarse, rocky shoreline (Riverine Unconsolidated Shoreline cover type). The associated riparian vegetation consists primarily of small stands of coyote willow (*Salix exigua*) on islands, gravel bars, and at the upper margins of the shoreline corridor.

Table E.4-33. Acreage of riparian and wetland cover types within the Project area[1].

	Acreage
Lacustrine/Littoral Habitats	
Lacustrine Unconsolidated Bottom (LUB)	1,381.8
Lacustrine Aquatic Bed (AB)	112.4
Lacustrine/Littoral Unconsolidated Shoreline (LUS)	133.6
Littoral Emergent Wetland (LEM)	14.7
Rocky Shoreline (ROC)	7.6
Lacustrine/Littoral Total	**1,650.1**
Wetland Habitats	
Palustrine Unconsolidated Bottom (PUB)/Pond	0.0
Palustrine Aquatic Bed (PAB)	0.4
Palustrine Emergent Wetland (PEM)	67.7
Palustrine Scrub-Shrub (PSS)	14.8
Palustrine Forested Wetland (PFO)	4.3
Wetland Total	**87.2**
Riverine/Riparian Habitats	
Riverine Unconsolidated Bottom (RUB)	35.9
Riverine Unconsolidated Shoreline (RUS)	11.3
Riparian Grass (RG)	3.4
Riparian Shrub (RS)	9.8
Riparian Deciduous Tree (RDT)	1.4
Riverine/Riparian Total	**61.9**
Total Water-Associated Habitat	**1,799.2**

Note:
1 Table E.4-33 includes data presented in the PAD (SCL 2006) that were updated with information from the Riparian Study Final Report (SCL 2009a).

There are only 1.7 acres of riparian shrub and palustrine scrub-shrub in the lower reservoir because of the steep slopes, rocky terrain, and lack of suitable sediments. Riparian vegetation in the lower reservoir is limited to the few areas with moderate slopes or coves with suitable substrate conditions. Shoreline vegetation associated with managed reservoir systems can be minimal and fragmented (Nilsson and Keddy 1988), but natural physical and ecological processes (e.g., topographic variation, moisture gradients, and wildfire) also create fragmented landscapes (Saunders et al. 1991).

4.5.4.1.4. Weeds

Eighteen weed species that are classified as noxious by the Washington State Noxious Weed Control Board (WSNWCB 2005; Revised Code of Washington [RCW] 17.10.010(2)) have been documented in the Project vicinity (Table E.4-34). The distributions of these invasive, non-native plant species are discussed in detail in the PAD (SCL 2006).

Weeds, including several that are state-listed as noxious, are a common feature of the landscape throughout the Project vicinity in uplands, wetlands, and riparian cover types. In uplands, weeds are more prevalent along roads and disturbed areas. Common upland weed species include Dalmatian toadflax (*Linaria dalmatica* ssp. *dalmatica*), cheatgrass (*Bromus tectorum*), common tansy, common St. John's-wort, spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), and meadow hawkweed (*Hieracium caespitosum*).

Weeds occur along most of the reservoir shoreline, but are especially common in the more sheltered backwaters of the upper reservoir. Ruderal weedy species dominate the sheltered areas because of their ability to tolerate daily changes in moisture compared to native plants. Common weeds in the fluctuation zone include St. John's wort, yellow flag, common tansy, oxeye daisy, Canada thistle, reed canarygrass, lanceleaf plantain, and white sweetclover. Most of these species also dominate the island complex between PRMs 28.5 and 29.0, while all the other islands in the upper reservoir are covered in reed canarygrass. Some of the densest weed infestations consist of reed canarygrass occurring in palustrine wetlands, such as those observed in the BWP and other alluvial habitats along the upper reservoir. Reed canarygrass is also the dominant groundcover in willow stands along Sullivan Creek that are not influenced by the reservoir.

4.5.4.1.5. Rare, Threatened, and Endangered Plant Species

Surveys conducted in 2007 and 2008 documented 15 different vascular RTE plant species in the Project area (SCL 2009a). There were 206 subpopulations of RTE species, which were combined into 53 populations (Table E.4-35). In comparison to other RTE plant surveys of similarly sized areas, the Project vicinity has a relatively large number of both RTE species and subpopulations. Four RTE plant species, yellow mountain-avens, least bladdery milk-vetch, orange balsam, and purple meadowrue, are locally abundant. No federally listed Threatened or Endangered plant species were found in the Project vicinity.

Table E.4-34. State-listed noxious weed species documented in the Project vicinity.

Common Name	Scientific Name	Class[1]	Number of Infestations Documented[2]
Spotted knapweed	*Centaurea biebersteinii*	B	225
Diffuse knapweed	*Centaurea diffusa*	B	1
Canada thistle	*Cirsium arvense*	C	116
Bull thistle[3]	*Cirsium vulgare*	C	X
Scotch Broom	*Cytisus scoparius*	B-designate	3
Houndstongue	*Cynoglossum officinale*	B	2
Wild carrot	*Daucus carota*	B	X
Leafy spurge[4]	*Euphorbia esula*	B - designate	1
Orange hawkweed[5]	*Hieracium aurantiacum*	B	Diffuse everywhere
Yellow hawkweed	*Hieracium caespitosum*	B	99
St. John's wort	*Hypericum perforatum*	C	330
Yellow flag iris	*Iris pseudacorus*	C	18
Oxeye daisy	*Leucanthemum vulgare*	B	272
Dalmatian toadflax	*Linaria dalmatica ssp. dalmatica*	B	53
Purple loosestrife	*Lythrum salicaria*	B - designate	7
Giant knotweed	*P. sachalinense*	B - designate	4
Reed canarygrass	*Phalaris arundinacea*	C	138
Sulfur cinquefoil	*Potentilla recta*	B	16
Perennial sowthistle[3,6]	*Sonchus arvensis ssp. arvensis*	B - designate	X
Common tansy	*Tanecetum vulgare*	C	173

Notes:

1 Class B Weeds – Non-native species established in some regions of Washington but of limited distribution or not present in other regions of the state. In regions where a Class B is unrecorded or of limited distribution, the weed is a "Class B designate," meaning it is designated for control by state law. In regions where a Class B species is already abundant or widespread, control is a local option. Class C Weeds – Non-native species that are already widely established in Washington or of special interest to the state's agricultural industry. Counties may enforce control if locally desired.

2 Italicized infestations represent number of times observed in polygons during field verification of vegetation mapping and not the actual number of infestations of these widespread, common invasive species. Non-italicized figures refer to the number of discrete infestations.

3 Species does not appear on the 2009 list of noxious weed for Pend Oreille County (County NWCB 2009).

4 Species is being controlled by the Pend Oreille County Noxious Weed Control Board and was not observed during relicensing studies in 2005, 2007, or 2008.

5 Orange hawkweed is a frequent yet minor component of yellow hawkweed infestations.

6 There is some question on the taxonomy of the perennial sowthistle found during relicensing surveys. The plants in the Project area may be marsh sowthistle, which is not classified as a noxious weed in Washington.

X Data regarding the number of infestations are not available, but occurrence is low.

Table E.4-35. RTE plant populations and subpopulations.

Taxon	USFS Status[1]	BLM Status[2]	WNHP Status[3]	No. of Populations	No. of Subpopulations
Astragalus microcystis least bladdery milk-vetch	S	BA	S	5	17
Carex capillaris hair-like sedge	S	BA	S	1	1
Carex flava yellow sedge	S	BA	S	2	18
Carex krausei ssp. *porsildiana* *Porsild's sedge*	-	-	-	1	1
Cryptogramma stelleri Steller's rock-brake	S	BA	S	4	11
Dryas drummondii yellow mountain-avens	S	BA	S	4	38
Hierochloe odorata common northern sweetgrass	-	-	R1	2	3
Hypericum majus Canadian St. John's-wort	S	BA	S	1	5
Impatiens aurella orange balsam	-	BT	R1	8	8
Muhlenbergia mexicana var. *mexicana* wirestem muhly	-	-	-	1	24
Ophioglossum pusillum adder's-tongue	S	BS	T	2	2
Sanicula marilandica black snake-root	S	BA	S	8	10
Sisyrinchium septentrionale northern blue-eyed grass	S	BA	S	2	3
Thalictrum dasycarpum purple meadowrue	S	BA	S	7	60
Viola renifolia kidney-leaved violet	S	BT	S	5	5
Totals				**53**	**206**

Notes:
Source: RTE Plant Study Final Report (SCL 2009a)
1 USFS Regional Forester's Sensitive Species List (USFS 2008). S = Sensitive.
2 BLM Special Status Species, updated March 2005 (BLM 2005).
BLM Special Status Species Categories:
BS = Bureau Sensitive – Nominated by BLM District Managers; must be listed by the Washington Natural Heritage Program (WNHP) to be eligible.
BA = Bureau Assessment – Species known or suspected on BLM land that are not federally listed, state listed, or BS and that are listed by the WNHP but not eligible as BS.
BT = Bureau Tracking – All species known or suspected on BLM land that are not federally listed, state listed, BS, or BA, and that are WNHP Review species or Watch species.
3 State Status: WNHP (2007) provides the following explanation of state status:
T = Threatened are likely to become Endangered in Washington within the foreseeable future if factors contributing to population decline or habitat degradation or loss continue.
S = Sensitive taxa are vulnerable or declining and could become Endangered or Threatened in the state without active management or removal of threats.
R = Review taxa are either R1 = Taxon in need of additional field work before a status can be assigned, or R2 = Taxon with unresolved taxonomic questions.

4.5.4.2. Environmental Analysis

Project operations have the potential to affect botanical resources through the following mechanisms:

- Tailrace water surface elevation fluctuations
- Erosion and inundation from Project-related water surface elevation fluctuations in the reservoir and boat-generated wave action
- Project maintenance activities
- Project-related weed infestations
- Project-related recreation

These mechanisms can interact with one another or with non Project-related factors, making it difficult to determine the proportionate responsibility of Project and non-Project effects. The following discussion of Project effects reflects the knowledge gained from field investigations and a review of the applicable literature. The identified effects from the Project are described for upland vegetation, riparian and wetland vegetation, weeds, and RTE plants.

4.5.4.2.1. Upland Vegetation

Because of the hydraulic control at Metaline Falls, there is a distinct difference in how water surface elevation fluctuations and erosion affect the upper reservoir (upstream of Metaline Falls) and the lower reservoir (downstream of Metaline Falls). Project-related water surface elevation fluctuations are attenuated by Metaline Falls: forebay elevation fluctuations are in the range of 5 to 20 feet but only 3 to 4 feet in the upper reservoir, depending on inflow and forebay elevation. Shoreline erosion in the upper reservoir is primarily related to high spring flows and not Project operations (Mainstem Aquatic Habitat Modeling Study Final Report, SCL 2009a, Erosion Study Final Report; SCL 2009a).

Approximately 15 acres of land have eroded over the last 40 years since the Project was established. Erosion of the shoreline in the lower reservoir due to Project operations is primarily affecting upland conifer forest habitat. The cause of this erosion in the lower reservoir is a combination of Project-related (water elevation fluctuations) and non Project-related (flood scour and wind-generated wave action) effects. In addition, some areas have eroded down to stable parent material or are now armored, minimizing future erosion. Thus, the losses in the next license term due to erosion are expected to be less than in the past because erosion rates are highest in the years immediately following reservoir inundation and many erosion sites have stabilized (Erosion Study Final Report, SCL 2009a).

Loss of less than 15 acres of mixed conifer forest is considered a minor effect to botanical resources in the Project area because (1) the amount of vegetation loss is insignificant relative to the total area present (597 acres of mixed coniferous forest in the Project area) and (2) the vegetation type that is most affected is common and widespread in the basin.

4.5.4.2.2. Riparian and Wetland Vegetation

Tailrace

The Boundary Dam tailrace is a high-energy environment and is subjected to frequent changes in flow. During the summer season (June 15 to September 15), mean hourly flows in the tailrace range from 0 to approximately 137,400 cfs (based on the period 1987 - 2005). Water surface elevations in the tailrace have ranged between approximately 1,716 and 1,756 feet NAVD 88 during the summer season (SCL 2009a).

The water surface elevation in the tailrace is closely correlated with operations at Seven Mile Dam and seasonal high flows in the Pend Oreille River (SCL 2009a). Existing operations at the Project do not have a significant influence on flood events or mean daily flows during summer. However, daily water surface elevation fluctuations outside of the spring runoff season do affect riparian vegetation in the tailrace.

Project-related effects occur when river flows are relatively low, usually later in the growing season when seasonal high flows do not mask the effects of turbine releases. The increased scour and inundation from daily water surface elevation fluctuations affects the occurrence and distribution of coyote willow, the only riparian species along the tailrace. The area of suitable habitat for coyote willow is relatively narrow, limited to about a 2-foot band along the bank. The magnitude, duration, velocity, and/or frequency of high flows appear to be precluding the establishment of more mature stands of coyote willow. Most of the coyote willow plants that occur here are seedlings or stunted saplings. In some years these stands can be submerged for weeks at a time. Other factors, particularly a high rate of beaver herbivory, also affect coyote willow occurrence. Proposed operations will continue to have an effect on riparian vegetation in the tailrace by precluding the establishment of mature stands.

Immediately north of the Boundary Dam parking lot there is a small creek (3 feet wide) supporting riparian vegetation that is mowed during routine landscape maintenance. This practice may be affecting the function of this narrow riparian corridor. Management actions identified in the TRMP (Attachment E-3) will address this issue.

Lower Reservoir

Although Project-related erosion within the fluctuation zone has influenced the extent and distribution of riparian habitat along the reservoir, there is little evidence that existing riparian vegetation is being actively eroded. Rather, Project operations are exerting an influence on the ability of riparian vegetation associations to colonize limited areas that might otherwise provide suitable habitat. An examination of 25 riparian stands associated with documented erosion sites concluded that only nine riparian stands were even minimally affected by erosion, generally due to a gradual undercutting of the banks (Erosion Study and Riparian Study Final Reports, SCL 2009a).

Although existing riparian cover types are not being eroded, Project-related daily water surface elevation fluctuations in the lower reservoir during the summer are a primary factor contributing to the reduction of the amount of fine sediment along the shoreline, affecting the ability of riparian vegetation to colonize these areas. At many sites in the lower reservoir wave

action/reservoir fluctuation has removed fine soils from the nearshore emergent zone, leaving cobble, gravel, and bare rock at the surface, which is not conducive to supporting riparian vegetation. Because proposed Project operations will be nearly the same as those under the existing license, the effect of water surface elevation fluctuations in the lower reservoir is expected to be similar for the term of the new license.

Riparian and palustrine wetland cover types in the lower reservoir are sparse and disconnected because rock cliffs and talus slopes that occur in this area do not naturally support these vegetation types. While Project-related water surface elevation fluctuations are affecting the plant species and substrate composition in the fluctuation zone, Project operations are not a factor affecting riparian and wetland habitat connectivity.

Inundation from seasonal flooding during the spring (in contrast to daily water surface elevation fluctuations in summer, described above) does not appear to be limiting the establishment or maintenance of riparian vegetation in the lower reservoir. By spilling water during high spring flows, Project operations attenuate the effects of spring flooding and maintain water surface elevations in the lower reservoir at about 1,988 feet NAVD 88. Because proposed Project operations during future high flows would be the same during the term of the new Project license as they are under existing operations, it is anticipated that the Project's attenuation effect would be similar.

A number of informal recreation trails have been developed through riparian vegetation along the reservoir shoreline, but no adverse effects on these cover types have been observed. An extensive user-created off-road vehicle (ORV) trail was constructed at Monument Bar, but significant effects to riparian vegetation were not noted as a result of this.

Upper Reservoir

The Analysis of Peak Flood Flow Conditions above Metaline Falls Final Report (SCL 2009a) estimated that the influence of the Project on water surface elevations in the upper reservoir (above Metaline Falls) during the evaluated flood events ranged between 1.6 feet at the downstream end of the reach to 1.1 feet at the upstream end of the reach. The top two feet of water observed during these conditions was within vegetated shoreline areas and was not causing substantial erosion (Erosion Study Final Report, SCL 2009a). Unlike the lower reservoir, flood scour is the primary factor affecting the occurrence and distribution of shoreline vegetation in the upper reservoir (Riparian Study Final Report, SCL 2009a).

Daily water surface elevation fluctuations can promote cottonwood seed germination at inappropriate elevations, or produce river stage declines that are too rapid for cottonwood seedlings to establish (Mahoney and Rood 1998). However, the majority of cottonwood stands in the Project vicinity are located in the upper reservoir, and Project-related water surface elevation fluctuations do not appear to be adversely affecting these stands. On the BWP, periodic flooding of backwater channels is likely a factor in maintaining cottonwood stands and some level of recruitment in this area. Seedlings or saplings were found in 79 percent of the acreage supporting mature cottonwood trees, suggesting that this species is reproducing and establishing. Additionally, there were 1.3 acres of forested or shrub stands that included only seedling or sapling cottonwoods. The BWP includes 49

percent (39.0 acres) of the shrub or forested acres with cottonwoods in the Project area, and all of them included some seedlings or saplings. There was only one riparian stand (at the mouth of Sullivan Creek) where erosion was a management concern, but seasonal flood-related scouring was determined to be the primary source of the erosion at this site, and daily water surface elevation fluctuation a secondary source.

Analysis of tree rings suggests that about 41 acres of cottonwood, or over three-quarters of the mature cottonwood acreage in the Project area, were established before the Project was constructed. Of these 41 acres, approximately 30 percent (13 acres) also contains trees that were established after the construction of the dam. The mature cottonwoods range from approximately 30 to 80 feet tall, with 84 percent over 60 feet. The saplings (defined as 1- to 5-inch diameter at breast height [dbh]) range from about 8 feet to 35 feet tall (Riparian Study Final Report, SCL 2009a). This varied age distribution is indicative of long-term recruitment of cottonwood.

ORV and snowmobile use at the BWP was documented several times during 2005 and 2007 field studies. This recreation use has harmed wetland and riparian vegetation by creating ruts and erosion patches primarily within areas dominated by reed canarygrass. In 2005, a single continuous ORV trail extended from the old road access to the BWP approximately 2,800 feet to the northern extent of the floodplain. Additional effects were observed in 2008 in the form of a small user-created ORV course. The current damage consists primarily of flattened reed canarygrass with a few bare areas where damage to reed canarygrass cover has exposed the sandy alluvial substrate. The impacts from ORV use are currently minor although it represents a potential ongoing and future threat to sensitive riparian and wetland vegetation at the BWP. During the new license term, the proposed TRMP (Attachment E-3) will address these issues. The TRMP also proposes site-specific habitat management measures including enhancement of the mowed stream near the power plant, among other actions.

4.5.4.2.3. Weeds

It is likely that the Project is influencing the occurrence and distribution of weeds in the Project area, but it is difficult to quantify the effect. Some weed species are ubiquitous, but not highly abundant around Project features or Project-related roads. Vehicle traffic may be aiding the dispersal of weeds along roads, although the level of Project-related road traffic versus non-Project-related use is unknown. Recreation users may also be a factor in dispersal of terrestrial and aquatic weeds. Some weed species, particularly reed canarygrass and yellow iris, are widespread along many river systems in Washington and throughout the Pacific Northwest. Phillips and Mettler (1994) found reed canarygrass to be the most aggressive colonizer of the drawdown zone of four reservoirs along the lower Snake River in Washington. Reed canarygrass seeds can be dispersed in animal fur, on human clothing, or on automobiles. The most common vector for reed canarygrass seeds and rhizome fragments is probably water, making it difficult to control (Apfelbaum and Sams 1987). Weeds are discussed further in the following section.

4.5.4.2.4. Rare, Threatened and Endangered Plant Species

Of the 206 RTE plant subpopulations located in the Project vicinity, 105 (51 percent) were located in the fluctuation zone. Eleven RTE plant species were affected by fluctuating water surface elevations: least bladdery milk-vetch, yellow sedge, Porsild's sedge, common northern sweetgrass, Canadian St. John's-wort, orange balsam, wirestem muhly, adder's-tongue, black snakeroot, northern blue-eyed grass, and purple meadowrue. The presence and persistence of these species in the fluctuation zone suggest that they are adapted to variable hydrological conditions (Table E.4-36), including those conditions created by existing Project operations. Regardless, although some plants, especially annual species, might not be killed directly, prolonged inundation during critical flowering and fruiting times could pose a threat to the reproductive success of some individual plants during some years. It is difficult to assess the potential RTE plant habitat that has been affected by Project-related water surface elevation fluctuations, but it is likely that these fluctuations have, and will continue to have, some limiting effect on the distribution of RTE plant species over the term of the new license.

Weed infestations commonly contribute to the degradation and destruction of RTE plant populations and native plant habitat (WSNWCB 2007). The most significant potential effect to RTE plant populations in the Project area appears to be competition with weeds, especially in the fluctuation zone, where many populations of RTE plants occur. The influence of existing Project operations on the establishment, persistence, and spread of weeds is unknown, as is whether RTE plant population sizes are increasing, decreasing, or remaining constant. Most of the weeds that are widespread in the Project vicinity are also common and widespread in the general region. Some RTE plant species in the Project vicinity have habitats with relatively low weed cover.

Of the 30 RTE plant locations where erosion was recorded, erosion at 16 sites is Project-related. RTE species that occur in Project-related erosion sites (the three species discussed below) are often found growing in similar densities at erosion sites and in adjacent non-eroding areas. Purple meadowrue and wirestem muhly are rhizomatous species often closely associated with the upper portion of the fluctuation zone whether erosion (Project or non-Project) is present or not. Rhizomatous species such as these are often able to effectively expand into new habitat as it is made available and thrive because competition from other plant species is low. Least bladdery milk-vetch is also associated with disturbed habitats (whether due to natural or Project-related disturbance factors); a long, stout, woody root appears to allow this species to survive spring inundation and some amount of erosion. Individual stems or plants of these three RTE species may be affected by erosion, but the overall populations (and, in most cases, the subpopulations) do not appear to be at risk due to current or proposed operations. Project-related erosion has the potential to adversely affect RTE plant species in only one location. A population of kidney-leaved violet and a sub-population of yellow mountain avens in the vicinity of an established BLM campsite are on the edge of an eroding bank. Overall, however, the combined effect of non-Project and Project-related erosion on RTE plant populations in the Project area is relatively low (SCL 2009a).

Table E.4-36. Project-related effects on RTE plants at Boundary Reservoir.

RTE Plant Species (# subpopulations)	Number of Subpopulations Affected				
	Water Surface Elevation Fluctuations	**Weeds Est. % Cover[1] L 0-10% M 11-50% H 51-100%**	**Erosion (Erosion Groups 2 and 3)[2]**	**Recreation**	**Project Maintenance Activities**
Least bladdery milk-vetch (17)	**2**	4 L, 12 M, 1 H	**3**	0	0
Hair-like sedge (1)	0	1 L	0	0	0
Yellow sedge (18)	**18**	6 L, 12 M-H	0	**2**	0
Porsild's sedge (1)	**1**	1 L	0	0	0
Steller's rock-brake (11)	0	11 L	0	0	0
Yellow mountain-avens (38)	0	38 L	**1**	**1**	**7**
Common northern sweetgrass (3)	**3**	2 L, 1 H	0	1	0
Canadian St. John's-wort (5)	**5**	5 M	0	0	0
Orange balsam (8)	**5**	5 M, 3 H	**1**	0	**1**
Wirestem muhly (24)	**24**	24 M-H	**3**	**8**	0
Adder's-tongue (2)	**2**	2 H	0	0	0
Black snake-root (10)	**1**	7 L, 3 M	0	0	**4**
Northern blue-eyed grass (3)	**3**	3 H	0	**1**	0
Purple meadowrue (60)	**41**	2 L, 54 M-H, 4 H	**9**	**14**	0
Kidney-leaved violet (5)	0	4 L, 1 M	**1**	**2**	**1**
Total (206)	105 (51%)	77 L (37%) 25 M (12%) 90 M-H (44%) 14 H (7%)	18 (9%)	29 (14%)	13 (6%)

Notes:

1 Ocular estimates of percent (%) canopy cover of live foliage for plant species represent an effective way to quickly collect abundance information. Because each plant species or vegetation layer (trees, shrubs, forbs, graminoids, etc.) has its own percent canopy cover, total percent cover typically exceeds 100 percent.

2 Erosion Group 2 = Project erosion without impacts to RTE plants at the population level. Erosion Group 3 = Project erosion with potential to adversely impact RTE plants at the population level.

A total of 29 subpopulations are in the vicinity of recreation sites, but the effect of Project-related recreation on RTE plants at these sites appears to be low. Most recreation use occurs in areas that do not support RTE plant populations. Several recreation sites are large enough that the use is fairly diffuse and does not impact the RTE plants that presently occur. The effects on the two populations identified above will be reduced by proposed management of the recreation areas over the term of the new license (see Section 4.5.9.3).

4.5.4.3. Proposed Environmental Measures

A number of environmental measures related to botanical resources will be implemented, in coordination with the resource agencies, under a TRMP (Attachment E-3). Elements of the TRMP that apply to botanical resources include an Integrated Weed Management Plan (IWMP), a RTE plant monitoring program, and a travel and public access management program. The IWMP and RTE programs include monitoring and reporting at regular intervals and an adaptive management program to address resource needs in coordination with the Terrestrial Resources Workgroup (TRWG).

Land affected by Project operations will be managed according to the guidelines of the TRMP. SCL proposes to incorporate the 89-acre BWP Addition into the Project boundary and manage these lands for the biodiversity goals described in the TRMP. The TRMP also outlines BMPs for operation and maintenance of Project facilities, which will ensure that activities are conducted in a way that protects, maintains, and enhances botanical resources on Project lands.

4.5.4.4. Cumulative Effects Analysis

A number of variables contribute to dispersal of weeds in the Project vicinity and the larger Pend Oreille watershed, which include ground-disturbing activities, aquatic and terrestrial recreation, road use, and the presence and operation of hydroelectric facilities. While the trends of weed populations in the Project vicinity are unclear, it is likely that weed populations in the watershed are increasing due to continued influence by these activities.

Although minor effects to individual RTE plants were identified in the Project vicinity, no effects were noted on a population level. Human activities in the watershed are likely having continued effects on RTE plants through habitat loss and degradation, but the Project does not appear to be cumulatively contributing to these effects.

The primary effect on riparian vegetation in the Project vicinity is from fluctuating water surface elevations in the lower reservoir, downstream of Metaline Falls, and to a minor extent in the Boundary Dam tailrace. Wetland habitat does not appear to be affected by the Project. Cumulative effects to riparian habitat in the watershed occur from shoreline development, habitat degradation, operation of hydroelectric facilities, road building and associated slope stabilization, shoreline erosion, and alteration of the sediment load of the river by dams. Upland vegetation is similarly affected by development and corresponding habitat removal and degradation. Erosion of up to an estimated 15 acres of upland habitat over the course of the new license would cumulatively contribute, albeit slightly, to effects on botanical resources in the watershed.

Land clearing activity in the basin is likely to continue to affect the distribution of weeds and rare plants and have continued effects on the extent, distribution, and composition of vegetation communities, including riparian habitat. Land clearing can be caused by timber operations, residential and commercial construction, and mining.

The TRMP establishes management goals for all SCL-owned lands and describes protection, enhancement, and monitoring efforts designed to benefit botanical resources on lands within the

Project boundary. These efforts will reduce cumulative effects on botanical resources in the basin by decreasing the contribution of Project-related factors.

4.5.4.5. Unavoidable Adverse Impacts

Erosion of an estimated 15 acres of upland habitat and effects to riparian vegetation in the lower reservoir may occur during the new license period. These effects are long-term and cumulative but relatively minor and will be adequately compensated for by the implementation of the TRMP and the associated botanical resource management programs for weed control, RTE plants, and habitat protection in the Project area.

4.5.4.6. Consistency with Comprehensive Plans

The botanical resource related management goals and policies associated with comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

- Maintaining rare plant populations
- Maintaining and enhancing important and sensitive habitat features
- Managing recreation in a compatible manner with resource protection
- Controlling weed populations
- Instituting BMPs for all land management activities

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

There are no goals or objectives listed in this plan that pertain to botanical resources in the Project area. Goals of the plan that pertain to vegetation relate to timber harvest and rangeland productivity.

Washington Department of Ecology. 1994. State wetlands integration strategy. Olympia, Washington, 80 pages.

Ecology's wetlands integration strategy brought together a variety of jurisdictions within the state to develop standardized approaches to wetland policy, implementation, permitting, and education. Any work in wetlands as part of Project operations or restoration activities will be conducted in accordance with local, state, and federal wetland regulations.

Washington Department of Natural Resources. 1987. State of Washington natural heritage plan. Olympia, Washington, 108 pages.

The 1981 amendment to the Natural Area Preserves Act requires the Natural Heritage Program (NHP) to develop a plan each biennium regarding the Act's implementation. Specifically, the purpose of the State of Washington Natural Heritage Plan is to identify priority species and ecosystems to be considered in the selection of potential natural areas and establish the criteria and process by which natural areas are selected. Washington's last NHP update was published in 2009. There are no NHP designated natural areas in the Project boundary, but a number of priority plant species on the NHP list are present. SCL has developed a TRMP that includes provisions for monitoring and management of rare plants.

4.5.5. Wildlife Resources

4.5.5.1. Affected Environment

The Affected Environment for wildlife resources includes the entire area within the FERC Project boundary (Project area). Information on wildlife resources in this section is primarily from the Waterfowl/Waterbird Study, Rare, Threatened, and Endangered (RTE) Wildlife Species Study (RTE Wildlife Study), Big Game Study, and Bat Surveys and Habitat Inventory (Bat Study) Final Reports (SCL 2009a). The study area varies slightly for each of the referenced final reports, and the area studied extends beyond the range of the Project's influence. Collectively, these study areas are referred to in this section as the Project vicinity.

Areas common to all of the above studies include:

- *Downstream of Metaline Falls* – The reservoir, fluctuation zone allowed under the current license (as defined in each technical study) and land within the FERC Project boundary (Project area), which includes most Project facilities, the area 200 horizontal feet (i.e., perpendicular to the shoreline) beyond the high water level along both reservoir shorelines, and the transmission line ROW from the power plant to the BPA substation.
- *Upstream of Metaline Falls* – The reservoir, fluctuation zone (approximately 1,986 – 2,020 feet NAVD 88, as measured at the USGS gage below Box Canyon Dam), and the land within approximately 200 horizontal feet above the high water level (approximately 2,020 feet NAVD 88) along both reservoir shorelines, extending to the FERC Project boundary for the Box Canyon Project.
- The BWP (149 acres) and adjoining 89-acre BWP Addition.
- 100 horizontal feet along both sides of the river from Boundary Dam to the U.S.-Canadian border (approximately 0.9 mile).
- 50 feet along both sides of Project-related roads, which include the road between the Boundary Dam and the Vista House, the road to the dam off County Road 2975, and the road from the Vista House to Highway 31.

In addition, a secondary study area was defined for big game to describe the larger area used by these wide-ranging species and their movement corridors outside the Project area. This included the following:

- *From Metaline Falls to Boundary Dam* – Between Highway 31 and the eastern edge of the Project boundary and between County Road 2975 and the western edge of the Project boundary.
- *From the Box Canyon Dam tailrace to Metaline Falls* – 0.5 miles on either side of the primary study area.

The dominant vegetation cover in the Project vicinity is mixed coniferous forests of interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) (Franklin and Dyrness 1988), growing on moderately steep, rolling slopes of rocky, predominantly well-drained soils. Sixty-five percent of the Project vicinity is forested, and both dry and moist mixed coniferous forests are present, although the moist type is dominant. Conifer species in these forests include western white pine (*Pinus monticola*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), western red cedar, and grand fir (*Abies grandis*). Black cottonwood (*Populus trichocarpa*) and paper birch (*Betula papyfira*) often occur in these stands as well. Other vegetation and cover types include recently harvested timber stands, shrub- and grass-dominated areas, sparsely vegetated rock outcrops, and some wetlands. Shrub species include snowberry (*Symphoricarpos albus*), hazelnut (*Corylus cornuta*), ocean spray (*Holodiscus discolor*), and mock orange (*Philadelphus lewisii*). For more details about the vegetation communities, see Section 4.5.4.1 of this Exhibit E.

Of the total 308 terrestrial vertebrate wildlife species that potentially occur in the Project vicinity, 152 species were confirmed during relicensing studies (SCL 2006; SCL 2009a). The remaining 156 species may occur in the Project vicinity based on range, habitat requirements, and migration patterns. The following sections provide a summary of the wildlife documented within the Project vicinity by major groups of terrestrial vertebrates (i.e., mammals, birds, and reptiles and amphibians). RTE wildlife species likely to occur within the Project vicinity are discussed separately.

4.5.5.1.1. Mammals

Twenty-six mammal species were confirmed to occur within the Project vicinity during the 2007/2008 field season. The results of these findings are summarized below.

White-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus*), and elk (*Cervus elaphus*) are the most common large game mammals and are of particular interest because of their overlapping wildlife, cultural, recreational, and commercial values. Deer are estimated at 4.1 to 4.9 animals per square mile in the Project vicinity. The Selkirk elk herd (about 1,450 individuals) occupies lands east of the Pend Oreille River, with some members of the herd commonly found in the Project vicinity (SCL 2009a). Because the Selkirk herd has expanded its range without any corresponding population increase (Big Game Study Final Report, SCL 2009a), it is hypothesized that winter range may be limiting the size of the elk population. Much of the terrain adjacent to the lower reservoir is steep and does not represent high quality deer or

elk habitat. This steep terrain forces big game to follow topographic features, such as drainages, to access the reservoir. A number of big game trails and crossing sites have been mapped in the lower reservoir. The topography of the upper reservoir is less steep, and big game movement in this reach appears more diffuse.

The extent and distribution of big game hiding and thermal cover and forage habitats in the Project vicinity are strongly influenced by the age of the conifer forest stands and topography (Big Game Study Final Report, SCL 2009a). More than one-third of the 1,563-acre primary study area for the Big Game Study does not provide habitat for deer or elk because of steep slopes or lack of vegetation (Table E.4-37). In the lower reservoir, non-habitat is typified by cliffs, rock outcrops, and slopes effectively too steep for big game use. This is especially true along the Canyon Reach, which extends from Metaline Falls to the downstream end of Z Canyon (PRM 26.8 to 18.0), where the average slope is greater than 100 percent. Steep slopes also characterize non-habitat along the upper reservoir, along with housing developments, mudflats, gravel bars, and riprap.

Table E.4-37. Acres of habitat types in the primary big game study area (SCL 2009a, habitat type definitions per the Colville National Forest Plan [USFS 1988]).

Species Reservoir area	**Big Game Habitat Type (acres)**			
	Foraging	**Hiding**	**Thermal and Hiding**	**Non-habitat**
Mule Deer				
Lower Reservoir	92	48	382	361
Upper Reservoir	87	216	207	171
Total	**179**	**263**	**589**	**531**
White-tailed Deer and Elk				
Lower Reservoir	72	38	306	466
Upper Reservoir	70	205	167	238
Total	**142**	**243**	**473**	**704**

Though less common than deer and elk, moose (*Alces alces*) are also frequently observed in the Project vicinity and are thought to be increasing in abundance locally (Big Game Study Final Report, SCL 2009a). Big-horn sheep (*Orvis canadensis*) and mountain goat (*Oreamos americanus*) are known to occur more than one mile away from the reservoir, with only rare sightings in the Project vicinity. Woodland caribou (*Rangifer tarandus caribou*) are a high-elevation species and may enter the Project vicinity occasionally; however, they have not been documented recently (SCL 2006; RTE Wildlife Study Final Report, SCL 2009a).

Mountain lion (*Felix concolor*), bobcat (*F. rufus*), and black bear (*Ursus americanus*) are common carnivores that may occur anywhere in the Project vicinity. Mountain lions were not observed during field studies, but tracks (including those of females with cubs) and deer kills were noted along the lower reservoir (in the Canyon Reach) during the winter of 2007-2008 (Big Game Study Final Report, SCL 2009a). Recent information from WDFW for five Washington

counties (Chelan, Okanogan, Ferry, Stevens, and Pend Oreille) indicates that mountain lion populations in these counties have been reduced substantially as a result of hound hunting and that populations are now relatively low (WDFW 2008a).

Bats are commonly observed in the Project vicinity, likely due to the extensive mines, mine adits, suitable forest habitat, natural caves, and large area of foraging habitat over the reservoir (Bat Study Final Report, SCL 2009a). Potential bat roosting habitat was investigated for 24 mines, seven caves, and one bridge in the Project vicinity, and for several Project-related structures, including the portals at the dam. Some roosting activity was documented at four mine locations and three shoreline caves (mostly California and Yuma myotis), and individual bats were observed in the visitor's tunnel north portal and inside the employee's tunnel (Bat Study Final Report, SCL 2009a). Ten species of bats were recorded foraging in the study area, including four RTE species, which are described in Section 4.5.5.1.4. Large numbers of bats were frequently observed foraging over the reservoir. These bats apparently roost outside of the Project vicinity, because few bat roosting sites were documented in the study area defined for the Bat Study. Some roost sites are also potential hibernacula or maternal colony habitat, but low winter temperatures inside potential sites and low numbers of animals recorded outside of potential hibernacula suggest that surveyed sites in the Project vicinity are not suitable for maternal colonies or winter roosts (Bat Study Final Report, SCL 2009a).

Muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*), mink (*Mustela vison*), and raccoon (*Procyon lotor*) use the Project reservoir. Beaver (*Castor canadensis*) are common at various locations along the reservoir where native riparian deciduous forest and shrublands provide important foraging habitat.

Small mammal trapping at the BWP (SCL 2006) resulted in the capture of short-tailed weasels (*Mustela erminea*), vagrant shrews (*Sorex vagrans*), a red-backed vole (*Clethrionomys gapperi*), a bushy-tailed woodrat (*Neotoma cinerea*), and deer mice (*Peromyscus maniculatus*). Each of these species occupies a wide range of habitats available in the Project vicinity.

4.5.5.1.2. Birds

One hundred and fourteen bird species were confirmed in the Project vicinity during field reconnaissance in 2005 and more detailed field investigations in 2007 and 2008. Another 113 species potentially occur in the Project vicinity (SCL 2006; SCL 2009a). The USFS regional species list identifies 185 bird species as resident to northeastern Washington, although some of these are quite rare (USFS et al. 2001).

Twenty species of waterfowl and 20 species of waterbirds (Waterfowl/Waterbird Study Final Report, SCL 2009a) were observed in the Project vicinity. Canada geese (*Branta canadensis*) are the most common nesting waterfowl that occur in the Project vicinity. This species nests primarily on islands in the upper reservoir; only seven of 44 nests found in 2007 were in the lower reservoir. Most of the Canada goose nest production occurs on a large island at PRM 27.7. Although a few mallard (*Anas platyrhynchos*) broods were observed on the reservoir, only one nest was located incidentally outside of the field surveys (SCL 2009a).

The double-crested cormorant (*Phalacrocorax auritus*), a piscivorous species, is a recent resident of the Pend Oreille River (Wahl et al. 2005). Limited numbers of cormorants use Boundary Reservoir, although this species is more numerous upstream of Box Canyon Dam. Other piscivorous birds that use the reservoir include common merganser (*Mergus merganser*), great blue heron (*Ardea herodias*), osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), and belted kingfisher (*Ceryle alcyon*).

The Project vicinity potentially supports 12 hawk and eagle species, four falcon species, and 13 owl species. The two most commonly observed raptors—bald eagles and ospreys—nest in the Project vicinity and are described in the RTE Wildlife Species discussion below.

Shorebirds migrate through the Project vicinity; however, only the spotted sandpiper (*Actitis macularia*) breeds in the vicinity, and it is commonly seen in the summer. The ring-billed gull (*Larus delawarensis*) and the California gull (*Larus californicus*) were the only gull species observed in the Project vicinity (RTE Wildlife Study Final Report, SCL 2009a).

Up to ten species of woodpecker potentially use the forests in the Project vicinity. Logging and wildfires that occurred prior to 1930 have affected the amount and distribution of mature and old-growth forest habitat that is available to larger woodpecker species, particularly pileated woodpeckers (*Dryocopus pileatus*). Nonetheless, the pileated woodpecker and four other woodpecker species were observed using the forests surrounding the reservoir (SCL 2006). Three species of native grouse are known to occur in the Project vicinity, and both wild turkey (*Meleagris gallopavo*) and ring-necked pheasant (*Phasianus colchicus*) were introduced into the Project vicinity for sport hunting.

Riparian areas characterized by a mix of deciduous woodlands, shrublands, grasslands, and wetlands support the greatest number of bird species in the Project vicinity. Sullivan Creek and the BWP represent excellent passerine bird habitat, indicated by the large numbers of species found at these sites. Additionally, several colonies of swallows are found in the Project vicinity. A large colony of cliff swallows (*Hirundo pyrrhonota*) and at least two bank swallow (*Columba domestica*) colonies occupy the cliffs surrounding Boundary Reservoir (SCL 2006; RTE Wildlife Study Final Report, SCL 2009a).

4.5.5.1.3. Reptiles and Amphibians

Records from the Colville National Forest (CNF) document the presence of western toads (*Bufo boreas*) and Columbia spotted frogs (*Rana luteiventris*), both RTE species, along with long-toed salamanders (*Ambystoma macrodactylum*), bullfrogs (*Rana catesbeiana*), Pacific treefrogs (*Pseudacris regilla*), painted turtles (*Chrysemys picta*), western terrestrial garter snakes (*Thamnophis elegans*), common garter snakes (*T. sirtalis*), and rubber boas (*Charina bottae*) in the Sullivan Lake Range District (Hallock 2003). Four amphibian and four reptile species were confirmed in the Project vicinity: the western toad, bullfrog, Pacific treefrog, Columbia spotted frog, painted turtle, northern alligator lizard (*Elgaria coerulea*), western terrestrial garter snake, and common garter snake (RTE Wildlife Study Final Report, SCL 2009a). No use of the Project reservoir by amphibians was documented (RTE Wildlife Study Final Report, SCL 2009a). Western toads and Columbia spotted frogs are discussed in more detail below.

4.5.5.1.4. Rare, Threatened, and Endangered Wildlife Species

RTE species discussed in this section include federal and Washington state listed, proposed, and candidate species; USFS CNF sensitive and management indicator species; BLM sensitive species; and WDFW priority species. In total, 43 RTE species may occur in the Project vicinity, with 20 species confirmed during the 2007/2008 field season (RTE Wildlife Study Final Report, SCL 2009a). RTE species observed in the Project vicinity include two amphibian, 12 bird, and six mammal species, four of which are bats (SCL 2009a). RTE species observed in the Project vicinity and general information about locations of observations are summarized in Table E.4-38. Species that were not confirmed but are likely to occur (based on nearby records, unconfirmed records, and historical records) are listed in Table E.4-39.

Table E.4-38. Rare, Threatened, and Endangered wildlife species observed in the Project vicinity.

Common Name	General Location Information	USFWS Status[1]	BLM Status[2]	USFS Status[2]	WDFW Status[3]
Amphibians (2)					
Western toad	Observed once, at the Boundary Forebay campsite.	—	—	—	SC, PS
Columbia spotted frog	Ten individuals observed downstream of Boundary Dam, on both the west and east banks of the river.	—	—	—	SC, PS
Birds (12)					
Common loon	Recorded five times; in the Boundary Forebay, Canyon Reach, and upper reservoir near Metaline.	—	S	S	SS, PS
Eared grebe	Recorded eight times (137 individuals); nearly all in either the Boundary Forebay or just upstream from the Metaline Falls bridge.	—	S	S	PS
Western grebe	Recorded five times (11 individuals), all near Metaline.	—	—	—	SC, PS
Great blue heron	Twenty-seven observations (36 individuals) throughout the study area.	—	—	MIS	SM, PS
Vaux's swift	Small group observed foraging over Sullivan Creek.	—	—	—	SC, PS
Turkey vulture	Thirty-six observations (77 individuals) throughout the study area.	—	—	—	SM
Osprey	Sixty-five observations throughout the study area; common.	—	—	—	SM
Bald eagle	More than 100 observations throughout the study area; ubiquitous.	—	—	—	SS, PS
Northern goshawk	Observed near Selkirk High School and Slate Creek.	—	—	—	SC, PS
American peregrine falcon	Pair appears to be nesting on Washington Rock.	—	S	S	SS, PS
Merlin	Single merlin observed perched at the top of a cottonwood at the BWP.	—	—	—	SC, PS
Pileated woodpecker	Observed four times; seen in Canyon Reach, BWP, Box Canyon Motel, and near Pend Oreille mine.	—	—	MIS	SC, PS
Mammals (6)					
Long-legged myotis	Acoustically detected at the Box Canyon tailrace.	—	—	—	SM, PS
Long-eared myotis	Acoustically detected at the Box Canyon tailrace.	—	—	—	SM, PS
Western small-footed myotis	Acoustically detected at the Box Canyon tailrace.	—	—	—	SM, PS

Table E.4-38, continued…

Common Name	General Location Information	USFWS Status[1]	BLM Status[2]	USFS Status[2]	WDFW Status[3]
Townsend's big-eared bat	Observed roosting in two mine adits and a natural cave. Also visually and acoustically detected near Washington Mine.	__	S	S	SC, PS
Beaver	Commonly seen throughout the study area.	__	__	MIS	Game
Canada lynx	Observed swimming across the reservoir in the Canyon Reach.	FT	FT	FT	ST, PS

Source: RTE Wildlife Study Final Report, SCL 2009a.
Notes:
1 USFWS — FE = Federal Endangered; FT = Federal Threatened.
2 USFS/BLM — S = Sensitive; MIS = USFS Management Indicator Species.
3 WDFW — SE = State Endangered; ST = State Threatened; SC = State Candidate; SS = State Sensitive; SM = State Monitor. All SE, ST, SC, and SS species are also designated Priority Species (PS) by the WDFW; there are also a number of game species that are designated PS. Game species that have no other status except PS were not included (e.g., wild turkey).

Table E.4-39. Rare, Threatened, and Endangered wildlife species likely to occur in the Project vicinity but not observed in 2007 or 2008.

Common Name	Detection Information	USFWS Status[1]	BLM Status[2]	USFS Status[2]	WDFW Status[3]
Birds (4)					
Golden eagle	Unconfirmed reports; may be confused with immature bald eagles.	__	__	__	SC, PS
Black-backed woodpecker	Unconfirmed report in the Priority Habitats and Species database (WDFW).	__	__	__	SC, PS
Black swift	Unconfirmed reports from local birders.	__	__	__	SM
Blue grouse	Scat found; USFS confirmation that this species occurs in study area.	__	__	MIS	Game, PS
Mammals (3)					
Fisher	Unconfirmed report in the Priority Habitats and Species database (WDFW).	__	S	S	SE, PS
Gray wolf	Unconfirmed sightings and reports of tracks and howling in the study area.	__	__	__	SE, PS
Grizzly bear	Unconfirmed reports outside of the Project vicinity, in the Colville National Forest.	FT	FT	MIS, FT	SE, PS

Source: RTE Wildlife Study Final Report, SCL 2009a.
Notes:
1 USFWS — FE = Federal Endangered; FT = Federal Threatened.
2 USFS/BLM — S = Sensitive; MIS = USFS Management Indicator Species.
3 WDFW — SE = State Endangered; ST = State Threatened; SC = State Candidate; SS = State Sensitive; SM = State Monitor. All SE, ST, SC, and SS species are also designated Priority Species (PS) by the WDFW; there are also a number of game species that are designated PS. Game species that have no other status except PS were not included (e.g., wild turkey).

The two RTE amphibian species documented in the Project vicinity were the western toad and Columbia spotted frog. Western toads prefer small, shallow lakes and ponds for breeding but spend much of their time in terrestrial forests or meadows with thick vegetation (Bull 2006). Two incidental sightings of western toads were recorded near the forebay boat ramp. Columbia spotted frogs are strongly associated with water and prefer small streams, wetlands, and seeps as their primary habitats (Bull 2005). Columbia spotted frogs appear to be confined to wetland and seep areas downstream of the dam. No evidence of breeding by western toads or Columbia spotted frogs was recorded in the Project vicinity.

RTE bird species that occur in the Project vicinity include both transient migratory species, and year-round residents. Western grebes (*Aechmophorus occidentalis*) and eared grebes (*Podiceps nigricollis*) have been observed on the reservoir during spring and summer, which are the migration seasons for these species. Great blue herons are regularly observed along the reservoir; although there are no known rookeries in the Project vicinity, individual nests may occur. A heron nest was observed in the forest at the mouth of Sullivan Creek in 2009 by SCL staff. Common loons (*Gavia immer*) appear to occasionally forage for fish in the reservoir, returning to the secluded local lakes where they nest (RTE Wildlife Study Final Report, SCL 2009a).

There were three active bald eagle territories in the Project vicinity in 2005: across the reservoir from the Box Canyon Resort, near Sand Creek, and on Everett Island. Only the Everett Island nest was confirmed to fledge eaglets (two) in 2005 (SCL 2006). In 2007, four eagle nesting territories were occupied in the Project vicinity, but only the three territories upstream of Metaline Falls were active, collectively producing at least five fledglings. The Everett Island nesting territory was occupied at various times by two adults and two juveniles. Although the nest tree was used as a roost by these eagles, no evidence of breeding was observed at the Everett Island site in 2007.

In 2008, the same three territories in the upper reservoir were occupied. The Sand Creek pair failed to nest, whereas the Metaline and Box Canyon nests fledged two eaglets each. Eagles were documented on several occasions along the lower reservoir on what appeared to be two territories (near Everett Island and Slate Creek), but active nests were not found. It is possible that nesting occurred outside of the Project vicinity. Nest data are summarized in Table E.4-40.

Four osprey nests were observed around the reservoir outside the Project area during relicensing studies in 2007 and 2008. Ospreys are frequently observed foraging in the Project reservoir. Peregrine falcons were observed on and around Washington Rock, outside of the Project area near the town of Metaline during 2007 and 2008. In spring of 2009, nesting on Washington Rock by peregrine falcons was confirmed by WDFW. Peregrine falcons have been observed hunting tree swallows near Washington Rock.

Table E.4-40. Bald eagle territories in the Project vicinity by year, including occupancy and number of fledglings, 1989–2008. 'Active' includes territories with evidence of nesting attempts, 'Occupied' includes territories where nesting attempts are unknown.

Year	Bald Eagle Territory			
	Everett Island	**Metaline**	**Sand Creek**	**Box Canyon**
1989	—	Unknown	Active, 1 fledgling	—
1990	—	Unknown	Active, 2 fledglings	—
1991	—	Unknown	Active, 2 fledglings	—
1992	—	Unknown	Active, 2 fledglings	—
1993	—	Unknown	Active, 2 fledglings	—
1994	—	Unknown	Active, 3 fledglings	—
1995	—	Unknown	Active, 3 fledglings	—
1996	—	Unknown	Active, Unknown	—
1997	—	Unknown	Active, Unknown	—
1998	—	Unknown	Active, 2 fledglings	—
1999	Active, 2 fledglings	Unknown	Active, Unknown	—
2000	Unknown	Unknown	Unknown	Active, 2 fledglings
2001	Unknown	Unknown	Unknown	Unknown
2002	Unknown	Unknown	Unknown	Unknown
2003	Unknown	Unknown	Unknown	Unknown
2004	Unknown	Unknown	Unknown	Unknown
2005	Active, 2 fledglings	Unknown	Active, Unknown	Active, Unknown
2006	Unknown	Unknown	Unknown	Unknown
2007	Occupied	Active, 1 fledgling	Active, 2 fledglings	Active, 2 fledglings
2008	Occupied	Active, 2 fledglings	Occupied	Active, 2 fledglings

Source: Adapted from the RTE Wildlife Study Final Report, SCL 2009a.

Four RTE bat species were documented in the Project vicinity (Bat Study Final Report, SCL 2009a). The Townsend's big-eared bat (*Corynorhinus townsendii*) roosts within the Project vicinity, and the long-legged myotis (*Myotis volans*), western small-footed myotis (*Myotis ciliolabrum*), and long-eared myotis (*Myotis evotis*) forage within the Project vicinity (SCL 2009a). In general, roosting bats, including RTE species, occur in small numbers within the Project vicinity (SCL 2009a). However, as noted above, large numbers of bats were regularly observed foraging above the reservoir's surface during the summer.

Beaver are common at the BWP and Sullivan Creek, and are often sighted at islands near PRM 28.8. Sixteen lodges were mapped that may support up to 80 beavers within the Project vicinity.

The only other RTE mammal observed in the Project vicinity during the 2007-2008 field surveys was the Canada lynx (*Lynx canadensis*), which is federally listed as Threatened and is discussed Section 4.5.6.

On February 27, 2009, the USFWS reclassified the gray wolf Rocky Mountain Distinct Population Segment (DPS), which includes the eastern one-third of Washington, from Threatened to Delisted (73FR10514). Wolf howling was heard on several occasions by field crews working in the vicinity of Boundary Dam during 2007 and 2008, coming from the Canadian side of the international border (Green, G., Tetra Tech, personal communication, March, 13, 2008). Unconfirmed sightings of wolves swimming across the reservoir and walking along the shoreline were recorded during 2007 field surveys (RTE Wildlife Study, SCL 2009a). A wolf pack was confirmed by WDFW in northeastern Pend Oreille County in July 2009.

4.5.5.2. Environmental Analysis

4.5.5.2.1. Mammals

Common Species

The most common mammals in the Project vicinity, including rodents, shrews, rabbits, and common carnivores such as raccoons (*Procyon lotor*) and short-tailed weasels, are typically ubiquitous generalists, with large populations in a variety of habitats. The primary effect of the Project on generalist species is the modification of shoreline vegetation from fluctuating water surface elevations in the lower reservoir. Fluctuating water surface elevations affect the ability of the shoreline to support vegetation and have a corresponding effect on the ability of the shoreline to provide cover and habitat for small mammals and other wildlife. This effect is more pronounced along the lower reservoir than the upper reservoir.

Approximately 14 to 15 acres of land adjacent to the shoreline have been lost over the past 40 years due to Project-related erosion (Erosion Study Final Report, SCL 2009a). Upland coniferous forest is a common habitat type in the Project vicinity and is the habitat most affected by erosion. Thus, loss of such habitat will have a relatively minor adverse effect over the term of the new license on any species that use this habitat. A small portion (an estimated 10 percent) of the 15 acres of erosion projected over the next license period would occur in riparian habitat, based on the analysis of past erosion. Continued effects on this habitat would have a corresponding effect on wildlife that use these areas.

Big Game Species

Several factors associated with Project operations potentially affect big game species. These factors are water fluctuation effects on shoreline vegetation, erosion effects on reservoir access, and behavior modification in response to human activity around Project-related roads and facilities or recreation areas.

Erosion is having little effect on existing woody riparian stands (Riparian Study Final Report, SCL 2009a), but Project-related erosion is causing some level of continuing loss of shoreline habitat (Erosion Study Final Report, SCL 2009a). Losses due to erosion during the past 40 years were associated with steep slopes (generally greater than 90 percent slope), particularly along the lower reservoir. A percentage of future losses may continue to be associated with sites that are too steep to provide big game habitat. Because erosion rates due to reservoir fluctuations are typically greatest during the first years following reservoir construction, erosion is expected to affect less area in the future than that observed during the first license term. Over the next

license term, losses of big game habitat due to erosion are expected to be approximately 1.6 acres along the lower reservoir and 3.0 acres along the upper reservoir (see Table 5.6-1 in the Big Game Study Final Report, SCL 2009a). Relative to the area within the Project boundary that serves as big game habitat (1,031 acres for mule deer and 858 acres for white-tailed deer and elk) (Table E.4-37), this potential loss is considered minor.

In addition, Project-related reservoir fluctuations contribute, along with non-Project factors, to the loss of fine sediment in the fluctuation zone, particularly in the lower reservoir. This affects the ability of herbaceous and woody vegetation, a potential source of forage and cover for big game, to establish in some areas. These combined erosion effects are expected to be relatively minor compared to the range of landscape features available for use by big game in the Project vicinity and the availability of food and cover.

Seventeen big game crossings were mapped along Boundary Reservoir (Big Game Study Final Report, SCL 2009a). These crossings correlate with natural topography, and although some erosion was documented at some of these locations, it did not appear to affect big game use of these sites. Observations of deer, elk, and moose crossing the lower reservoir in 2007 and 2008 suggest that although these animals may take an easily traveled route down to the water, they seem to cross regardless of the exit opportunities on the opposite side. Except for locations with rocky cliffs, none of the shoreline appears to be too treacherous to impede the ability of big game to exit the river (SCL 2009a).

Within the 26.5-square-mile big game secondary study area, there are 117.2 miles of road, of which 7.25 miles are Project-related. Most roads are primitive USFS roads (2.47 miles/square mile) or paved highways and county roads (1.06 miles/square mile) (Table E.4-41). The area with the greatest road density within the Project boundary is located east of the reservoir between Metaline Falls and Boundary Dam. The high road densities are related to the number of roads associated with the dam and maintenance facilities within a relatively small area.

Overall, road densities in the Project vicinity are not high enough to greatly influence deer use of available habitat. Results of the Thomas et al. (1979) model indicate that habitat effectiveness ranges from 73 to 92 percent for deer and 26 to 74 percent for elk (SCL 2009a). Elk are more sensitive to the presence of roads, particularly main and secondary roads, which is reflected in the modeling results. There is little human use of closed roads in the winter. According to the USFS (Borysewicz 2008), NFS roads in the secondary study area are infrequently used by snowmobilers, but are sometimes used by mountain lion hunters and a few locals living along Highway 31. Big game could potentially be subject to disturbance during winter, when their energy reserves are low, but because of the minimal use of these roads in winter there does not appear to be a disturbance threat.

ORVs use the BWP and are creating trails, increasing noise disturbance, and affecting habitat (RTE Wildlife Study Final Report, SCL 2009a). Documented snowmobile use of the BWP in winter can disturb wildlife and degrade habitat. While ORV and snowmobile use of the BWP is not a direct Project-related activity, it does suggest that more active management might help to ensure that the BWP can fulfill its intended purpose as high-quality habitat for many species near Boundary Reservoir. ORV use has been shown to cause flight response in elk, and occasionally

in deer, which may reduce the ability of these species to successfully use available habitat (Wisdom et al. 2004).

Table E.4-41. Road densities in the Big Game secondary study area and six subareas, and approximate habitat effectiveness for deer and elk.

	Road Density			Habitat Effectiveness[4]	
Subarea	**Main[1]**	**Secondary[2]**	**Primitive[3]**	**Deer**	**Elk**
Northwest (0.67 m^2)	2.08	0.60	1.21	85%	26%
West-central (7.54 m^2)	1.53	0.07	2.44	84%	46%
Southwest (3.94 m^2)	2.16	0.21	1.68	84%	38%
Northeast (2.02 m^2)	0.34	0.44	1.00	92%	74%
East-central (7.42 m^2)	1.72	0.71	3.41	62%	25%
Southeast (4.93 m^2)	0.54	1.16	2.51	77%	46%
Overall (26.52 m^2)	1.44	0.51	2.49	80%	37%

Source: Big Game Study Final Report, SCL 2009a; Thomas et al. 1979.
Notes:
1 Main road – at least one and one-half lanes wide and regularly maintained (paved or oiled).
2 Secondary road – one and one-half lanes wide, are somewhat improved, and are not regularly maintained.
3 Primitive road – single-lane roads are unimproved and seldom maintained.
4 Habitat effectiveness – the effectiveness of deer and elk in obtaining optimum of the maximum area of available habitat; the higher the road density, the lower the habitat effectiveness.

Bats

Water surface elevation fluctuations may affect shoreline caves used by bats. A natural cave near the mouth of the Canyon Reach at PRM 18.2 is often closed by high water during peak pool levels in the course of daily reservoir fluctuations, but approximately 10 feet of dry space remains in the cave, even during the highest pool levels. Up to three bats have been recorded roosting in the cave. In general, this cave is closed 3–14 percent of the time annually (on average, about 4 hours per day, when closed), and always during the morning hours. The cave is never closed during the evening hours when bats are active. A second cave located at PRM 18.8 in the Canyon Reach also has an entrance that is occasionally under water. This cave also contains a dry ceiling that remains above the fluctuating water surface. No bat use was recorded in this cave. It is possible that high water levels at these sites could affect bats, but because high water levels occur in the morning when bats are not active, potential effects are likely minimal.

Structures associated with Boundary Dam receive only minor bat use. No more than four individual bats were detected at the employee's portal and visitor's tunnel, and the maintenance buildings north of the dam do not represent high-quality bat habitat. The two stands of trees that represent the best tree roosting habitat in the Project vicinity (at Sullivan Creek and the BWP) are well above the fluctuation zone and are not affected by changing reservoir water surface elevations. Because of the limited roosting by bats in the Project vicinity and the minor effect of Project operations on available shoreline caves, the Project does not appear to affect roosting bats.

Fluctuating water surface elevations at Boundary Reservoir appear to prevent or limit the production of midges, caddisflies, and mayflies in both rocky and mud substrates in areas that have very shallow water (< 2 feet) and are subject to daily desiccation. The deeper portions of the fluctuation zone, however, support a moderate to high biomass of macroinvertebrates that represent bat prey. Macroinvertebrate production from these deeper zones apparently provides prey in quantities sufficient to attract the high numbers of bats observed foraging over the reservoir (Mainstem Habitat Modeling Study Final Report and Bat Study Final Report, SCL 2009a).

4.5.5.2.2. Birds

Common Species

Most bird species occurring in the Project vicinity, such as woodpeckers and passerines, use habitats adjacent to the reservoir. These species groups use a variety of available vegetation associations, including upland conifer forest and shrubland, riparian habitat, and wetlands. Based on documented erosion rates, erosion due to proposed operations over the next license period would affect fewer than 15 acres, mostly of second-growth upland conifer forest that dominates the vicinity. Loss of this habitat is considered a minor effect to common bird species that use this habitat. There are minimal effects to existing riparian habitat in the lower reservoir from daily water surface elevation fluctuations, but the lack of fine sediments along the shoreline likely affects the ability of riparian vegetation to further colonize some areas. This has an indirect and corresponding effect on species that may use these habitats. Riparian shrub and forest habitat is an important feature for a wide variety of birds, including neotropical migrant songbirds and woodpeckers, among others.

Raptors

Erosion of primarily mixed conifer forest may affect owls and other raptors by reducing the long-term availability of perch trees along the reservoir in discrete areas. This is considered a minor effect because of the availability of upland conifer forest and perch sites in the Project area and the basin in general. There may be a corresponding, although minor, effect on the prey species of owls and raptors, such as small mammals and song birds in the vicinity of erosion sites. Common raptors, such as saw whet owl (*Aegolius acadicus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), and American kestrel (*Falco sparverius*), which tend to use the edge of forest habitats, could be affected by this minor habitat loss. Other forest interior species, such as the northern goshawk (*Accipiter gentilis*), will not be affected.

Waterfowl

Changes in water surface elevations in the reservoir due to operations and flood events have the potential to inundate goose nests. Based on modeling, Project operations increased water surface elevations during the peaks of the 1972, 1974, and 1997 flood events above the elevation of flooding that would have occurred without the influence of the Project. The simulated Project-related increase was no more than 1.6 feet near Metaline Falls and up to 1.1 feet near Box Canyon Dam. Because proposed operations are the same as existing operations, depending on timing, an additional 1.1 to 1.6 feet in increased water surface elevations could potentially flood

more goose nests under proposed operations than would otherwise be affected without the influence of Project operations (Waterfowl/Waterbird Study Final Report, SCL 2009a). The elevation range of the 33 goose nests used in the flooding impacts analysis (Waterfowl/Waterbird Study Final Report, SCL 2009a) was 2,000.6 to 2,007.4 feet NAVD 88. Assuming that maximum flood levels during the goose nesting season would have averaged 1.6 feet lower without the influence of Project operations, the incremental influence of the Project on water surface elevations would have caused two addition years of nest loss (one nest lost each year) out of 19-year period of analysis (1987-2005) (Waterfowl/Waterbird Study Final Report, SCL 2009a). With or without the Project, all nests would have flooded during the 1997 flood (Figure E.4-69). Overall, Project operations have increased the number of inundated nests in nine of the 10 years when flooding contributed to loss of goose nests. Annual nest loss due to Project operations ranged from one to 12 depending on the year (Figure E.4-69). Since the proposed operations are the same as existing operations, the same effect on goose nests would be expected during flood years over the course of the new license period.

Land-bridging is a concern to nesting geese, allowing mammalian predators (especially coyotes [*Canis latrans*]) access to nesting islands (Craighead and Craighead 1949; Geis 1956; Hanson and Eberhardt 1971; Zoellick et al. 2004). Zoellick et al. (2004) investigated the impacts of land-bridging on goose nesting islands in the Snake River and concluded that coyotes could access islands when water depth was ≤ 1.5 feet. The island with the highest goose nest production (at PRM 27.7) is separated by a channel deep enough that a land bridge rarely (2.6 percent chance during a dry year) forms during the goose nesting season (Table E.4-42). Three of the islands in the upper reservoir (at PRMs 28.9, 31.5, and 33.2) will land-bridge during the low end of the daily fluctuation cycle, the latter two quite frequently. The historical hydrological record indicates that water depths have been less than 1.5 feet 18 to 77 percent of the time during the goose breeding season at the island complexes at PRMs 28.9, 31.5, and 33.2 during dry years, and 14 to 45 percent of the time during average water years. The hydrological record confirms that the islands at PRM 27.7 and 31.3 very rarely land-bridge during the goose nesting season during existing (and proposed) operating conditions. Similar to existing conditions, water surface elevation changes resulting from proposed Project operations may reduce overall goose nesting success in the Project area by affecting the frequency and timing with which land bridges provide access to some island habitats by mammalian predators. Effects on waterfowl nesting from water surface elevation fluctuations resulting in land bridges are expected to be minimal, because goose nesting is limited on many of the smaller islands. Overall goose production was consistent with levels documented along the Columbia River (SCL 2009a, Hanson and Eberhardt 1971, Fitzner et al. 1994, Eberhardt et al. 1989).

Cormorants and great blue herons were the most commonly observed piscivorous birds during field studies (Waterfowl/Waterbird Study Final Report, SCL 2009a), but these species do not breed in the vicinity. No Project effects have been identified for these or other piscivorous bird species that use the Project vicinity.

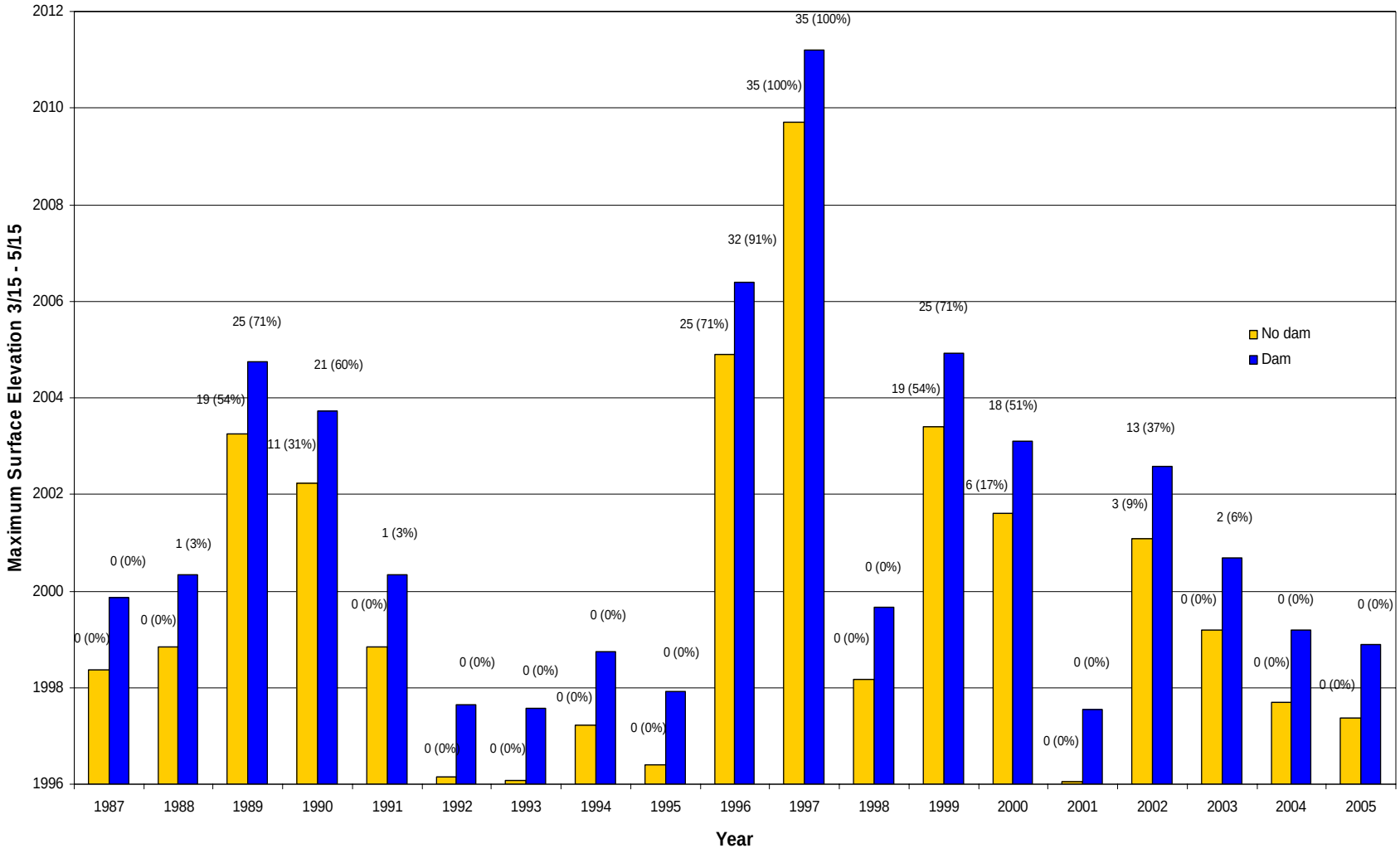

Figure E.4-69. Maximum water surface elevations in the absence (orange) and presence (blue) of Project operations and the number of Canada goose nests lost (percentage of nests lost is in parentheses).

Table E.4-42. Percent of time from March 15 to May 15 that islands in the upper reservoir land bridge (defined as having no more than 1.5 feet of water depth between the island and the mainland at any point) in a representative dry year (2001), average year (2002), and wet year (1997).

Island Location[1]	Island Acreage	Land-bridge Surface Elevation (feet NAVD 88)	Percent of Time Land-bridged March 15–May 15		
			2001 (dry)	2002 (avg)	1997 (wet)
PRM 33.2	6.3	1,993.2	76.8%	42.7%	6.3%
PRM 31.5	5.9	1,992.9	73.4%	44.6%	6.4%
PRM 31.3	0.3	1,985.9	0.4%	0.2%	0.0%
PRM 28.9	14.5	1,989.5	17.7%	14.0%	1.0%
PRM 27.7	8.2	1,986.7	2.6%	2.0%	0.0%

4.5.5.2.3. Reptiles and Amphibians

None of four reptile species and four amphibian species documented in the Project vicinity is directly affected by Project operations. Painted turtles and both garter snake species are highly aquatic and prefer off-channel habitat, such as that provided in the small tributaries and the wetlands at the BWP. These habitats are most prevalent above Metaline Falls and are minimally affected by daily fluctuations in water surface elevation. Northern alligator lizards are most typically found in cool, moist habitats, including forests (Storm and Leonard 1995), and are probably more affected by factors not associated with the Project, such as logging and land use, as well as fire history. Rubber boas are fossorial and crepuscular snakes with wide-ranging habitat adaptability. Because of their adaptability and low association with riparian areas, they are unlikely to be affected by the Project. Pacific treefrogs and long-toed salamanders are ubiquitous in Washington and breed in small ponds and are not affected by Project operations.

As with other terrestrial species, reptiles and amphibians are indirectly affected by the loss of upland habitat from Project-related erosion on steep slopes and the preclusion of woody vegetation along the fluctuation zone that is partially influenced by Project water surface elevation fluctuations. The reservoir is not high-quality breeding habitat for amphibians, which prefer seasonally stable water levels and littoral vegetation for breeding (Bull 2005, 2006). The observed reptiles in the Project area are common and widely distributed, and the effects on habitat from erosion and shoreline vegetation from water elevation fluctuations are not considered significant.

4.5.5.2.4. Rare, Threatened, and Endangered Wildlife Species

Amphibians and Reptiles

Western toads and Columbia spotted frogs are declining across their ranges for a variety of reasons that are poorly understood (Bull 2005; Keisecker and Blaustein 1998). No spotted frogs were observed above the dam during the field surveys, but the species was observed in seeps and along a small stream near the Project power plant. The only recorded occurrence of a western toad was in a small burrow near the forebay boat ramp. There is no suitable toad or spotted frog breeding habitat in the Project vicinity. Project operations are not affecting habitat used by

spotted frogs. Western toads may use shoreline areas that are affected by Project-related erosion, but these effects are minor and will continue to be minor under the proposed terms for the new license.

Birds (Non-Raptors)

Grebes, loons, and great blue herons that use the Project vicinity do not appear to be affected by Project operations. Common loons and herons that feed in the reservoir are nesting elsewhere, and eared and western grebes are transitory visitors to the vicinity (RTE Wildlife Study Final Report, SCL 2009a). Species that are primarily found in the second-growth conifer forests such as the pileated woodpecker, Vaux's swift (*Chaetura vauxi*), and turkey vulture (*Cathartes aura*) are not affected by Project operations. Dusky grouse (*Dendragapus obscurus*) (formerly blue grouse), confirmed in the Project vicinity by the USFS, is an upland conifer forest species common at higher elevations and does not rely on habitats that are affected by reservoir fluctuations.

Bald Eagle

Certain types of recreational activities (e.g., motorized boating, ORV use, and shooting guns) in the vicinity of bald eagle nests have the potential to adversely affect breeding behavior and nest success. The USFWS (2007) has developed guidelines for managing disturbance around active eagle nests based on studies by Anthony and Isaacs (1989) and others. These guidelines recommend restricting ORV use, loud boats, and camping activity within 330 feet of active bald eagle nests, especially during critical periods. Reported flush distances for eagles in response to human presence vary from 82 to 3,248 feet (Vian 1971; Steenhof 1976; Nye and Suring 1978; Stalmaster and Newman 1978; Skagen 1980; Knight and Knight 1984; McGarigal et al. 1991). Eagle response to recreationists is apparently dependent on site conditions, level of acclimation, age of the bird, season, and other factors (Knight and Gutzwiller 1995).

Three eagle nests in the Project vicinity (two in the Sand Creek territory in the BWP and one on Everett Island) were abandoned in areas where boating and ORV use occur (RTE Wildlife Study Final Report, SCL 2009a). However, because there has been no regular monitoring of these nests, it is impossible to ascertain the timing or the specific cause of the nest abandonment. Because multiple factors can contribute to nest abandonment, it is unknown whether disturbance from recreational activities was the cause of these three nests being abandoned. The Sand Creek territory, for example, has been in existence since 1989, with productivity confirmed in many years. This territory currently includes three nest sites (one active and two abandoned), all within 330 feet of potential boating and/or ORV activity. The oldest site, last thought to be used in 2004, is located in the BWP in a large cottonwood tree within 100 feet of the reservoir. The active nest site in 2005 and 2007, also in the BWP, is located farther from the reservoir shoreline in a relatively small-diameter cottonwood tree that is leaning over a wetland. In 2008, the pair constructed a new nest in a large cottonwood at the mouth of Sand Creek, just north of the BWP, but did not produce any young. The Everett Island nest site is within 330 feet of a slough that receives some boat use. This territory has been in existence since 1999, but productivity data are not available for most years; the nest was productive in 2005 but has been inactive for two years.

According to the Seattle Audubon Society (2008), there were more than 550 active bald eagle nests in Washington in 2008. Many productive nesting territories are in urban settings and along

lakes and other water bodies, such as Hood Canal and the San Juan Islands, which are used extensively for recreational boating. Therefore, threats to eagles from boat noise or other recreational activities must be evaluated in the context of the susceptibility of the specific breeding pair to disturbance at different times of the nesting cycle. The most critical periods relative to eagle nest disturbance are the initial nest-building, egg-laying, and incubation periods. In the Project area, this period runs from January to April, when there is little boat or camping activity on the reservoir. At the BWP, snowmobile activity may occur during these months and may pose a threat to the Sand Creek nest territory (although the nest is more than 800 feet north of the BWP).

Other Raptors

Other RTE raptors found in the Project vicinity include osprey, peregrine falcon, merlin, and goshawk. The only potential effect on these species from Project operations could be a negligible reduction in perch trees along the reservoir shoreline associated with the erosion of 15 acres of primarily mixed conifer forests. Ospreys are the most likely of these species to use shoreline perch trees while goshawk, more of a forest interior species, is the least likely. Loss of this shoreline habitat also would have a corresponding effect on these sites to support passerine birds that are preyed upon by peregrine falcon and merlins. Loss of 15 acres of shoreline vegetation is considered a negligible adverse effect to these raptors because of the availability of this common habitat type in the Project area and throughout the Pend Oreille River basin. There are no Project-related effects on nesting osprey or to the pair of peregrine falcons that nest on Washington Rock, outside the Project area and near Metaline Falls.

Bats

Western small-footed myotis, long-eared myotis, long-legged myotis, and Townsend's big eared bat were acoustically detected foraging over the reservoir. Insect production in the reservoir is comparable to production in water bodies outside of the Project vicinity and appears to support large numbers of bats. A few Townsend's big-eared bats were detected at several caves that are not affected by Project-related reservoir fluctuations. Two caves along the reservoir (PRM 18.2 and 18.8) that could provide some roost habitat for RTE bats are regularly closed off for a portion of the morning by reservoir fluctuations. Townsend's big-eared bats were observed in caves nearby (PRM 18.7), and it is possible that this species, or other RTE bats, use the caves that are sealed off by high water levels. These sites are not used as maternity sites or as hibernacula and appear to be used only on an occasional basis by a few bats. There is only a small possibility that bats could be harmed by high water levels, as these high water levels occur in the morning when bat activity is low. Because roost habitat (forested areas) is minimally affected by reservoir fluctuations, there appears to be only a small effect on bats from Project operations. As discussed above, the reservoir supports a healthy prey base for bats.

Wolves

Wolves are wide ranging predators that are currently reestablishing themselves in Washington. Individuals and/or packs are likely to use the Project area and adjacent habitats at least occasionally. While Project operations will affect upland and riparian habitats, there would be negligible effects on wolves that may use the Project area because of the abundance of these habitats in the vicinity and the wolves' wide-ranging habits.

4.5.5.3. Proposed Environmental Measures

Proposed mitigation measures for wildlife resources are incorporated into the TRMP (Attachment E-3) for the Project. Specific measures applicable to wildlife include monitoring bald eagles, peregrine falcon, osprey, and bank swallows; habitat enhancements on select SCL-owned parcels; and development of an adaptive management strategy that will respond to Project-related human disturbances or other Project-related effects. The implementation of measures outlined in the TRMP will be coordinated with the TRWG and will require regular reporting and meeting with the TRWG throughout the license period. The TRMP includes a travel and public access management program, standard practices and BMPs to minimize effects on habitat and wildlife, and the inclusion of 89 acres of land into the Project boundary for protection and enhancement of wildlife habitat values. In addition, the TRMP includes a provision for developing a monitoring plan for rare species, such as wolves, if a substantial increase in their use of the Project area is detected. All efforts will be coordinated through the TRWG.

4.5.5.4. Cumulative Effects Analysis

Project operations contribute to minor, long-term cumulative adverse effects on shoreline vegetation, which have a corresponding effect on the ability of the watershed to support certain wildlife species. However, on a basin-wide and cumulative scale these effects are insignificant. Vegetation loss and modification from development, road building and maintenance, recreation, and operation of hydroelectric facilities in the basin cumulatively affect the distribution and quality of shoreline habitat for wildlife. Land clearing in the basin from residential and commercial development, timber harvest, and mining are likely to continue to cumulatively affect wildlife habitat. The Project also has a minor adverse effect on wildlife use of land within the Project boundary because of associated roads and shoreline recreation. The Project's contribution to cumulative effects related to wildlife disturbance is insignificant.

4.5.5.5. Unavoidable Adverse Impacts

The proposed mitigation measures will adequately compensate for the long-term, minor adverse effects to wildlife from continued operation of the Project, but there will be continued long-term minor adverse effects to wildlife from human disturbance and shoreline vegetation modification resulting from fluctuations in water surface elevations in the lower reservoir.

4.5.5.6. Consistency with Comprehensive Plans

The wildlife-resource-related management goals and policies associated with relevant comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The CNF land and resource management plan includes provisions for evaluating effects to habitat and wildlife and protection of rare and Management Indicator Species, such as deer and elk.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

The BLM's district resource management plan mandates that sufficient forage and cover should be maintained for existing wildlife species.

U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada.

The North American waterfowl management plan calls for biologically based planning refined through ongoing evaluation, definition of the landscape conditions needed to sustain waterfowl and benefit other wetland-associated species, and collaborative initiatives to reach out to others sectors and communities to forge broad resource management alliances.

Washington Department of Ecology. 1994. State wetlands integration strategy. Olympia, Washington, 80 pages.

Ecology's wetlands integration strategy brought together a variety of jurisdictions within the state to develop standardized approaches to wetland policy, implementation, permitting, and education. Any work in wetlands as part of Project operations or restoration activities will be conducted in accordance with local, state, and federal wetland regulations.

Washington Department of Game. 1987. Strategies for Washington's wildlife. Olympia, Washington.

This program has been superseded by the 2005 Washington Comprehensive Wildlife Conservation Strategy (WCWCS). All State Wildlife Grants funded by Congress are predicated on the completion and acceptance of state Comprehensive Wildlife Conservation Strategies (CWCS) by October 2005. This program develops a number of programs including status and trend monitoring of wildlife, implementation and effectiveness monitoring, priority settings, and adaptive management.

4.5.6. Threatened and Endangered Species

4.5.6.1. Affected Environment

4.5.6.1.1. Terrestrial Species

The Affected Environment for terrestrial Threatened and Endangered species (TES) is the same as that described under Wildlife, Section 4.5.5.1. Three wildlife species listed as Threatened or

Endangered under the ESA may occur in the Project vicinity. Table E.4-43 lists these species and provides a summary of their potential occurrence. No federally listed or proposed Threatened or Endangered plant species are known to occur in the Project vicinity. Figure 2.4-1 in the Draft BA (Attachment E-9) includes a map of current and historical TES observations in the Project vicinity.

Table E.4-43. Federally listed Threatened, Endangered, and candidate wildlife species that may occur in the Project area.

Scientific/ Common Name	USFWS Status[1]	USFS Status	BLM Status	WDFW Status[2]	Occurrence
Lynx canadensis Canada Lynx	FT	None	None	ST	Documented swimming across Canyon Reach in 2008.
Rangifer tarandus caribou Woodland Caribou	FE	None	None	SE	Documented in Project vicinity.
Ursus arctos Grizzly Bear	FT	None	None	SE	Documented in Project vicinity.

Notes:
1 FT = federal Threatened species, FE = federal Endangered species,
2 SE = state Endangered, ST = state threatened.

The following sections provide a summary of existing information on federally Threatened and Endangered terrestrial species and an analysis of the Project effects.

Canada Lynx

The Canada lynx is a federal and state-listed Threatened species. In northeastern Washington, lynx use remote, high-elevation (> 4,000 feet) forests dominated by mature spruce (*Picea* sp.)/subalpine fir (*Abies lasiocarpa*) and thickets of dense lodgepole pine (*Pinus contorta*) that support prey (primarily snowshoe hare [*Lepus americanus*]) populations (Brittell et al. 1989; Stinson 2001). Only a small amount of the land in the general area (within 5 miles) of the Project vicinity is above elevation 4,000 feet. Lynx habitat quality is believed to be lower in the southern periphery of its range than in the northern taiga, because landscapes are more heterogeneous in terms of topography, climate, and vegetation (Buskirk et al. 2000). Population recruitment and home range sizes of lynx in the United States are similar to those reported during the decline or low phase of snowshoe hare cycles at more northern latitudes (Koehler 1990; Apps 2000). Lynx at the southern periphery of the range may prey on a wider diversity of prey because of differences in small mammal communities and lower average hare densities, compared with northern taiga.

There have been several reported lynx sightings within 5 miles of the Project according to USFS records (USFS unpublished data, CNF Sullivan Lake Ranger District, Borysewicz 2008). During the 2007/2008 field season, a fisheries study crew observed a lynx swimming across the Canyon Reach of the reservoir south of Monument Bar in a narrow section of the reservoir (about 300 feet wide) (Big Game Study Final Report, SCL 2009a), confirming lynx use in the Project vicinity. This individual was thought to be a dispersing individual, traversing the Project vicinity and headed toward higher elevations and more suitable habitat.

The Project area is not located within a designated Lynx Management Zone (LMZ) established in the Washington State Recovery Plan for Lynx (Stinson 2001). LMZs include regions of the state that should be managed for lynx because they are occupied, or were recently occupied (within the past 30 years), by lynx. These LMZs are to be regularly surveyed to monitor the status of populations (Stinson 2001), although no status reports or updates have been issued since the 2001 recovery plan (WDFW 2008b). The two LMZs closest to the Project are the Salmo Priest LMZ to the east and the Little Pend Oreille LMZ to the west. The LMZs have been divided into Lynx Analysis Units (LAUs), which were established to assess habitat conditions and are useful as survey units for documenting lynx occurrence. The Project is nearest to the Russian and Cedar (to the west) and Slate and Totem (to the east) LAUs. The LAUs are at least 1 mile from the Project area.

Recovery goals in the Washington State Recovery Plan for Lynx (Stinson 2001) include the following:

- Lynx are consistently present during 10 consecutive years in >75 percent of the LAUs in LMZs.
- Lynx surveys indicate that recruitment from local reproduction regularly occurs.
- Agreements or forest management plans are in place for federal, state, and major private landholdings.

When these goals are met and verified, lynx will be considered for down-listing from state threatened to state sensitive (Stinson 2001).

The USFS signed an agreement with the USFWS on February 7, 2000, to manage habitat specifically for lynx to minimize the impact of the listing on forest management operations and comply with the ESA (USFWS 2000). While the species is unlikely to regularly inhabit the Project vicinity, individual animals apparently travel through the area. The USFWS has initiated the five-year review of Canada lynx (72 FR 19549 19551); however, publication of this document is pending.

Woodland Caribou

The woodland caribou (*Rangifer tarandus caribou*) is a federal and state-listed endangered species. A small number of woodland caribou occur in the southern Selkirk Mountains, with most of the animals occurring in British Columbia, north of the Project area. Caribou have been transplanted into northeastern Washington and northern Idaho, including some in the upper Sullivan Creek drainage on the Sullivan Lake Ranger District beginning in the late 1990s (Audet and Allen 1996). During early winter, caribou move to low-elevation, old-growth cedar (*Thuja plicata*)/hemlock (*Tsuga heterophylla*) forests. They move up to subalpine fir and whitebark pine (*Pinus albicaulis*) stands once snow becomes sufficiently compacted and crusted for caribou to be able to walk on top of it (USFWS 1994). During spring, caribou move downslope to forage in shrubfields, meadows, and open forest stands.

The majority of the caribou population resides in the Salmo-Priest Wilderness Area, more than 5 miles east of the Project. Areas above elevation 4,000 feet are included in the Selkirk Mountain Woodland Caribou Recovery Area (USFWS 1994).

Specific goals of the Selkirk Mountain Woodland Caribou Recovery Plan include the following:

- Maintain the two existing caribou herds in the Selkirk ecosystem.
- Establish a herd in the western portion of the Selkirk Mountains in Washington.
- Maintain an increasing population as reflected by March aerial surveys (i.e., r>l).
- Secure and enhance at least 179,000 hectares (442,317 acres) of suitable and potential caribou habitat in the Selkirk Mountains to support a self-sustaining population.

To date, no updated information has been reported on the progress of management activities toward these goals.

Over the last 25 years, woodland caribou have occasionally been observed in the general vicinity of the town of Metaline Falls and near the West Side Access Road, and have been documented crossing the river north of Metaline (CNF Sullivan Lake Ranger District Wildlife Species Occurrence database 1996; Borysewicz 2008). Despite these rare observations, the Project vicinity itself lacks the older forests and elevations typically used by this species.

Grizzly Bear

The grizzly bear (*Ursus arctos*) is listed as a Threatened species under the ESA and as a Washington state-listed endangered species. The USFWS has determined that the grizzly bear population in the Selkirk area of Idaho and Washington warrants reclassification to Endangered status, but such action has been precluded by work on other higher priority species (FR 64(94):26725-26733, May 17, 1999). The Grizzly Bear Recovery Plan lists human activity, road building, forestry, and mining as factors adversely affecting the grizzly bear (USFWS 1993). Since 1975, habitat protection measures implemented by federal agencies under the ESA have focused on providing secure habitat for bears that lessens opportunities for human-caused mortality resulting from hunting (i.e., mistaken for black bear [*Ursus americanus*]), poaching, human-bear conflicts, and livestock-bear conflicts.

The boundary of the Selkirk Mountain Grizzly Bear Recovery Area (Highway 31) is approximately 0.75 miles east of the Project boundary. Thus, the Project area is not within a designated grizzly bear recovery area, although individual grizzly bears that occur outside the recovery area are protected. Populations are estimated to be 40 - 50 animals within the 2,200 square-mile Selkirk Mountain recovery zone (USFWS 2004).

Recovery goals for the Selkirk Mountain grizzly bear population are largely focused on retaining breeding females and reducing the human-caused mortality to zero. These goals are:

- Six females with cubs over a running six-year average, both inside the recovery zone and within a 10-mile area immediately surrounding the recovery zone, including Canada.
- Seven of the 10 bear management units on the U.S. side of the border occupied by females with young from a running six-year sum of observations.

- Known human-caused mortality not to exceed 4 percent of the population estimate based on the most recent three-year sum of females with cubs; furthermore, no more than 30 percent of this 4 percent mortality limit shall be females.
- The mortality limits cannot be exceeded during any two consecutive years.

The USFWS has initiated the five-year review for grizzly bear (72 FR 19549 19551); however, publication of this document is pending.

The CNF Forest Plan (USFS 1988) includes grizzly bear management in accordance with the Interagency Grizzly Bear Guidelines (IGBC 1986) and the CNF Guidelines for Management in Occupied Grizzly Bear Habitat. Secure bear habitat is primarily a function of the total and accessible (non-gated) motorized vehicle road density. Other guidelines are aimed at reducing bear habituation to recreation sites and other areas of human activity and reducing direct and indirect bear mortality.

In the early 1990s, Wielgus et al. (1994) estimated densities of 3.65 bears per 100 square miles in the U.S. portion of the Selkirk grizzly bear recovery zone, whereas the Canadian portion had a density of 6.3 bears per 100 square miles. In 2004, USFS biologists observed a grizzly bear feeding on a deer carcass in the lower Sullivan Creek drainage (USFS unpublished data, CNF Sullivan Lake Ranger District, Borysewicz 2008). Grizzly bears require spring forage habitats that provide large amounts of succulent, palatable herbaceous plants when they emerge from den sites. In most cases, these habitats are restricted to wetlands and riparian areas. During the summer and fall, berry-producing shrubfields are important. Radiotelemetry from 2003 indicated that a grizzly bear may have used Slate Creek as a travel corridor before crossing the reservoir (USFS unpublished data, CNF Sullivan Lake Ranger District, Borysewicz 2008). A local resident reported that grizzly bears are often seen in the spring foraging in the meadows on both sides of Boundary Reservoir south of Metaline Falls in the secondary study area (Luhr 2008). Both spring and summer/fall forage habitats are limited in the portions of the CNF near the Project (USFS 1998b). Den sites are associated with high elevations farther to the east near the Salmo-Priest Wilderness Area (USFS 1998a).

4.5.6.1.2. Aquatic Species

The only aquatic RTE species present in the Project area is bull trout, which was federally listed as Threatened on November 1, 1999. Westslope cutthroat trout is a USFWS species of concern and USFS sensitive species. WDFW includes five resident fish species on the state endangered list for Region 1 (eastern Washington): three minnows (lake chub, leopard dace, and Umatilla dace), mountain sucker, and pygmy whitefish. Neither the minnows nor the sucker have been documented in Boundary Reservoir or elsewhere in the Project vicinity. Pygmy whitefish are known to be present in Sullivan Lake, which is in the Project vicinity, but have not been documented in Boundary Reservoir.

Currently there are no bull trout spawning populations in the Project Area, but individual bull trout are occasionally observed. The Project Area is located within the Pend Oreille Core Area of the Northeast Washington Unit (NWU) of the Columbia River Distinct Population Segment (DPS). The available information suggests that there are two, and perhaps four, populations of

bull trout in tributaries to the Pend Oreille River, but only one of them, in LeClerc Creek, is within the Pend Oreille Core Area. The Salmo River located at RM 12.7 and the Priest River at RM 95.2 are both known to sustain reproducing bull trout populations, but they are located outside the Pend Oreille Core Area. LeClerc Creek, which drains into Box Canyon Reservoir, is suspected of having a small reproducing population of bull trout, but its status is unknown (Scholz et al. 2005). Five juvenile bull trout were observed in Nine Mile Creek, which drains into Seven Mile Reservoir, but it is uncertain if a self-reproducing population exists there.

Tributaries that drain into Boundary Reservoir with particular pertinence to bull trout include Sullivan Creek (PRM 27.9), Slate Creek (PRM 23.1), Sweet Creek (PRM 32)), and Flume Creek (PRM 25.8). Adfluvial fish habitat is very limited in tributaries draining into Boundary Reservoir because of stream size and the presence of natural passage barriers at or near the mouths of the tributaries (Table E.4-19). Sullivan Creek is the largest tributary, but it has a partial natural barrier at RM 0.65. A recent study concluded that the barrier would be passable by bull trout 18 inches or larger under low flow (99 cfs) conditions, but at high flows (1,528 cfs) the falls is a complete barrier (Powers 2008). In addition, the dam at Mill Pond, located 3.97 miles from the mouth of Sullivan Creek, does not include any fish passage facilities and is a complete barrier to upstream fish passage. The dam at the outlet of Sullivan Lake on Outlet Creek is also a complete barrier to upstream fish passage. Slate Creek is the second largest drainage in the Project vicinity and includes about 3,474 linear feet of adfluvial habitat downstream of a 19.7-foot waterfall (McLellan 2001). The Sweet Creek\Lunch Creek drainage is the third largest, and a series of three waterfalls limit potential adfluvial habitat to about 2,659 feet. McLellan (2001) reported the coordinates of a 13-foot barrier falls approximately 0.2 miles from the mouth of Flume Creek. However, a series of steep cascades and falls within 100 feet of the mouth of Flume Creek may also limit access of adfluvial fish to the creek (SCL 2009a). With the exception of potential thermal refugia near their outlets, Sullivan, Slate, Sweet, and Flume creeks are the only tributaries to Boundary Reservoir considered to have any potential bull trout spawning or rearing habitat.

In the final rule designating critical habitat for bull trout (70 FR 56212), the USFWS identified short sections of lower Slate Creek and Sullivan Creek as critical habitat. All impoundments behind dams that have a primary purpose of providing flood control, energy production, or water supply for human consumption were excluded from designation as critical habitat because disruption of these functions could adversely affect human health and safety or would have been inconsistent with the President's energy policy (70 FR 56212) at the time. Consequently, Boundary Reservoir is not considered critical habitat for bull trout. Except for short reaches near the mouths of Sweet, Slate, and Sullivan creeks, these creeks are located on NFS lands.

Few bull trout have been observed in the Project area since the early 1980s (Table E.4-22). Within Sullivan Creek, the one documented bull trout was found gutted (McLellan 2001), indicating it had been captured by an angler, but it is unknown if the fish was captured in Sullivan Creek or discarded there by the angler. An unidentified char was observed in Sullivan Creek by snorkelers, but they were unable to confirm its identity (Fish Distribution, Timing, and Abundance Study Final Report, SCL 2009a). Three bull trout have been captured within or near the mouth of Sweet Creek (Lembcke, personal communication, 2001; McLellan 2001). Fyke nets were deployed just upstream of the mouths of both Sullivan Creek and Sweet Creek during

2007 and 2008, but failed to capture any bull trout (SCL 2009c). Three bull trout were captured in the tailrace of Boundary Dam during relicensing studies, and genetic analysis indicates that one was from the Salmo River and two were from tributaries draining into Lake Pend Oreille (SCL 2009c). A fourth bull trout, a radio-tagged individual from the Salmo River was detected in the Boundary Dam tailrace in 2008. A radio-tagged bull trout originally captured in Lake Pend Oreille near Memaloose Island and then released at the Newport Boat ramp in Box Canyon Reservoir was detected in the Canyon Reach of the Project area during July 2009 (Olson, J., [KDNR], personal communication, 2009).

Currently, adfluvial bull trout may use the Pend Oreille River on a seasonal basis, but water temperatures are too high during the summer for continuous use, although while migrating bull trout may exhibit a short-term tolerance for high water temperatures (KCDNR 2000). Juvenile bull trout, however, are particularly sensitive to changes in water temperature and are typically found in the coldest stream reaches within a basin. Researchers studying tributaries to Lake Pend Oreille found the highest densities of juvenile bull trout at sites with summer maximum temperatures between 11 and 14 ˚C (Saffel and Scarnecchia 1995). Based on a review of bull trout temperature studies, including those cited by the EPA in support of EPA standards, Hillman and Essig (1998) concluded that optimal water temperatures for juvenile bull trout growth and rearing range from 12 ˚C to 14 ˚C. Temperatures in the Pend Oreille River can exceed these optimum conditions from June through September (Figure E.4-54). Water temperature modeling (CE-QUAL-W2) conducted in support of the application for Clean Water Act Section 401 certification and the Interstate (Idaho and Washington) Temperature Total Maximum Daily Load (TMDL) processes indicates that water temperatures under existing conditions are similar to what they would have been under natural conditions (see Section 4.5.2.2 of this Exhibit E for detail regarding the results of temperature modeling).

Observations of bull trout near Albeni Falls Dam (Geist et al. 2004, Dupont and Horner 2003), show that they use thermal refugia when mainstem river temperatures begin to exceed 18 ˚C. Bull trout were captured and observed via snorkeling below Albeni Falls near a culvert that provided a thermal refuge (Geist et al. 2004). Geist et al. (2004) reported at the time of capture that river temperatures ranged from 18.0 to 23.1 ˚C, while the plume created by flow from the culvert ranged from 11.8 to 15.0 ˚C, depending on the day and depth.

4.5.6.2. Environmental Analysis

4.5.6.2.1. Terrestrial Species

The three federally-listed wildlife species that may occur in the Project vicinity are wide-ranging species with territories far beyond the size of the Project area. Limited use of the Project vicinity by these species has been observed. Potential Project effects, i.e., water surface elevation fluctuation effects on shoreline habitat, erosion and loss of habitat, and human disturbance, occur on a localized and discrete scale compared to the expansive home ranges of these species. Greater detail regarding potential effects to terrestrial these species is provided in the draft BA (Attachment E-9).

Water bodies, including streams, rivers, and lakes, can be obstacles to wildlife movement across the landscape. In undisturbed landscapes, these features are part of the “natural matrix” (Meffe

and Carroll 1997) and represent barriers to the movement of some species but not others. Boundary Reservoir does not represent a barrier to the movement of large Threatened or Endangered mammals; however, the slope and composition of the shoreline, as well as water currents in the reservoir, influence where these species can cross. This may affect the movement patterns of large mammals.

Within the 26.5-square-mile big game secondary study area, there are 117.2 miles of road, of which 7.25 miles are Project-related. Most roads are primitive USFS roads (2.47 miles/square mile) or paved highways and county roads (1.06 miles/square mile) (Table E.4-41). Although most roads in the vicinity are not Project-related, they may cumulatively affect these wide-ranging mammal species. Greater detail regarding the potential effects of the Project for each species is presented below.

Canada Lynx

Canada lynx use of the Project vicinity is presumed to be primarily as a travel corridor between lynx populations on either side of the Pend Oreille River, in the designated LMZs (RTE Wildlife Study Final Report, SCL 2009a). Lynx are not directly dependant on resources associated with the river or Project, and are not affected by water fluctuations, vegetation changes in the fluctuation zone, or erosion. The observation of an individual lynx swimming across the Canyon Reach (RTE Wildlife Study Final Report, SCL 2009a) shows that lynx occasionally use the Project vicinity, at least as a travel corridor.

Construction of roads may reduce lynx habitat by removing forest cover. In some instances, however, lynx are known to use less-traveled roads through snowshoe hare habitat for traveling and foraging (Koehler and Brittell 1990). Roads and trails may facilitate snowmobile and other human uses in the winter, and snow compaction on roads or trails may allow competing carnivores, such as coyotes (*Canis latrans*) and mountain lions (*Felix concolor*), access to lynx habitat (Buskirk et al. 2000). In the absence of roads and trails, snow depths and snow conditions normally limit the mobility of these other predators during winter.

Preliminary information suggests that lynx do not avoid roads (Ruggiero et al. 2000a), except at high traffic volumes (Apps 2000). It is possible that summer use of roads and trails through denning habitat may have negative effects if lynx are forced to move kittens because of associated human disturbance (Ruggiero et al. 2000b). At this time, there is no evidence to suggest that management of road density is necessary to conserve lynx. However, new road construction continues to occur in many watersheds within lynx habitat, with many areas having high road densities, and the effects on lynx are largely unknown (Interagency Lynx Biology Team 2000). The primary prey of lynx, snowshoe hare, is common in the Project vicinity (SCL 2006), as are other small animals that lynx are known to prey upon (Squires et al. 2007). Project-related effects on lynx over the term of the new license are expected to be negligible because of the lack of suitable habitat in the Project area, the absence of effects on lynx prey base (Stinson 2001), and the minor contribution of Project-related roads to the overall landscape.

Woodland Caribou

There are few records of woodland caribou in the Project vicinity, but this species may use the general area east of the Project for winter forage grounds. Woodland caribou are occasionally

known to cross the reservoir south of Metaline Falls, where topography may allow easier river access crossing points. Because of the steeper terrain around the lower reservoir (below Metaline Falls), big game trails are concentrated in areas that follow terrain features such as drainages. Along the upper reservoir (above Metaline Falls) the terrain is gentler and allows for a more diffuse pattern of big game travel. No impediments to big game travel or to reservoir access were identified during field studies and subsequent analysis (Big Game Study Final Report, SCL 2009a). Woodland caribou are likely to use big game trails that other ungulates use, especially in areas of steep topography. In Jasper National Park, woodland caribou generally avoided areas within 1 kilometer (0.6 miles) of campgrounds and up to 750 meters (2,460 feet) from trails; however, displacement distances and intensity of avoidance depended on the level of human use on the nearest trails (Whittington and Mercer 2004). Caribou were noted to avoid areas with 250 meters (820 feet) of linear features such as gravel roads and seismic test corridors (Dyer 1999).

Habitat in the Project vicinity is generally unsuitable for woodland caribou because of its low elevation and lack of older forests; therefore, Project operations would not be expected to affect caribou. Project-related roads are not a primary component of the road network in the vicinity and would not hinder the movement of any woodland caribou that may wander into the vicinity. Recreation or road use could temporarily alter the habitat use of this species, but this is a negligible effect. Project-related effects on woodland caribou over the term of the new license are expected to be negligible because the quality of available caribou habitat in the Project vicinity is marginal and use is therefore extremely low.

Grizzly Bear

The Grizzly Bear Recovery Plan lists human activity, road building, forestry, and mining as factors adversely affecting grizzly bears (USFWS 1993). Grizzly bears are not affected by Project operations, but road use has the potential to alter grizzly bear use of the vicinity.

Road density and associated human activity affect grizzly bear movements and can cause significant mortality to bears from road kills and human-bear conflicts (Mace and Jonkel 1980). In southeastern British Columbia, McLellan and Mace (1985) reported that adult bears, on average, used an area extending 100 - 250 meters (328-820 feet) from open roads significantly less than the area available; use within 100 meters (328 feet) of roads was 40 percent of that expected in spring and 50 percent of that expected in summer/fall. Kasworm and Manley (1988) reported a similar response of bears to roads in the Cabinet Mountains, Montana: use within 500 meters (1,640 feet) of open roads was reduced 78 percent from that expected in spring and 87 percent in fall. However, bears have readily habituated to high levels of human disturbance, as long as it was predictable and non-lethal (McArthur 1979; Dood et al. 1986).

Aune and Kasworm (1989) found that bears living in the foothills of the Rocky Mountains appeared to accommodate a high level of human activity by adopting a more nocturnal activity pattern than bears that occupied more remote backcountry areas. Kasworm and Manley (1988) compared habitat use by bears in two areas in the Cabinet Mountains with different road densities and seasonal access. In the areas with 4 kilometers (2.5 miles) of road open only from July 1 to October 15, the average distance of bear use to the nearest road prior to July 1 was 0.6 kilometers (0.4 miles). When roads opened, the mean distance of bear activity to roads increased

to 1.1 kilometers (0.7 miles). Most importantly, the area avoided by bears after the roads were open was similar to the maximum distance avoided by bears in the area with a higher open road density and no seasonal closure. Grizzly bears can become habituated to roads and will regularly cross even high-traffic highways, such as Highway 31 through the Project vicinity (Gibeau et al. 2001).

Despite the continued influence of human-caused mortality in the Selkirk Mountain recovery zone, the grizzly bear population appears to be expanding its range, as evidenced by an increase in sightings in the vicinity. This range expansion may also be at least partially responsible for the increase in agency removal of bears and other interactions with humans around the periphery of the recovery zone. This grizzly bear population is still small, and gains in recovery could quickly be reversed (Wakkinen and Kasworm 2004).

Grizzly bears may occasionally use the Project vicinity, but Project operations do not have an effect on the habitat of this wide-ranging species. In addition, Project-related roads represent a minor contribution to the landscape conditions of the vicinity and would not hinder the movement of grizzly bears that may wander through the vicinity. Use of the BWP by snowmobiles and ORVs could discourage use of this area by bears, if they were to wander into this area. Project-related effects on grizzly bears over the term of the new license are expected to be negligible because use of the Project vicinity by this species is low and impacts on habitat from proposed Project operations will be minimal.

4.5.6.2.2. Aquatic Species

The effects of the Project on native salmonids, as described in Section 4.5.3.2, apply to bull trout. These effects include mortality or injury from entrainment and passage through or over Boundary Dam, loss of habitat connectivity as a result of the lack of upstream passage facilities at Boundary Dam, potential trapping and stranding in Boundary Reservoir or tailrace as a result of fluctuating water surface elevations, reduced productivity and fluctuating availability of habitat located in the varial zone, including thermal refugia, and potential competition from triploid rainbow trout, and inadvertent injury or mortality associated with angler effort targeted at triploid rainbow trout. Each of these effects was described in more detail in Section 4.5.3.2, but will be summarized briefly below with reference to bull trout. Greater detail regarding potential effects to bull trout is provided in the draft BA (Attachment E-9).

Although bull trout are very rare in the Project area (Table E.4-22), any individuals entrained at Boundary Dam could suffer injury or mortality as the result of turbine or spillway passage. A desktop analysis suggested midpoint mortality rates would range from 35 to 43 percent for turbine or spillway passage depending on fish size. Collection of two healthy bull trout in the Boundary Tailrace Reach that originated in tributaries to Lake Pend Oreille (origin based on genetics testing) confirms that some bull trout survive entrainment at Boundary, Box, and Albeni Falls dams. The relatively low number of observations of bull trout in Boundary Reservoir since the early 1980s, despite intensive sampling in 2000, 2007, and 2008, suggests that the overall incidence of bull trout entrainment, and therefore mortality, at Boundary Dam is low.

The potential for bull trout stranding and trapping varies with location in the Project area. Fluctuations in water surface elevation due to Project operations are more extreme and frequent

in the Forebay and Canyon reaches of the reservoir than in the Upper Reservoir Reach. Fluctuations in the Tailrace Reach, influenced by both Project operations and operations of the Seven Mile Project, are also more extreme than in the Upper Reservoir Reach. Despite the more extreme fluctuations in the Tailrace, Forebay, and Canyon reaches, the physical characteristics and length of these reaches result in a much lower potential risk of bull trout stranding and trapping than in the Upper Reservoir Reach, which accounts for about 77 to 95 percent of the available trapping or stranding index area, depending on year type. Surveys conducted during 2007 and 2008 in 23 areas with the potential for stranding and trapping of fish resulted in only one salmonid, an adult rainbow trout, being stranded or trapped. Monthly surveys from March through August 2008 revealed that suckers and minnows (88 percent combined), centrarchids (6 percent), and perch (4 percent) accounted for nearly all of the fish stranded. The composition of trapped fish was similar, with suckers and minnows (84 percent), centrarchids (12 percent), and perch (4 percent) dominating the observations. Nearly all stranded or trapped fish were fry or fingerling-size individuals. For bull trout greater than 6 inches, which represent the size most likely to use the mainstem Pend Oreille River, the risk of stranding is likely low because of their relatively large size and ability to access deeper water as water surface elevations decline. The risk of bull trout trapping is somewhat higher than for stranding, particularly if an individual bull trout were foraging on the smaller fish typically found in trapping pools. However, the fact that only one salmonid was observed to be stranded or trapped during surveys in 2007 and 2008 suggests the overall risk for bull trout, which are even rarer in the reservoir than other salmonid species, is low.

Fluctuations in water surface elevations also reduce the level of productivity by periphyton and BMI in the varial zone as a result of cyclical exposure to air and drying. Bull trout are known to have a diverse diet as they become larger (> 4.3 inches), foraging more heavily on other fish if they are available, in addition to invertebrates. Large bull trout diets may consist entirely of fish (Reiman and McIntyre 1993). Nevertheless, bull trout could be indirectly affected by fluctuations in water surface elevations that cause reductions in BMI as a food source. Aquatic Habitat Modeling suggests that about 64 to 68 percent of the potential WUA for periphyton and BMI in the Project area is located in the Upper Reservoir Reach, depending on year type (Figure E.4-49). The amount of BMI WUA fluctuates on a daily basis as water surface elevations vary, and the range between the minimum and maximum monthly values can be used as an indicator of the effects of water surface fluctuations on potential BMI habitat. Under average year flow conditions in the Upper Reservoir Reach, the annual minimum BMI WUA is 16.3 million square feet and the range between minimum and maximum values varies from 9.3 to 36.5 percent of the monthly mean value and suggests water surface fluctuations have a low to moderate effect on potential BMI habitat, so the indirect effect on any bull trout occupying the reservoir would be small.

Aquatic Habitat Modeling was also used to provide an index of the amount of physical habitat that might be available to bull trout based on the suitability of available water depths, water velocities, and substrate types. For comparability between reaches, the index calculated was WUA per foot of river reach. The model suggests that during mean flow years the Forebay and Canyon reaches have a relatively low density (less than 35 square feet of monthly minimum WUA per foot of river) of potentially suitable habitat for bull trout juveniles, particularly during the fall and spring months, when water surface elevations fluctuate more frequently and with a

higher range than during summer period (Figure E.4-70). Monthly minimum WUA density was slightly higher for the Tailrace (36 - 45 square feet per foot of river) and substantially higher for the Upper Reservoir Reach (60 - 158 square feet per foot of river). Because of its greater length, the Upper Reservoir Reach provides the most potential habitat for juvenile bull trout. Given the overall lack of bull trout observations, it is apparent that a factor (or factors) other than physical habitat limits bull trout use of the Project area.

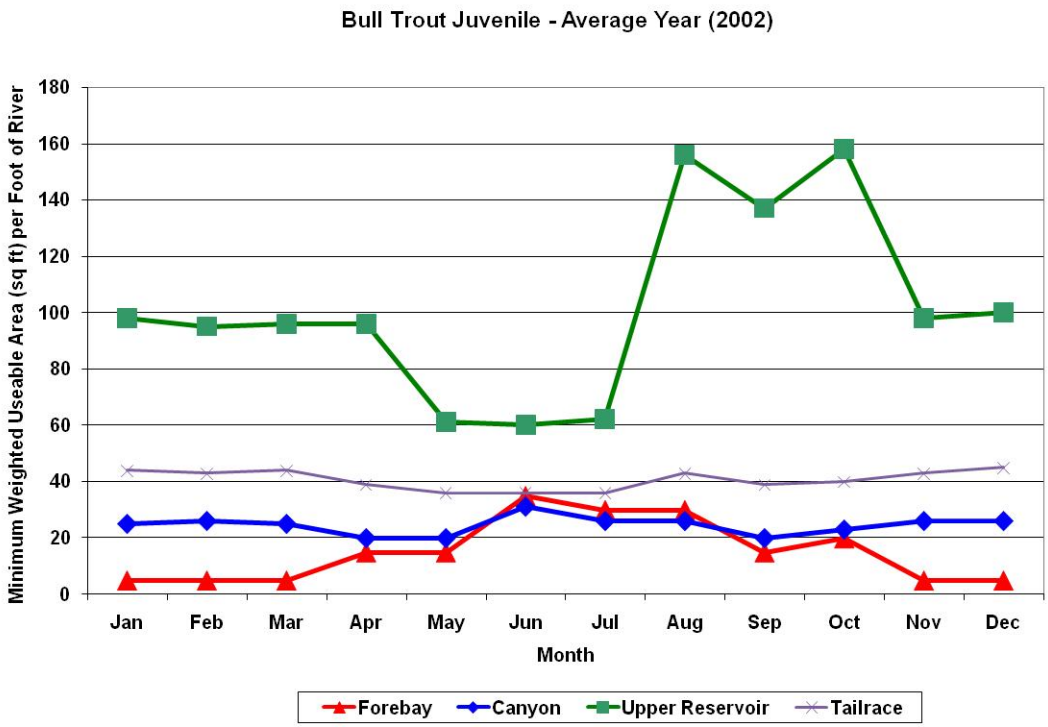

Figure E.4-70. Monthly WUA minima for juvenile bull trout during an average flow year.

The Aquatic Habitat Model indicated that adult bull trout WUA density was about three times that of juvenile bull trout, primarily as a result of the higher suitability of deeper and faster water for adults. For an average flow year, the density of adult bull trout WUA was similar for the Upper Reservoir, Canyon, and Tailrace reaches between November and March at about 85 to 145 square feet per foot of river (Figure E.4-71). In contrast, the Forebay Reach was substantially higher at about 300 square feet per foot of river throughout the year. Between April and October the Upper Reservoir WUA density was more similar to the Forebay Reach. Similar to juvenile bull trout, the rare observations of bull trout greater than 6 inches in length in any of the Project reaches indicates that a factor (or factors) other than physical habitat limits bull trout use of the Project area.

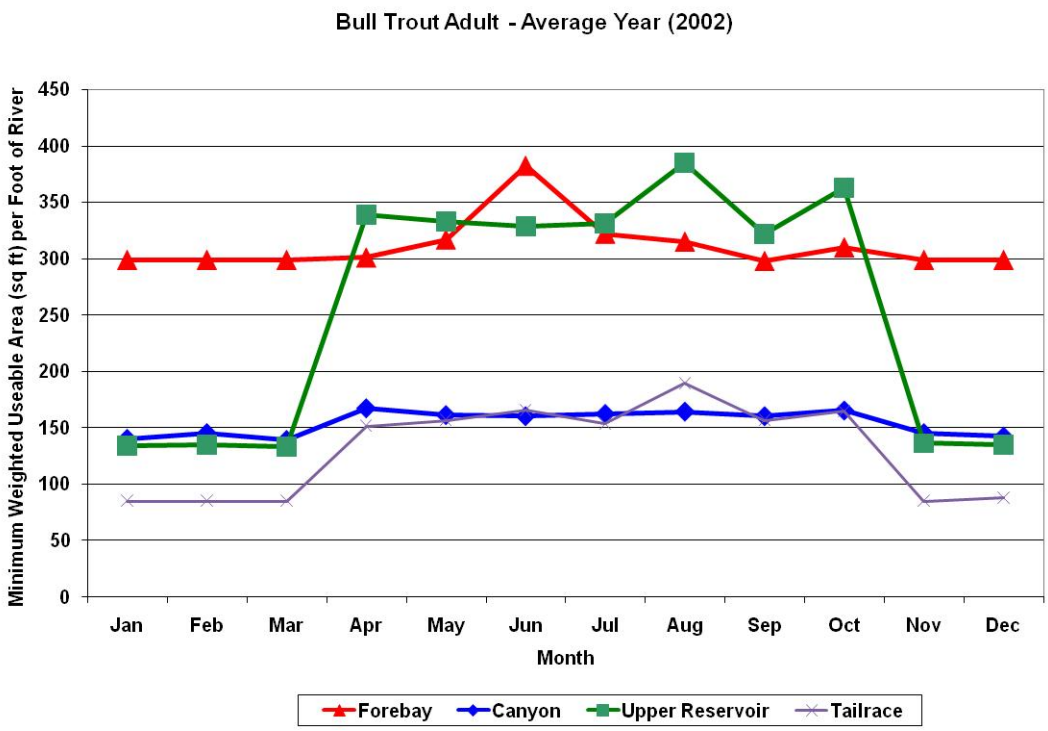

Figure E.4-71. Monthly WUA minima for adult bull trout during an average flow year.

Similar to other salmonids in the Project area, thermal plumes could provide refugia for bull trout during periods of high mainstem water temperatures. Although bull trout have rarely been observed in Boundary Reservoir, most observations of bull trout during the summer have been associated with thermal plumes at the mouths of tributaries. If bull trout were more abundant, thermal plumes could potentially be the limiting habitat type in the Project area. Because bull trout have lower optimal temperature requirements than other trout species in the Project area, bull trout could potentially use thermal plumes for longer periods than other salmonids.

Fluctuations in water surface elevations due to Project operations change the physical characteristics of thermal plumes at tributary mouths and, as a result, could influence use of those thermal plumes by any bull trout present near the tributary mouths. Modeling of the surface area of thermal plumes indicated the Slate Creek thermal plume was unaffected by fluctuations in reservoir water surface elevations. In contrast, the size of thermal plumes at the mouths of Flume, Sullivan, Linton, and Sweet creeks fluctuated in response to changes in water surface elevation by a factor of 2 to 10 times, depending on the stream and water year type. The thermal plume at Sullivan Creek generally has at least an order of magnitude larger surface area than other modeled thermal plumes in the Project area. With the exception of Slate Creek, the surface areas of thermal plumes are generally larger at high water surface elevations than at lower elevations. However, because the volume of water delivered by a tributary is relatively stable on a daily basis, a larger plume surface area may be accompanied by a decrease in the quality of the plume because the depth, which is already relatively shallow, is reduced or there is increased mixing with mainstem water and thus less of a temperature differential between the

plume and the mainstem flow. Cutthroat trout implanted with temperature and depth sensing tags were observed to move into the mouth of Sweet Creek to remain in cooler water when mainstem water temperatures increased and appeared to make relatively frequent (hourly scale) adjustments in location to remain in suitable conditions as water surface elevations changed. It is likely that a bull trout would behave in a similar fashion, thereby compensating for changes in the physical characteristics of the thermal plume.

Refugia provided by thermal plumes at tributary deltas are generally small. Other coolwater refugia may exist in Boundary Reservoir at groundwater seeps, but the location, size, and number of seeps is unknown. Competition for space at thermal refugia could be a factor adversely affecting any bull trout using a thermal plume, if space in the plume is limited. Thermal plumes are used as refugia by triploid rainbow trout, Westslope cutthroat trout, and mountain whitefish, as observed during relicensing studies in 2007 and 2008. In particular, numerous triploid trout, on the order 100 to 150 fish, were observed congregating at the Sweet Creek delta during August of 2007. Many anglers are aware of this behavioral pattern and target their effort towards thermal plumes during periods when mainstem temperatures are high. Consequently, any bull trout also using these plumes could be at a higher risk of capture by anglers.

In response to input from RPs, SCL developed modeled indices to reflect the availability of thermal refugia at four tributary deltas (Sullivan, Sweet, Flume, and Linton creeks). The area of thermal refugia was defined by water temperatures less than 18 ˚C when Pend Oreille river mainstem water temperatures exceed 20 ˚C and by water temperatures 2 ˚C less than the mainstem when mainstem water temperatures are between 18 and 20 ˚C. Under existing conditions, the average daily minimum refugia area between June 30 and September 30 summed over the four tributary deltas ranges from 35,000 square feet under dry conditions to 60,000 square feet under wet year conditions and is 52,000 square feet under average conditions. Under the proposed operating conditions for the Project, the thermal refugia index value would be slightly higher under dry year conditions (37,000 square feet), but similar under other year types. To provide perspective, average minimum thermal refugia index for the four deltas is equivalent to a little over 3 percent of the adult average minimum WUA for bull trout in the upper reservoir during an average year type, which further emphasizes that the availability of thermal refugia would likely be a limiting factor to bull trout use of Boundary Reservoir during warm summer periods if bull trout abundance were higher.

4.5.6.3. Proposed Environmental Measures

4.5.6.3.1. Terrestrial Species

Proposed environmental measures that will benefit terrestrial, federally listed Threatened and Endangered species is addressed in the TRMP (Attachment E-3) for the Project. If a listed species significantly increases its presence in the Project area during the term of the new license, a joint solution regarding any measures related to that species will be developed between SCL and the TRWG. Other aspects of the TRMP that will benefit federally listed species include standards and BMPs for SCL maintenance activities, management prescriptions for SCL-owned lands within the Project boundary, and incorporation of the 89-acre BWP Addition into the

Project boundary, as well as management of these lands for terrestrial resource protection and enhancement.

4.5.6.3.2. Aquatic Species

Bull trout could potentially benefit from the proposed environment measures listed below. Greater detail regarding the effects of these measures is provided in the sections identified in parentheses below and in the FAMP (Attachment E-8):

- Gravel augmentation below Box Canyon Dam (see Section 4.5.3.3.1)
- Channel modifications for mainstem trapping pools at PRM 30.3 (see Section 4.5.3.3.2)
- Upstream fish passage (see Section 4.5.3.3.3)
- Mainstem large woody debris and tributary deltas (see Section 4.5.3.3.4)
- Boundary Reservoir fish community monitoring (see Section 4.5.3.3.5)
- Habitat protection, riparian improvement, and stream channel enhancement in Sullivan Creek from RM 0.00 to RM 0.54 (see Section 4.5.3.3.6)
- Riparian, streambank, and channel improvements in Sullivan Creek from RM 2.30 to 3.93 (see Section 4.5.3.3.7)
- Culvert replacements in Slate Creek tributaries Slumber Creek at RM 0.2 and Styx Creek at RM 0.1 (see Section 4.5.3.3.8)
- Riparian planting in Linton Creek RM 0.0 to 0.2 (see Section 4.5.3.3.9)
- Channel improvements in Sweet Creek from RM 0.40 to 0.50 (see Section 4.5.3.3.10)
- Riparian buffer protection and improvements in Sweet Creek from RM 0.0 to 0.5 (Section 4.5.3.3.11)
- Tributary non-native trout suppression (see Section 4.5.3.3.12)
- Native trout supplementation facility (see Section 4.5.3.3.13)
- Formalization of summer restrictions on water surface elevation fluctuations (see Section 4.5.3.3.14)
- TDG abatement measures (see Section 4.5.2.3.3)

4.5.6.4. Cumulative Effects Analysis

4.5.6.4.1. Terrestrial Species

Canada lynx, woodland caribou, and grizzly bear are affected by a number of human activities in the basin, including land development and habitat modification, human disturbance from road use, and recreation. Project-related roads and recreation use have an insignificant contribution to cumulative effects on these federally listed species. Inclusion of 89 acres of land into the Project boundary and development of the TRMP will provide important local benefits to federally-listed Threatened and Endangered wildlife species.

4.5.6.4.2. Aquatic Species

Bull trout could be cumulatively affected by the Boundary Project because it is the third of five hydroelectric projects situated along the Pend Oreille River between Lake Pend Oreille and the

Columbia River. Project effects that could contribute to cumulative effects in the basin include disruption of LWD movement and a lack of habitat connectivity.

Juvenile bull trout have a high propensity for using cover in the form of large substrate and LWD, particularly at night (McPhail and Baxter 1997). Each of the hydroelectric projects collects and removes LWD from its forebay, because debris can be destructive to project facilities. The overall LWD budget in terms of the amount of wood that enters the river from Lake Pend Oreille and tributary streams and the amount of wood that is removed is unknown. Nevertheless, the overall trend is the cumulative loss of LWD that could potentially provide aquatic habitat along the river shorelines or at islands and cobble bars.

None of the five dams on the Pend Oreille River has upstream or downstream fish passage or screening facilities. Consequently, all bull trout entrained over or through the projects are at risk of injury or mortality. Because the level of mortality at each of the dams is unknown, the cumulative level of injury or mortality for any bull trout that pass multiple facilities is also unknown. However, it is known that at least some fish survive passage, as evidenced by the capture and release of healthy fish in the Boundary Dam tailrace that had been tagged upstream of the dam. In addition, genetic analysis of tissue from two bull trout captured in the Boundary Tailrace Reach indicates that these fish were derived from populations in tributaries to Lake Pend Oreille and survived passage at Albeni Falls, Box Canyon, and Boundary dams. SCL's proposed measures related to gravel augmentation and LWD augmentation would reduce this effect.

Status reviews for bull trout (Rieman and McIntyre 1993) suggest that the lack of habitat connectivity (i.e., fish passage) is an important factor contributing to the patchy distribution and low viability of bull trout in the Pend Oreille River. The lack of passage facilities at the Boundary Project contributes to cumulative adverse effects to habitat connectivity for migratory bull trout. SCL proposes to institute upstream passage under the new license, but no downstream passage or protection facilities are proposed due to a lack of feasibility.

Within the Lake Pend Oreille region downstream to the U.S.-Canada border, federal, state, tribal, and conservation groups are collaborating on the development of plans and projects designed to help recover bull trout populations. Pertinent plans and actions include:

- The Land and Resource Management Plan for the Colville National Forest (USFS 1989)
- The Inland Native Fish Strategy (INFISH; USFS 1995)
- Joint WDFW/Tribal Wild Salmonid Policy (WDFW and Western Washington Treaty Tribes 1997)
- Draft Bull Trout Recovery Plan (USFWS 2002)
- The NWPPC Intermountain Province Subbasin Plan (GEI Consultants 2004)
- Watershed Management Plan for WRIA 62 (Golder Associates, Inc. 2005)
- Implementation of License Articles for Box Canyon Hydroelectric Project (FERC No. 2042)

The goals, objectives, and strategies for these plans are generally consistent, if not similar to each other, with regard to aquatic habitat and any bull trout in and around the Project area and its tributaries. In general, there is a regional desire expressed in the various plans to reduce the effects of ongoing anthropogenic activities on water quantity and quality and habitat quantity, quality, and accessibility to improve the beneficial uses of water for any bull trout that use the water. Several of the plans are specific to bull trout in general, but many similarities are present in the types of specific strategies that are proposed among all the plans. However, most of the plans did not have specific on-the-ground projects identified for implementation at the time of publication and are also dependent on uncertain funding such as private, state, or federal grants, or regular state or federal agency funding requiring authorizations on an annual or bi-annual basis that have substantial fluctuations depending on economic conditions. Implementation of these plans should improve some aspects of water quality, riparian habitat, and bull trout habitat, but the rate at which improvements will occur in the future is uncertain.

Box Canyon Dam and Albeni Falls Dam are likely to provide passage to bull trout, to the extent they are present, in the foreseeable future. The Box Canyon Project has fish passage requirements as part of its recently acquired FERC license, which should be implemented by July 2018, for upstream passage using a trap-and-haul facility, and by 2015 for downstream passage facilities. The 2000 Biological Opinion for Federal Columbia River Power System Operations (USFWS 2000) called for investigating the feasibility of providing passage to bull trout, and the USFWS (2002) recovery plan for bull trout suggested passage would be necessary to recover bull trout in the NWU. The USACE and other federal, state, and tribal agencies continue to study the feasibility of passage at the Albeni Falls Project, but currently there are no specific plans for passage facilities.

Nevertheless, passage facilities are likely to be implemented over the next 30 to 50 years. The provision of downstream passage at Box Canyon and Albeni Falls dams would likely increase the number of bull trout entering Boundary Reservoir from upstream, assuming that tributary spawning populations are stable or increase in size.

If the number of bull trout entering Boundary Reservoir increases as a result of successful implementation of the listed plans and tributary improvements throughout the Pend Oreille River basin, including PM&E measures proposed by SCL for Boundary Reservoir tributaries, and passage improvements at upstream hydroelectric projects, then the number of bull trout that could be at risk from trapping or stranding or entrainment at Boundary Dam would also increase. Use of coldwater plumes by bull trout at tributary mouths would also likely increase. Because releases of triploid rainbow trout into Boundary Reservoir will not occur under the Proposed Action, competition for space at coldwater plumes would likely not occur initially under the new license until, and if, native salmonid populations, including bull trout, increase substantially in size.

4.5.6.5. Unavoidable Adverse Impacts

4.5.6.5.1. Terrestrial Species

There are negligible long-term effects on Canada lynx, woodland caribou, and grizzly bear from Project-related road use and shoreline recreation. Adequate compensation for these effects will be provided by the management of SCL lands for terrestrial resources as identified in the TRMP.

4.5.6.5.2. Aquatic Species

Some potential effects of the Project are unavoidable or cannot be completely mitigated by proposed in-kind mitigation measures, and consequently, a number of out-of-kind mitigation measures are proposed for tributaries draining into Boundary Reservoir to provide complete mitigation (Section 4.5.3.3). These unavoidable or partially mitigated potential adverse impacts to bull trout include:

- Injury and mortality to bull trout entrained at Boundary Dam.
- Disruption of sediment and large wood transport.
- Trapping and stranding of bull trout due to fluctuating water surface elevation, to the extent fluctuation is caused by Project operations.
- Fluctuations in aquatic habitat and thermal plume characteristics in tributary delta regions, to the extent fluctuation is caused by Project operations.

All of the unavoidable adverse impacts identified above are long-term and would occur throughout the term of the new license. The magnitude of these effects on bull trout is difficult to evaluate because very few bull trout reside in Boundary Reservoir and many out-of-Project factors also affect bull trout population abundance.

Disruption of sediment and LWD transport are both partially the result of transport disruption at Box Canyon and Albeni Falls dams and are therefore cumulative in nature. PM&E measures proposed to provide LWD jams at tributary deltas (Section 4.5.3.3.4) are anticipated to partially mitigate for sediment and LWD transport disruptions at the Project. Trapping and stranding of bull trout and fluctuations in bull trout habitat and thermal plume characteristics are site-specific and occur episodically. Trapping and stranding impacts are largest during large drawdowns that occur infrequently. A PM&E measure (Section 4.5.3.3.2) is proposed to reduce the effects of stranding and trapping at one of the major locations in Boundary Reservoir where trapping was identified. Thermal plume characteristics are important primarily during summertime periods when mainstem water temperatures exceed 18 ˚C. Although some thermal plumes are generally available to bull trout seeking cool water temperatures, load following operations result in continuous changes to the shape and location of the thermal plumes, which means any bull trout that are present would have to frequently adjust their locations to remain in desirable thermal conditions. For bull trout, which prefer relatively low temperatures, these effects could be substantial, to the extent that this species occurs in the Project area. Because no bull trout were captured, resulting in no biotelemetry being conducted for this species during relicensing studies, the magnitude of these effects on both a short-term basis and on the overall status of bull trout in Boundary Reservoir is highly uncertain.

4.5.6.6. Consistency with Comprehensive Plans

4.5.6.6.1. Terrestrial Species

The wildlife-resource-related management goals and policies associated with relevant comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The Colville National Forest land and resource management plan includes provisions for evaluating effects to habitat and wildlife and protection of rare and Management Indicator Species, such as deer and elk.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

The BLM's district resource management plan mandates that sufficient forage and cover should be maintained for existing wildlife species.

Washington Department of Game. 1987. Strategies for Washington's wildlife. Olympia, Washington.

This program has been superseded by the 2005 Washington Comprehensive Wildlife Conservation Strategy (WCWCS). All State Wildlife Grants funded by Congress are predicated on the completion and acceptance of state Comprehensive Wildlife Conservation Strategies (CWCS) by October 2005. This program develops a number of programs including status and trend monitoring of wildlife, implementation and effectiveness monitoring, priority settings, and adaptive management.

4.5.6.6.2. Aquatic Species

The fish and aquatics resource related management goals and policies associated with relevant comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The CNF land and resource management plan includes a number of forest management goals relevant to fish and aquatic resources:

- Fisheries - Provide a diversity of high quality aquatic habitats, which insures viable populations of fish in sufficient numbers to meet angler demands.

- Water - Provide for the continued supply of high quality water which meets established standards.
- Riparian - Provide and manage for riparian plant communities which maintain a high level of riparian dependent resources.

The plan includes the following standards and guidelines for fisheries, to be followed when evaluating or implementing management activities:

- Protect existing fish habitat from degradation where feasible. Rehabilitate habitats which have been degraded as a result of management activities where degradation is unavoidable. Mitigation will be at the affected site, when possible, but may be through off-site habitat enhancement when on-site mitigation is not possible.
- Emphasize management of native fish species habitat. Non-native species may be managed for in waters where they can be expected to provide at least 15 percent more biomass production or 15 percent more angler days recreation than native species. Non-native species may be used to provide diversity only where they will not adversely affect native fish or other native organisms in the affected or adjacent waters.
- Road crossings of Class I and II streams and fish-bearing Class III streams will be the minimum necessary. Existing crossings will be used whenever possible. New crossings will be located at areas of the least possible stream gradient. Stream crossing structures will provide the least resistance to upstream fish passage. Bridges or bottomless arches will be used instead of culverts unless the culvert can be installed in a manner that will allow passage of native trout during their spawning period. Drainage from roads will be dispersed prior to entering streams.
- Maintain the general character of aquatic and riparian habitat features. Maintain a natural source of large woody debris to provide structural fish habitat.
- In-stream migration barriers will normally be removed unless desired to prevent immigration by non-native, invasive fish or other aquatic organisms or when their removal would cause degradation to the stream and/or aquatic habitat.
- Maintain water quality parameters within the range of good fish habitat conditions, and within State water quality standards.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

The goal of BLM's resource management plan is to “Provide a variety of uses within the sustained yield capability of the resource.” General management objectives pertinent to fish and aquatic species include:

- Protect or enhance water quality with particular attention to those watersheds with major downstream water uses including anadromous and other sport fisheries and agriculture.

- Consider the protection and/or enhancement of state listed threatened or endangered species habitat.

U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

The USFWS's goals for aquatic ecosystems are as follows:

- Protect, enhance, or restore diverse high-quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed, and mitigate for loss or degradation of these habitats.
- Maintain and/or restore aquatic habitat connectivity in the watershed to provide movement, migration, and dispersal corridors for salmonids and other aquatic organisms and provide longitudinal connectivity for nutrient cycling processes.
- Restore naturally reproducing stocks of resident fish to historically accessible riverine habitat, using native stocks where feasible, with priority given to the restoration of listed native stocks.
- Provide an instream flow regime that meets the spawning, incubation, rearing, and migration requirements of wild salmonids and other resident fish and amphibian species, throughout the Project area.
- Meet or exceed federal and state regulatory standards and objectives for water quality in the basin.
- Minimize current and potential negative Project operation effects on water quality and downstream fishery resources.

4.5.7. Aesthetic/Visual Resources

4.5.7.1. Affected Environment

The Project is located within a remote, scenic reach of the Pend Oreille River with limited opportunities for public access and viewpoints; viewing opportunities are limited by the steep topography and land ownership patterns (SCL 2006). The Affected Environment (Project vicinity) includes the lands and waters within and adjacent to the Project boundary. However, areas between the reservoir shoreline and adjoining parallel county roads and/or state highway are also included where public viewing opportunities of the Project exist.

The Project is surrounded by the Chewelah Mountains to the west and the Selkirk Mountains to the east. The Project vicinity is generally characterized by forested hills and mountains, rock outcrops and high cliffs, and some rural development along the Highway 31 corridor, especially in and around the towns of Metaline and Metaline Falls. The primary modifications that have been made to the Project area's scenic character include urban development, such as the towns of Metaline and Metaline Falls, the Highway 31 bridge, the abandoned cement manufacturing facility in Metaline Falls, mining-related buildings and mine tailings disposal areas, Project

hydroelectric facilities and those of Pend Oreille County PUD, shoreline recreation sites, and regional transmission lines.

The primary visual characteristics of the Project vicinity include:

- *Topography* – The Project is located within the Okanogan Highlands physiographic province, which is characterized by moderate slopes and broad, rounded mountain summits with elevations of up to 8,000 feet. The Okanogan Highlands are located east of the Cascade Range and north of the Columbia Basin and extend into southern British Columbia and northern Idaho. The Selkirk, Chewelah, and Huckleberry mountains are the primary mountain ranges within the eastern Okanogan Highlands. The Pend Oreille River in the Project vicinity flows through a valley of varying width and steepness. Much of the Project from Boundary Dam upstream (south) to Metaline Falls is located in a relatively narrow, deep gorge section of the river canyon. By contrast, the portion of the reservoir from Metaline Falls upstream to the Box Canyon Dam tailrace is located in a wider, more open valley.
- *Vegetation* – The Project lies within a region characterized as Interior Red Cedar and Interior Western Hemlock forest, as well as Interior Douglas-fir forest. Prevalent species in these zones include western hemlock (*Tsuga heterophylla*), ponderosa pine (*Pinus ponderosa*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), grand fir (*Abies grandis*), and western red cedar (*Thuja plicata*). The unusual combination of geographical location and mixture of vegetation communities results in a high species richness in the Project vicinity, particularly for mammals and birds (Cassidy 1997).
- *Timber Harvesting* – Timber harvesting, along with mining, has historically been one of the primary extractive industries in the Project vicinity. Some of the landscape seen by the general public in the Project vicinity is that of a working forest, with visibly distinct harvest units of varying ages. However, logging (both current and past) is less evident around Boundary Reservoir, as well as on surrounding USFS-managed lands.
- *Land Use and Management* – Land use and management affects the visual characteristics of the Project vicinity. Land management within and adjacent to the Project boundary is under the jurisdiction of a number of entities, including the USFS, BLM, Pend Oreille County, and the towns of Metaline and Metaline Falls. Of these entities, Pend Oreille County oversees management of shorelines and adjacent land within the Project boundary by means of (1) the Pend Oreille County Shoreline Master Plan (Pend Oreille County 1974), (2) the Pend Oreille County Comprehensive Plan (Pend Oreille County 2008), and (3) the Pend Oreille Critical Areas Ordinance (Pend Oreille County 1996). In addition to the County's policies, the USFS and the BLM adhere to land and resource management policies defined in their respective Forest Plan and Resource Management Plan. The towns of Metaline and Metaline Falls also play a role in land management within their town limits, which extend up to the reservoir shoreline.
- *North Pend Oreille Scenic Byway and International Selkirk Loop* – Both the North Pend Oreille Scenic Byway and the International Selkirk Loop pass through the

Project vicinity on Highway 31, from its junction with Highway 20 to the U.S.-Canada border and into Canada to the north (in the case of the International Selkirk Loop). The designation of these routes as scenic byways acknowledges and provides for the continued protection of the spectacular scenic quality of the Project vicinity.

Apart from the reservoir, the Project's hydroelectric facilities are not visible from many locations within the Project vicinity. These facilities can be seen in the vicinity of the dam and the power plant and from the northernmost part of the reservoir by boat. The visual characteristics of these Project facilities are described below:

- *Boundary Dam* – The Boundary Dam is a double-curvature, thin-arch concrete dam. The grey, concrete dam, spillways, and sluice gates can be viewed from the Vista House Recreation Area and Tailrace Recreation Area. The crest of the dam is visible from the Forebay Recreation Area, as well as from the reservoir by boat. The dam is not visible from any major travel routes.
- *Underground Power Plant Entrance, Tailrace Maintenance Buildings, and Storage Yards* – The underground power plant is accessed through two large, grey portals at the Tailrace Recreation Area. Several Project maintenance buildings, storage yards, and access roads are also located in the vicinity of the Tailrace Recreation Area. The access portals, as well as the maintenance buildings/storage yards are visible from both the Tailrace Recreation Area and Vista House Recreation Area.
- *Project Transmission Lines* – Transmission lines run from the Project underground power plant to the BPA substation located just west of the Project area. The transmission lines exit the underground power plant through a series of six transformer bays located along the rock cliff to the west of the dam. The transmission lines run up the cliff to a set of metal support towers ("pickle forks"), across the access road to the Forebay Recreation Area, and uphill to the BPA substation near County Road 2975. The Project's transmission lines from the underground power plant to the BPA substation are approximately 0.5 mile long. The Project transmission lines and support towers are visible from the Vista House Recreation Area and Forebay Recreation Area, as well as from the public access road to the dam area. The transformer bays and transmission lines are visible from the Vista House Recreation Area and Tailrace Recreation Area.
- *Boundary Reservoir* – Formed by Boundary Dam, Boundary Reservoir extends approximately 17.5 miles upstream to the base of Box Canyon Dam. At normal maximum water surface elevation (1,994 feet NAVD 88), the reservoir has a total surface area of approximately 1,794 acres. The maximum reservoir drawdown allowed under the current license is 40 feet. The upper portion of the reservoir (from Box Canyon dam to the Highway 31 bridge at Metaline Falls) can be viewed from several locations along Highway 31 (North Pend Oreille Scenic Byway), which extends along the western shoreline of the reservoir to the Highway 31 bridge connecting Metaline and Metaline Falls. The lower part of the reservoir (from the Highway 31 bridge to Boundary Dam) is only visible from a few public viewpoints because of the steep topography along the reservoir shoreline and forested hilltops

between the reservoir and Highway 31 (to the east) and County Road 2975 (to the west).

From the reservoir surface and shoreline the upper part of the reservoir offers broad views of a primarily rural setting including homes and businesses in and around the towns of Metaline and Metaline Falls, remnants of old mining activities, and views of managed hillsides. The lower part of the reservoir provides a more pristine and natural landscape compared to the upper part, though evidence of past and current mining activity is visible from the reservoir at several locations. The scenic features of the lower reservoir are dominated by steep canyon walls with spectacular rock formations, several tributaries, waterfalls, and a distinctly semi-primitive setting. The lower part of the reservoir ends at the Boundary Dam forebay, a wider section of the reservoir that provides more expansive vistas of the surrounding mountains. Also visible from the forebay are the Project facilities, including the crest of the dam, transmission lines, and the Forebay Recreation Area. Peewee Falls, a 200-foot-high waterfall along the western shoreline of the reservoir, can also be viewed by boat from the forebay.

Public use on the Pend Oreille River downstream of Boundary Dam is prohibited. As such, there are very few public viewing opportunities for this portion of the river. Visitors can view a portion of this river reach from the Tailrace Recreation Area and the Vista House Recreation Area.

SCL operates three recreation sites in the Project vicinity: (1) Forebay Recreation Area; (2) Tailrace Recreation Area; and (3) Vista House Recreation Area. Project hydroelectric facilities, aside from the reservoir, are only visible from these three SCL-managed sites.

4.5.7.2. Environmental Analysis

This section describes the effects of the current Project and its operations on aesthetic/visual resources in the Project area. This effects analysis is based primarily on the results of the Aesthetics/Visual Resource Study (SCL 2009f)[14], as well as applicable results from the Recreation Resource Study (SCL 2009a). Identified effects are organized in two broad categories, as discussed below.

4.5.7.2.1. Effects of Project Facilities on Aesthetic/Visual Resources

The existing Project facilities consist of the dam and power plant structures, the adjacent operations and maintenance area, electric transmission lines (between the power plant and BPA substation), roadways, and recreational sites maintained by SCL. These facilities are concentrated in the immediate vicinity of Boundary Dam and, because of the mountainous terrain, are visible from a very limited geographic area. The primary publicly-accessible areas from which Project facilities are visible include the Forebay area of the reservoir, SCL-operated recreation facilities (Vista House Recreation Area, Tailrace Recreation Area, and Forebay Recreation Area), dispersed use areas along the eastern shoreline of the reservoir (in the vicinity of the forebay), and the SCL west-side access road to Boundary Dam.

[14] This report was revised, per FERC's July 6, 2009 Determination on Requests for Modifications to the Boundary Hydroelectric Project Study Plan and filed with FERC on September 30, 2009.

Project facilities are not visible from major land-based travel routes, specifically Highway 31 or County Road 2975. However, Project facilities can be viewed from limited locations along FR 3165, primarily at the western end of the road near the Vista House Recreation Area. Project facilities create substantial visual contrast with the surrounding landscape when viewed in the foreground (within approximately 0.5 mile). The appearance of the facilities reflects a form and texture that are noticeably different from adjacent forested slopes or exposed rock faces, and are readily identifiable as constructed features. The facilities introduce a variety of geometric shapes that are distinct from lines evident in the natural landscape. Project roads and some of the structural components are light in color and stand out from the background. The visual contrast created by the Project facilities is especially noticeable from the Vista House and Tailrace Recreation Area, where close-in views are oriented directly to features such as the face of the dam and spillways, and the transmission lines from the power plant ascending the adjacent rock wall.

Although Project facilities visually contrast with the surrounding landscape, visitors tend to have positive opinions of the aesthetic quality of these facilities. Results from the Recreation Resource Study indicate that:

- Nearly 60 percent of the respondents to the 2007 visitor survey reported seeing structures associated with the Project while recreating in the Project vicinity.
- A majority (53 percent) of the respondents indicated these views *enhanced* their enjoyment of the scenery, while 40 percent reported the views of Project facilities had *no effect* on their enjoyment of the scenery.
- Less than 8 percent of the sample population indicated that views of Project structures detracted in a minor or major way from their enjoyment of the scenery.
- Approximately 50 percent of all respondents rated the overall quality of the scenery in the Boundary Reservoir area as "excellent," while only 3 percent rated the scenery as "average" or below average.

These survey responses strongly indicate that very few visitors who view the existing Project facilities react adversely to those views. In addition, visitors generally assigned overwhelmingly positive ratings to the existing scenic quality of the Project area, even though a large majority of them experienced views of Project facilities. A likely factor for this positive viewer reaction is that almost all visitors who see the Project facilities are at an SCL-managed recreation site (all of which are located adjacent to Project hydroelectric facilities) and must know in advance they are going to a hydropower project. Based on the survey responses and consideration of the viewer context, the existing Project facilities are not considered to have an adverse effect on aesthetic/visual resources in the Project area.

4.5.7.2.2. Effects of Project Operations on Aesthetic/Visual Resources

The reservoir is a Project feature and is visible from an extensive area surrounding the Project that includes major land-based travel routes (primarily Highway 31), the towns of Metaline and Metaline Falls, private developments along the reservoir, shoreline developed recreation sites, and shoreline undeveloped dispersed use areas. The visual aspect of Project operations is based

on the extent, or absence, of reservoir level fluctuation (in response to generation levels) and the corresponding change evident along the reservoir shoreline.

Reservoir pool level fluctuations are primarily limited by the normal operating range of the reservoir, which SCL voluntarily restricts to 10 feet in the summer during daylight hours (1,984 - 1,994 feet NAVD 88, 6:00 am - 8:00 pm from Memorial Day weekend through Labor Day weekend) when most people visit the Project. Additionally, the steep topography along much of the reservoir limits potential views of reservoir fluctuations. Recent historical hydrologic data indicate that the typical daily summer fluctuation is 7 feet at the Forebay, and only 3 to 4 feet in the upper reservoir above Metaline Falls (Aesthetics/Visual Resource Study, as revised per July 6, 2009 FERC determination, SCL 2009f). The visual condition of the shoreline when the reservoir is at the low end of this normal range does not include exposure of extensive areas of the reservoir substrate (i.e., there is no prominent "bathtub ring"). Consequently, the visual contrast under this condition is minimal, and is unlikely to be detected by many viewers or prompt them to react adversely (i.e., reservoir fluctuations due to Project operations are not considered to have an adverse effect on aesthetic/visual resources in the Project area). Because SCL proposes to continue to operate the Project as it is currently licensed, with the added formalization of summer water surface elevation restrictions for recreation, potential adverse effects on aesthetic/visual resources from Project operations are not anticipated during the new license term.

In response to FERC's Determination on Requests for Modifications to the Boundary Hydroelectric Project Study Plan (letter dated July 6, 2009), SCL took additional photographs and conducted a supplemental evaluation of reservoir shoreline exposure in the lower reservoir at water surface elevations near the lower end of the normal summer operating range; the complete evaluation is included in an amended version of the Aesthetic/Visual Resources Study Final Report (SCL 2009f). The new photographs were taken in August 2009 when water surface elevations were between approximately 1,985 and 1,986 feet NAVD 88, or approximately 1 to 2 feet above the normal summer daytime minimum water surface elevation. Conclusions from review of these supplemental photos of Key Observation Points (KOPs) 1, 3, 4, 9, 10, and 11, plus two high elevation viewpoints east of the reservoir (as requested by FERC), are summarized as follows:

- For the six KOPs evaluated in the original Aesthetic/Visual Resources Study, exposure of reservoir shoreline areas at water surface elevations near the summer minimum elevation introduces some degree of color and/or texture contrast between the water and upland areas. Where this occurs, the contrast is in the form of a thin band that is evident but not prominent, because it occupies a small segment of the vertical field of view. In some locations, the exposed shoreline area is a band or line of light color between dark vegetation and water. In other locations, the exposed area is vegetated and appears as a transitional upland zone, whereas in some locations the exposed reservoir substrate blends in color and texture with the bank areas above the full-pool level. Because the contrast created by the shoreline exposure is not distinct or prominent, it would not result in changes to the overall scenic integrity ratings for any of these six KOPs. Scenic integrity for KOPs 10 and 11, for example, was rated as High in both the original evaluation and for the supplemental views at low water surface elevations.

- The two additional high elevation viewpoints are located east of the reservoir at points several hundred feet above the water surface. One of these viewpoints offers a foreground view of a steep, rock-walled section of the Canyon Reach and a distant view to the south along the canyon. The other offers a view southwest across the reservoir to Peewee Falls, and to the west and northwest in the direction of the Project facilities. Review of the supplemental photos from these locations indicates that the color and/or texture contrast introduced by shoreline exposure at low water surface elevations is evident only in close telephoto images and not to the unaided eye or in a photo taken at a normal focal length. Reservoir fluctuations have no or negligible effects on viewing conditions from these locations.
- Based on the pool elevations associated with the typical daily and weekly operating patterns for the Project, water surface elevations near the lower end of the normal summer range are most likely to occur late in the day (typically, during the early evening) and on weekdays. Consequently, as indicated in the supplemental photographs, at these times the ambient light is relatively low, shadows are typically present, and the contrast created by the exposed shoreline area is less distinct than it might otherwise be. In addition, the times of greatest shoreline exposure tend to coincide with periods of lower recreational visitor activity; recreational activity is generally much less in the early evening than during the early afternoon, and is lower on weekdays than on weekends.

In summary, the supplemental evaluation confirms the original conclusion that fluctuations in reservoir water surface elevation due to normal Project operations are not considered to have a measurable adverse effect on aesthetic/visual resources in the Project area or on the viewers of those resources.

Under some circumstances, there can be visual evidence of shoreline erosion, dispersed recreation sites, Project road cuts, and/or invasive weeds. Major CIP and O&M projects occasionally may result in short-term effects on aesthetic/visual resources. For example, work planned on the sluice maintenance gate would necessitate a temporary structure at the boat ramp in the Forebay Recreation Area, possibly early in the new license period and approximately every 10 years thereafter, as needed. This area will be accommodated in the redesign of the Forebay Recreation Area and, although some of the work would need to be conducted in the summer, much of it would occur under cover and during the fall and winter. To date, these potential indirect effects have not been identified as notable concerns at the Project.

4.5.7.3. Proposed Environmental Measures

No specific aesthetic/visual resource measures are proposed. However, general aesthetic/visual resource management guidelines for future Project recreation facilities, such as facility colors and surrounding vegetation, will be included in the proposed RRMP (see Section 4.5.9.3). Such guidelines would ensure that new facilities blend into the surrounding natural environment.

4.5.7.4. Cumulative Effects Analysis

In its SD2, FERC did not identify aesthetic and visual resources as a resource area of concern with regard to cumulative effects associated with the Project (FERC 2006). The Project would not contribute to cumulative effects associated with aesthetic and visual resources.

4.5.7.5. Unavoidable Adverse Impacts

No unavoidable adverse impacts to aesthetic and visual resources resulting from the continued presence and operation of the Project have been identified.

4.5.7.6. Consistency with Comprehensive Plans.

The aesthetics and visual resource related management goals and policies associated with comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The Forest Plan has an overall management goal of providing CNF visitors with visually acceptable scenery, consistent with management use and public demand. The plan includes 13 management areas for visual resource management purposes. NFS lands at the Project and vicinity generally fall within the following management areas:

- Recreation Management Area – this area provides roaded and unroaded recreation opportunities in a natural appearing foreground, middleground, and background. In the Project vicinity, this management area generally includes the FR 3165 corridor between Highway 31 and the Vista House Recreation Area.
- Scenic/Timber Management Area – this area provides a natural appearing foreground, middleground, and background along major scenic routes while providing wood products. In the Project vicinity, this management area includes NFS lands to the west of the Pend Oreille River below Boundary Dam.
- Scenic/Winter Range – this area provides a natural appearing foreground, middleground, and background along major scenic routes while providing for winter range management. In the Project vicinity, this management area includes most NFS lands along the eastern and some lands along the western Boundary Reservoir shoreline.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

There is no specific visual resource management direction assigned to those BLM-managed lands at the Project.

4.5.8. Cultural Resources

4.5.8.1. Affected Environment

Section 106 of the NHPA requires federal agencies having licensing authority for any undertaking to take into account the effect of the undertaking on historic properties. Because FERC is a federal agency, the relicensing of the Project is considered an undertaking under the NHPA, and its implementing regulations are applicable. Historic properties include prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the NRHP. Traditional cultural properties (TCPs) can also be historic properties. TCPs are associated with the cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

SCL conducted a Cultural Resources Study (SCL 2009a) in consultation with the State Historic Preservation Officer (SHPO) of the Washington Department of Archaeology and Historic Preservation (WDAHP), Indian tribes, and federal agencies. Consultation included the following agencies and tribes: the USFS, BLM, the Kalispel Tribe, the Confederated Tribes of the Colville Reservation, the Kootenai Tribe of Idaho, the Spokane Tribe of Indians, the Coeur d'Alene Indian Tribe, the Confederated Salish and Kootenai Tribe, and the WDAHP.

The Cultural Resources Study documented historic properties within the Project's APE, attempted to identify potential TCPs within the Project APE through consultation, evaluated the NRHP eligibility of historic properties within the APE, and assessed the potential effects of any Project-related impacts. SCL established a Cultural Resources Workgroup (CRWG), consisting of tribal, federal agency, and state agency representatives. For the purposes of the relicensing analysis, SCL and the CRWG defined the Project APE as[15]:

- *Downstream of Metaline Falls* – The reservoir and the land within the FERC Project boundary, which includes most Project facilities, the land 200 horizontal feet inland of the high water elevation (1,994 feet NAVD 88) along both shorelines, and the transmission line ROW from the power plant to the BPA .
- *Upstream of Metaline Falls* – The reservoir and the land within the FERC Project boundary, plus the land within 25 horizontal feet inland of the high water elevation along both shorelines (approximately 2,020 feet NAVD 88), extending south to the FERC project boundary for the Box Canyon Project.
- The APE included the SCL-owned BWP (149 acres) and adjoining SCL-owned property (89 acres) (BWP Addition). It also includes major Project related roads.
- All SCL-owned lands outside the FERC Project boundary, in the Pend Oreille valley between Box Canyon Dam and the international border, including lands where there are Project-related structures or activities, such as maintenance and equipment staging locations.

[15] Full definition of the APE is presented in the PAD (SCL 2006).

- In addition, definition of the APE would be adjusted to include any areas where other resource studies (e.g., erosion, dispersed recreation) identify a Project effect in an area not within the original APE.

For ease of general location reference, portions of the Project APE are referred to as the Upper Reservoir Reach, the Lower Reservoir Reach, and the Tailrace Reach as defined below:

- *Upper Reservoir Reach* – includes the area from the south end of the Project APE below Box Canyon Dam to Metaline Falls.
- *Lower Reservoir Reach* – includes the area from Metaline Falls downstream to Boundary Dam. As such, the Lower Reservoir Reach includes the narrow, incised canyon portion of the river.
- *Tailrace Reach* – includes the SCL-owned land from Boundary Dam north to the extent of SCL-owned land at the U.S.-Canada border.

The Cultural Resources Study developed information used to develop a HPMP for the Project. The HPMP includes recommended PM&E measures for the management of historic properties under the new Project license (Attachment E-10).

4.5.8.1.1. Cultural Resources Context

Background information for the prehistoric/ethnographic and historic periods is presented in the PAD (SCL 2006) and RSP (SCL 2007). In addition, information about previous cultural resource studies in the vicinity of the Project is summarized in these documents, and the Cultural Resources Study Final Report (SCL 2009a). Archaeological investigations conducted prior to development of the Project did not identify any prehistoric archaeological resources that would be affected by the Project. There is minimal evidence for extensive historic era activity in the Pend Oreille valley prior to the second half of the nineteenth century, when mining, homesteading, and logging stimulated local development.

4.5.8.1.2. Archaeological Expectations

The physical geography of the Project produces two distinct zones for cultural resources investigations. Upstream of Metaline Falls, the river approximates its pre-development configuration. The river gradient is moderate, and alluvial fans and terraces are evident. Below the falls, the pre-development river was incised into a deep, steep-sided gorge. There, the original riverside environments are now deeply submerged by as much as 270 feet of water.

A predictive model was developed using empirical environmental data to better explain the distribution of prehistoric archaeological sites in the Project. This predictive model was supplemented with additional information from previous archaeological investigations in the Pend Oreille valley (south of the Project) and with locational information derived from ethnohistorical literature. The model provided a set of GIS-based maps describing zones as having high, moderate, or low potential to contain prehistoric archaeological sites. The underlying assumption in developing the model was that most prehistoric archaeological

occurrences would be associated with sets of environmental and cultural variables. The model was developed in consultation with the CRWG.

Archaeological sensitivity mapping for prehistoric sites suggests that the Project APE downstream from Metaline Falls to the dam, the Lower Reservoir Reach, has a relatively low potential to contain cultural resource sites; however, the part of the Project upstream of the falls, the Upper Reservoir Reach, had greater potential for prehistoric archaeology. Conversely, the Lower Reservoir Reach contains extensive mineral deposits that were mined historically and had greater potential for evidence of mining-related activities. Throughout the Project APE there was potential for logging-related features and isolated artifacts.

4.5.8.1.3. Identification of Historic Properties and Archaeological Sites

Under the NHPA and its implementing regulations, the term "historic properties" is applied to any prehistoric or historic district, site, building, structure, or object eligible for inclusion in the NRHP (36 CFR Part 800.16 [1]), and may include archaeological sites, historic buildings and structures, and TCPs. As noted above, TCPs are eligible for inclusion in the NRHP based on their "association with cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community."

For the purpose of classifying cultural resources, the Cultural Resources Study used current WDAHP definitions for isolates and archaeological site types. Archaeological sites were defined as at least two artifacts within an area 50 feet in diameter or one or more archaeological features in spatial association with any number of artifacts. Isolated finds were defined as less than two artifacts within an area 50 feet in diameter. Collapsed historic-era structures were recorded as archaeological sites on Washington Archaeological Site Inventory forms.

4.5.8.1.4. Identified Prehistoric and Historic Archaeological Sites

The Cultural Resources Study documented 25 archaeological sites within the Project APE. Two of the sites date to the prehistoric period and the remaining 23 sites are from the historic era that relate to mining, homesteading, logging, or hydroelectric development activities. Summary information for all archaeological sites inventoried within the Project APE is presented in Table E.4-44. Detailed site descriptions are provided in the Cultural Resources Study Final Report (SCL 2009a). Washington Archaeological Site Inventory forms were prepared for all newly recorded sites, and forms for the three previously recorded sites were updated. These confidential forms were shared with the CRWG and filed with the WDAHP.

Table E.4-44. Archaeological and historic sites identified within the Project APE.

Archaeological Site	DAHP Site Type	NRHP Eligible?
45PO520 - Josephine Mine	Historic Mining Property	Yes – NRHP District
45PO573– Chickahominey Prospects	Historic Mining Property	No, but within NRHP District
45PO575 – Flume Creek Aqueduct	Historic Mining Property	Yes, part of NRHP District
45PO576 – Robert E. Lee Lode	Historic Mining Property	no
45PO577 – POMMC Powerhouse Dump	Historic Debris Scatter	No, but within NRHP District
45PO578 – Riverside Mine	Historic Mining Property	no
45PO579 – Raise 3	Historic Mining Property	no
45PO580 – Flusey Lode	Historic Mining Property	no
45PO581	Pre-Contact Feature	no
45PO582 – Metaline Mine/Hercules Adit	Historic Mining Property	no
45PO583	Pre-Contact Feature	no
45PO584 – Harvey Homestead	Historic Homestead	Yes
45PO585	Historic Homestead	no
45PO586	Historic Homestead	no
45PO587	Historic Structure Unknown	no
45PO588	Historic Mining Property	no
45PO589 – Z Canyon Footbridge	Historic Transportation	no
45PO590	Historic Mining Property	no
45PO592	Historic Mining Property	no
45PO593	Historic Transportation	no
45PO594	Historic Mining Property	no
45PO597	Historic Mining Property	no
45PO598	Historic Mining Property	no
45PO599	Historic Mining Property	no
45PO600	Historic Mining Property	no
Historic Site	**DAHP Site Type**	**NRHP Eligible?**
Pend Oreille Mines and Metals Company Powerhouse	Energy Facility	Yes, part of NRHP District
Miner's Cabin (Ross Cabin)	Domestic – Single family house	no

4.5.8.1.5. Archaeological Resources Condition

Recordation of the newly identified archaeological sites in the Project APE provides a baseline for future assessment of their condition. Natural erosion and weathering are the principal influences on all sites' present condition. Inventory observations taken during the Cultural Resources Study provide a baseline assessment of site condition to be applied throughout the new license period.

4.5.8.1.6. Historic Resources Inventory

The Cultural Resources Study inventoried the Pend Oreille Mines and Metals Company (POMMC) Powerhouse and the Ross Cabin, both of which are more than 50 years old and located within the Project APE. Structures and buildings were examined, photographed, and recorded according to published WDAHP guidelines for inventory and documentation.

4.5.8.1.7. Traditional Cultural Properties (TCPs)

There are no TCPs documented or otherwise known to be present within the Project vicinity. SCL consulted with affected tribes and other cultural groups to identify and evaluate information necessary to determine whether any TCPs were present near or within the Project APE. The Kalispel Tribe's representative on the CRWG reviewed all available information on the Project area and determined that the Project area does not have any identifiable and active TCPs (A letter from Kevin Lyons, Cultural Resources Program Manager, Kalispel Tribe of Indians, dated January 22, 2009 is included in Appendix 2 of the HPMP, Attachment E-10).

4.5.8.1.8. Affected Historic Properties

All archaeological sites and historic structures identified within the Project APE were evaluated for eligibility for inclusion in the NRHP. Determinations of Eligibility (DOE) forms were prepared for all sites in consultation with the CRWG. Most of the historic archaeological sites are deteriorated mining features lacking potential to contribute new information relevant to mining in the late 1800s and early 1900s. Both prehistoric archaeological sites lacked depositional integrity. WDAHP has concurred that the following historic properties are NRHP-eligible:

- The Josephine Mine Historic District (45PO520), which includes the Flume Creek Aqueduct (45PO575) and the Chickahominey Prospects (45PO573),
- The POMMC Powerhouse District (includes a non–contributing element, archaeological site 45PO577, which is the power plant dump), and
- The Carl Harvey Homestead (45PO584).

4.5.8.2. Environmental Analysis

The Project has limited effect on historic properties, as there are only three NRHP-eligible sites within the Project APE. The Josephine Mine Historic District is minimally affected by Project operations; the POMMC Powerhouse is partially inundated by Boundary Reservoir; and the Harvey Homestead may be impacted by some Project-related dispersed recreation. Because proposed operations are the same as those associated with the existing effects on the NRHP-eligible sites, it is anticipated that the Project would continue to have similar impacts on these sites throughout the term of the new license.

Portions of the Josephine Mine Historic District (45PO520) are within the inundation zone of the Project. Most of the district is outside the Project APE on BLM lands. Historic–era archaeological materials associated with the Josephine Mine and the Chickahominey Prospects (45PO573) are periodically submerged by Project operations; however, adverse effects to the district as a consequence of Project operations appear to be negligible, as there is minimal

evidence of adverse effects to the archaeological deposits (e.g., erosion). The Flume Creek Aqueduct is within the Project APE; however, it is suspended high above the river and is not affected by Project operations and will not be affected by proposed operations.

The non-functioning POMMC Powerhouse is partially submerged by the Project reservoir; the powerhouse is not completely visible at normal maximum water surface elevation. Proposed operations would continue to partially submerge the powerhouse. Available information indicates that the powerhouse contents (i.e., the power-generating machinery and associated equipment) were removed many years ago. Inundation may contribute to accelerated deterioration of the powerhouse building. Inundation partially obscures the powerhouse from view, restricting public access to the structure and limiting interpretive possibilities. There is no safe public access to the site. The archaeological site within the district, 45PO577 (the associated power plant dump), is not affected by Project operations as it is not within the inundation zone. Moreover, the archaeological component is not a contributing element to the NRHP-eligibility of the district.

The Carl Harvey Homestead Site (45PO584) is not affected by Project operations; however, recreation data indicate that the site is used periodically for dispersed recreation (i.e., camping), which may be partially attributed to access from the reservoir. The intensity of recreational use here was classified as low to moderate. There are some indications that campers have had an adverse effect on the cabin at the site by removing some of its contents. There are no indications of unauthorized archaeological excavations at 45PO584.

4.5.8.3. Proposed Environmental Measures

Three NRHP-eligible properties have been identified within the Project APE. Historic property treatment at all three sites, as presented in the attached HPMP (Attachment E-10), will include ongoing monitoring and development of materials to support public interpretation. Information generated for development of interpretive displays will preserve information about each of these sites. Public education and interpretation materials related to cultural resources will be developed in coordination with the CRWG.

The Josephine Mine Historic Mining District was recommended NRHP-eligible under all four eligibility criteria. Although most of the site lies outside of the Project APE on BLM lands, minor physical impacts have occurred due to inundation, and proposed Project operation may continue to have minor impacts due to inundation. SCL proposes to develop interpretive materials about the Josephine Mine and early mining in the Project area in collaboration with the BLM and CRWG. The resulting text and graphics from that effort would be used for the heritage display to be installed at the Boundary Project Visitor Center (Vista House), the Cutter Theatre in the Town of Metaline Falls, or another appropriate venue(s) identified in coordination with the CRWG.

The POMMC Powerhouse and associated contributing historic archaeological elements were determined NRHP-eligible as a district under Criterion A and under Criterion C. The archaeological elements have been disturbed and several structures associated with the powerhouse have been removed. SCL proposes to develop interpretive materials about the powerhouse, its architect, and the historical development of hydroelectric power in the Pend

Oreille Valley. These would be installed at the Vista House or other appropriate venue. Currently, the powerhouse itself is not amenable to on-site interpretation due to safety concerns. If this site is developed for recreational purposes (Metaline Falls portage trail), the opportunity for onsite I&E will be explored with the CRWG.

In addition, detailed architectural documentation will be accomplished at the POMMC Powerhouse. SCL will document the POMMC Powerhouse to appropriate Historic American Buildings Survey (HABS) / Historic American Engineering Record (HAER) standards in consultation with WDAHP staff and in accordance with WDAHP mitigation and documentation standards.

The Carl Harvey Homestead archaeological site, which is mostly on USFS land, has been determined NRHP-eligible based on its association with an early pioneer (Criterion B) and its potential to yield important archaeological information (Criterion D). In collaboration with the USFS and CRWG, SCL proposes to develop interpretive materials about the Harvey Homestead and early pioneering in the Project area. Text and graphics will be developed and located at an appropriate site in consultation with the CRWG.

The HPMP will facilitate protection of historic properties within the Project APE during the term of the new license. The purpose of the HPMP is to provide guidance for managing historic properties affected by the operation and maintenance of the Project and to provide compliance with the NHPA. The HPMP includes protocols for achieving compliance through protection of historic properties and consultation with the SHPO, federal land management agencies, and the Kalispel Tribe. The HPMP will be implemented in consultation with the CRWG, which will include representatives of FERC, WDAHP, the Kalispel Tribe, BLM, and the USFS.

The HPMP identifies preservation and mitigation measures for the three historic properties affected by the Project. Treatment options include monitoring, development of interpretive materials, and detailed documentation of historic structures.

The HPMP also provides for a monitoring protocol that includes the three sites that have been determined to be NRHP-eligible, as well as the locations of two prehistoric archaeological sites, 45PO581 and 45PO583. Archaeological monitoring in the Project area will begin the first year of the new license term and will be conducted every five years thereafter. Monitoring also may occur following extreme high-water events if erosion is known to occur in the vicinity of these sites. If the opportunity arises, selected inundated lands downstream of Metaline Falls will be monitored during a scheduled low water surface elevation event (below 1,974 feet NAVD 88). Within one year following issuance of the new license, SCL, in consultation with the CRWG, will develop a prioritized list of inundated places to be monitored by boat during such an event, based on the archaeological predictive model data.

4.5.8.4. Cumulative Effects Analysis

In its SD2, FERC did not identify cultural resources as a resource area of concern with regard to cumulative effects associated with the Project (FERC 2006). The limited Project effects discussed above are not expected to contribute to cumulative impacts on cultural resources.

4.5.8.5. Unavoidable Adverse Impacts

Direct effects on NRHP-eligible archaeological sites have been minimal: there is some indication of inundation effects at the Josephine Mine Historic District; however, most of the site is not within the inundation zone. There are potentially Project-related recreation impacts at the Carl Harvey Homestead site. The proposed "Shoreline Dispersed Recreation Management Program" and associated interpretive materials described in the draft RRMP (Section 4.5.9.3) will help manage potential recreation-related impacts to the Carl Harvey Homestead site.

The Project has a significant long-term effect on the POMMC Powerhouse in that the structure is partially inundated by the reservoir. The historic archaeological site at the POMMC Powerhouse, archaeological site 45PO577, is not affected by Project operations.

The overall conditions of NRHP-eligible archaeological sites within the Project APE (sites 45PO520, 45PO573, 45PO575, 45PO584) are fair to good, and Project operations as proposed for the new license term are not anticipated to increase existing minor effects. The same is true for the POMMC Powerhouse, which has been partially inundated by the Project, i.e. Project operations as proposed for the new license term are not expected to increase the site-specific effects on the powerhouse.

4.5.8.6. Consistency with Comprehensive Plans

The cultural resource related management goals and policies associated with comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

The CNF land resource and management plan provides guidance for the management of cultural resources. Additionally, the CNF has developed a plan for cultural resources inventories within the Forest, which complies with the 1997 Programmatic Agreement among the USFS, Advisory Council on Historic Preservation (ACHP), and the SHPO.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

The BLM cultural resources program is managed according to the standards described in 36 CFR 800.

4.5.9. Recreation and Land Use

4.5.9.1. Affected Environment

The Affected Environment for recreation resources and land use includes the Project and its vicinity. As used in this Recreation and Land Use section, the Project vicinity encompasses the

entire area within the FERC Project boundary—which includes all Project structures, the reservoir, and the transmission line ROW from the underground power plant to the BPA substation—as well as the following:

- The Pend Oreille River from the Box Canyon tailrace downstream to the U.S.-Canada border (the border is approximately 0.9 mile downstream of Boundary Dam),
- The land within 0.25 mile on either side of the river downstream of Boundary Dam to the U.S.-Canada border,
- From Boundary Dam to Metaline Falls, the area between SR31 (on the east side of the reservoir) and County Road 2975 (on the west side of the reservoir),
- From Metaline Falls to the Box Canyon Dam tailrace, the area between Highway 31 (on the west side of the reservoir) and 0.25 mile east of the reservoir shoreline, and
- The SCL-owned BWP and adjoining 89-acre parcel.

The Affected Environment for the regional component includes a broader geographic area than that described above. This broader geographic area generally includes recreation opportunities within a five-county area spanning parts of Washington (Pend Oreille, Stevens, and Spokane counties) and Idaho (Bonner and Kootenai counties), as well as Canada (southern British Columbia generally within the International Selkirk Loop corridor).

The Affected Environment, including the 17.5-mile-long, approximately 1,794-acre Boundary Reservoir, offers many recreational opportunities including boating, waterskiing, fishing, swimming, sightseeing, picnicking, wildlife viewing, and camping, among other activities. There are also several developed recreation sites, some of which are within the existing FERC Project boundary. The SCL-managed Forebay, Tailrace, and Vista House recreation areas, as well as the BLM's dispersed Boundary Recreation Site are within the existing FERC Project boundary. Outside of the existing boundary, but within the Project vicinity (i.e., Affected Environment), there are several other developed recreation sites including the USFS's Crescent Lake Recreation Area, the Town of Metaline's Waterfront Park and boat launch, the Washington State Department of Transportation (WSDOT) Sweet Creek Falls Rest Stop, and Pend Oreille County PUD's Campbell Park boat launch. Additional information regarding developed recreation sites in the Project vicinity, including sites within the existing FERC Project boundary, is provided below and in the PAD (SCL 2006) and the Recreation Resource Study (SCL 2009a).

Land ownership patterns adjacent to Boundary Reservoir are a mixture of public and private ownership. North of Metaline Falls, the reservoir shoreline is a mixture of private and federal ownership, with a large portion of the eastern shoreline falling within the CNF, managed by the USFS. The BLM, Spokane District, manages a large area along the western shoreline. The portion of the reservoir shoreline south of Metaline Falls is predominantly in private ownership, with some NFS lands along the eastern shoreline. Because of the steeply sloping topography and large amount of public land in the Project vicinity, much of the land is undeveloped, with more than two-thirds of the area currently consisting of forested open space. Additional information regarding existing land use in the Project vicinity is described below, as well as the PAD (SCL 2006).

4.5.9.1.1. Recreation Resources

Existing Recreation Sites and Use Areas

Recreation Resources in the Project Vicinity

SCL developed and currently operates three recreation sites in conjunction with the Project:

- *Forebay Recreation Area* – Located on the western shoreline of Boundary Reservoir immediately upstream of the dam (Figure E.4-72), this site provides public day use, picnicking, boating, and camping opportunities, among others. Developed recreation facilities at this site as of 2008 include a two-lane concrete boat launch and boarding float, RV and tent campsites (11), picnic sites with tables (2), restroom building with flush toilets, gravel parking area (20 vehicle spaces), bear-proof trash receptacles, horseshoe pits, a viewpoint of Boundary Dam, and a historic miner's log cabin with an informational sign. This site is within the existing FERC Project boundary.
- *Tailrace Recreation Area* – Located immediately downstream of Boundary Dam on the western bank of the Pend Oreille River (Figure E.4-72), this site provides public day use opportunities including picnicking, sightseeing, and access to the power plant, among others. Visitors must pass through a staffed security checkpoint at the top of the access road to reach this site. Developed facilities at this site include picnic sites with covered tables (3), parking area (36 single-vehicle, 2 bus, and 6 vehicle-with-trailer spaces; available parking is shared by SCL employees and visitors), bear-proof trash receptacles, benches, and the entrance to the nearby Visitors' Gallery (inside the Machine Hall). The Visitor's Gallery consists of interpretive displays, a viewing area with views of the generator floor, and restrooms (2). There is also a gravel boat launch at this site; however, it is not used by the public given its proximity to the U.S.-Canada border (less than 1 mile) and the potential hazard associated with its location in the Project's tailrace. This site is within the existing FERC Project boundary.
- *Vista House Recreation Area* – Located immediately downstream of Boundary Dam on a promontory along the eastern bank of the Pend Oreille River (Figure E.4-72), this site was built in 1965 to provide views of construction of the dam. Accessed from a road intersecting Highway 31, the Vista House Recreation Area provides public day use opportunities including sightseeing, picnicking, and hiking, among others. Developed recreation facilities at this site include the Vista House observation and interpretive building, interpretive displays, a wooden viewing platform, gravel trail to the viewing platform, restrooms (2), bear-proof trash receptacle, a picnic table, and gravel parking area (50 vehicle spaces).

SCL is responsible for all operations and maintenance at these three recreation sites. During the primary recreation season (Memorial Day weekend through Labor Day weekend) these sites are open and maintained on a daily basis. During the shoulder seasons (April/May and September/October), these sites, if open (depending on staff availability), are maintained two to three times per week.

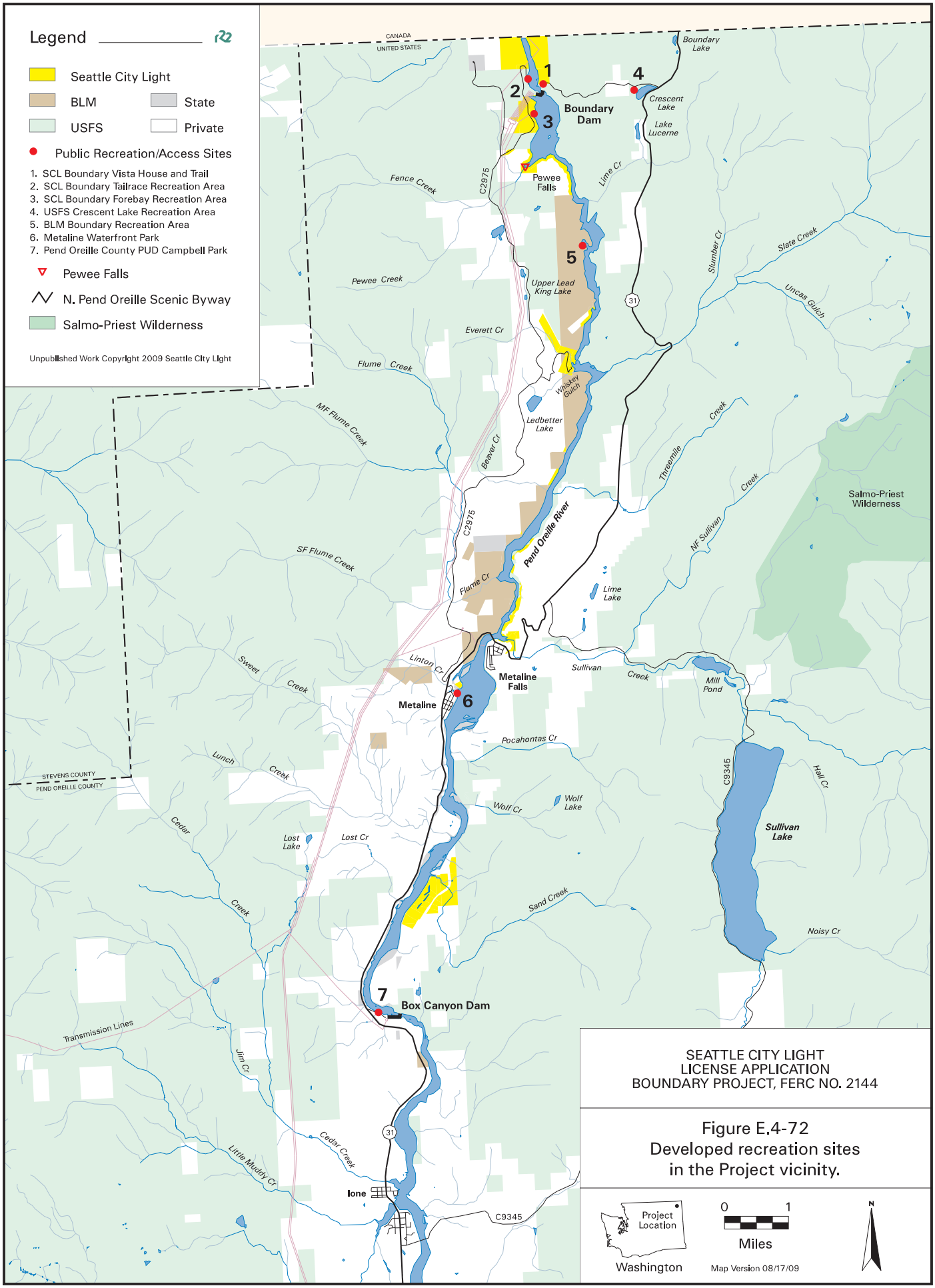

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Figure E.4-72
Developed recreation sites in the Project vicinity.

There are also several dispersed recreation sites and use areas along the Boundary Reservoir shoreline, some of which are on SCL-owned land. Six larger dispersed sites receiving overnight and day use are on BLM- and USFS-managed lands. Dispersed sites are characterized by the presence of user-created site features and/or site impacts (e.g., fire rings, bare ground, and user-made trails). Dispersed recreation sites on the Boundary Reservoir shoreline are primarily accessed by boat and are used for day use, as well as short-term camping.

In addition to the three developed recreation sites operated by SCL, there are several other recreation sites in the Project vicinity, operated by the Town of Metaline, Pend Oreille County PUD, USFS, and WSDOT, including:

- *Metaline Waterfront Park* – Managed by the Town of Metaline, this day use park is located along the western shoreline of Boundary Reservoir in Metaline (Figure E.4-72). The site provides day use opportunities including picnicking, boat launching, and shoreline fishing, among others. Developed recreation facilities include a one-lane gravel and concrete boat launch with a boarding float (the boarding float is maintained by SCL), covered and open picnic sites, playground area, gazebo, basketball court, stone fireplaces, trash receptacles, restroom with flush toilets, portable toilet, and several gravel parking areas. The existing FERC Project boundary meanders through the park at a lower elevation. SCL granted the Town of Metaline an easement for reservoir shoreline access for the boat launch at this site.
- *Pend Oreille County PUD Campbell Park* – Located immediately downstream of Box Canyon Dam (Figure E.4-72), this site is managed by Pend Oreille County PUD as a recreation condition of the Box Canyon Project (FERC No. 2042) license. The site is on the western shoreline of Boundary Reservoir and is accessed via Highway 31, approximately 4 miles north of the town of Ione. Developed recreation facilities at Campbell Park include a single-lane concrete and asphalt boat launch improved in 2008, RV and tent campsites (10), restrooms, a 2-acre swimming lagoon, visitor center with interpretive displays, and trash receptacles. This recreation site is not associated with the Project and is not within the existing FERC Project boundary.
- *USFS Crescent Lake Recreation Area* – The CNF manages this small recreation area off of Highway 31 along the road to the Vista House Recreation Area (Figure E.4-72). The site, while designed for day use, consists of three day use/camping sites, with picnic tables and fire pits with grills, a bear-proof trash receptacle, an information kiosk, and a single vault CXT-type restroom. This site is not within the Project boundary.
- *Sweet Creek Falls Rest Stop* – Managed by WSDOT, this highway rest area is located along Highway 31 (Figure E.4-72) and provides day use opportunities including picnicking and hiking. The site consists of a paved parking area, picnic sites, a short trail to the falls, restroom, and interpretive signs. This site is not within the Project boundary.

Regional Recreation Resources

In addition to the recreation facilities within the Project vicinity, many other regional recreation areas provide public facilities and opportunities. In particular, there are three trails included in the National Trails System (the Pacific Northwest National Scenic Trail [designated by Congress in 2009] that crosses Boundary Dam, Kettle Crest National Recreation Trail, and Lewis and Clark National Historic Trail), one federally-designated wilderness area (Salmo-Priest Wilderness Area), and a scenic byway (North Pend Oreille Scenic Byway/International Selkirk Loop). There are no federally-designated wild and scenic rivers in the Project region, although the Kettle River, which flows into the Pend Oreille River, is managed to retain its wild and scenic characteristics for potential future inclusion in the Wild and Scenic River System. Additionally, the Pend Oreille River is a Washington river of statewide significance under Chapter 173-18 of the WAC; however, the river has not been included to date in the State Scenic River System.

The primary regional recreation providers in the Project region include the USFS, BLM, USFWS, WDFW, Pend Oreille County, Pend Oreille County PUD, Kalispel Tribe, and Washington State Parks and Recreation Commission (WSPRC), among others. A description of the recreation sites and use areas provided by these regional recreation entities is presented in the PAD (SCL 2006) and the Recreation Resource Study Final Report (SCL 2009a).

Project-Related Recreation Use Estimate

Based on the results of the Recreation Resource Study, existing Project-related recreation use is estimated to account for approximately 15,000 visits per year or recreation days (RD). Table E.4-45 indicates the estimated annual Project-related use for each of the Project vicinity's developed recreation sites. Annual recreation use at SCL's three developed recreation sites accounts for approximately 11,100 visits. Of the SCL-managed recreation sites, the Forebay Recreation Area (campground and day use area combined) has the highest estimated annual use (6,500 RD).

Table E.4-45. Project-related recreation use.

Recreation Site/Use Area	Estimated Annual Use (Recreation Days)
Vista House Recreation Area (SCL)	2,200
Tailrace Recreation Area (SCL)	2,400
Forebay Recreation Area – Campground (SCL)	1,900
Forebay Recreation Area – Day Use Area (SCL)	4,600
BLM Boundary Recreation Site	100
Metaline Waterfront Park (Town of Metaline) – Reservoir-based Use Only	1,800
Box Canyon Boat Launch (Pend Oreille County PUD)	600
Reservoir Dispersed Campsites	400
Private Shoreline Use Areas	1,000
TOTAL	**15,000**

Boating-based use of the reservoir is estimated to account for approximately 381 boats and 1,215 RDs on an annual basis. Most of this use originates at one of the three developed boat launches on Boundary Reservoir (and thus is already included in the land-based use estimates provided in Table E.4-45).

4.5.9.1.2. Land Use

Shoreline and Adjoining Land Uses

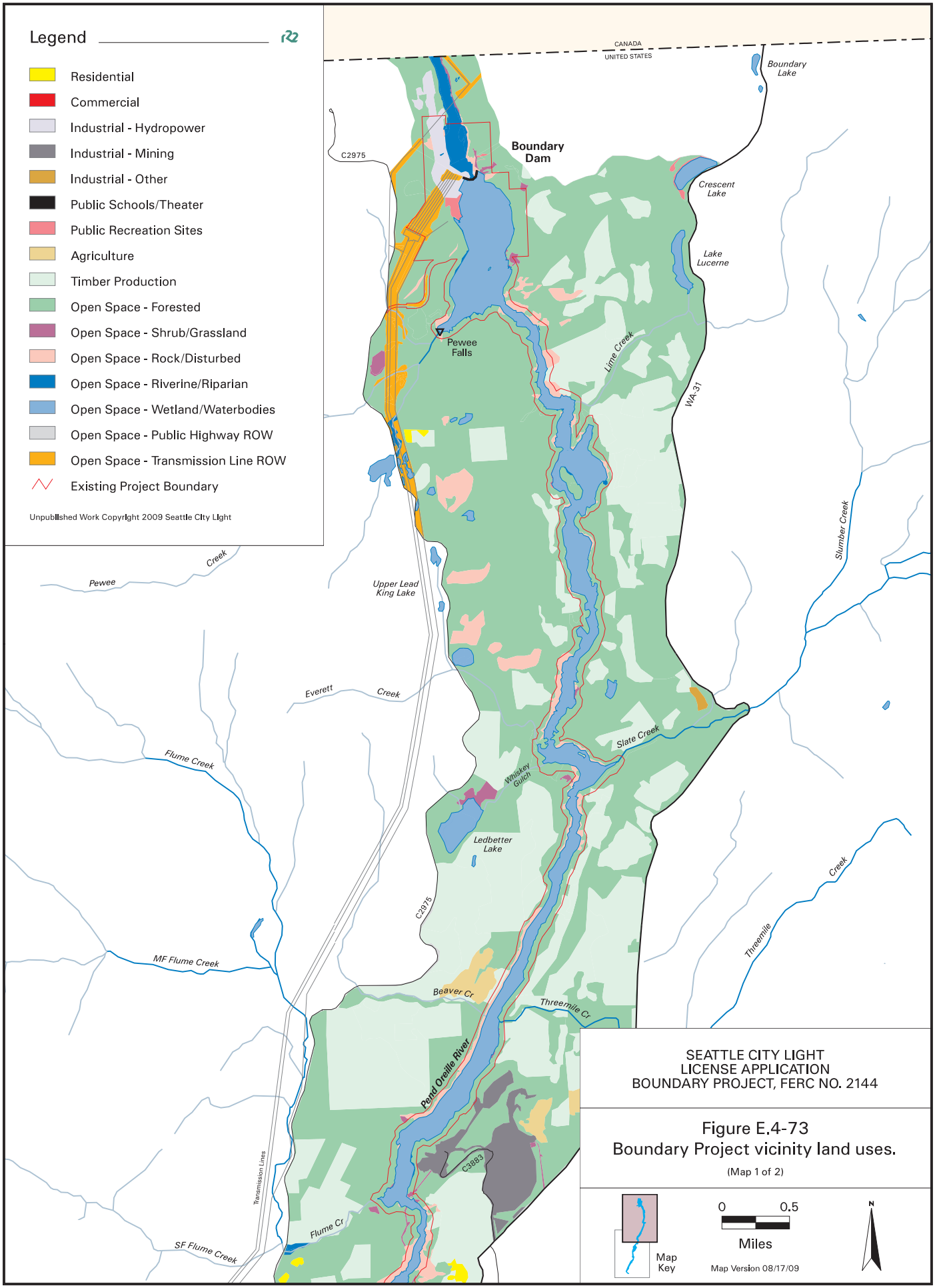
The current FERC Project boundary (also referred to as the Project area) surrounds Boundary Reservoir and most Project facilities and encircles the land and water area needed to effectively operate the Project (exceptions are the maintenance area north of the dam and the relocated portion of the West Side Access Road; however, these areas are being proposed for inclusion within the Project boundary for the term of a new license). North of Metaline Falls, the Project boundary is generally located 200 feet horizontally above the reservoir's normal high pool elevation (1,994 feet NAVD 88); south of Metaline Falls, the boundary is a surveyed line that generally approximates the pre-Project ordinary high water line. The Project boundary encompasses portions of NFS lands to the east of the reservoir, some BLM-managed lands west of the reservoir, some SCL-owned lands, lands within the jurisdictions of the State of Washington and the towns of Metaline and Metaline Falls, and private lands, which include rural residential uses. Much of the shoreline is undeveloped open space and has little or no development.

Much of the land within the Project vicinity (or Affected Environment, as defined above) is currently undeveloped, with more than two-thirds (67.6 percent) defined as open space of various types (Figure E.4-73). Open space adjoins both sides of the reservoir north and south of Metaline Falls. Of this open space, forested land accounts for more than 6,500 acres, or 48.9 percent. Wetlands and water bodies (14.5 percent) are the only other open space designations that make up more than 10 percent of the Project vicinity; Boundary Reservoir accounts for the majority of this designation (SCL 2006).

Developed land uses comprise 30.3 percent of the Project vicinity (Figure E.4-73). Lands currently used for timber production represent the largest developed land use category, with more than 3,200 acres (24.2 percent). Agricultural and mining activities account for the second- and third-largest developed land use categories, representing more than 232.6 acres (1.7 percent) and 216.5 acres (1.6 percent), respectively. Hydropower facilities account for 74 acres (0.5 percent), while transmission lines for those facilities cover 198.1 acres (1.5 percent) in the Project vicinity. Residential land uses cover 183 acres (1.4 percent), while commercial uses cover a total of only 16.5 acres (0.1 percent). The majority of residential uses and all of the commercial activities are focused in and around the towns of Metaline and Metaline Falls. An additional 41 acres (0.3 percent) in the Project vicinity are devoted to public recreation sites (SCL 2006).

Downstream of Boundary Dam, forested open space accounts for more than 56 percent of the portion of the Project vicinity from the dam to the U.S.-Canada border. Boundary Dam and its associated facilities account for the only other land uses in this portion of the Project vicinity,

with Project facilities and transmission lines covering 62.5 acres. There are no residential, commercial, or agricultural activities in this portion of the Project vicinity.


Legend
Residential
Commercial
Industrial - Hydropower
Industrial - Mining
Industrial - Other
Public Schools/Theater
Public Recreation Sites
Agriculture
Timber Production
Open Space - Forested
Open Space - Shrub/Grassland
Open Space - Rock/Disturbed
Open Space - Riverine/Riparian
Open Space - Wetland/Waterbodies
Open Space - Public Highway ROW
Open Space - Transmission Line ROW
Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
CANADA
UNITED STATES
Boundary Lake
Boundary Dam
C2975
Crescent Lake
Lake Lucerne
Pewee Falls
Lime Creek
WA-31
Slumber Creek
Pewee
Creek
Upper Lead King Lake
Everett
Creek
Flume Creek
Slate Creek
Whiskey Gulch
Ledbetter Lake
C2975
Threemile
Creek
MF Flume Creek
Beaver Cr
Threemile Cr
Pend Oreille River
C3883
Transmission Lines
Flume Cr
SF Flume Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-73
Boundary Project vicinity land uses.
(Map 1 of 2)
Map Key
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Miles
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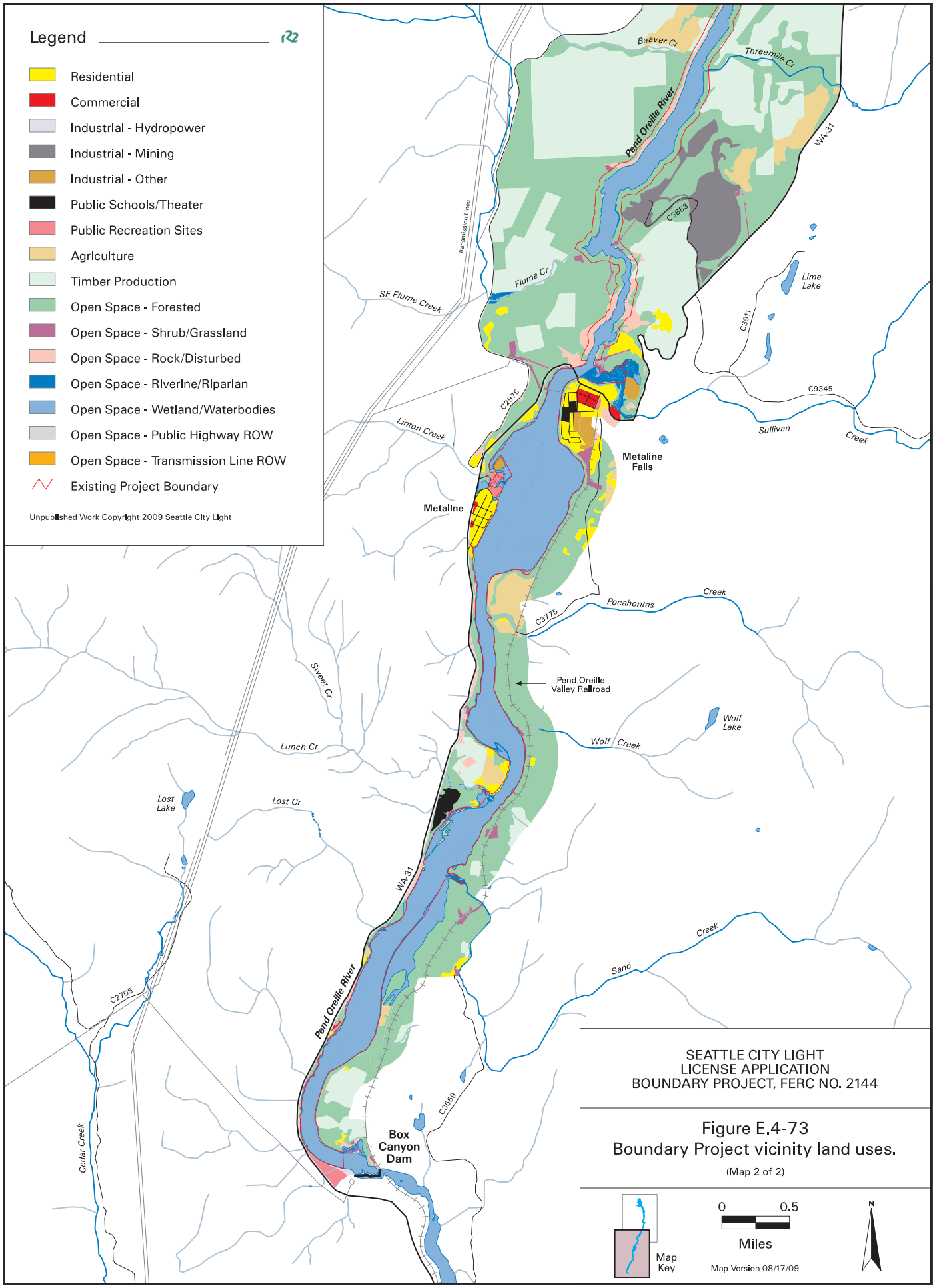
Legend
Residential
Commercial
Industrial - Hydropower
Industrial - Mining
Industrial - Other
Public Schools/Theater
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Open Space - Forested
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Existing Project Boundary
Unpublished Work Copyright 2009 Seattle City Light
Beaver Cr
Threemile Cr
Pend Oreille River
WA-31
C3883
Transmission Lines
Flume Cr
SF Flume Creek
Lime Lake
C3911
C9345
Sullivan
Creek
C2975
Linton Creek
Metaline Falls
Metaline
Pocahontas
Creek
C3775
Pend Oreille Valley Railroad
Sweet Cr
Wolf Lake
Wolf Creek
Lunch Cr
Lost Lake
Lost Cr
WA-31
Sand
Creek
C2705
Pend Oreille River
C3669
Box Canyon Dam
Cedar Creek
SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-73
Boundary Project vicinity land uses.
(Map 2 of 2)
Map Key
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Miles
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Land Ownership

Land ownership in the Project vicinity is characterized by approximately one-half public ownership and one-third private ownership, with the remainder classified in other categories (e.g., roads, railroads, shorelines) (Figure E.4-74). The federal government owns approximately 42 percent of the land in the Project vicinity. Management of this land is split between the USFS and BLM. The USFS manages a total of 4,360 acres (32.4 percent of the Project vicinity), located primarily on the eastern side of Boundary Reservoir. NFS lands are part of the CNF, which surrounds the reservoir. The BLM manages 1,310 acres (9.7 percent) in the Project vicinity, with most of the acreage located along the western shoreline of the reservoir and north of the town of Metaline. Other public land owners in the Project vicinity include SCL, the Pend Oreille County PUD, the State of Washington, Pend Oreille County, and the Selkirk School District.

Collectively, private parties own approximately 4,458 acres, or 33.1 percent of land in the Project vicinity (Figure E.4-74). These private lands include residences and businesses. An additional 118 acres of land within the Project vicinity is located within the incorporated towns of Metaline and Metaline Falls; the majority of this property is in private ownership. The remainder of land (2,290 acres) within the Project vicinity includes roads, railroad facilities, and other similar uses.

For a summary of land ownership within the Project boundary (current and proposed), see Exhibit A, Section 4 of this License Application.

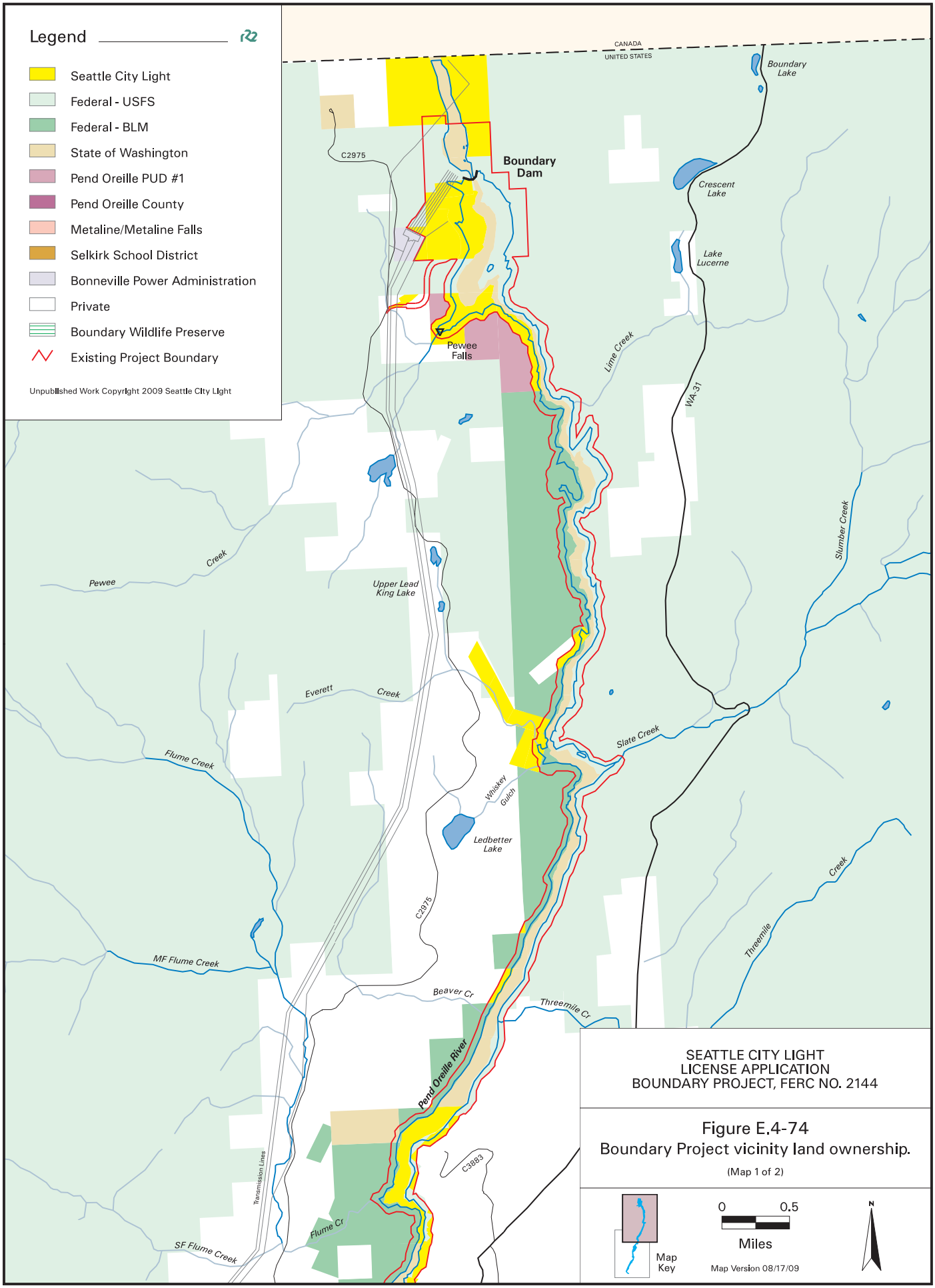

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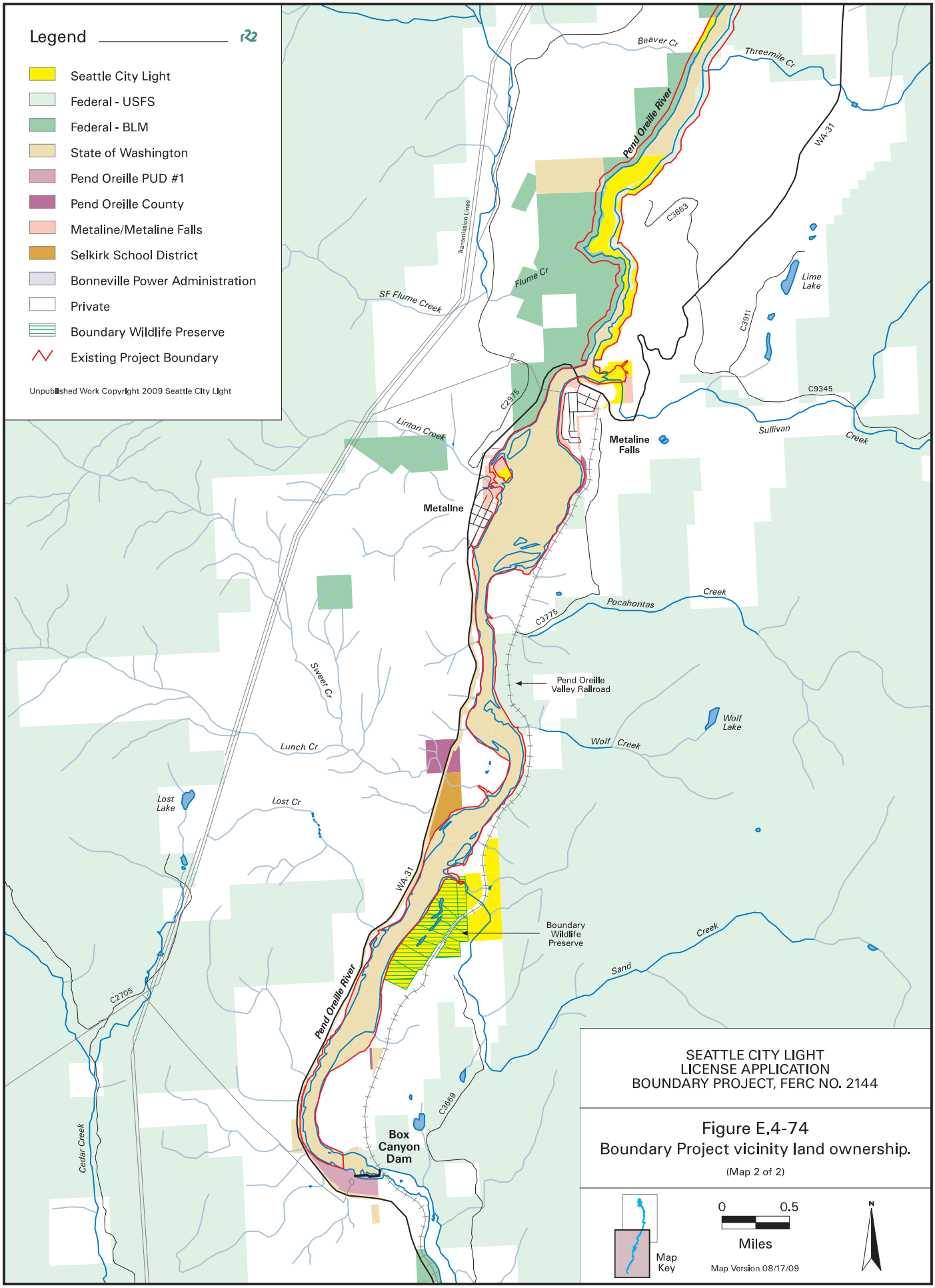
Figure E.4-74
Boundary Project vicinity land ownership.

(Map 1 of 2)


Legend
Seattle City Light
Federal - USFS
Federal - BLM
State of Washington
Pend Oreille PUD #1
Pend Oreille County
Metaline/Metaline Falls
Selkirk School District
Bonneville Power Administration
Private
Boundary Wildlife Preserve
Existing Project Boundary
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Pend Oreille Valley Railroad
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SEATTLE CITY LIGHT
LICENSE APPLICATION
BOUNDARY PROJECT, FERC NO. 2144
Figure E.4-74
Boundary Project vicinity land ownership.
(Map 2 of 2)
Map Key
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Miles
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Land Management within and Adjacent to the Project Boundary

Land management within and adjacent to the Project boundary is under the jurisdiction of a number of entities, including Pend Oreille County, USFS, BLM, and the towns of Metaline and Metaline Falls. Of these groups, Pend Oreille County oversees the management of shorelines and private land within and adjacent to the Project boundary through applicable plans and ordinances, including: (1) Pend Oreille County Shoreline Master Plan (Pend Oreille County 1974); (2) Pend Oreille County Comprehensive Plan, as amended (Pend Oreille County 2005); and (3) Pend Oreille Critical Areas Ordinance (Pend Oreille County 1996). Collectively, these three documents represent the primary determinants of the type, intensity, and location of development near the Project and are described in more detail in the PAD (SCL 2006).

In addition to the County's policies, the USFS and BLM follow established land and resource management plans (Colville National Forest Plan [USFS 1988] and Spokane District Resource Management Plan [BLM 1985], respectively) for federal lands. The towns of Metaline and Metaline Falls also play a role in land management within and adjacent to the Project boundary (via the Pend Oreille County Comprehensive Plan, as amended), as the boundaries of these towns extend to the reservoir shoreline. Finally, the Pend Oreille Conservation District manages the implementation of the Pend Oreille River Watershed Management Plan (Pend Oreille Conservation District 2004).

Project-Related Roads

There are 11 roads in the Project vicinity that were identified by SCL as being used for Project-related purposes. Since the PLP was completed, SCL has determined that two of the roads–a spur off of FR 3165-200 and a spur off of FR 3165-340–are no longer needed for Project purposes. The updated list of roads is presented in Table E.4-46. The roads listed in this table are also presented in the Recreation Needs Analysis (RNA) (Attachment E-11). Some of these roads are used exclusively by SCL; others are known to also be used by other parties. Only those roads used exclusively or primarily for Project purposes are proposed for inclusion within the Project boundary. The roadway condition of all of these roads is consistent with SCL's need for and use of the roads, and with USFS management objectives, where applicable. Most of the nine Project-related roads are included or partially included in the existing FERC Project boundary, though two roads (maintenance facility road network and BPA substation road) are not but are being proposed for inclusion (Table E.4-46). There are also approximately 30 other roads in the broader Project vicinity, although none of these roads were identified as Project-related (SCL 2009a).

Table E.4-46. Project-related roads.

Road Description	Land Owner(s)	Length (miles)	Relation of Road to Project	Relation to Existing FERC Boundary
West Side Access Road	SCL, USFS	1.1	Used for Project operations and to access SCL recreation facility	Partially Included
Maintenance facility road network	SCL	1.6+	Used for Project operations	Not included
Road to SCL Forebay Recreation Area	SCL	0.3	Used for Project operations and to access SCL recreation facility	Included
BPA substation road	BPA, USFS	0.2	Used for Project operations	Not included
Spur off the BPA substation road	BPA, SCL, USFS	0.3	Used for Project operations	Partially Included
South end of FR 6200-348	SCL, USFS	0.9	Used for Project operations	Partially Included
POC 3990/FR 3165-000	SCL, USFS, Private	2	Used for Project operations and to access SCL recreation facility	Portion needed exclusively for Project purposes included
FR 3165-350 (across dam)	SCL, USFS	0.6	Used for Project operations	Partially Included
Tailrace boat launch road	SCL, USFS	0.25	Used for Project operations	Included
Total miles	**-**	**7.25**	**-**	**-**

Source: Land and Roads Study (SCL 2009a)

4.5.9.2. Environmental Analysis

4.5.9.2.1. Recreation

This section describes the effects of the current Project and its operations on recreation resources primarily within the existing FERC Project boundary. It also addresses the effects of recreation on other Project area resources. This effects analysis is based on (1) the results of the Recreation Resource Study, which focused primarily on characterizing recreational resources and use patterns rather than identifying Project effects, and (2) the results of the RNA (Attachment E-11) that identifies existing and future Project recreation needs. General Project effects have been organized into three broad categories as described below.

<u>Effects of Project Facilities on Recreation Resources</u>

The Recreation Resource Study Final Report (SCL 2009a) and RNA indicate that the presence of the Project along the Pend Oreille River attracts visitors and promotes recreational use in the Project vicinity. Specifically, the Project provides opportunities for various types of flat-water recreation, as well as land-based recreation opportunities that are enhanced by the presence of the reservoir. The Project's unique setting and characteristics (e.g., river canyon [Z Canyon], Peewee Falls, remoteness, and underground power plant) also enhance these recreational opportunities, thereby increasing the attraction of the Project vicinity. Thus, outdoor activities at recreational facilities located at the Project, along the Project's reservoir shoreline, and on the reservoir surface are considered to have a Project nexus (i.e., outdoor activities are induced by the Project) and are considered a beneficial effect of the Project.

Project-related recreation use occurs both at developed sites and in dispersed sites and use areas along the reservoir shoreline. At this time, most developed recreation sites at the Project appear to be underutilized (i.e., use is below a theoretical capacity estimate), although weekend use during summer at the Forebay Recreation Area occasionally exceeds the physical capacity of the site. For developed recreation sites, facility capacity (a component of management capacity) is considered a limiting factor (i.e., has the potential to limit recreation use levels), while biophysical capacity is a limiting factor at dispersed recreation sites.

Project recreational use also occurs on the reservoir. On-water use levels (e.g., boating and fishing) are related to available land-based capacity (e.g., number of vehicle-with-trailer parking stalls, boat launch ramp lanes, etc.), as well as on-water safety considerations, types of watercraft/activities, and physical attributes of the water body, among others. Current recreational use of the reservoir surface is below capacity at this time.

Effects of Project Operations on Recreation Resources

Hydroelectric project operations and, occasionally, maintenance requirements can result in reservoir water surface elevation fluctuations, potentially impacting recreation resources and reservoir use levels. Reservoir water surface fluctuations can affect the overall accessibility of the reservoir and specifically the usability of boat launches and other shoreline areas for recreational purposes. At Boundary Reservoir, the Recreation Resource Study indicated that some visitors (9 percent of respondents) and area residents (32 percent of respondents) did not feel that the current boat launches on the reservoir met their needs. A portion of this dissatisfaction is related to the physical condition of some of the boat launches; however, 54 percent of area residents specifically expressed problems or concerns (combined “minor” and “major” problem response categories) about water conditions, including the effect of reservoir water surface elevations on their ability to safely launch/retrieve boats. As such, fluctuations in water surface elevations resulting from Project operations may at times adversely affect boat launching and retrieval. From Memorial Day weekend to Labor Day weekend, SCL voluntarily restricts water surface fluctuations to facilitate reservoir access and related-recreational activities. The voluntary summer forebay pool restriction results in the maintenance of water surface elevations at or above 1,984 NAVD 88 (i.e., within 10 feet of normal maximum water surface elevation) from 6:00 am through 8:00 pm from Memorial Day weekend (starting Friday evening) through Labor Day weekend (ending Monday evening). At night (from 8:00 pm through 6:00 am) during the voluntary summer condition, the forebay pool elevation is maintained at or above elevation 1,982 feet NAVD 88.

Project operations, sometimes in combination with high natural river flows, can result in difficult boating conditions at the Metaline Falls area of the reservoir (located just north of the Highway 31 bridge at the town of Metaline Falls). At times the falls are impassable by watercraft. Over a portion of the normal operating range for the reservoir, the falls take on the appearance and physical characteristics of a river rapid. The fast current, eddies, turbulence, and gradient between the upstream and downstream ends of the falls make watercraft travel through this area potentially difficult, particularly in smaller motorized boats and non-motorized watercraft. As documented in the Recreation Resource Study (SCL 2009a), a small portion of Project visitors (approximately 10 percent – “minor” and “major” problems combined) and a larger portion of area residents (54 percent – “minor” and “major” problems combined) identified issues or

problems related to water conditions, including difficulty with navigating the falls. This indicates that for some Project visitors and area residents, water conditions associated with the falls area adversely affect their boating experience at certain times. For most visitors and area residents, however, neither the falls area nor any other aspect related to Project operations was reported as limiting overall boating use of the reservoir. Because SCL is not proposing to change Project operations during the new license term, and proposes to formalize the summer water surface elevation restrictions, most visitors and area residents would remain largely satisfied with reservoir conditions and unaffected by the falls area and other aspects of Project operations, whereas a small portion of Project visitors and area residents still might be adversely affected by the boating challenges associated with the falls area (although SCL is proposing a portage trail at Metaline Falls, see Section 4.5.9.3).

In addition, major CIP and O&M projects occasionally may result in short-term effects on recreation resources. For example, work planned on the sluice maintenance gate would necessitate a temporary structure at the boat ramp in the Forebay Recreation Area approximately every 10 years, as needed. This work area would be accommodated in the proposed redesign of the Forebay Recreation Area and, although some of the work would need to be conducted in the summer, much of it would occur under cover and during the fall and winter. Although the work would be contained, the temporary structure would displace some boat launch parking that otherwise would be available. The Forebay Recreation Area likely would be closed to public use while the sluice maintenance gate is moved onto the site and approximately one year later when it is re-installed on the dam. The long-term effect on recreation resources would be minor.

Effects of Project-related Recreation on Project Resources

In general, developed recreation sites are designed to minimize potential recreation impacts on other resources by concentrating use at developed/hardened sites. Alternatively, dispersed recreation sites or use areas tend to have a greater potential for impacts on other resources, including soil (erosion), plants (vegetation trampling and damage), spread of noxious weeds, wildlife (wildlife harassment or habitat degradation), and historic/cultural resources (vandalism), among others. Overall, dispersed recreational use at the Project does not have a widespread adverse effect on other resources. Potential effects from dispersed recreational use appear to be minor and localized at a few shoreline locations. Other resource studies found a few areas of shoreline erosion (Erosion Study Final Report, SCL 2009a) and vegetation damage (RTE Plant Inventory Final Report, SCL 2009a) that were attributed to Project-related recreational use; however, these studies identified no widespread concerns.

4.5.9.2.2. Land Use and Roads

This section describes the effects of the current Project and its operations on land use and roads in the Project area. In general, the Project does not appear to adversely affect either of these resources.

Project Effects on Land Use

Based on available information, the Project does not appear to adversely affect adjacent land uses or ownership. Shoreline land uses and related private development (e.g., residential and commercial) are limited to specific areas because of steep slope constraints and land ownership

patterns found along the reservoir shoreline, among other factors. There is minimal shoreline development at this time and this condition is not anticipated to change substantially in the future. Only two private docks currently exist in the Project area, and site constraints limit the potential for more private docks or shoreline development extending into the Project boundary. Under the current FERC Project license, SCL has the authority to permit docks and other shoreline development within the Project boundary, as needed, in cooperation with Pend Oreille County and other agencies.

Project Effects on Roads

The Project does not appear to adversely affect roads in the Project vicinity. Project roads benefit the public by providing access to Project recreation resources. Substantial Project-related road improvements are not warranted at this time. However, ongoing maintenance of these roads will be required through the new license period (see Section 4.5.9.3.2). The SCL access road leading to Boundary Dam was realigned by SCL in response to a landslide and a portion of the road is located outside of the current FERC Project boundary; SCL is proposing in this License Application to include the entire road within the Project boundary.

SCL has coordinated with the USFS on the decommissioning of various forest roads previously used by the Project to access groundwater monitoring wells installed by SCL but no longer needed. A comprehensive Road Decommissioning Plan is included as Attachment E-13 to this Exhibit E.

4.5.9.3. Proposed Environmental Measures

4.5.9.3.1. Recreation

SCL's RRMP (Attachment E-12) will help effectively and efficiently guide recreation use and management at the Project during the new license term. The RRMP is an umbrella PM&E measure that will capture all applicable Project-related recreation measures proposed for the new license. The RRMP contains several management programs that will help guide SCL's recreation-related decision-making process during the new license term. The RRMP includes Capital Facility Development, Operations and Maintenance, Shoreline Dispersed Recreation Management, Recreation Monitoring, and Multi-Resource I&E programs. Each of these programs will include a set of appropriate measures, as described below, as well as implementation plans, a schedule, and budget guidance. The RRMP also includes general goals, objectives, resource integration and coordination guidance, Recreation Opportunity Spectrum (ROS)-type land management classifications, and other appropriate management considerations for recreation at the Project under the new license.

Capital Facility Development Measures

Specific measures that will be included in the Capital Facility Development Program are listed below. Any proposed new facilities or modifications to existing facilities will be subject to FERC review and approval. The Capital Facility Development Measures will also include ADA regulations and guidance, general aesthetic/visual design guidelines, and an appropriate development scale level (that establish the extent of development) to guide the design, construction, and management of Project recreation sites and facilities. Related to ADA

regulations and guidance, FERC encourages "Universal Design" and "Universal Access" at licensed-hydroelectric projects. Universal design typically refers to sites, facilities, and other features that are usable for all people, not just those with disabilities. SCL will consider universal design during the design phase of recreation capital improvements, but will generally rely on ADA accessibility guidelines to help foster consistency between Project recreation sites located on federal and SCL-managed Project lands.

At the time of this License Application, the following capital facility measures are included in the RRMP:

- Forebay Recreation Area
    - Enhance campground facilities at this site: increase the number of designated RV and tent campsites (phased - up to approximately 22 to 25 total), better delineate campsites, provide appropriate signage, use vegetation and/or other site features (e.g., rocks) to create separation between campsites and day use picnic sites, and limit vehicle access to roads and parking areas
    - Enhance day use picnic sites with signage, improved access, and separation from campsites
    - Provide additional I&E signage and/or other visitor I&E opportunities (see I&E Program)
    - Extend an existing boat ramp lane so that boats may be launched/retrieved during the primary recreation season (Memorial Day weekend to Labor Day weekend) without problems due to fluctuating reservoir water surface elevations. Provide adequate parking, signage, and circulation at the boat launch
    - Provide for a sluice maintenance gate area to be used approximately every 10 years, as needed
    - Incorporate ADA enhancements into the design
- Vista House Recreation Area
    - Add I&E signage and/or other opportunities at the overlook platform
    - Incorporate ADA enhancements into the design
- Tailrace Recreation Area/Machine Hall Visitors' Gallery
    - Update I&E signage, displays and visitor opportunities at the Machine Hall Visitors' Gallery (see I&E Program) (the extent of upgrades at this site needs to be consistent with the level of anticipated use; security restrictions contribute to low use levels)
    - Incorporate ADA enhancements into the design
- Peewee Falls Viewpoint and Trail
    - Develop a new trail in the vicinity of the Vista House access road to a viewpoint of Peewee Falls. The trail alignment would take advantage of the existing NFS road network in this area.

  - Develop appropriate support facilities, including parking, vault toilet, and signage
  - I Incorporate ADA enhancements into the design
- Metaline Falls Portage Trail
  - Develop a new portage trail in the vicinity of the falls to provide non-motorized boaters an alternative to avoiding or running the rapids at the falls under certain natural flow and Project operational conditions
  - Provide I&E signage
- Metaline Waterfront Park Boat Launch
  - Replace the existing boat launch and extend a boat ramp lane so that boats may be launched/ retrieved during the primary recreation season (Memorial Day weekend to Labor Day weekend) without problems due to fluctuating reservoir water surface elevations
  - Provide adequate roadway access to the boat ramp, improved circulation and parking for single vehicles and vehicles with trailers, and other boat launch support facilities (e.g., signage, dock, and boarding float)
  - Provide an accessible restroom in the vicinity of the boat launch parking area (may be dual vault toilets or may potentially combine this new facility with an upgraded park restroom facility, location undefined)
  - Incorporate ADA enhancements into the design
- Future repair and/or replacement of existing recreation sites
  - Replace and/or repair recreation site facilities, infrastructure, and amenities, as needed, based on monitoring facility conditions and normal facility life cycles, during the new license term
  - If needed, consider additional recreation capital facility development based on periodic monitoring during the new license term (see RRMP Monitoring Program)

Programmatic and O&M Measures

- Operations and Maintenance (O&M) Program
  - Develop an O&M Program for SCL-managed recreation sites and use areas
  - Provide annual maintenance at the boat launch at the Town of Metaline Waterfront Park
  - Provide appropriate O&M of Project-related recreation sites and use areas
  - Periodically re-assess public access/security policies at the Tailrace Recreation Area and Machine Hall Visitors' Gallery
- Shoreline Dispersed Recreation Management Program

  - Develop a Shoreline Dispersed Recreation Management Program to guide development and management of shoreline dispersed recreation sites and use areas
  - Incorporate 16 existing shoreline sites into the management program by establishing appropriate development levels (as described under the Capital Facility Development Program) and management direction for dispersed shoreline recreation sites
- Recreation Monitoring Program
  - Develop and implement a periodic Recreation Monitoring Program with facility and visitor management actions and triggers identified
- Multi-Resource Interpretation and Education (I&E) Program
  - Develop a comprehensive Multi-Resource Interpretation and Education (I&E) Program that establishes themes, messages, and media that would be considered at recreation sites throughout the Project. Address all Project resources in one integrated multi-resource I&E Program: recreation, aesthetics, geology, engineering, scenic byway, fisheries/aquatics, cultural/historic, and terrestrial resources
  - Communicate to the public the seasonal changes in flows, spring runoff conditions, and Project operations that may affect conditions at the falls north of the Highway 31 bridge, as well as reservoir fluctuation related issues

4.5.9.3.2. Land Use and Roads

SCL proposes to adjust the current FERC Project boundary to include certain Project-related lands and roads (i.e., roads that are used exclusively or primarily for Project purposes) that are currently outside of the Project boundary. These adjustments include:

- *West Side Access Road* – A portion of the original West Side Access Road followed a different alignment than the current road. After a landslide in 1982, the road was relocated to the west of the original grade. Authorization to site the new road was obtained through a USFS Special Use Permit and a property exchange; however, the FERC Project boundary was never modified to incorporate the new road alignment. The proposed adjustment to the FERC Project boundary will shift the narrow portion of the boundary line in Sections 10 and 15 to the west to surround the current location of the road.
- *Operations and Maintenance Support Area* – This site and the associated road network are needed to support key operations functions and are not currently fully contained within the FERC Project boundary. The boundary will be adjusted to include all of this facility.
- *BPA substation road and spur off of BPA substation road* – The portions of these roads needed for Project purposes are being proposed for inclusion within the FERC Project boundary.

- *South end of FR 6200-348* – All but a small segment of this road is currently contained within the FERC Project boundary; this additional segment is being proposed for inclusion within the boundary.
- *FR 3165-350* – A small portion of the access road from the dam to the Vista House Recreation Area is currently outside of the FERC Project boundary. The boundary will be adjusted to include the entire road.
- *Boundary Wildlife Preserve* – SCL designated a 149-acre parcel of land as a wildlife preserve in accordance with the 1986 license amendment; however, SCL did not amend the FERC license exhibits to incorporate this new parcel of land into the FERC Project boundary. SCL will include this parcel within the FERC Project boundary.
- *Terrestrial mitigation lands* - SCL proposes to incorporate the 89-acre BWP Addition into the Project boundary and manage these lands for biodiversity goals.
- *Metaline Falls Portage Trail* – SCL is proposing to develop a portage trail around Metaline Falls (see Section 4.5.9.3.1). A portion of the proposed trail alignment is currently outside of the FERC Project boundary and is being proposed for inclusion within the boundary.

A shoreline management program consistent with FERC guidelines is included in the TRMP as part of the License Application (Attachment E-3). The TRMP, and specifically the Shoreline Management Program, identifies appropriate shoreline land uses to minimize potential environmental effects on sensitive plant and wildlife species and habitat and to protect and enhance the Project shoreline. It also recommends managing and coordinating private and public (non-federal) shoreline development permitting within the Project boundary. Finally, the Shoreline Management Program recommends managing debris accumulation and removal along the Project shoreline, particularly following high-flow spring runoff.

SCL has coordinated with the USFS regarding the decommissioning of various forest roads previously used by SCL to access groundwater monitoring wells installed by SCL but no longer needed. A Road Decommissioning Plan is included in this License Application (Attachment E-13).

Regarding ongoing maintenance of roads used for Project purposes, SCL will be fully responsible for maintenance of roads located on SCL-owned property. For roads located on NFS or other federal lands that are used exclusively or primarily for Project-related purposes, Table E.4-47 outlines SCL's proposal for maintenance of such roads.

Table E.4-47. Maintenance responsibility for Project-related roads.

Road Description	Landowner(s)	Share Split and Type of Sharing[1]
West Side Access Road	SCL, USFS	100% SCL, share by primary purpose
Maintenance facility road network	SCL	100% SCL responsibility
Road to SCL Forebay Recreation Area	SCL	100% SCL responsibility
BPA substation road	BPA, USFS	Share by first use
Spur off the BPA substation road	SCL, BPA	100% SCL, share by primary purpose
FR 6200-348	USFS, SCL	Share in the segment of the 6200348 road accessing the towers by first use
POC 3990/FR 3165-000	USFS	Maintained by Pend Oreille County per agreement between USFS and County. USFS to continue granting an easement across National Forest lands to Pend Oreille County; no action needed by SCL.[2]
FR 3165-350 (across dam)	SCL, USFS	100% SCL, share by primary purpose
Tailrace boat launch road	USFS	100% SCL, share by primary purpose
Portion of FR 3165-325 - Access to proposed Peewee Falls overlook from FR 3165-000 to junction with FR 3165-315	USFS	100% SCL, share by primary purpose for recurrent road maintenance; USFS to maintain for USFS commercial use
Portion of FR 3165-315 - Access to Peewee Falls overlook from FR 3165-325 to trailhead	USFS	100% SCL, share by primary purpose for recurrent road maintenance; USFS to maintain for USFS commercial use

Notes:

1 Share by Primary Purpose - Share in road maintenance and reconstruction based upon the primary road user or the primary reason the road exists. Since the road was built for a primary purpose and most all of the traffic using the road is associated with that primary purpose, the primary user will be responsible for all road maintenance and reconstruction on the route.

Share by First Use - Share in road maintenance and reconstruction by who needs the road first. This type of sharing would be applicable to low standard, low use or closed roads built primarily for National Forest resource access. When the road is needed, the organization that needs the road first will perform the maintenance and reconstruction needed to accommodate their use. For currently closed roads, once the road is no longer needed, the road will be closed and maintained to a Forest Service maintenance level 1 configuration.

Share by use - Share in road maintenance and reconstruction based upon the proportion of use by SCL-generated traffic and traffic for which the Forest Service is responsible as authorized by 16 USC 537. The maintenance to be borne by each user shall be proportionate to the total use. This method of sharing would apply to roads with higher volumes of traffic which are needed for both project operation and maintenance and access to National Forest resources. Traffic amounts will be estimated by use of traffic counts, recreation use inventories or other methods of estimating the amount of traffic using a route.

2 See Comment Response Number 141 of the PLP comment-response table, Attachment E-2 to Exhibit E.

4.5.9.4. Cumulative Effects Analysis

During the new license term, the Project will provide enhanced recreation opportunities and, therefore, will not contribute to adverse cumulative effects on recreation resources along the Pend Oreille River.

4.5.9.5. Unavoidable Adverse Impacts

No unavoidable adverse impacts to either recreation resources or land uses from continued operation of the Project have been identified.

4.5.9.6. Consistency with Comprehensive Plans

The recreation and land use resource related management goals and policies associated with comprehensive resource management plans identified by FERC were reviewed to assess Project consistency. The Proposed Action for the Project will result in a condition that is consistent with the following relevant comprehensive plans.

USDA Forest Service. 1988. Colville National Forest land and resource management plan. Department of Agriculture, Colville, Washington.

To the extent feasible, Project recreation development and management on NFS lands within the Project boundary will be consistent with USFS management guidelines, as described in the Forest Plan. In particular, Project-related recreation facility development and shoreline dispersed recreation management will be consistent with USFS ROS setting classifications, facility development levels, and incorporate ADA enhancements into the design. The USFS is in the process of updating the Forest Plan; as such, future Project-related recreation measures should be reviewed for consistency with the updated plan as needed.

Bureau of Land Management. 1985. Spokane resource area management plan. Department of the Interior, Spokane, Washington.

This plan does not discuss recreation-specific management for the BLM-managed parcels of land at the Project; however, these parcels are generally managed for dispersed recreational use. Because the BLM's plan lacks recreation-related goals and objectives, Project-related measures, including those for dispersed use areas, are consistent with BLM dispersed recreation management goals. Specifically, the shoreline dispersed recreation management program and any associated site development and management on BLM-managed lands will be consistent with the BLM's management direction under the existing RMP, as amended.

Interagency Committee for Outdoor Recreation. 2008. Washington Statewide Comprehensive Outdoor Recreation Plan (2008); Interagency Committee for Outdoor Recreation.

Washington State Comprehensive Outdoor Recreation Plan (SCORP) – The Recreation Resource Study (SCL 2009a) investigated the statewide and regional outdoor recreation needs and demand for various activities defined by the Washington State Recreation and Conservation Office (RCO). These needs are further defined and addressed in the RNA (Attachment E-11). The

RNA was subsequently used to develop the RRMP (Attachment E-12). As a result, the RRMP for the Project is consistent with the WA SCORP.

Washington State outdoor recreation and habitat: Assessment and policy plan 1995-2001. Tumwater, Washington. November 1995.

The Washington State outdoor recreation and habitat: assessment and policy plan is one of the documents composing the Washington Statewide Comprehensive Outdoor Recreation Plan (SCORP).

Washington Interagency Committee for Outdoor Recreation. 1991. Washington State trails plan: policy and action document. Tumwater, Washington. June 1991.

The Washington State trails plan: policy and action document discusses existing and proposed trails in the state. No trails were identified in the plan within the Project area; therefore, the Project is consistent with the plan.

Washington Department of Ecology. 1986. Application of shoreline management to hydroelectric developments. Olympia, Washington.

The Application of shoreline management to hydroelectric developments document discusses general shoreline management at hydroelectric projects.

4.5.10. Socioeconomics Resources

4.5.10.1. Affected Environment

As one of Washington's least populated counties, Pend Oreille County (County) is characterized by a low-population-density, rural landscape separating a number of small towns and cities. Due in part to the presence of the CNF both east and west of Boundary Reservoir, land development along the reservoir is limited to the area north of Metaline Falls. Mining, timber harvest, and recreational activities are more common than urban land uses. The County's largest urban area is the City of Newport (also the county seat), located at the southern end of the County. Metaline, Metaline Falls, and Ione are three towns near the Project, and each has fewer than 500 residents. In the recent past, population increases have mostly occurred in the unincorporated parts of the County rather than in existing towns and cities. This pattern of population growth is expected to continue in the future. Relatively inexpensive land and affordable housing generally characterize the real estate market in the county. Prominent employers in the county have included the Teck Cominco Company and the Ponderay Newsprint Company.

The Project vicinity is characterized predominantly by resource-dependent industries and rural land uses, and has comparatively low incomes and high poverty rates relative to the state as a whole (SCL 2006). Over the last 25 years, the unemployment rate in the County has been substantially higher than the state as a whole and the County was one of 16 counties designated by the State as a "distressed area" in 2004.

4.5.10.1.1. Public Sector (taxes and services)

The primary source of tax revenue for Pend Oreille County is through intergovernmental agreements. In 2006, the County obtained a total of $9,507,237 from such agreements, including payments from the state and federal government (State of Washington OFM 2007). Property taxes generated the second largest revenues for the County, producing a total of $2,910,261. "Charges for services" ($1,949,009), retail sales and use tax ($794,456), and "all other taxes" ($1,052,110) also generated sizeable tax revenues for the County. Total revenues in unincorporated Pend Oreille County in 2006 came to $18,669,763.

Because it is a city-owned utility, SCL is not required to pay state property tax or the Pend Oreille County PUD privilege tax. Instead, Washington State law requires the City of Seattle to compensate counties and school districts for loss of revenues and increased costs caused by the operation of the Project (RCW 35.21.425-427). Under the most recent 10-year agreement, SCL provided annual payments to the County that were allocated by the County in specified amounts to each of the affected jurisdictions (the County, towns of Metaline, Metaline Falls, and Ione; and the Selkirk, Cusick, and Newport School Districts) (City of Seattle 1999). Project impact payments consisted of the following two components: an Impact Compensation Payment, which was generally based on the compensation methodology for the state PUD privilege tax on generation, and was subject to a 3.1 percent annual escalator (inflation factor), and a Retroactive Payment. The Retroactive Payment was set at $84,653 each year, while the Impact Compensation Payment increased throughout the term of the agreement in accordance with the annual escalator. From 1998 - 2008, impact payments varied by a negotiated amount but were approximately $1.2 million annually. In 2008 the payment was $1,315,137 (Rennie, L., SCL, personal communication, December 2008). SCL is currently engaged in negotiating a new agreement with representatives of Pend Oreille County, with the intent of continuing payments for the period 2009 - 2019.

4.5.10.1.2. SCL Contribution to Local Services

In addition to the payments discussed above, SCL contracts with Pend Oreille County Fire District #2 for fire protection at the Boundary Project facilities. This agreement, first signed in 1998 and now extended through 2009, established Fire District #2 as the provider of fire and emergency management services to the Project in exchange for financial compensation from SCL (City of Seattle 2001). SCL's 2008 payment for fire protection service from Fire District #2 was $42,035. Payments in future years will increase by an inflation factor of 3.1 percent.

SCL also contributes to local services through local purchasing and vendor agreements. In 2004, SCL made approximately $217,000 in payments to merchants within Pend Oreille County. Vendor payments increased to $275,174 in 2005. Vendors included in this total vary from the Pend Oreille County PUD and the Pend Oreille Telephone Company to local electrical and hardware stores. Purchases from these vendors generate sales tax revenue for local jurisdictions. In 2004 and 2005, $10,527 and $7,350, respectively, were paid in local sales tax (Holter, C., SCL, Boundary Project power plant employee, personal communication, December 15, 2005).

Through the tax and fee revenues discussed above, Pend Oreille County supports a range of programs for its residents. In 2006, the County's three largest expenditures for services included almost $3.8 million for the security of persons and property (police, fire, etc.), approximately

$3.9 million for "capital outlays", and $4,465,868 for transportation-related activities (State of Washington OFM 2007). General government services ($3,297,006), health services ($1,501,446), and monies for natural resources ($1,317,193) represented the County's three other major expenditures. Other expenditures, including debt service, support of culture and recreation activities, and economic development each totaled less than $400,000.

4.5.10.1.3. Electricity

SCL does not supply electricity directly to residential and industrial customers in Pend Oreille County. However, Article 49 of the current license for the Project requires SCL to assign up to 48 MW of power from the Project to the PUD at cost.

In 1992, SCL and the PUD entered into a Settlement Agreement establishing the terms and conditions for the assignment of firm power pursuant to Article 49, including utilization of the PUD's weekly system load factor in determining the amount of energy to be delivered and the methodology to be used in calculating the annual Project costs. FERC approved the Settlement Agreement as fair and equitable and in the public interest (City of Seattle, Wash., 61 FERC P61, 200 [1992]). On July 5, 2000, SCL and the PUD entered into a Memorandum of Agreement by which the parties agreed, among other things, that SCL would seek a continuation of Article 49 in the new license for the Project.

In 2005, SCL and the PUD entered into another Memorandum of Agreement by which the parties agreed, among other things, to clarify the interpretation of Article 49. Consistent with current operations and the foregoing agreements, SCL requests that FERC incorporate as a license article the text set forth below, which is substantially similar to Article 49.

> "The Licensee shall assign 48,000 kilowatts to the PUD from the Boundary Project at the PUD's weekly system load factor, any part or all of which shall be available to the PUD at cost upon two years' notice by the PUD, to meet the load requirements of the present or potential customers."

The PUD currently generates electricity at the Box Canyon Hydroelectric Project and the Calispell Hydroelectric Project, and distributes power to Pend Oreille County customers. In 2007, Boundary Project energy represented 30 percent of the total energy resources of the PUD, but only 5 percent of the PUD's power costs (Pend Oreille County PUD 2008). The PUD also purchases power from BPA. In 2007, BPA and other power purchases represented 31 percent of the PUD's energy resources, and 44 percent of the PUD's power costs (Pend Oreille County PUD 2008). The following section briefly describes some of the characteristics of electricity provision within the County, including prices, and consumption patterns.

Electricity prices in Pend Oreille County are substantially lower than in other areas of the state. In 2007, residential customers of the PUD purchased electricity at a rate of 4.61 cents per kilowatt hour (Pend Oreille County PUD 2008). The statewide average is 6.37 cents per kilowatt hour. On average, commercial customers in Pend Oreille County paid less than residential customers, averaging a rate of about 4 cents per kilowatt hour. This average rate for commercial customers compared to a statewide rate of 6.17 cents per kilowatt hour (EIA 2005). On average, the PUD's industrial users paid less than 3 cents per kilowatt hour in 2007. These comparatively

low electricity rates benefit the County's industrial companies, such as the Ponderay Newsprint Company, until recently Teck Cominco, and others. In particular, as the largest power user in the County, Ponderay Newsprint is billed based on the actual cost of services and the BPA power is purchased solely to serve the Ponderay Newsprint Company. In its 2007 Annual Report, the PUD specifically discussed the relationship between the power received from the Project and the electricity rates in Pend Oreille County. The report states that "power received from Boundary Hydroelectric Project is the District's most inexpensive source of power and is a key component of the District's current low power rates" (Pend Oreille County PUD 2008). The low industrial electricity rates recorded in Pend Oreille County compared to a statewide average of 4.25 cents per kilowatt hour (EIA 2005).

In 2008, the Box Canyon Hydroelectric Project generated more than 426 million kilowatt hours of energy, while the Calispell power plant produced more than 2.6 million kilowatt hours of electricity (Pend Oreille County PUD 2008). The majority of electricity demand for and consumption of that energy originates from commercial and industrial users. Specifically, the Ponderay Newsprint Company represents 73 percent of the total PUD electric distribution system customer load and represents over 40 percent of revenues from customers. The remainder of electricity consumption is split between residential and other commercial and industrial users.

4.5.10.2. Environmental Analysis

Although FERC's Study Plan Determination for Boundary Hydroelectric Project (FERC 2007b) did not direct SCL to undertake any studies related specifically to socioeconomics, the Project provides economic benefits to the local economy through direct compensation payments to local jurisdictions in lieu of taxes, and SCL's fire protection contract. The Project provides jobs on location, and supports local vendors through purchasing contracts. In addition, SCL maintains an at-cost power contract with the PUD, which contributes to the PUD's ability to provide some of the lowest cost power in the region. In addition, any Project improvements, such as turbine efficiency enhancements at Boundary Dam, would benefit the local economy through local hiring and purchasing of materials and services.

Many of the enhancement measures that benefit other resources would also provide a social or economic benefit to the local community. These include measures such as additional employment related to construction or operation of recreation and fish passage facilities. The types of measures that will directly or indirectly benefit socioeconomics are listed below, followed by a brief summary of the related socioeconomic impacts.

- SCL contributions to local services
- Power plant equipment upgrades, other improvements, and maintenance activities
- PM&E measures related to recreation resources
- PM&E measures for facility construction or capital improvements
- PM&E measures for resource enhancement or maintenance

These environmental measures would have primarily positive effects on socioeconomic resources in the Project vicinity. Possible effects include direct changes in employment, local expenditures for goods and services, and indirect influences on the local economy. Overall, the

proposed measures would not have significant adverse effects on social and economic conditions in the area surrounding the Project. Rather, most of the proposed measures would enhance the local economy during construction and, upon completion, by attracting and/or serving more visitors. These effects are described in more detail below.

As most of the PM&E measures are still in the conceptual phase, the analysis presented in this section is qualitative by nature, not quantitative. Where specific dollar values are available or could be estimated, such information is included as appropriate.

Section 4.6 (Developmental Analysis) provides a more complete discussion of Project economics associated with electrical generation.

4.5.10.2.1. SCL Contributions to Local Services

As described above in Section 4.5.10.1.2 (Affected Environment, SCL Contributions to Local Services), over the course of the existing license period, SCL has provided direct socioeconomic benefits to Pend Oreille County in the form of financial compensation for fire and emergency management services, compensatory payments to local communities and school districts, local purchasing and vendor agreements, and local payroll, and by providing at-cost energy.

For fire and emergency management services, SCL will continue to make annual payments to Fire District #2 in exchange for such services. In 2008, the annual payments were $42,035; based on the agreement, originally signed in 1998, the payments would increase each year by 3.1 percent to account for inflation. It is expected that the agreement and payments will continue through the new license term. Over an assumed 50-year license term starting in 2012, this would amount to approximately $5.5 million in direct compensation over the course of the new license.

In addition, SCL will continue providing its compensatory payments to Ione, Metaline, and Metaline Falls, and the Newport, Cusik, and Selkirk school districts. SCL has provided funding annually to Pend Oreille County through a local Impact Fee Agreement, in effect from 1998 - 2008. The County dispersed these funds to three local towns (Ione, Metaline, and Metaline Falls) and three County school districts (Newport, Cusik, and Selkirk). These payments varied by a negotiated amount but were approximately $1.2 million annually. In 2008, the payment was $1,315,137 (Rennie, C., SCL, personal communication, December 2008). SCL is currently engaged in negotiating a new agreement with representatives of Pend Oreille County, with the intent of continuing payments for the period 2009 - 2019.

Similarly, SCL's economic contributions in the form of local purchasing and vendor agreements are expected to continue over the course of the new license, at dollar values similar to those that have occurred in the past over the existing license term. While it is not possible to estimate specific dollar values as future expenditures are based on needs not determined at this time, they will likely be in the range of the amounts in the recent past (e.g., approximately $275,000 in 2005). Such purchases provide both direct sales and also generate associated local sales tax revenue.

In addition, the ongoing operation and maintenance of the Project represents a minor beneficial socioeconomic impact in the Project vicinity associated with local expenditures by SCL staff and

contractors when working at the Project. Staff and contractors purchase local goods and services (including meals, lodging, materials, gas, and other services) when visiting and working in the area, primarily in Metaline, Metaline Falls, and Ione. The level of impact is minor, and would not displace other demands for goods and services.

As of 2009, 41 full-time workers are employed at the Project, with total annual salaries or compensation of approximately $3.9 million (representing an average annual compensation of $96,000, including benefits). In addition, SCL employs three hydro maintenance workers (each representing an approximate $34,000 annual compensation), an electrician (representing an approximate annual compensation of $47,000), and temporary summer employees (e.g., tour guide, representing approximately $9,300). This local payroll represents a beneficial socioeconomic effect in the Project vicinity. Some of the earned wages are spent in the Project vicinity on such things as goods and services, food, living expenses, etc.

As a condition of its existing license, SCL sells up to 48 MW of electricity priced at the cost of production at the Project to the Pend Oreille County PUD, which the PUD uses to serve its retail customers. Under an agreement with the PUD, SCL will continue to provide this low-cost energy for the term of the new Project license (SCL 2005). Annually, SCL provides up to 48 MW of electricity at cost to the Pend Oreille County PUD. In 2007, 367,944 MWh of energy was provided to the PUD, with a market value of $20.6 million. The PUD paid $1.4 million for the energy, resulting in a net benefit to Pend Oreille County ratepayers of $19.2 million.

4.5.10.2.2. Power Plant Equipment Upgrades, Other Improvements, and Maintenance Activities

Over the course of the new license, SCL will perform numerous capital improvement projects (both major and minor), as well as ongoing and periodic O&M activities. Some of these activities and projects have been tentatively scheduled and budgeted, whereas others would occur on an as-needed basis over the course of the new license. These are summarized in Section 2.3.2 (Proposed Power Plant Equipment Upgrades); the anticipated socioeconomic impacts associated with these capital improvement and O&M projects are summarized below.

Planned, scheduled, and budgeted major CIPs include the rebuilding and runner replacement for the generating units, rock damage mitigation for the transformer banks, forebay wall hardening, and other replacement projects. These are currently scheduled to occur over the course of the new license, with scheduled dates ranging from 2011 to 2059. The total costs associated with the major CIPs are estimated at approximately $340 million over the course of the new license (see Table D.4-1 in Exhibit D of this License Application).

Planned minor CIPs over the course of the new license include (but are not limited to) the following types of projects: continued structural improvement of the facilities and the grounds, control and network improvements, continued forebay stabilization efforts (and associated dredging), replacement of IT and security systems, groundwater control in power plant and dam, refurbishing buildings and improvements to service, recreation and tourism areas, dam safety instrumentation upgrades and new installations, generator operational improvements, gate upgrades, safety projects, sump and other containment improvements, well decommissioning, service water piping replacement, lighting systems, protective relaying, shaft seal replacements,

draft tube discharge improvements, high-voltage breaker and switchgear replacements, infrastructure improvements, and communication projects. The estimated annual budget for the minor CIPs is $10 million.

In addition to the CIPs, operation of the Project includes ongoing and periodic O&M activities. Anticipated O&M projects include (but are not limited to) the replacement of turbine bearings, transmission conductors, and domestic water system; refurbishment of the draft tube, spill gate, trash rack, and head gate; sluice gate refurbishment and maintenance; and road resurfacing. Like the CIPs, these O&M projects are scheduled periodically over the course of the new license. The estimated budget for the O&M projects (over the course of the new license) is approximately $27 million.

The majority of these CIP and O&M projects will be performed by existing SCL full-time staff with specialized experience in maintaining hydroelectric facilities. Similarly, the specialized industrial equipment necessary to implement the projects requires custom fabrication, most of which would occur outside the immediate Project area or vicinity. To a certain extent, however, the substantial costs and expenditures associated with these projects (more than $367 million in major CIP and O&M projects over the new license term, and $10 million annually in minor CIPs) would represent the potential for beneficial socioeconomic impacts in the Project vicinity, as a certain amount of goods and services would be procured locally, as would potential equipment rental. Short-term local laborers also could be involved, in particular for some of the O&M projects. In addition, the influx of SCL work crews into the Project vicinity to accomplish the work represents a positive impact in the form of expenditures on local goods and services, and for short-term housing (for some of the projects that require longer term construction). These impacts have not been quantified but would be beneficial to the local communities.

4.5.10.2.3. PM&E Measures Related to Recreation Resources

Recreation use and activities in the Project area contribute substantially to socioeconomic benefits. SCL's proposed recreation-related PM&E measures may result in benefits to the economy of Pend Oreille County and in particular those of the towns of Metaline, Metaline Falls, and Ione. There are two primary methods by which the recreation-related PM&E measures may contribute to the local economy: (1) construction and O&M-related expenditures by SCL to construct and maintain Project recreation facilities, and (2) visitor expenditures on products and services.

SCL proposes to improve facilities at its existing recreation sites (Vista House, Tailrace, and Forebay recreation areas), construct new improvements at several new sites (Peewee Falls Viewpoint and Trail, Metaline Falls Portage Trail, Metaline Waterfront Park Boat Launch, and six dispersed shoreline sites), and maintain these sites during the term of the new FERC license. The recreation capital improvements are proposed during the first 10 years of the new license and are estimated to cost approximately $5.6 million (including design and permitting costs; see Exhibit D, Table D.4-1). Assuming local construction firms are available and able to complete the recreation construction projects, these Project-related capital improvements would result in direct economic benefits, potentially including jobs, to Pend Oreille County during the first 10 years of the new license.

After the initial recreation construction projects are completed, SCL proposes to maintain the Project-related recreation sites and facilities during the new license term. SCL staff currently performs all O&M activities at Project recreation sites. During the new license, SCL may opt to contract O&M responsibilities or hire new staff for this purpose. Either of these options would likely result in minor benefits to the local economy. In the long term, recreation sites and facilities typically need to be replaced periodically due to normal wear-and-tear. Over the term of the new license, it is estimated that recreation site and facility replacement costs will be between $2 million and $3 million. As with the initial recreation-related construction costs, the replacement of recreation sites and facilities may periodically benefit the local economy (again, assuming local firms are available and able to perform this type of work).

Recreation, specifically destination and nature/setting-based outdoor recreation, often has a positive economic impact on surrounding communities. Typically, visitors to a recreation area (from outside the identified area) spend money on products and services in the region. One of the challenges at the Project in terms of recreation expenditures is the short primary season (assumed to be late May through early September). In recognition of this peak season, SCL maintains surface water elevations at the forebay at levels conducive to recreation from Memorial Day weekend through Labor Day weekend. Because the primary season is short (approximately 100 days), the potential for year-round economic benefits from recreation is limited. Nonetheless, during the primary recreation season, visitors do spend money in the Project region (particularly the local communities of Metaline, Metaline Falls, and Ione).

The Recreation Resource Study Final Report (SCL 2009a) includes a trip expenses component in the visitor survey. Visitors were asked to estimate how much money they had spent in Pend Oreille County during their trip to the Project. Table E.4-48 provides an overview of mean expenditures for several goods or services available in the Project region. In general, visitors spent the most money on lodging and groceries (based on average expenditures). However, the percentage of visitors who spent money on specific goods or services varied greatly, from as much as 73.3 percent of visitors who spent money on gasoline to as little as 2.4 percent of visitors who rented boats or RVs (Table E.4-48).

Current recreational use at the Project is estimated to be about 15,000 RDs annually (one RD is defined as a visit by a person to a recreation area for any length of time during a 24-hour period). RDs do not correspond to the number of visitors so estimating direct economic impacts based on RDs is difficult. If it is assumed that visitors from outside of Pend Oreille County reflect approximately 50 percent of current recreation use (approximately 7,500 recreation days) and that these visitors averaged three nights in the Project vicinity (per Recreation Resource Study results), then the estimated number of visitors (not including area residents) would be approximately 2,500 (7,500/3 recreation days). Given an estimate of 2,500 visitors and the percentages of visitors reporting specific expenditures (Table E.4-48), it is evident that certain Project-related recreation expenditures (e.g., gasoline, groceries) likely result in moderate economic benefits to Pend Oreille County, while other expenditures (e.g., recreation services, rental of boats/RVs, etc.) offer only modest benefits to the local economy.

Although the Recreation Resource Study limited its visitation projections to a 30-year timeframe (SCL 2009a), it is anticipated that recreation use at the Project will continue to increase at a

similar rate throughout a 50-year license term (Cordell 2004). Because recreational use at the Project is anticipated to increase approximately 1 percent per year during the first 30 years of the new license, to about 19,500 RDs (SCL 2009a), it can reasonably be assumed that this annual level of increase will continue through a 50-year timeframe. Under this assumption, recreational use would account for approximately 22,500 RDs in 50 years.

Table E.4-48. Mean recreation-related expenditures in the Project region.

Type of Expenditure	Percentage of Visitors Reporting Expense	Mean Expenditure
Gasoline	73.3	$79.86
Groceries	69.6	$91.52
Eating and drinking establishments	45.5	$64.22
Hunting/fishing supplies	21.1	$42.34
Shopping/souvenirs	14.0	$77.27
Camping	12.3	$77.85
Lodging	10.8	$136.58
Other	5.8	$55.33
Recreation services, guided tours	3.2	$43.87
Rental of boats/RVs	2.4	$71.82

Source: Recreation Resource Study Final Report (SCL 2009a).

Again, assuming current use levels reflect approximately 2,500 visitors from outside of Pend Oreille County, a 50 percent increase over the next 50 years would result in about 1,250 more visitors (from outside of Pend Oreille County) to the Project annually. As with current expenditures, these new visitors likely would spend more on some goods and services than on others, thereby resulting in a range of potential economic benefits to the local economy. Note: both the 30- and 50-year visitation projections are based on the best available data and information at the time of relicensing. In the future, many factors would affect demand for and participation in outdoor recreation activities, including population, age, demographics, and income, as well as the general state of the economy, education, leisure time, past experience, and the supply of recreation facilities (Cordell et al. 1999).

Demand for recreation opportunities can be manipulated or induced (much like demand for goods and services) through advertising, special promotions, news stories/articles, and other forms of publicity. Such actions may increase recreational use levels beyond those anticipated in the Recreation Resource Study (SCL 2009a). At the Project, the existing North Pend Oreille Scenic Byway and International Selkirk Loop, as well as the planned Pend Oreille Water Trail and federal recognition of the Pacific Northwest Trail (as a National Scenic Trail), may increase the demand for recreation at the Project, especially if these opportunities are heavily promoted. Higher recreation use levels likely would lead to greater potential economic benefit of recreation expenditures in Pend Oreille County.

Direct visitor-related expenditures represent only a portion of the total economic activity influenced by recreation opportunities at the Project. Local businesses that serve the Project visitor population may purchase goods and services from other local businesses, thereby creating a multiplier effect. If large enough, this multiplier can result in new jobs. While the current economic benefit of Project-related recreation is relatively minor, the increase in future benefits would correlate with the increase in recreation demand and use levels and factors contributing to increased demand. In addition, both increases in recreation use, as well as new opportunities (e.g., Pend Oreille Water Trail, Pacific Northwest Trail, etc.) may create conditions that are conducive to new recreation-related services (e.g., guide services, shuttle services, etc.). These potential new services may result in secondary economic benefits related to recreation opportunities at the Project.

4.5.10.2.4. PM&E Measures for Facility Construction and Capital Improvements

In addition to the recreation-related PM&E measures described above, other environmental enhancement measures for facility construction and capital improvements have the potential to generate beneficial socioeconomic effects. In general, these measures would have less overall impact relative to recreation resources and are therefore described collectively below, rather than by resource area. These include the following:

- Upstream fish passage trap-and-haul facility
- Structural TDG abatement measures

Such socioeconomic effects are primary beneficial and could include output (the total value of industry production), wages, other income, direct local expenditures, and indirect business taxes. These capital improvements are not considered major construction projects and would therefore not represent a significant increase in labor or related wages. In addition, the scope, extent, and schedule for these projects have not yet been determined. Therefore, the descriptions and analysis below are primarily qualitative and conceptual.

Upstream Fish Passage

Construction and operation of upstream fish passage facilities have the potential to generate socioeconomic impacts in the Project area. As described in more detail in Section 4.5.3.3.5 (Upstream Fish Passage), SCL proposes to conduct a three-phase upstream fish passage program. Phase I would include the design and construction of a temporary trap-and-haul facility and development of protocols for deploying the trap and handling captured fish. Phase II will involve deploying, testing, and refining the temporary trap-and-haul facility. Phase III will involve operation of a permanent trap-and-haul facility at a fixed location or a long-term temporary trap-and-haul facility that could be deployed on a seasonal basis and operated at various locations. Construction of the initial Phase I trap-and-haul facility and the Phase III facility has the potential to generate socioeconomic benefits in the Project area, primarily in the form of labor and direct local expenditures.

As with the major CIPs described above, the specialized equipment to be installed would require custom steel fabrication that most likely would be completed outside of the immediate Project vicinity; however, a certain amount of goods and services would be procured locally, as would

potential equipment rental. The influx of SCL work crews into the Project region to accomplish the work represents a positive impact in the form of expenditures on local goods and services, and for short-term housing (if any of the phases require longer term construction). Capital costs associated with Phase I construction are estimated at $3.3 million. Capital costs associated with Phase III construction are estimated at $11.2 million. These impacts would be beneficial to the local communities.

In addition, the proposed trap-and-haul facility would require crews to handle operations over the longer term, including both full-time and seasonal workers (during peak salmonid run periods), some of whom would be hired locally. Workers are assumed to be the equivalent of 1.5-3 full-time employees over the life of the facility (each representing an approximate $34,000 annual compensation) with support being greatest during Phase I and least during Phase III. The estimated payroll for the full-time staff and seasonal workers would have a multiplier effect on the local economy through expenditures on housing, goods, and services.

All of these would be considered beneficial socioeconomic impacts, and no adverse impacts are anticipated.

Structural TDG Abatement Measures

Like the construction and operation of the proposed fish passage facilities, the implementation of the TDG abatement measures represents both construction and operations related components with the potential for socioeconomic impacts. As described in more detail in Section 4.5.2.3 (Total Dissolved Gas), SCL proposes to modify the operation or configuration of the existing facilities as follows:

- Throttle Sluice Gates, which involves operating the sluice gates in partially open positions
- Roughen Sluice Flow, which entails modifying the sluice gate outlets to break up and spread flow
- Spillway Flow Splitter/Aerator, which entails modifying the spillways to aerate, break up, and spread flow

These three options would entail capital expenditures, similar to those described above for upstream fish passage facilities, totaling approximately $36.4 million (see Exhibit D, Table D.4-1). Any major steel fabrication would likely occur outside the Project area, with the products being transported to the Project for installation. The local socioeconomic effects of the installation and operation of TDG abatement measures would be beneficial.

4.5.10.2.5. Other Proposed PM&E Measures for Resource Enhancement

Like the non-recreation PM&E measures for construction and capital facilities, the other PM&E measures for resource enhancement with potential socioeconomic effects are described below. These PM&E measures include the following:

- Purchase of flood easements
- Fish and aquatic habitat enhancement and maintenance measures

- Terrestrial habitat and weed management
- Erosion control measures

Purchase of Flood Easements

SCL proposes to acquire flood easements from private landowners in the towns of Metaline and Metaline Falls to compensate them for the incremental component of flooding that is Project-related and that occurs on rare occasions on their properties during high-flow events. Easement rights will be acquired to compensate landowners for the occasional flooding of these properties and would provide some economic benefit to certain community members.

Habitat Enhancement and Maintenance Measures

A group of measures would entail habitat enhancement or maintenance activities throughout the Project area over the term of the new license. These include aquatic habitat enhancement, overall terrestrial habitat and weed management activities, and erosion control. The enhancement and maintenance activities are summarized in Table E-4-49, with more detailed information presented, by resource, in sections 4.5.1 through 4.5.9 of this Exhibit E.

Each of these activities could involve hiring seasonal or temporary work crews from the local area, as well as local expenditures for materials needed to complete the activities. Work crews would be managed by existing SCL staff and would include labor typically applied to small or medium-scale landscaping services. Some of the materials needed to accomplish the work, such as gravel, fill dirt and topsoil, felled logs, fuel, hand tools, nursery stock, etc., would be procured locally, to the extent feasible. Equipment such as front-end loaders (e.g., Bobcats) would be used, some of which may be rented locally if Project equipment is not available

Because of their relatively small scale, none of these measures would generate a significant socioeconomic impact in terms of employment, wages, or local expenditures (direct or indirect) at the regional scale. In most cases, specific designs, activities, or schedules associated with these measures have yet to be determined, and will be developed with respective resource workgroups after license issuance. Over the course of the new license period, such measures would represent a beneficial but minor socioeconomic impact.

Table E.4-49. Summary of habitat enhancement and maintenance measures.

PM&E Measure	Description/Location of Activity	Estimated Capital Cost	Estimated FTE
Fish and aquatic habitat enhancement measures	• Mainstem gravel augmentation • Channel modifications for mainstem trapping pools • LWD placement and enhancement (e.g., at tributary deltas, Sullivan Creek) • Riparian plantings and improvements (e.g., Sullivan Creek, Linton Creek, Sweet Creek) • Stream channel enhancement and improvements (e.g., at Sullivan Creek, Sweet Creek) • Culvert replacement (e.g., Slate Creek, Slumber Creek, Styx Creek) • Native trout supplementation facility	$17 million	1) Hatchery manager at $47,000; 2) Technicians at $34,000
Terrestrial habitat and weed management	•To be identified during post-license refinements of the TRMP	TBD	TBD
Erosion control	•Three sites include: o Forebay Recreation Area o BLM Boundary Recreation Area o Dispersed Recreation Day Use/Overnight Campsite on BLM-Managed Land •Potential measures include o Minor site grading o Installing erosion control mats o Using biotechnical stabilization techniques o Constructing swales to control runoff	$242,000	NA

4.5.10.3. Cumulative Effects

There are no adverse socioeconomic impacts associated with the Proposed Action and, therefore, no potential for a contribution to adverse cumulative effects. In its SD2 (FERC 2006), FERC did not identify socioeconomics as an area of concern with regard to Project impacts.

4.5.10.4. Unavoidable Adverse Impacts

There are no unavoidable adverse socioeconomic impacts associated with the Proposed Action.

4.5.10.5. Consistency with Comprehensive Plans

There are no comprehensive plans pertaining directly to socioeconomic resources identified in FERC's List of Comprehensive Plans for the State of Washington (FERC 2009). SCL's Proposed Action, as discussed above, will generate socioeconomic benefits for Pend Oreille County by

providing jobs on location, supporting local vendors through purchasing contracts, and increasing retail sales by bringing contractors and attracting recreational users to the area. In addition, SCL maintains a low-cost power contract with the Pend Oreille County PUD, which contributes to the PUD's ability to provide some of the lowest cost power in the region. As such, the Proposed Action is consistent with local and County-wide planning documents in terms of incurring benefits on the local economy.

4.5.11. Tribal Resources

In November 2000, Executive Order 13175 articulated a process of consultation and coordination with Indian tribal governments to provide regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications. Consistent with the federal government's broader tribal consultation obligations, FERC has issued a "Policy Statement on Consultation with Indian Tribes in Commission Proceedings" (2003) to articulate its commitment to promote a government-to-government relationship between itself and federally recognized Indian tribes. The policy statement recognizes the sovereignty of tribal nations and FERC's trust responsibility to federally recognized Indian tribes. Because FERC cannot delegate tribal consultation, it has established a tribal liaison position to fulfill this commitment and to coordinate consultation with other jurisdictions as appropriate.

Several federally recognized Native American tribes were identified as having tribal lands and/or potential interests within the Project region that may be affected by the Project relicensing, based on location of traditional tribal territories:

- Kalispel Tribe of Indians
- Confederated Tribes of the Colville Reservation
- Kootenai Tribe of Idaho
- Spokane Tribe of Indians
- Coeur d'Alene Tribe
- Confederated Salish and Kootenai Tribe

Most of the federally recognized tribes with lands that may be affected by the Project relicensing do not have a signed treaty with the U.S. government identifying the rights of the tribe. Most of the reservations for potentially affected U.S. tribes in the Project region (including the Kalispel, Colville, Spokane, and Coeur d'Alene tribes) were created during the late 1800s to early 1900s by a series of executive orders of the President of the United States. The Confederated Salish and Kootenai negotiated the "Hellgate Treaty of 1855" with the U.S. government. The Kootenai Reservation, located outside of the Project area in northern Idaho, was established by statute in October 1974.

None of the identified tribes has reservations, trust lands, or TCPs directly within or adjacent to the Project boundary. The nearest reservation lands are those of the Kalispel Tribe, which are approximately 21 miles south-southeast of the Project boundary. However, the Project is within traditional territory of the Kalispel Tribe. According to the Bureau of Indian Affairs (BIA), no

Native American group has legal authority over lands within the Project boundary (Argel, G. BIA Northwest Regional Office, personal communication, August 31, 2005).

FERC's Determination Letter (FERC 2007b) did not direct the Licensee to undertake any studies related specifically to Tribal Resources. However, the Determination directed SCL to perform one study directly related to TCPs, the Cultural Resources Study. As noted in the Cultural Resources Section (Section 4.5.8), TCPs are a type of historic property that are eligible for inclusion in the NRHP because of their association with cultural practices or beliefs of a living community that are rooted in that community's history or are important in maintaining the continuing cultural identity of the community (NPS 1990).

As described in Section 4.5.8 and the Cultural Resources Study Final Report (SCL 2009a), no TCPs were identified in the Project area. However, interested tribes, in particular the Kalispel Tribe, have engaged directly in resource area workgroups of significance to them, including fish and aquatics, water quality, terrestrial, recreation, and cultural resources. Project effects on resources of interest to tribes are discussed in the respective resource sections of this Exhibit E.

4.6. Developmental Analysis

The following subsections provide SCL's analysis of the effect of costs associated with proposed PM&E measures on power generation and economic benefits of the Project. SCL's analysis includes an estimate of the costs of PM&E measures, by resource area, and a comparison of costs under SCL's Proposed Action with those associated with the No Action alternative. The Project's net economic benefit under a given alternative is the difference between the cost of producing power and the value of that power. Consistent with FERC's approach to economic analysis, the power benefit of the Project is estimated based on the cost of obtaining an equivalent amount of energy and capacity using the most likely alternative generating resources in the region. The analysis is based on current (i.e., 2007) electric power cost conditions and does not consider future escalation of fuel prices in estimating the value of the Project's benefits.

4.6.1. Power and Economic Benefits of the Project

As SCL's within-hour, load-following resource the Project is of significant value to SCL's ratepayers. In addition to the power used to serve load, the net excess generation is sold on the secondary market, and the net wholesale revenue is used to maintain stable, affordable rates for SCL's ratepayers.

For the No Action alternative, total energy output from the Project is approximately 4,110,505 MWh (see Exhibit B, Section 3 of this License Application). Purchasing an equivalent quantity of energy from the Mid-Columbia trading hub would have cost SCL approximately $212.7 million, given relative on-peak and off-peak output and prices in 2007, resulting in an average price, weighted by the on-peak and off-peak production, of $51.75/MWh (see Exhibit D, Section 6 of this License Application). The annual costs (i.e., production costs and an allocated share of debt service) for the Project totaled $26.3 million in 2007, resulting in an average cost of $6.40/MWh. An estimate of the net 2007 value of the Project is approximately $186.4 million, which is the difference between the gross value of the energy ($212.7 million) and the annual costs ($26.3 million). However, the 2007 market price does not capture all the benefits or

monetize all the values of the Project. These values include ancillary services, load following, price-following, and resource reliability to SCL (see Exhibit D, Section 6 of this License Application).

A summary of parameters and assumptions used for the economic analysis of the Project are provided in Table E.4-50. Greater detail regarding the values included in the table can be found in exhibits B and D of this License Application.

Table E.4-50. Summary of parameters and assumptions used for the economic analysis of the Boundary Project.

Parameter	**Value**
Costs	
Period of analysis (years)	50 years
Weighted cost of capital (nominal)	5.44 percent [1]
Weighted cost of capital (real)	3.2 percent
Inflation and escalation	2.1 percent
Property taxes	NA [2]
Federal tax rate	Exempt [2]
Combined state and local sales tax rate (2007)	7.6 percent [2]
Taxes paid to the City of Seattle	Undefined (see Exhibit D, Section 5.2)
State taxes based on retail revenue	Undefined (see Exhibit D, Section 5.2)
Total annual costs (2007)	$26.3 million [3]
-Production expenses (2007)	$13.8 million [3]
-Allocated debt service (2007)	$12.5 million [3]
Cost to develop License Application	$34 million [4]
Power value	
Average annual generation (2002 average year [modeled])	4,110,505 MWh [5]
Approximate alternative power value	$212.7 million [3]

Notes:
1 From Exhibit D, Section 5.1, Table D.5-2
2 From Exhibit D, Section 5.2
3 From Exhibit D, Section 6
4 From Exhibit D, Section 8
5 From Exhibit B, Section 3

4.6.2. Costs of Environmental Measures

SCL's Proposed Action includes a variety of PM&E measures that would increase operating costs. Annualized costs of SCL's Proposed PM&E measures, by resource area, are presented in Table E.4-51. A breakdown of costs for each resource area can be found in Exhibit D, Attachment D-1.

Table E.4-51. Summary of estimated costs associated with SCL's PM&E proposal (All costs in 2007 dollars).[16],[17].

Component	Estimated Capital	Estimated Annual O&M	Annualized Cost [1]
Project Operational Measures	NA	$0 [2]	$0
Geology and Soils	$380,037	$26,817	$43,993
Water Resources	$31,227,000	$1,463,383	$3,315,235
Fish and Aquatic Resources	$27,678,323	$1,550,496	$2,739,684
Botanical Resources	NA	$82,807	$82,807
Wildlife Resources	NA	$102,425	$102,425
Threatened and Endangered Resources (Addressed by Wildlife and Fish and Aquatics Resources measures)	NA	NA	NA
Aesthetics/Visual Resources (Addressed by Recreation Resources measures)	NA	NA	NA
Cultural Resources	NA	$19,211	$19,211
Recreation Resources and Land Use	$5,734,664	$236,736	$498,578
Socioeconomics (Addressed by measures of other resource areas)	NA	NA	NA
Tribal Resources (Addressed by measures of other resource areas)	NA	NA	NA
Operational PM&Es Subtotal:	**NA**	**$0**	**$0**
Non-operational PM&Es Subtotal:	**$65,020,024**	**$3,481,875**	**$6,801,933**
Total:	**$65,020,024**	**$3,481,875**	**$6,801,933**

Notes:
1 Annualized values based on a 50-year license term.
2 There is no anticipated loss of total generation for the proposed operational PM&Es.

4.6.3. Comparison of Alternatives

Annualized costs, benefits, and net benefits of the Proposed Action and No Action alternatives are presented in Table E.4-52. The net annual benefit under the No Action Alternative is $186.4 million ($45.35/MWh). Under the Proposed Action, annual net benefit would be $174 million ($41.92/MWh), a decrease of $ 12.4 million ($3.43/MWh) relative to the No Action Alternative.

[16] A breakdown of costs for each resource area can be found in Exhibit D, Attachment D-1, of this License Application.
[17] All costs of PM&E measures in this table are reported in 2007 dollars; costs reported in the attached Recreation Resources Management Plan (RRMP) are reported in 2009 dollars.

Table E.4-52. Summary of cost, power benefits, and net benefits of the Boundary Project alternatives (All costs in 2007 dollars).

Parameter	No Action	Proposed Action
Approximate power plant capability	1,040 MW [1]	1,070 MW [3]
Annual generation	4,110,505 MWh [1]	4,150,343 MWh [4]
Annual power values	$212.7 million [2]	$214.8 million [5]
Annual cost	$26.3 million [2]	$40.8 million [6]
Net annual benefit	$186.4 million [2]	$174.0 million

Notes:

1 From Exhibit B, Section 3

2 From Exhibit D, Section 6

3 The increased power plant capability of 30 MW is due to proposed turbine upgrades (from Exhibit B, Section 5.2)

4 The increased Project generation of 39,838 MWh is due to proposed turbine upgrades (from Exhibit B, Section 5.2)

5 Based on a power price of $51.75/MWh (from Exhibit D, Section 6, footnote 2)

6 The annual cost for the Proposed Action includes ongoing operation of the Project ($21.0 million), the cost of all capital for hydroelectric infrastructure ($13.0 million; see Exhibit D, Table D.4-1) and the cost of PM&Es ($6.8 million; see Table E.4-51). All costs annualized over 50-year license term.

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